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Australian Centre for
International Agricultural Research

An evaluation of the ACIAR Transformative Agriculture and Enterprise Development Program



2

ACIAR OUTCOME
EVALUATION SERIES

An evaluation of the ACIAR Transformative Agriculture and Enterprise Development Program

Clare Hanley and Luke Passfield
Alinea International



2022

The Australian Centre for International Agricultural Research (ACIAR) was established in June 1982 by an Act of the Australian Parliament. ACIAR operates as part of Australia's international development assistance program, with a mission to achieve more productive and sustainable agricultural systems, for the benefit of developing countries and Australia. It commissions collaborative research between Australian and developing-country researchers in areas where Australia has special research competence. It also administers Australia's contribution to the International Agricultural Research Centres.

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Foreword

This report is the second in a new series of reports that are based on outcome evaluations of research programs supported by the Australian Centre for International Agricultural Research (ACIAR). ACIAR initiates, brokers, funds and manages international research partnerships between scientists from Australia and partner countries in the Indo-Pacific region to improve the productivity and sustainability of agriculture, fisheries and forestry for smallholder farmers.

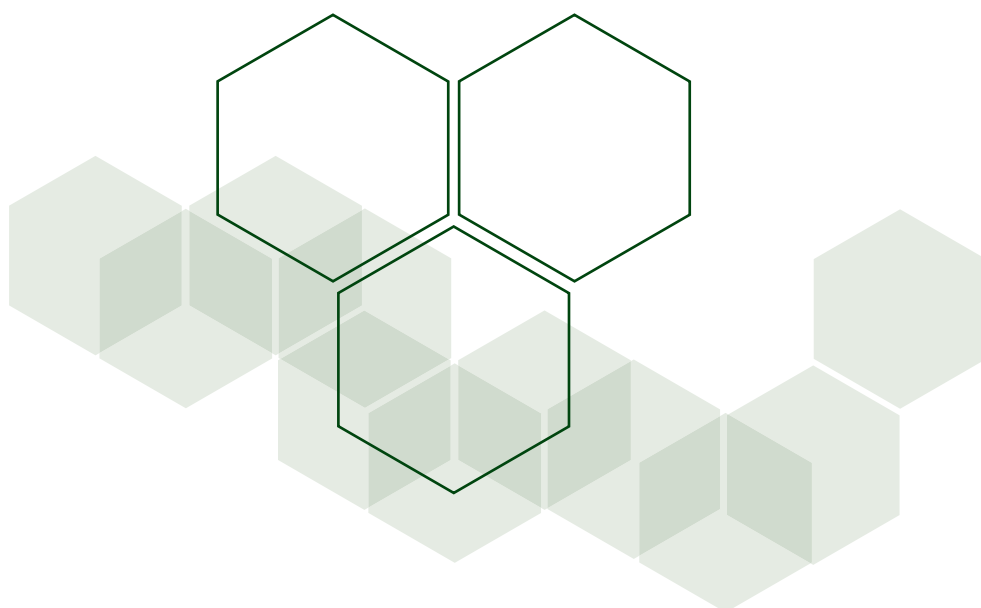
As a learning organisation, ACIAR is committed to understanding the diverse outcomes delivered by the research collaborations we develop, to demonstrate the value of investment of public funds, to inform research design and to boost the capacity of our research to improve the lives of farming communities in partner countries. An important mechanism for achieving our aims is to work closely with the wider Australian aid program to transition promising research into better agricultural practices and more profitable enterprises at scale.

This report presents a suite of evaluations of the Transformative Agriculture and Enterprise Development Program (TADEP), co-funded by the Department of Foreign Affairs and Trade (DFAT) and ACIAR from 2015 to 2021. The program was an opportunity for the 2 agencies to promote agricultural development in Papua New Guinea by leveraging a foundation of strong scientific research. It focused on opportunities to scale up successful innovations from previous ACIAR projects focused on cocoa, galip nut and sweetpotato, as well as a project developing extension methodology through the family farm teams approach. The program was also an opportunity to engage the private sector, expanding reach of the projects over larger areas and to more people. The DFAT and ACIAR investment sought to deliver efficiencies and co-benefits by linking a group of 5 projects into a programmatic structure.

The evaluations ultimately seek to understand the value that this programmatic structure delivered and identify lessons for future research-for-development investments. To inform these insights, a series of project-level outcome evaluations were conducted to see how the funded projects contributed to short-term development outcomes. Outcome evaluations adopt a largely qualitative, theory-based approach and seek to empirically test project logic and underpinning assumptions. These outcome evaluations are also intended to generate data for cross-case analysis that, over time, will help us to improve our research-for-development practice.



Andrew Campbell
Chief Executive Officer, ACIAR



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Collecting fallen galip tree fruit to process into galip nuts.
Photo: Conor Ashleigh, ACIAR



Part 4: Galip nut project

An evaluation of the ACIAR Transformative
Agriculture and Enterprise Development
Program Galip nut project

Abbreviations and acronyms

ACIAR	Australian Centre for International Agricultural Research
ASLP	Agriculture Sector Linkages Program
DFAT	Department of Foreign Affairs and Trade (Australia)
DMS	Devine Management Systems
ENB	East New Britain
FFT	Family Farm Teams
KEQ	KEQ Key Evaluation Question
MEL	Monitoring, evaluation and learning
NARI	National Agricultural Research Institute (PNG)
PGK	Papua New Guinea kina
PhD	Doctor of Philosophy
PNG	Papua New Guinea
PPP	Public-private partnership
SEE4D	Strategy, Evaluation, Engagement for Development Pty Ltd
SME	Small medium enterprise
TADEP	Transformative Agriculture and Enterprise Development Program

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Summary

From 2015 to 2021, the Australian Centre for International Agricultural Research (ACIAR) oversaw the Transformative Agriculture and Enterprise Development Program (TADEP), which was a multidisciplinary research program that aimed to improve the livelihoods of rural men and women in Papua New Guinea (PNG). The program involved 5 research-for-development projects: PNG cocoa, Bougainville cocoa, galip nut, sweetpotato and Family Farm Teams.

This evaluation focuses on the 'Enhancing private sector-led development of the *Canarium* nut industry in Papua New Guinea' (FST/2014/099), known as the galip nut project. This project aimed to **accelerate private sector-led development of the emerging galip nut industry in PNG**. It was led by the University of the Sunshine Coast, working in partnership with the University of Adelaide and the National Agricultural Research Institute (NARI). It commenced in June 2015 and concluded in December 2019, following a 12-month extension. The budget for the project was A\$3,500,000.

The galip nut project built on a decade of ACIAR research on galip nut processing techniques and previous European Union funding to establish a pilot galip nut processing factory at NARI in Keravat, East New Britain (ENB). It employed a whole-of-value-chain approach, researching markets, providing technical advice, building capacity, mentoring businesses, and giving private and public sector stakeholders access to infrastructure. It aimed to attract the private sector into this new agribusiness at 3 different scales: smallholder and small-scale entrepreneurs, small medium enterprise (SME), and large-scale processors.

The galip nut project had 4 objectives:

1. To assess the needs of the private sector to participate in the *Canarium* industry.
2. To develop and undertake research-based interventions that address the needs of the private sector, including smallholders, small-scale entrepreneurs (especially women), SMEs, and large-scale processors.
3. To develop an appropriate commercial model for a medium-scale value-adding factory for the *Canarium* industry.
4. To create a model for public-private partnerships in the *Canarium* industry in PNG.

This project evaluation is Part 4 of a suite of evaluations of TADEP, which assess the effectiveness of each of the 5 individual projects (Parts 2–6) and the lessons learned from the overall TADEP programmatic approach (Part 1).

A similar evaluation was conducted on the Agriculture Sector Linkages Program (ASLP) and is reported in ACIAR Outcome Evaluation No. 1.

A separate synthesis report, ACIAR Outcome Evaluation No. 3, will summarise lessons from the 2 ACIAR programs, ASLP and TADEP.



A galip nut tree in the PNG forest. Photo: Conor Ashleigh



Key findings

1

What was the project's theory of change and how did this evolve during implementation?

The central theory of change was stimulating medium-scale to large-scale private sector development of the galip nut industry, which was highly appropriate to the context. Testing and demonstrating what was possible in a real commercial environment, and refining processes to improve efficiencies along the way, was a logical approach to overcoming scepticism from the private sector and proved an effective strategy. The project implemented a number of activities under objectives 2 and 4 which were not as central to the theory of change, and it is questionable whether these were needed to help the project achieve its overall goal. In particular, some of the training activities conducted with smallholder farmers and efforts to establish a public-private partnership with the NARI demonstration factory appeared less central.

In contrast to some other ACIAR projects, limited attention was given to the role of government departments (beyond NARI) and extension workers in supporting growth of the new industry. This was understandable for this initial project, given that the industry was newly emerging, but could usefully be taken up in future projects. This should include thinking strategically about how processing and value-adding approaches with smallholder farmers could be institutionalised into existing government and non-government agricultural extension systems.

2

What outcomes (intended and unintended) has the project achieved or contributed to?

Outputs

The project completed various studies to assess:

- the needs of the private sector at different levels to enable their participation in the galip nut industry
- the nutritional composition of galip nuts
- how to prolong the shelf life of galip nuts.

Using the knowledge gained through these studies, **the project developed, trialled and refined several value-added galip nut products at the NARI factory and developed a commercial model for production. These products proved so popular the factory could not keep up with demand in 2018 and 2019.** In addition, the project investigated how to improve key stages of galip nut processing to improve efficiency and maximise quality within a medium- to large-scale factory setting. Technological innovations introduced by the project allowed the NARI factory to increase its capacity and contributed to the factory more than doubling its production of processed galip nut products each year, to a total of over 2.4 tonnes in the final year of the project. The project also worked **extensively with women smallholders and small-scale entrepreneurs in ENB and surrounding areas, providing training and mentoring on a diverse range of topics.**

Key findings (cont.)

Adoption

The action-research methodology used by the project meant that staff at NARI were closely involved in implementing and testing the commercial model as it was developed. This meant that **adoption of the commercial model by the NARI demonstration factory was strong**. However, having NARI enter the market as a commercial player was considered by some stakeholders as an unorthodox approach, stretching the boundaries of what was commonly understood as research. While it appears the existence and success of this model did influence other private sector investors to enter the industry, there is limited evidence on exactly what aspects of this model were adopted by other private sector processors.

Individual examples are available of women's groups or smallholders making and selling galip nut products immediately following training; however, **there is limited evidence of widespread adoption of the new galip nut processing or value-adding practices amongst smallholder farmers and small-scale entrepreneurs**. Smallholder farmers did adopt new practices in relation to the type of galip fruit sold to the NARI factory, with the quality of fruit sold improving substantially throughout implementation.

Outcomes

Substantially more is now known about galip nut processing in PNG, and the impact different processing techniques have on nutritional qualities and product shelf life. This knowledge has been used to develop and test new value-added products which proved to be desirable within the market.

By the conclusion of the project, 4 private sector processors were processing and selling galip nut products commercially. Given the lack of interest from SMEs and large-scale processors at the beginning of the project, this is a significant achievement. Over the life of the project, the NARI factory directly purchased over PGK400,000 of unprocessed galip nut from smallholder farmers and entrepreneurs in ENB and surrounding areas, supporting the livelihoods of more than 1,300 farmers by the end of 2018. The other processors are now also buying galip nut from smallholders, with an estimated farm gate value of PGK300,000–400,000 per annum. While no impact studies have been completed, individual case studies suggest this additional income is assisting women smallholders to cover living expenses and pay for costs associated with schooling and health care.



3

How did project activities and outputs contribute to the outcomes achieved?

Demonstrating commercially viable products in the market, particularly in Port Moresby, appears to have had a strong positive influence on prompting private sector investment in the galip nut industry.

Getting products on the shelf – at the right price point and in a form that was attractive to consumers – was the culmination of a significant body of research and commercial engagement by the project over the previous 3 years. The multidisciplinary nature of the project team was a critical success factor in ensuring all these different components came together to achieve this result.

The project faced a number of challenges which also influenced the results. **Operating the demonstration factory within a public research institute which was not designed for commercial operations was a major challenge.** Shortfalls in resourcing at the factory and inefficient work processes contributed to substantial delays and resulted in most of the results of the project being achieved within the final year of implementation. A public-private partnership at the NARI factory with the processor Equanut helped to address some of these issues; however it appears there were also challenges with this arrangement. The factory also struggled to determine the most appropriate scale of production, considering the supply of galip fruit available, demand for products and capacity of the factory. This may have impacted on analysis of the commercial model. Finally, uncertainty over continuity of funding towards the end of the project may have impacted on the willingness of investors to enter the industry.

4

What strategies were adopted to address gender equity and social inclusion and how effective were these?

The primary strategy used to promote gender equity was to target women smallholder farmers and entrepreneurs to increase their income from selling galip fruit to processors and undertaking small-scale value-adding of their own. This resulted in a **steady increase in women farmers selling galip fruit to the NARI factory.** It is unclear what impact this had on gender equity and the extent to which women had control of this income. About halfway through implementation, the NARI factory changed its approach to purchasing most galip fruit from the factory gate rather than travelling into the community and purchasing it at the farm gate. While this proved more cost-effective, it resulted in an increase in men selling galip fruit compared to women. Further research is needed to determine the gender impacts of this shift in approach.

Consideration was also given to promoting opportunities for women researchers within the project team to have their work profiled and take on leadership roles, and actions were taken to enable women to manage family responsibilities alongside work commitments. This should be commended and encouraged in other projects. Overall, a gender and social inclusion analysis undertaken early during project implementation, and a targeted gender strategy, may have helped contribute to more strategic gender outcomes.

Key findings (cont.)

5

How did management arrangements impact delivery of the project?

The multidisciplinary nature of the project team was a key strength and was critical in supporting achievement of a range of project outcomes. While this could have created division within the project, it appears to have been managed well. Having members of the project team based in-country was also widely regarded as a critical success factor. The project adopted an action-research methodology which involved an annual review and planning process. This process could have been strengthened by giving further attention to the broader theory of change underpinning project activities, and ensuring sufficient monitoring of initial outcomes was undertaken and considered during annual planning.

6

How well did the project align with and contribute to the overall goals of its umbrella program?

The project aligned well with TADEP objectives and contributed to all 4 objectives to at least some extent. There were mixed impressions of whether the 5 projects under TADEP had enough commonality to be part of a coherent program – some stakeholders thought they did, while others suggested that the fact they were different commodities and operating in different locations within PNG made collaboration difficult. Having said that, the galip nut project did collaborate with at least 2 other TADEP projects, primarily the Family Farm Teams project, and PNG cocoa to a lesser extent. This involved raising awareness of the potential of the galip nut industry and providing practical training for family farm teams, and investigating *Canarium*-cocoa systems.

Overall, the annual learning events and regular TADEP newsletters were appreciated by stakeholders and seen as providing opportunities for mutual sharing and learning across projects. Some PNG stakeholders noted these could be quite Australian-centric, and more could be done to increase involvement of PNG research partners as equal participants in these events.



Conclusion and lessons learned

‘Enhancing private sector-led development of the *Canarium* nut industry in Papua New Guinea’ has achieved substantial results in relation to raising the profile of a new industry in PNG, and attracting private sector investment in that industry. While very limited galip nut was processed and sold commercially in PNG when the project commenced in June 2015, by December 2019, 4 private sector processors had entered the market. This has contributed to increased income for smallholder farmers, and created jobs for workers in the processing facilities. Substantially more is now known about the science and technology required to process galip nut within a medium- to large-scale factory setting, and the economic viability of the commercial model. The key strategy used to achieve this outcome was developing and testing products using the NARI demonstration factory to demonstrate what was possible to potential investors. This was considered by some to be an unorthodox approach to research, yet proved effective.

Further research and development interventions are needed to build on the successes of this project to consolidate the gains made, and address gaps in the current knowledge. Many of these have already been taken forward in the Phase 2 project (FST/2017/038), which commenced in December 2019 and will continue until December 2022. Specific recommendations for future research have been documented elsewhere and will not be summarised in this report (Wallace et al. 2020; Markham and Yakuma 2019).



Lessons learned

General lessons for ACIAR in relation to implementation of research-for-development projects and the programmatic approach include:

1. The action-research approach is an effective methodology for allowing projects to adapt to changing contexts and iteratively use research findings to inform project interventions. It could be enhanced by encouraging stronger line of sight to the project's theory of change, and by enabling more flexible reporting formats. In addition, consideration should be given as to whether more substantial changes to project objectives are permissible and how these would impact contracting arrangements.
2. Developing and testing new products within a commercial setting was an effective way of stimulating private sector interest and investment within a new industry. This approach appeared to be fairly unique within ACIAR-funded projects. There would be value in sharing the strengths and challenges of this approach more broadly with ACIAR research networks to encourage adoption of this approach in other contexts.
3. Capacity-building activities need to be accompanied by stronger attention given to monitoring their effectiveness and outcomes throughout implementation. Consideration should also be given to the sustainability of capacity-development activities, and whether there are opportunities to build the capacity of existing extension workers (either government or non-government) to ensure knowledge generated through the project is shared widely.
4. A multidisciplinary team was a key strength of this project – this should be encouraged, but needs to be accompanied with strong project leadership (as in this project) to ensure the project team remains cohesive.
5. Gender analysis, social inclusion analysis and development of a targeted gender equality and social inclusion strategy would assist projects in developing a more strategic approach to influencing gender equity and women's empowerment, and ensuring people with disability and other marginalised groups can also benefit from the project. This needs to be monitored during implementation.
6. Wherever possible, in-country members of research teams should be supported to receive formal research qualifications (such as a Masters degree or PhD) through project implementation, alongside gaining practical skills.
7. Programmatic approaches such as TADEP are valuable to enable broader sharing and learning across projects. Collaborative research grants were particularly effective in allowing meaningful collaboration, and appeared to produce good outcomes for limited cost. Consideration should be given to ensuring in-country research partners are seen as equal contributors to these programs. This could be achieved by ensuring good representation on steering committees or in other governance structures. In addition, the programmatic approach could support a more strategic approach to building capacity of key in-country stakeholders (particularly when these stakeholders are involved in multiple projects).



Introduction

Purpose, scope and audience

Since 1982, the Australian Centre for International Agricultural Research (ACIAR) has brokered and funded research partnerships between Australian scientists and their counterparts in developing countries. As Australia’s specialist international agricultural research-for-development agency, ACIAR articulates its current mission as ‘achieving more productive and sustainable agricultural systems, for the benefit of developing countries and Australia, through international agricultural research partnerships’. ACIAR receives a direct funding appropriation from the official development assistance budget, as well as contributions for specific initiatives from external sources including the Department of Foreign Affairs and Trade (DFAT).

From 2015 to 2021, ACIAR managed the Transformative Agriculture and Enterprise Development Program (TADEP) in Papua New Guinea (PNG). The program focused on opportunities to scale up successful innovations from previous ACIAR projects in PNG, with impetus provided by private sector involvement, over larger areas and for more people. It was expected to achieve economic benefits, especially increased employment and incomes in rural areas, and enhanced rural-urban supply chains. It worked in the sectors of greatest benefit to rural communities and had a particular focus on the empowerment of women and commodities that could be brought to market.

ACIAR commissioned project-level evaluations of the TADEP projects shown in Table 12 to identify lessons that will inform the design and implementation of future ACIAR projects and improve the quality of outcomes. These evaluations form Parts 2–6 of Outcome Evaluation 2.

Drawing on these project evaluations, the program-level evaluation (Outcome Evaluation 2, Part 1) includes an analysis of the program structure and the value-add from these management arrangements.

A similar evaluation has been undertaken for the ACIAR Agriculture Sector Linkages Program (ASLP) in Pakistan (Outcome Evaluation 1), and the ASLP and TADEP evaluations will be synthesised into a final report to outline common lessons from ACIAR programs (Outcome Evaluation 3).

This evaluation focuses on the commodity-specific galip nut project.

Purpose

The project-level evaluation has 2 key purposes:

1. Compile performance information from each project under a program and investigate the contribution to specific project outcomes, with a particular focus on differential effects for women and men.
2. Generate project-level case studies for use in a qualitative cross-case analysis.

Table 12 Projects in TADEP

Program / Project	Project full name
PNG cocoa	Enterprise-driven transformation of family cocoa production in East Sepik, Madang, New Ireland and Chimbu provinces of Papua New Guinea
Bougainville cocoa	Developing the cocoa value chain in Bougainville
Sweetpotato	Supporting commercial sweetpotato production and marketing in the Papua New Guinea highlands
Galip Nut	Enhancing private sector-led development of the <i>Canarium</i> industry in Papua New Guinea
Family Farm Teams	Improving opportunities for economic development for women smallholders in rural Papua New Guinea

Scope

This project-level evaluation assesses 'Enhancing private sector-led development of the *Canarium* industry in Papua New Guinea' (FST/2014/099), known as the galip nut project. It provides an assessment against the following key evaluation questions:

1. What was the project's theory of change and how did this evolve during implementation?
 - Was the theory of change appropriate to the project context and desired results?
2. What outcomes (intended and unintended) has the project achieved or contributed to?
 - What was the unique knowledge contribution of the project/cluster that was/is expected to influence practice/policy?
 - To what extent is there evidence of adoption of new practices based on research process and findings?
3. How did project activities and outputs contribute to the outcomes achieved?
 - To what extent and how did they differ from what was planned?
4. What strategies were adopted to address gender equity and social inclusion and how effective were these?
 - How did the project impact men and women differently?
5. How did management arrangements impact delivery of the project?
 - What other factors influenced project performance?
6. How well did the project align with and contribute to the overall goals of its umbrella program?
 - To what extent has the programmatic approach added value at project level?

Audiences

The primary audience for this programmatic evaluation is ACIAR staff with direct responsibilities for programs and/or their constituent projects. This includes Canberra-based research program managers and country network managers and coordinators.



Methodology

Data collection and analysis

Evaluation data was primarily drawn from existing project reports and reviews, supplemented by 9 semi-structured interviews with key stakeholders. Stakeholders were intentionally selected in consultation with Australian Centre for International Agricultural Research (ACIAR) and the project leader (see Appendix 4.1). Interviews were conducted online using Zoom, and via telephone. Thematic analysis of data collected through these processes was undertaken using NVivo qualitative data analysis software to distil findings.

ACIAR working definitions and assessment frameworks for project outputs, outcomes and 'next users' were used to analyse, categorise and summarise findings (see Table 13). In addition, economic and gender equality outcomes were assessed in line with the project design. Preliminary findings were shared and tested in a project verification workshop involving key project stakeholders and ACIAR. These workshops provided the opportunity to 'ground-truth' the assessments, identify any key issues not addressed, clarify any areas of uncertainty and correct any misinterpretations. A draft evaluation report was then prepared for review by ACIAR and finalised in accordance with feedback received.

Limitations

The evaluation relied heavily on data produced through routine project reporting, with only a limited number of interviews completed. Interviewees for the project were intentionally selected by ACIAR and the project leader (so they were not a representative sample). Given the selection process, it is also likely that respondent experiences fall at the positive end of the spectrum, meaning data from interviews is likely positively biased.

Conducting interviews via Zoom or phone provided limited opportunity to build rapport with interviewees, and in some cases, poor phone/internet connections disrupted interviews and may have limited understanding.

Undertaking community-level consultations or impact assessment was beyond the scope of this evaluation. Given no systematic impact assessments or independent evaluations have been undertaken of the project, there is limited evidence of the impact project activities have had on communities. These gaps in evidence have been highlighted throughout the report.

Table 13 ACIAR project outcome assessment terminology

Outputs	Next users	Outcomes
Scientific knowledge: New knowledge or current knowledge tested in other conditions, locations, etc.	<ul style="list-style-type: none"> Individual scientists/researchers/ agricultural professionals Individuals responsible for the management of research or a government institution Producers that the project engages directly or influences outside its immediate zone of operation (for instance, at scale), including crop and livestock producers as well as fisherfolk Public and private extension service providers Public policy actors Public and private value chain operators Consumers 	Scientific achievement: Researchers use scientific knowledge outputs to make new discoveries or do their work differently
Technologies: New or adapted technologies and products that offer added value to intended end users		Capacity built: Project partners or stakeholders use enhanced capacity to do something differently
Practices: New practices and processes		Innovation enabled: Includes the adoption of improved technologies, systems or processes, access to new markets, or changes in the opinions or practices of policymakers and advocates
Policy: Evidence for policy formulation		
Capacity building: Short courses, academic training, coaching and mentoring		

Ethical considerations

The evaluation was conducted in accordance with the *DFAT Monitoring and Evaluation Standards (2017)*. This included considering:

- **Informed consent:** All participants in consultations were provided with a verbal overview of why they are being consulted, how the information will be used and that their participation is voluntary prior to the consultation. Consultations were only undertaken once verbal consent was obtained.
- **Privacy and confidentiality:** The identity of any program beneficiaries involved in the evaluation is protected. Key informants in professional roles may be referred to by their position title in the report where explicit consent has been obtained; otherwise they are referred to as a representative of the organisation they work with.



Inside a galip nut seedling nursery.
Photo: Conor Ashleigh, ACIAR



Overview of project

Project number	FST/2014/099
Project title	Enhancing private sector-led development of the <i>Canarium</i> industry in Papua New Guinea
Collaborating institutions	University of the Sunshine Coast Griffith University The University of Adelaide PNG National Agricultural Research Institute (NARI)
Project leaders	Professor Helen Wallace, Griffith University (formerly University of the Sunshine Coast) Dr Birte Komolong, NARI Tio Nevenimo, NARI Craig Johns, The University of Adelaide Theo Simos, The University of Adelaide
Project duration	June 2015 to December 2019 (following 12-month extension)
Funding	AUD3.5 million
Countries involved	Australia and Papua New Guinea
Commodities involved	<i>Canarium</i> (galip nut)
Related projects	FST/2010/013

Context

Nuts have huge potential to improve the livelihood of the rural poor in developing countries. They have excellent nutritional value and can be stored for long periods and therefore can improve food security. *Canarium indicum* (galip nut) is an agroforestry tree in eastern Indonesia and the Pacific that produces edible nuts and timber. The tree has been domesticated in traditional agricultural systems in Papua New Guinea (PNG) for over 6,000 years. It is grown mostly in smallholder blocks, or harvested from the wild.

Galip nut has been the focus of efforts by donor agencies to commercialise the industry in PNG and the Pacific. In PNG, approximately 250,000 elite trees have been produced using various donor funds, and distributed to smallholders and cocoa plantations over the past 4 years. Most of these have been planted in East New Britain (ENB) with a small number going to West New Britain. At the commencement of the project there was no commercial market or processing factory for these nuts.

Women conduct the majority of galip nut growing and trading activities, including nut cultivation, harvesting, processing and selling. However, prior to the project women simply sold the raw nuts in village and roadside markets as there were no reliable commercial markets for value-added products. Earlier work undertaken by ACIAR developed appropriate technologies for value-adding, but a pilot nut processing facility at NARI in ENB (established with European Union funding) was only utilised on an ad hoc basis.

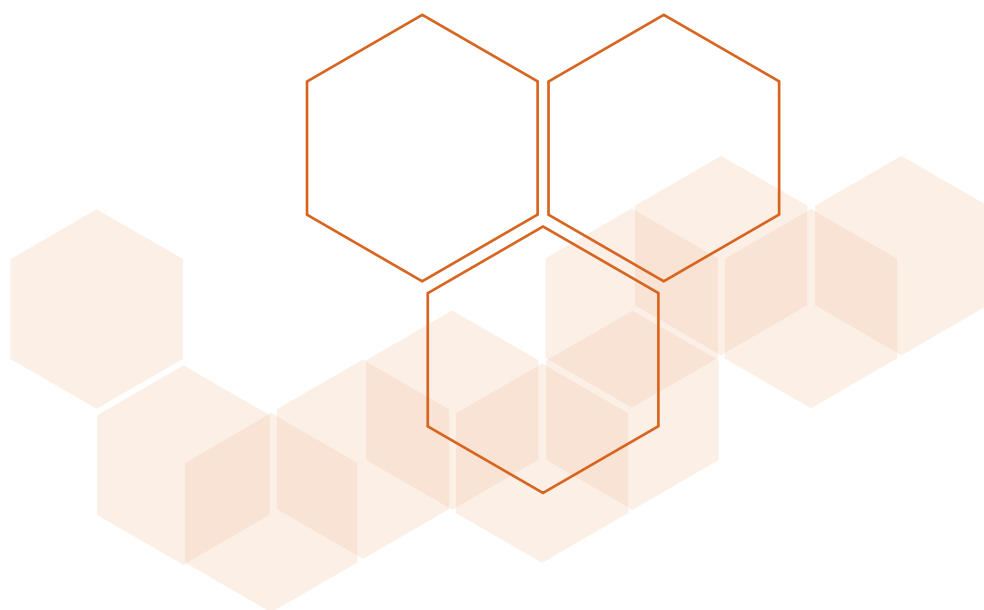
The galip nut industry has great potential for expansion and a strong industry will improve livelihoods for rural smallholders in PNG. However, the galip nut industry urgently needs more private sector investment to grow the industry, utilise the nut resources coming on stream and improve access to distant markets. The galip nut project was designed to address these needs.

The project

This project (FST/2014/099) sought to expand markets and processing of galip nuts in ENB by strengthening private sector capacity and engagement using nuts from existing trees. The aim of the project was to **accelerate private sector-led development of the emerging *Canarium* (galip) nut industry in PNG and facilitate the development of a public-private partnership based around the NARI pilot processing plant in ENB.**

The objectives of the project were:

1. To assess the needs of the private sector to participate in the *Canarium* industry.
2. To develop and undertake research-based interventions that address the needs of the private sector including smallholders, small-scale entrepreneurs (especially women) SMEs, and large-scale processors.
3. To develop an appropriate commercial model for a medium-scale value-adding factory for the *Canarium* industry.
4. To create a model for public-private partnerships in the *Canarium* industry in PNG.





Findings

1. What was the project's theory of change and how did this evolve during implementation?

In 2016, consultancy firm Strategy, Evaluation, Engagement for Development (SEE4D) was engaged by the Australian Centre for International Agricultural Research (ACIAR) to assist the project team to develop an impact pathway (theory of change) for the galip nut project, and prepare a monitoring, evaluation and learning (MEL) framework (Roberts 2016). The resulting impact pathway and MEL framework were very detailed and possibly too complex for the project team to engage with. It appears that this pathway and the MEL framework were not widely used by the team, except as a reference point for the team leader during reporting.

For the purposes of this evaluation, the evaluation team has further refined the impact pathway developed in 2016, taking into account the project objectives, activities and verbal descriptions of the strategy adopted by the project team to reach the project's goals. Through this process, it became apparent that while an impact pathway or theory of change was not explicitly part of the project's lexicon, the project team did have an underlying strategy which could be articulated, linking various activities with higher-level outcomes or objectives. The theory of change describes that strategy below.

Description of the theory of change

The aim of the project was to accelerate private sector-led development of the emerging galip nut industry in Papua New Guinea (PNG). The central strategy to achieve this was to use the demonstration factory at the National Agricultural Research Institute (NARI) to refine galip nut processing strategies, develop trial products and test these in the market. This was designed to demonstrate what was possible to potential medium- and large-scale private sector investors and therefore attract investment. A separate stream of activities was undertaken to stimulate involvement of women smallholder farmers and small-scale enterprises in processing and sale of value-added galip nut products in local markets, in addition to supplying galip nut to larger-scale processors.

A high-level summary of the theory of change is (also presented visually in Appendix 4.2):

- If scientific and technological advances can be made in the processing of galip nut, sale of value-added galip nut products can become a viable industry and attract private-sector investment. For this to take place, these scientific advances are needed:
 - Finding efficiencies in processing methods to increase production and reduce costs.
 - Extending shelf life (through improved drying technologies, processing and packaging).
 - Researching nutritional value and impact of different processing options on nutritional properties.
- Private sector investors need to have confidence in the potential industry. If galip nut products can be successfully produced and sold in the marketplace in PNG and prove to be profitable during pilots, this will increase confidence of private sector investors and encourage investment. For this to take place:
 - Pilot products ready for commercial sale need to be developed using the NARI demonstration factory.
 - Suitable market connections need to be made with wholesalers and retailers to enable distribution and sale of pilot products.
 - Appropriate price points need to be determined through economic analysis to maximise profitability, and this information shared with potential investors.
- If interested private sector investors can visit the NARI demonstration factory to see galip nut processing in action, and access technical and financial information about establishing their own processing line, this will assist them in starting their own processing. This requires:
 - relationships to be established with the private sector
 - tours/open days at the factory to share knowledge and expertise
 - information products available to share with potential processors.

- Increased commercial processing of galip nut will result in increased demand for raw/unprocessed galip nut from local smallholder farmers. This will contribute to increasing the income of PNG local farmers (particularly women). This requires:
 - knowledge of the available galip nut supply, including both wild and elite varieties
 - farmers to understand the type and quality of nuts required by the factory/private processors, and where and how to sell their produce
 - an attractive price point for farmers.
- Smallholder farmers and small medium enterprises (SMEs) can increase their income by undertaking their own processing and selling value-added galip nut products in the market. This requires:
 - knowledge of processing techniques, and the right skills and equipment to undertake processing
 - knowledge of the types of value-added products that can be produced and sold locally.

Analysis of the theory of change

The central theory of change regarding stimulating medium- to large-scale private sector development of the galip nut industry was highly appropriate to the context, where one of the main barriers identified in attracting private sector investment was scepticism as to the potential of the industry (Young 2017). Testing and demonstrating what was possible, and refining processes to improve efficiencies along the way, was a logical approach to addressing this challenge and proved an effective strategy to achieve results.

By design, the project sought to work across all levels of the value chain simultaneously. This was seen by the project team as critical to ensure that smallholder farmers currently selling produce in the local markets were not disadvantaged by commercial developments. While this is important, it did result in the project undertaking many separate small activities, which didn't always have apparent outcomes. There is often a trade-off between addressing the various facets of an issue simultaneously but potentially spreading resources too thinly; versus focusing on a smaller number of issues and addressing these well, but with the risk of doing harm, or missing opportunities to 'do good' through less central activities.

A number of activities under Objectives 2 and 4 certainly seem to be less central to the theory of change, and it is questionable whether these were needed to help the project achieve its overall goal.

One of the challenges with activities under Objective 2 was that the original design assumed a greater number of existing SMEs would be available, but project stakeholders reported that these numbers did not exist in the way the design envisaged. This resulted in a shift to focusing more on smallholder farmers. However, that too had its challenges. Training activities were deliberately demand-driven, however in some cases, this meant activities strayed from focusing on galip nut at all. For example, training on producing jams and cordials from other harvested fruit, and training in coconut oil production, did not have a clear line of sight to the project's theory of change. The assumptions around how training activities would prompt changed behaviours with smallholders also did not hold true, in that training and mentoring did not produce the change in practice foreseen in the project design. Further work is needed to unpack the barriers to uptake of value-adding techniques amongst smallholders and small-scale entrepreneurs within the PNG context.

Objective 4 to 'create a model for public-private partnerships in the *Canarium* industry in PNG' and related activities was also not central to achieving the overall aim of the project. While technically this objective formed part of the official project aim, it appears this was more of an add-on to meet a political imperative around public-private partnerships (PPPs) and the need for NARI to offset some of its operating costs, rather than being a central part of the theory of change. It is unclear how activities in this area align with bigger picture goals of stimulating private sector investment.

In contrast to some other ACIAR projects, limited attention was given to the policy enabling environment, or the role of government departments and extension workers in supporting growth of the new industry. Brief mention of the role of government departments is noted under Objective 4 of the project design, where one of the activities was to 'build capacity of NARI and relevant government departments in markets and agribusiness skills to support the growth of the private sector'. It does not appear that any government departments (beyond NARI) were actively engaged in the project. Similarly, where other ACIAR projects have focused on building the capacity of extension workers or peer educators, training in this project was largely provided directly by the project team. This was understandable given the nascent nature of the galip nut industry in PNG (in contrast to other commodities), however additional focus on this area would be valuable in future projects to increase sustainability of the emerging industry.



2. What outcomes (intended and unintended) has the project achieved or contributed to?

Outputs

Scientific knowledge

The project completed a broad range of studies to assess the needs of the private sector to participate in the galip nut industry. This included investigating:

- the existing scale of market participation by women smallholders, SMEs and large-scale processors
- mapping the galip nut resource supply (although this proved difficult to assess and requires further investigation) (Markham and Yakuma 2019)
- barriers to scaling up sale and processing of galip nut at different levels of the value chain
- the priority training and extension needs of different actors in the value chain.

These studies were used to develop knowledge products, and also informed other aspects of project decision-making.

The project researched and refined appropriate methods for extending the shelf life of galip nut products, and investigated the nutritional composition of galip and soil nutrient concentrations of *Canarium*-cocoa plantations.

Experiments were undertaken to determine how different storage options and processing affects kernel quality and shelf life of kernels, and how this can be extended. Galip nuts are regularly sold fresh in markets with a limited shelf life of 72 hours, whereas the project was able to extend shelf life to up to 12 months when processed and packed correctly (Wallace et al. 2020). Nutritional analysis included comparing the nutrients of galip nut with other popular nuts including almond, cashew, pistachio and peanut. Information was used to develop accurate nutrition labelling on products and inform decisions on the maturity of nuts purchased from suppliers. Nutrient content of by-products was also examined to explore its suitability for use as livestock feed.

Using the knowledge gained through these studies, **the project developed, trialled and refined a range of value-added galip nut products at the NARI factory and developed a commercial model for production.**

This included investigating consumer preferences about taste, new market opportunities, packaging and labelling, and retail price points. Products were first tested in the East New Britain (ENB) market during 2015–16. Demand for the products was strong and the factory received many repeat orders (Wallace et al. 2016). After market analysis, a decision was taken to focus on a premium product. New products with premium packaging and labelling were developed and produced under the brand of the Galip Nut Company. These were launched in ENB in May 2018 and Port Moresby in July 2018 at 3 CPL supermarkets and Prouds Duty Free at Jackson Airport. **These products proved so popular the factory could not keep up with demand in 2018 and 2019**, with the products being out of stock for long periods (Wallace et al. 2020). Financial analysis of the commercial model was undertaken at all stages of the project and used to inform operational and strategic decisions (Wallace et al. 2020).

Technology

The project investigated how to improve key stages of galip nut processing to improve efficiency and maximise quality within a medium- to large-scale factory setting. In doing so, it developed and introduced a range of new technologies at the NARI factory. This was an iterative process, whereby technologies and processes were trialled and adapted during each processing season as bottlenecks were identified. Key innovations included:

- Construction of a solar-assisted dryer, which allowed for better control and analysis of moisture levels than using the sun directly (which resulted in substantial product losses during the 2018 season).
- Refinement and testing of a mechanical cracker, which was imported and then modified locally to suit galip nut.
- Introduction of a mechanical de-pulper to replace the practice of de-pulping by trampling with feet.

Collectively, these technological innovations **increased the capacity of the NARI factory and contributed to it more than doubling production of processed galip nut products each year**, to a total of over 2.4 tonnes in the final year of the project (Wallace et al. 2020).

'[Technological innovations] helped us to process more nuts, more efficiently and to a better quality.'

– NARI representative

A range of technological advances aimed at small-scale entrepreneurs were also developed and tested in relation to cracking, de-pulping, drying and processing. Two key advances were a solar dryer and nutcracker. These were both designed to be affordable and produced locally from available materials so they could assist small-scale processors to add value to galip nut products and other foods.

Practices

The project developed a range of information products to improve food safety practices and food handling, and share information about the galip nut industry. These targeted different levels of the value chain:

- A food safety booklet targeting female entrepreneurs in the market was produced and distributed.
- Packaging demonstrations were undertaken with SMEs (using locally available materials such as second hand jars) to encourage appropriate storage of products.
- Factory standard operating procedures were developed and produced to assist SMEs looking to move into the industry.
- An information manual for processors interested in investing in the industry was produced to document lessons learned and best practices in a user-friendly manner.

Capacity building

Capacity building was originally designed to be provided to both women smallholders and SMEs on galip nut processing and value-adding, however the project was unable to find SMEs to work with at the beginning of the project, and so adapted activities in early years to focus primarily on smallholders.

Following a training needs assessment, an extensive range of training was provided to women smallholders and small-scale entrepreneurs in ENB and surrounding areas on a diverse range of topics.

This involved workshops with 10–40 participants, both in the community and at the NARI factory. Training was often very practical, including demonstrations of new technologies (such as a solar dryer) and opportunities for participants to try these for themselves.

Training participants included members of the ENB Women in Agriculture Cooperative Society, smallholder families, local market stallholders identified as selling galip nut, and members of the Galip Club.⁸ Training was also undertaken in Bougainville and New Ireland in collaboration with the Transformative Agriculture and Enterprise Development Program (TADEP) Family Farm Teams project. While women were the primary target, some men did attend various events.

Topics were demand-driven and covered a range of subjects, including:

- Small-scale galip nut growing and processing techniques, including drying (using an oven or solar dryer), cracking, de-pulping, packaging, labelling and storage.
- Sanitation, hygiene and safe food handling.
- Creation of value-added products, such as cooking with galip nut, making jams and cordials, and coconut oil production.
- Farm management and tree spacing.

Reports and stakeholder interviews indicate that the training was widely appreciated by participants and helped to strengthen their knowledge on processing techniques and value-added products that could be produced.

Stalls were set up and awareness activities undertaken at large festivals and events to build awareness of the type and quality of nuts that could be sold to the factory. This included stalls at the World Environment Day celebrations each year, the ENB Fire Dance Festival and Kokopo Agricultural Show. It is estimated that several hundred people were reached through each of these events (Wallace et al. 2020).

More targeted business development mentoring and support was provided to women entrepreneurs, and technical advice to emergent processors in the later years of the project as they showed interest and entered the industry (Wallace et al. 2017). This included technical advice on processing stages such as drying, de-pulping and packaging, and food safety and hygiene. Interested processors visited the NARI factory regularly, and were able to use the NARI factory to run tests or request the project team to check the quality or their products.

⁸ The Galip Club is a group of farmers participating in the galip nut industry. The club is facilitated by Devine Management Services, which purchase galip nut from farmers, and in return provide training and other capacity-development opportunities to members.



A notable strength of capacity-building activities with smallholders and SMEs was the practical demonstration of products and approaches and the flexible, contextually driven approach. For example, drying techniques and packaging options shared with smallholders were adapted from location to location to suit the context and local resources available. Given the lack of SMEs available early in the project, the project team also did well to adapt their approach and then introduce these activities later once sufficient interest and demand had been built. Training activities were also very demand driven. This is a key strength but also meant that topics occasionally strayed from the specific objectives of the project.

In 2016, a work experience program was developed in response to concerns at the lack of opportunities available to young people. This provided an opportunity for young people to gain experience in the workplace, and downstream processing and marketing of galip nuts. Twelve young people identified by ENB Women and Youth in Agriculture Cooperative participated in the 2-week program. Feedback from the program was very positive, with participants indicating that it had broadened their knowledge and would inform what they do in the future. From the 12 participants, 2 have found employment in the galip nut industry, and several others are now pursuing further study in the area of agriculture and related fields (Wallace et al. 2020:51).

The project team also built capacity of NARI throughout implementation, training staff in using new technologies and equipment, as well as plant hygiene and plant maintenance required to run the factory and maintain high-quality standards (Wallace et al. 2020:23). This was undertaken through ongoing one-on-one mentoring and support with Australian members of the project team, and more structured training courses. NARI staff also developed skills in market assessment and product development processes. While NARI staff appreciated the capacity-development opportunities provided, some stakeholders indicated that these focused too much on technical capacity to operate the factory, rather than broader research skills. Multiple stakeholders also commented on the missed opportunity for the project to contribute to formal qualifications for PNG team members (such as Master degrees or PhDs), despite the project contributing to numerous such qualifications for Australian-based team members. This is something that should be prioritised in future projects, noting that it is not a straightforward process. PNG counterparts would need to be accepted into a suitable university course either in PNG or through an Australian scholarship arrangement, with sufficient lead time for the academic qualification to be built into the ACIAR project design.

'There is a need to build in post-graduate study courses into the project proposals, where NARI staff have supervision through the hosting university.'

– Project team representative

Policy

Policy influence was not a strong focus of the project. One activity that had potential influence was the development of a Canarium Industry Roadmap. This was prepared during the proposal development stage as a result of stakeholder consultations and then refined towards the end of the project. Development of the roadmap appeared to be a process of consulting with stakeholders to identify key knowledge gaps, and areas where further assistance was required to inform research activities, rather than developing a strategic plan for development of the sector. This was highlighted in the final project review, which noted that while the roadmap was informative, it would have benefited from being a more strategic document, which outlined a vision for the galip nut industry in PNG together with a process on how to achieve that vision (Markham and Yakuma 2019).

Adoption

ACIAR uses a 4-level classification scheme to indicate the level of uptake of key outputs. This has been used by the evaluation team to summarise output adoption for the projects reviewed under each program, as illustrated in Table 14.

New scientific knowledge

Knowledge on extending product shelf life and nutritional composition

Knowledge generated on extending product shelf life and the nutritional composition of galip nut products was adopted by the NARI demonstration factory and influenced decisions on processing methods and the type of packaging used. Beyond NARI, one of the private sector processors, Devine Management Systems (DMS), did appear to adopt many of the scientific advancements in galip nut processing and storage, noting that this meant there was far less wastage. Limited evidence is available of how other final users adopted the new knowledge generated by the program.

Commercial model for value-added galip nut products in PNG market

The action-research methodology used for this component of the project meant that staff at NARI were closely involved in implementing and testing the commercial model as it was developed. This resulted in strong adoption of the model by the NARI demonstration factory. NARI produced a variety of products, including raw and roasted galip nut kernels and oil, which were sold into commercial markets in ENB and Port Moresby. In 2018–19, the last year of the project, total revenue from all sales from the factory was PGK246,222, equivalent to AUD103,413 (Wallace et al. 2020:47). Financial and market analysis of the model was positive, with farmers showing interest in selling galip fruit at the prices offered, and products generating strong repeat demand and producing reasonable gross profit margins (Wallace et al. 2019:16).

Table 14 Levels of adoption of key project outputs

Category	Output	Users	Level of adoption
New scientific knowledge	Knowledge on extending product shelf life and nutritional composition	<ul style="list-style-type: none"> NARI factory is an initial user Other processors are final users 	Nf*
	Commercial model for value-added galip nut products in PNG market	<ul style="list-style-type: none"> NARI factory is an initial user Other processors are final users 	Nf*
New technologies or practical approaches	Technology and capacity building for small-scale processing and value-added galip nut products	<ul style="list-style-type: none"> Smallholders and small-scale processors are initial and final users 	O / N
	Capacity building on quality of nuts to sell to NARI factory	<ul style="list-style-type: none"> Smallholders and SMEs are initial and final users 	NF
	Technology and capacity building for medium- to large-scale processing of galip nut	<ul style="list-style-type: none"> NARI factory is an initial user Other processors are final users 	Nf
Knowledge or models for policy and policymakers	Roadmap for <i>Canarium</i> industry	<ul style="list-style-type: none"> Project team are initial users Government and donors are final users 	N

Notes:

* Nf – limited evidence available of the level of uptake by final users

O No uptake by either initial or final users.

N Some use of results by the initial users but no uptake by the final users

Nf Demonstrated and considerable use of results by the initial users but only minimal uptake by the final users

NF Demonstrated and considerable use of results by the initial and final users



Having NARI (a public research institute) enter the market as a commercial player was considered by some stakeholders as an unorthodox approach, stretching the boundaries of what was commonly understood as research. This did cause some tension throughout implementation. Some industry stakeholders suggested NARI had an unfair advantage in the market, as its products received substantial financial backing from Australia. Questions were also raised as to whether NARI potentially faced a conflict of interest between the imperative to share knowledge and research findings with potential private sector investors when these same investors would then become commercial competitors to NARI. It is clear how this could present a conflict of interest if NARI did seek to be a long-term commercial player in the galip nut industry, however consultations with NARI representatives do not support this finding. Key stakeholders confirmed that NARI continued to be highly transparent throughout the project, sharing research findings and technological advances with private sector processors, and doing what it could to build up other processors, regardless of how this would impact its own sales. Furthermore, while NARI has benefited financially from selling products commercially, and has indicated an intention to continue production at the factory, at least in the short-term, the primary goal of this arrangement remains supporting broader development of the industry rather than its own commercial gain.

The entry of 4 private sector players into the galip nut industry during 2018–19 (one in a partnership with NARI, and 3 processing and selling products independently) is the best indication of adoption of the commercial model by final users. Limited evidence is available about the specifics of what aspects of the commercial model have been adopted, although the project team indicated that aspects such as the price points of products, packaging and distribution points have been adopted.

New technologies or practical approaches

Some examples are available of women's groups or smallholders making and selling galip nut products immediately following training, however **there is limited evidence of widespread adoption of the new galip nut processing or value-adding practices amongst smallholder farmers and small-scale entrepreneurs.** The end of project review noted:

The project invested considerable effort in community-level capacity building but so far there seems to be only limited uptake of improved processing technology and value-adding opportunities.

– Markham and Yakuma 2019

While no systematic assessment of uptake has been undertaken, stakeholders shared a similar sentiment, noting that no matter what strategies the project adopted, smallholder farmers and small-scale entrepreneurs continued to be reluctant to adopt new processing strategies and instead continued to sell existing products at the markets. There were some reports of improved hygiene practices, such as more frequent handwashing following training, but again, there is insufficient evidence on how widespread this uptake was.

Efforts to improve the quality of nuts sold to the NARI factory by smallholder farmers appear to have achieved good results, with project reports and multiple stakeholders noting that the quality improved over the life of the project. Whereas in early years farmers brought all types and sizes of galip nut to the factory for sale and many nuts had to be rejected, in later years the quality of product sold to the factory was higher and more consistent.

'At the start they were just giving us any type of nuts. As we continued to do training and awareness on the specific type of nuts we wanted we saw a change – people started giving us quality nuts.'

– NARI representative

Technology and capacity building for medium- to large-scale processing of galip nut

New technologies and practices introduced by the project were widely adopted by the staff in the NARI factory. Most of these are reported to still be used after the project's completion (with the exception of the mechanical cracker which needs further adjustment by an engineer). **This greatly increased the throughput capacity of the factory, which was able to go from processing less than one tonne of raw material in 2014 to 207 tonnes in 2018.**

NARI staff have used their increased knowledge and skills to undertake a range of activities, for example:

- Analysing product samples for quality and providing testing services to other export processors.
- Performing leaf and soil sample processing and litter decomposition experiments.
- Using the CommCare⁹ application to design several surveys.
- Delivering food safety and hygiene workshops for local smallholders and SMEs (Wallace et al. 2020).

9 CommCare is a mobile data collection platform designed for low resource settings.

Limited information is available about the extent to which specific technologies or practices were adopted by SMEs or large-scale processors as a result of the project. **DMS appeared to adopt a range of practices, including new drying, de-pulping and roasting techniques, and new food safety and hygiene practices.** BISI Trading is also reported to have adopted new drying and roasting techniques based on the project's advice.

Interestingly, 2 emerging processors, Niugini Organics and BISI Trading, have modified the NARI factory's processing model, buying nut-in-kernel which has been hand-cracked in the community rather than nut-in-pulp. This is purchased from farmers at the higher price of PGK15–20 per kilogram, rather than nut-in-pulp at PGK1 per kilogram. The project team has avoided this model because of concerns about maintaining quality control when the nuts have already been cracked, although acknowledges the livelihood benefits this would bring to smallholders (Wallace et al. 2019). It remains to be seen which model proves to be more viable.

Knowledge or models for policy and policymakers

The project team used the Canarium Industry Roadmap to inform research activities, which helped to ensure they were grounded in the needs and priorities of key stakeholders. However, there is no evidence that this document has been used by others within the industry.

Strengthening the galip nut value-adding processes of DMS

Dorothy Luana from DMS became engaged with the project team during the last 2 years of project implementation. DMS was already processing and selling galip nut products on a small scale, but was interested to learn better processing techniques. The project team provided information on a range of processing techniques such as drying, roasting and de-pulping, as well as training on food handling, hygiene and new galip nut recipes. The team also provided technical assistance to troubleshoot issues and conducted testing on DMS products to ensure their quality.

Dorothy adopted many of the new processes shared by the project, including adapting her drying, de-pulping and storage techniques, and changing her food handling practices. She noted that this helped to systematise her production, which resulted in her discarding far less spoiled product. She said, 'Through [the project] I was able to improve the quality of my product and I was really motivated to take it to the next stage.'

She went on to construct a commercial kitchen, and in doing so, increased her production capacity substantially. Dorothy also attended training and conferences with the project and shared her experiences to encourage others to take up galip nut processing.



Outcomes

Scientific achievement

Substantially more is known about galip nut processing in PNG, and the impact different processing techniques have on nutritional qualities and product shelf life.

This knowledge has been used to develop and test new value-added products which proved to be desirable within the market. New technologies have been introduced within the NARI factory, which have improved the efficiency of processing and enabled sale of value-added products to become more economically viable. This knowledge has been shared through papers in scientific journals, and with other potential processors through factory tours, and informal mentoring and networking.

Capacity built

The key capacities built through the project are summarised in Table 15. These have been critical in underpinning the other outcomes achieved by the project.

Economic outcomes

By the conclusion of the project, 4 private sector processors were processing and selling galip nut products commercially. Three of these processors were sourcing and producing their own value-added product separately to the NARI factory, while the fourth, Equanut, entered into a partnership arrangement with the NARI factory (Wallace et al. 2020:8). The emerging industry has an estimated farm gate value of PGK300,000–400,000 per annum. Given the lack of interest from SMEs and large-scale processors at the beginning of the project, this is a significant achievement. While further work may be needed to develop a sustainable industry, there appears to be substantially more interest and willingness to engage in galip nut processing than when the project commenced.

Equanut entered the market in 2018–19 in a PPP with NARI. Equanut is a New Zealand-based investor with co-funding from the New Zealand Ministry of Foreign Affairs and Trade. It entered into a factory-sharing arrangement whereby it would source and crack the galip nut and then pass to NARI staff for packaging. Creating a model for PPPs was one of the 4 objectives of the project, although this does not seem central to the project achieving its overall goal. The establishment of the partnership with Equanut helped address some of the inefficiencies in the factory operations, but also appeared to create some displacement of NARI staff, and introduced confusion over roles and responsibilities in factory operations (Markham and Yakuma 2019). Equanut was involved in processing during the 2019 season, but then pulled out of PNG with the rise of COVID-19 in early 2020. As yet, no other commercial processor has taken its place.

The demonstration factory has been an important source of revenue for NARI, which faces significant resource constraints. While this was not the primary objective, the revenue has assisted the research institute to meet some of its operating costs.

Table 15 Capacity built relevant to project objectives

Who	Skills and knowledge
NARI	<ul style="list-style-type: none"> • Use of new technologies and equipment required to run the galip nut factory • Plant hygiene and plant maintenance • Quality testing and techniques for maintaining high-quality standards
Medium- to large-scale processors	<ul style="list-style-type: none"> • New galip nut drying, de-pulping and roasting techniques • New food safety and hygiene practices • Knowledge of commercial models for production
Women smallholders and small-scale entrepreneurs	<ul style="list-style-type: none"> • Small-scale galip nut growing and processing techniques, including drying (using an oven or solar dryer), cracking, de-pulping, packaging, labelling and storage • Sanitation, hygiene and safe food handling • Creation of value-added products • Farm management and tree spacing

Community outcomes

Prior to the project, there were very few opportunities for local smallholders to sell unprocessed galip nut to private processors. **Over the life of the project, the NARI factory directly purchased over PGK400,000 of unprocessed galip nut from smallholder farmers and entrepreneurs in ENB and surrounding areas, supporting the livelihoods of over 1,300 farmers by the end of 2018** (Table 1, Wallace et al. 2020).

In addition, the other private sector investors that entered the industry in 2019 were also purchasing nuts from local smallholders, with an estimated farm gate value of PGK300,000–400,000 per annum. A number of intermediary actors and microenterprises have also now emerged, purchasing galip nut from farms and then transporting and reselling it to the NARI factory.

With the different processing models now in operation, there are now 2 main income generating options for smallholder farmers: selling nut-in-pulp to the NARI factory at PGK1 per kilogram, or manually cracking the nut and selling it nut-in-kernel for PGK15–20 per kilogram to the other processors. Stakeholders suggest that some farmers choose to sell both products – cracking some of the galip nut themselves to sell for a higher value, and then also selling the nut-in-pulp with any leftover supply. While no impact studies have been completed, examples of the impact this increased income has had on farmers are included in project reports. These suggest that women are using the additional income from selling galip nut to the factory to meet general family expenses, such as covering the costs of school uniforms and buying medication for unwell children (Wallace et al. 2019:29).

The emerging industry is also estimated to have created approximately 40 formal jobs across the processing facilities in ENB and New Ireland (Wallace et al. 2020).

Environmental outcomes

Project reports indicate that there may be some positive environmental outcomes resulting from the increased market opportunities for galip nut, and research on the *Canarium*–cocoa cropping system, as this will stimulate more investment in planting galip trees, resulting in more carbon sequestered and greater resilience of the cocoa cropping systems.

A possible negative environmental impact of the project is waste from factory de-pulping as the current process requires large volumes of water and produces a slurry of fruit pulp. Further work is needed to investigate methods of on-farm de-pulping and composting of the fruit pulp to turn the waste into an opportunity, along with more efficient methods of large-scale de-pulping (Wallace et al. 2020:65).

Table 16 Galip nut purchased by the NARI factory each year

Year	Nut in pulp purchased (PGK101.5 per kg)	Number of farmers selling to the factory	Farm gate value
2014	Small volumes (under 1 tonne)	N/A	N/A
2015	11 tonnes	243	PGK10,669
2016	25 tonnes	647	PGK26,349
2017	65 tonnes	Women selling direct, and entrepreneurs collecting from farmers and selling to factory	PGK65,000
2018	207 tonnes	Women selling direct, and entrepreneurs collecting from farmers and selling to factory	PGK310,500 at factory gate

Source: Wallace et al. 2020:48



3. How did project activities and outputs contribute to the outcomes achieved?

Factors influencing adoption and outcomes

Table 17 provides key findings against the categories and factors influencing adoption and outcomes as part of the ACIAR evaluation framework. It should be noted that no systemic research was undertaken about the factors influencing adoption of the project outputs, so the findings below are primarily based on what key stakeholders and the evaluator perceive to be the factors.

Table 17 Factors influencing adoption and impact

	Factor	Key findings
Knowledge	Do potential users know about the outputs?	<ul style="list-style-type: none"> Not identified as a constraint for this project. Substantial time was taken to raise awareness of outputs and engage with private sector at all levels.
	Is there continuity of staff in organisations associated with adoption?	<ul style="list-style-type: none"> Not identified as a constraint for this project.
	Are outputs complex in comparison with the capability of users?	<ul style="list-style-type: none"> Not identified as a constraint for this project. Outputs for smallholder farmers appeared to be tailored specifically to their needs and manageable within the context.
Incentives	Are there sufficient incentives to adopt the outputs?	<ul style="list-style-type: none"> Lack of incentives were identified as a potential issue for smallholders in adoption of value-added approaches. For medium to larger private sector processors, a lack of incentives may have contributed to initial reluctance to invest in the industry, however the success of the Galip Nut Company products in the market appeared to address this.
	Does adoption increase risk or uncertainty?	<ul style="list-style-type: none"> This is potentially a constraint at multiple levels of the value chain. For smallholders and women entrepreneurs, stepping outside of the social norm may pose risks and may have contributed to a reluctance to adopt new approaches. For medium- to large-scale processors, the nature of galip nut as a new industry poses risks associated with the uncertainty of the commercial viability of the product. Project activities directly sought to address this through the NARI demonstration factory.
	Is adoption compulsory or effectively prohibited?	<ul style="list-style-type: none"> Not identified as a constraint for these projects.
Barriers	Do potential users face capital or infrastructure constraints?	<ul style="list-style-type: none"> Some smallholders may face capital constraints in adopting new technology. This appeared to effect adoption of the new nutcracker and solar dryer. This did not appear to be a constraint for medium- to large-scale processors, some of which were already processing other nut products and could re-purpose equipment.
	Are there cultural or social barriers to adoption?	<ul style="list-style-type: none"> As noted above, smallholders appear to be impacted by social and cultural norms, however further research is required to fully understand this.

Demonstrating commercially viable products in the market, particularly in Port Moresby, appeared to have a strong positive influence on prompting private sector investment in the galip nut industry.

The launch of the Galip Nut Company products was widely identified by project stakeholders as a pivotal turning point, whereby potential investors moved from being sceptical about the emerging industry, to showing interest and then actually commencing their own production processes. While only DMS was consulted as part of this evaluation, other evidence is available to support this assertion. Scepticism over the potential of the industry was a key barrier identified in previous projects, and an issue this project specifically sought to address. Despite the project's industry engagement efforts, private sector investors were still wary of investing in the industry prior to the product launches in 2018, and sceptical as to whether the products could be sold at a high price point. This can be seen in the mid-term review report of June 2017 which stated, 'At this stage private sector investors still need to be convinced of the financial viability of producing processed galip nuts commercially' (Young 2017). DMS commenced selling product commercially on a small scale prior to the Galip Nut Company product launches in 2018, however all other processors commenced production following these launches and the success of the 2018 season. The increase in consumer awareness through sales of Galip Nut Company products may also have assisted other entrepreneurs to capture a share of the emerging market.

Getting products on the shelf, at the right price point and in a form that was attractive to consumers was the culmination of a significant body of research work and commercial engagement by the project over the previous 3 years. This was made possible because of:

- the technological advances made in processing at the NARI factory
- engagement with smallholder farmers to ensure a sufficient supply of galip nut to the factory
- refinement of packaging and labelling
- economic and financial analysis
- development of a commercial partnership with CPL supermarkets to distribute and sell products in its retail outlets.

The multidisciplinary nature of the project team was a critical success factor in ensuring all these different components were considered and given appropriate attention. In particular, having targeted expertise in financial/economic analysis and marketing to help develop the commercial model and engage the private sector was an important addition to the agricultural science and social science skills within the project team.

The project faced several challenges which also influenced the extent of adoption and impact. One major challenge was **operating the demonstration factory within a public research institute, which is not designed for commercial operations**. Issues around staff rosters and competing staff priorities created workflow issues as staff would become unavailable at short notice. These arrangements were highly inefficient and led to frequent handovers of work between staff (Marham and Yakuma 2019). Lengthy public sector procurement processes also delayed key infrastructure investments, and funding shortfalls within the NARI operating budget led to ongoing issues with unreliable electricity supply and telecommunications, as well as vehicle shortages (Young 2017). Some of these issues were addressed through the partnership with Equanut as it enabled a commercial entity to take over a range of factory processes. However, this arrangement was relatively short-lived and had its own challenges. Co-locating 2 team members from University of the Sunshine Coast in ENB (initially full time, then fly-in fly-out), and the project team's ability to think creatively and solve issues as they arose, were particularly beneficial in overcoming these challenges (Young 2017).

Another related challenge was determining the most appropriate scale of production at the factory. This stemmed from difficulties in assessing the supply of galip nut available in the community and the potential demand for products. In 2016, there were concerns about supply of galip nut from farmers, however this eased during 2017 when there was a threefold increase in nut sold to the factory. Then the factory was over-supplied and faced storage issues. In 2018 with the successful product launches in ENB and Port Moresby, the factory was unable to produce sufficient supply to meet demand, resulting in products being out of stock for extended periods. In 2019, challenges with Equanut's mobilisation and a lower yield from farmers again contributed to shortages of products. These challenges in calibrating supply and demand were potentially unavoidable when developing a new industry but may have impacted on economic and financial analysis of the commercial model.

Uncertainty around continuity of funding for the project also affected the project's implementation and its ability to secure private sector investors.

Earlier delays meant that product launches were planned for 2018, which was in the final year of the project (under the original timeframe). This caused significant anxiety for the project team because there was a danger that new products would be launched into the market just as the project was due to finish and then could not be supported. This held substantial reputational risk for ACIAR and NARI. Fortunately, a project extension was granted and ACIAR made the decision to continue supporting the project's second phase, despite a DFAT decision to discontinue funding. It is also fortunate that commercial distributing partner CPL supermarkets continued to support the project despite the frequent interruptions to the supply of products and uncertainty during this period.

For smallholder farmers, a range of factors were identified in project reports and consultations which may have limited the uptake of value-adding approaches shared by the program. These included:

- Women were reluctant to leave their produce in the solar dryer in case it was stolen while drying.
- The cost outlay of the solar dryer and mechanical cracker (although designed to be affordable) were still prohibitively expensive (Young 2017).
- Social stigmatisation and unwanted community attention occurred when people stepped outside of traditional activities, acting as a disincentive (Wallace et al. 2020:35).
- The additional time required to process value-added products is not seen as worthwhile (Wallace et al. 2018).

It is important to note that similar technologies such as the solar dryer have been used successfully in Pacific countries such as Vanuatu (Wallace et al. 2016), so cultural and economic factors unique to PNG may be important to investigate further to fully understand why these approaches were not taken up.



Unripe galip fruit on the tree. Photo: Conor Ashleigh, ACIAR

4. What strategies were adopted to address gender equity and social inclusion and how effective were these?

Gender equity

The galip nut project showed some awareness of gender and sought to contribute to women's economic empowerment. The project design noted that women are generally responsible for the majority of galip nut growing and trading activities, including nut cultivation, harvesting, processing and selling. The design indicated that the project would help to foster social inclusion of women because it targets an activity that is often women's domain (Wallace et al. 2019). The primary strategy adopted by the project to promote gender equity was to target women smallholder farmers and entrepreneurs for capacity building and mentoring – to increase their income from selling galip nut to processors and encourage small-scale value-adding of their own.

While women were often the primary focus of capacity-building activities, project team members report learning from the Family Farm Teams (FFT) approach and inviting men in communities to participate as well. This led to a few instances of men showing a greater appreciation for women's role in preparing food, with some noting for example that 'cooking is really hard work' (Wallace et al. 2020). While these examples are positive, they appear to be an unexpected outcome, rather than part of a strategy to encourage reflection on the gendered division of labour within households and how this could become more equitable. Instead, the project worked primarily within the existing gender norms, potentially reinforcing them by focusing capacity-development activities on women. There was limited awareness or monitoring of potential negative consequences that could come from this approach – for example, the potential for increased workloads for women if they took on additional productive tasks within the family but still expected to undertake the majority of reproductive tasks, or potential backlash from spouses if productive work interfered with their domestic responsibilities.

While capacity-development activities around small-scale processing didn't appear to have strong uptake, **the project did contribute to a steady increase in the number of smallholder farmers selling galip nut to the NARI factory, providing a new source of income for these families. Many of these farmers were women.** Examples are available of the positive impact this had on women, although it is unclear how widespread these impacts were. There was also no evidence of the extent to which women who did sell galip nut to the NARI factory could control decision-making on how this income was used.

During implementation, the project made a few decisions which could potentially have had negative impacts for women. The first was when the project commenced selling galip nut commercially in ENB. The project received feedback that their products were potentially competing with the produce women were selling informally in the markets. This was unintentional and was quickly rectified by raising the price of products sold commercially. A second issue related to the model of purchasing galip nut from smallholder farmers for processing. Midway through project implementation, the NARI factory introduced a dual price strategy for how nuts were purchased from farmers. Whereas initially NARI would travel into the community to purchase galip nut at the farm gate, under the new strategy, NARI purchased galip nut for PKG1 per kilogram at the farm gate or PKG1.5 per kilogram delivered to the factory gate. This led to a large increase in factory gate sales, with almost 95% of sales occurring at the factory gate in 2018 (Wallace et al. 2019:6). **While this proved to be more cost-effective, it resulted in a shift from women primarily selling galip nut, to far more men bringing produce to the factory for sale** (Marham and Yakuma 2019). This is likely due to concerns around safety for women when travelling further from home, and challenges with transporting produce to the factory. Further research is needed to determine the impact this has on women and gender relations within families.

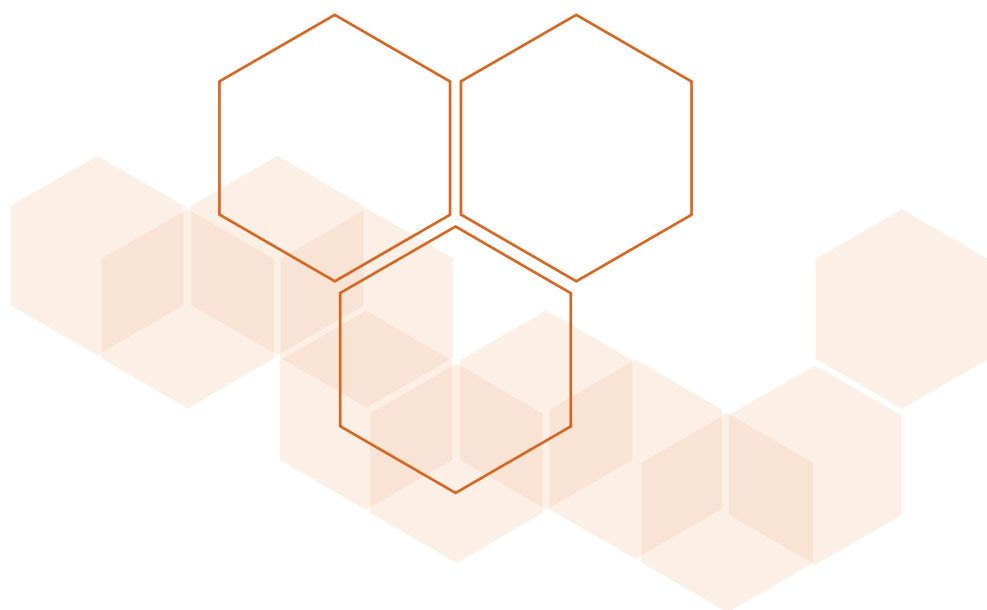
Within the project team, consideration was given to promoting opportunities for women researchers to have their work profiled and to take on leadership roles, and actions were taken to enable women to manage family responsibilities alongside work commitments. This should be commended and appears to have had a positive impact on PNG women within the team.



Overall, the approach to gender equity could have been strengthened by undertaking more in-depth analysis of the roles of women and men within the communities where the project was operating and considering how project activities would influence these. Future projects should be encouraged to move beyond reinforcing existing gender norms to challenging unequitable division of labour within families and communities, or at a minimum, ensuring they do no harm. Developing a targeted strategy of how the program will achieve this, and implementing ongoing monitoring of potential intended and unintended gender-related consequences is also critical to ensure a 'do no harm' approach.

Social inclusion

Through consultations with women smallholders, the project team identified disadvantaged young people as another key target audience for capacity development. This was due to high rates of youth unemployment within the area and concerns around a lack of opportunity for youth to gain work experience. In response to these concerns, **the project designed and implemented a 2-week work experience program at the NARI factory which was run once in 2016 for 12 young people who were neither studying nor working.** The young people were identified by the Women and Youth in Agriculture Cooperative Society and gained experience in all aspects of the factory's activities including collecting, buying, processing, packaging and labelling galip nut. Following this program, 2 participants gained employment in the galip nut industry, and several others are pursuing studies in related fields (Wallace et al. 2020). While this activity seemed worthwhile and was well received, it was not part of any broader strategy to support inclusion of diverse groups within the project. **Future projects could consider strategies to ensure youth, people with disability and other groups benefit from project activities.**



5. How did management arrangements impact delivery of the project?

The multidisciplinary nature of the project team was a key strength and was critical in supporting achievement of a range of project outcomes. While this could have created division within the project, it appears to have been managed well and created fertile ground for robust discussion and problem solving as challenges arose. This is testament to the strong leadership of the project leader, who was widely regarded to have managed the overall coordination of the project well, and actively encouraged team members to feel confident in voicing their opinions and actively contributing to discussion.

The project adopted an action-research methodology which involved an annual review process, whereby activities from the previous year were evaluated and activities for the next year planned in response to emerging research and challenges. This approach appeared to be implemented well and enabled the team to be responsive to the changing environment. This was particularly important given the nature of the project in attempting to establish a new industry which had many unknowns. Some reports suggest that an annual cycle was not frequent enough and that additional revisions to activities were needed throughout the year as challenges emerged and the project evolved (Wallace et al. 2020). Examples of activities that benefited from adaptive planning included:

- The approach to financial analysis of the commercial model was changed to focus on gross margin analysis. This enabled better identification of inefficiencies in the production process (Markham and Yakuma 2019).
- Financial analysis identified that the purchase of fruit contributed to 49% of the cost of the final product. This was expensive because the purchasing model required the project team to visit villages and collect the fruit directly from the farm gate. Changing the purchasing model to the factory gate reduced this to 31% of the cost of the final product (Markham and Yakuma 2019).

The action-research process could have been strengthened by giving further attention to the broader theory of change underpinning project activities and ensuring sufficient monitoring of initial outcomes was undertaken and considered in the annual planning process. This occurred relatively well for activities related to the factory, but was lacking in relation to capacity-building activities with smallholders, which continued to be undertaken despite very limited evidence of their success. In addition, some stakeholders reflected that despite good intentions, the real ability to change the project substantially during implementation was actually quite limited. Adaptions could be made to how individual activities within objectives were undertaken but the overall objectives themselves had to be retained, despite some aspects of these no longer appearing to be relevant. The rigid structure of project reporting was also seen as reducing the extent to which outcomes achieved could be reported.

'Adaptive planning was good in theory but there was no adaptability within the reports. We still needed to report against the same objectives. That was one of the most frustrating things – we couldn't really list our real outcomes because they didn't fit in the boxes.'

– Project team representative

Having 2 team members based in-country (initially full time, then fly-in fly-out) was widely regarded as critical to the success of the project. This enabled the Australian project team to develop strong relationships with staff at NARI and more broadly, and also helped the team to build an in-depth understanding of the context and the challenges operating on the ground. Within the NARI factory, this enabled a greater level of one-on-one mentoring and support than would have been available otherwise, and supported real-time problem solving of issues as they emerged. It also enabled the flexible and demand-driven approach to training, as time was taken to understand the priority learning needs of different stakeholders and communities to adapt the approach as needed.



6. How well did the project align with and contribute to the overall goals of its umbrella program?

Most project stakeholders were aware of TADEP and its objectives, however, there were contrasting perspectives on the appropriateness of grouping the individual projects under TADEP. Some stakeholders considered the program a useful tool for cross-project collaboration and learning, and valued the opportunity to network with the other project participants. Others questioned whether there was enough commonality between the projects, considering they involved different commodities and were implemented in different locations within PNG and Bougainville. This was perhaps felt most acutely for the galip nut project compared to other TADEP projects because the galip nut industry was newly emerging, whereas other projects worked on commodities that were considerably more established.

'On a high level we can all see how [the projects] relate to each other but more closely it started to become more difficult to see how they were complementary.'

– Project representative

Overall, it appears that Australian-based researchers from this project were more involved in TADEP activities than their PNG counterparts. Some PNG stakeholders would have appreciated greater involvement. This was a source of frustration for some of the stakeholders consulted, who expressed that TADEP meetings and dialogue seemed largely 'Australian-centric' and provided less scope for PNG nationals to be represented. When they were present at TADEP meetings, they did not always feel like equal partners. More could be done in future programs and in the remaining TADEP lifetime to ensure better representation of in-country stakeholders, and engagement of in-country stakeholders in setting the agenda and directions of program activities. In addition, some suggested that more could have been done to support and encourage local collaboration across the PNG organisations involved in the projects.

Alignment with TADEP objectives

The project aligned well with, and contributed to, all 4 TADEP objectives:

- 1. To stimulate and strengthen inclusive private sector-led development in agriculture.**
The project made a direct contribution to this objective by attracting private sector investment in the galip nut industry and providing scientific knowledge to help strengthen the industry.
- 2. To sustainably increase agricultural productivity, quality and value.** Galip nut production has potential to be highly sustainable, either from indigenous trees or through plantations (Young 2017). The project has directly supported increased quality and value of galip nut products through product development and technological advances.
- 3. To improve access to markets and strengthen value chains.** Whole value chain initiatives helped to link poor rural households to urban markets and provided new avenues for smallholders to sell their produce. Decentralising early-stage processing, as has been done by some of the newly emerging processors, has the potential to provide additional cash income for isolated rural communities that are otherwise unable to access markets directly.
- 4. To promote gender equity and women's empowerment in rural communities.**
Collaboration with women's organisations such as cooperatives and Women and Youth in Agriculture Cooperative groups has placed women as the main beneficiaries of post-harvest management training activities. However, there remains scope to move the focus beyond women as beneficiaries to more holistically consider gender equity and empowerment.

Stronger monitoring and evaluation is needed at both the programmatic and project levels to capture the extent to which planned activities have meaningfully contributed to both project and program objectives. Considering the overarching goal of TADEP is to improve livelihoods of rural men and women in PNG, additional monitoring is needed to really understand how project activities are contributing to this goal. This was a source of frustration to some stakeholders consulted, who indicated there was too much emphasis on reporting activities and outputs, and insufficient focus on outcomes.

Collaboration with other projects

Opportunities for collaboration with other TADEP projects were highly valued by project stakeholders. The project collaborated most closely with the FFT project, delivering training with FFT groups in Bougainville on galip nut and value-adding in 2017, and then going on to work together on 2 Collaborative Research Grants with the FFT project once these grants were introduced, as summarised below.

1. **Sharing income generating ideas for women market sellers across provinces**

This grant involved the galip nut project disseminating knowledge on preservation, packaging and value-adding of galip nut and other produce with smallholder groups engaged in the FFT project in New Ireland and ENB. Approximately 400 women and men smallholders participated in the workshops. The grant also supported development of a cookbook titled, *Food for Life*, which was disseminated to participants and focused on preparing nutritional food from locally grown produce. The level of uptake of the recipes and new technology from this training is unknown (ACIAR n.d.b).

2. **Organic wastes or wasted opportunities**

This grant enabled collaboration with the FFT project and another ACIAR project on soil management in PNG¹⁰. It involved assessing the impact of using galip nut waste products as compost on soil nutrients and yield of sweet potatoes, and training smallholder farmers in compost and biochar production. Composting trials were held at the NARI research station in Kerevat, ENB, and training conducted in ENB and New Ireland (ACIAR n.d.a).

The Collaborative Research Grants were highly valued by stakeholders and seen as a cost-effective way of contributing to the program goals and also an important opportunity for ACIAR to role model collaboration between its projects. They also enabled the project to broaden its footprint into new provinces of PNG, raising awareness of the newly emerging industry.

The project also had ongoing engagement and discussion with the PNG cocoa project about *Canarium*-cocoa intercropping systems. This included sharing knowledge on galip nut, and supplying some galip trees, which were planted by the cocoa project.

'Before we were working in isolation, it was TADEP that brought us together.'

– Project representative

Knowledge transfer and learning

TADEP annual meetings were cited as the most effective mechanism for sharing project results and cross-program learning. Stakeholders noted these meetings were extremely useful for building knowledge and networks between the projects. However, as the meetings were face to face, costs associated with travel limited the involvement of a wide range of project stakeholders. This contributed to a sense that they were primarily for the Australian project leaders. Some stakeholders suggested that in the future, increased use of technology to support virtual networking events between the face-to-face meetings could be helpful.

The TADEP updates (an electronic newsletter) reached a broader range of project stakeholders than could attend the meetings and for some people this was the main engagement they had with the program. Most stakeholders indicated these updates were very useful, with one highlighting that they helped to build a culture of amicable 'competitive tension' between the projects. **While the updates were appreciated, the reporting required from project teams to feed into the updates was widely disliked and seen as too burdensome.** Reducing reporting from monthly to bi-monthly midway through implementation assisted with managing this somewhat, although further efforts could be made to better align program reporting with existing project-level reporting requirements.

TADEP also provided capacity-building opportunities for projects beyond what would have been available within the project itself, and encouraged cross-project capacity development.

For the galip nut project, a key highlight was gaining access to and using the CommCare mobile data app. The galip nut project team used this app across multiple data collection activities, and then provided training and support to other TADEP project teams and partners in using the app.

10 Optimising soil management and health in Papua New Guinea integrated cocoa farming systems (SMCM/2014/048).



Conclusions and lessons learned

The project has achieved substantial results in raising the profile of a new industry in Papua New Guinea (PNG), and attracting private sector investment in that industry. In 2015 very limited galip nut was processed and sold commercially in PNG, but 4 private sector processors had entered the market by 2019. This is a significant achievement, contributing to increased income for smallholders and creating processing facility jobs.

The science and technology required to process galip nut within a medium- to large-scale factory is now better understood, as is the economic viability of the commercial model. The developing and testing of products using the National Agricultural Research Institute (NARI) demonstration factory to show potential investors what was possible was central to this outcome. This unorthodox research approach proved to be very effective.

Lessons learned

Further research and development interventions are needed to build on the successes of this project to consolidate the gains made and address gaps in the current knowledge. Many of these have already been taken forward in the Phase 2 project (FST/2017/038), which commenced in December 2019 and will continue until December 2022. Specific recommendations for future research have been documented elsewhere and will not be summarised here (Wallace et al. 2020; Markham and Yakuma 2019). General lessons for ACIAR in relation to implementation of research-for-development projects and the programmatic approach include:

- 1. The action research approach allows projects to adapt to changing contexts and iteratively use research findings to inform project interventions.** It could be enhanced by encouraging stronger line of sight to the project's theory of change, and by enabling more flexible reporting formats. In addition, consideration should be given as to whether more substantial changes to project objectives are permissible and how these would impact contracting arrangements.
- 2. Developing and testing new products within a commercial setting was an effective way of stimulating private sector interest and investment in a new industry.** This approach appeared to be fairly unique for ACIAR-funded projects. There would be value in sharing the strengths and challenges of this approach more broadly within ACIAR research networks to encourage adoption of this approach in other contexts.
- 3. Capacity-building activities need to be accompanied by stronger attention given to monitoring their effectiveness and outcomes throughout implementation.** Consideration should also be given to the sustainability of capacity-development activities, and whether there are opportunities to build the capacity of existing extension workers (either government or non-government) to ensure knowledge generated through the project is shared widely and embedded in local systems rather than being dependent on ongoing project support.
- 4. A multidisciplinary team was a key strength.** This should be encouraged, but needs to be accompanied by strong project leadership to ensure the project team remains cohesive.
- 5. Gender and social inclusion analysis, and development of a targeted gender equality and social inclusion strategy would help develop a more strategic approach** to influencing gender equity and women's empowerment, and ensure people with disability and other marginalised groups also benefit from projects. This needs to be monitored during implementation.
- 6. Wherever possible, in-country members of research teams should be supported to receive formal research qualifications** (such as Master degrees and PhDs) through project implementation, alongside gaining practical skills.
- 7. Programmatic approaches enable broader sharing and learning across projects.** Collaborative research grants were particularly effective in allowing meaningful collaboration, and appeared to produce good outcomes for limited cost. However, in-country research partners need to be seen as equal contributors to these programs by ensuring good representation on steering committees or other governance structures. In addition, the programmatic approach could support a more strategic approach to building capacity of key in-country stakeholders (particularly when these stakeholders are involved in multiple projects).

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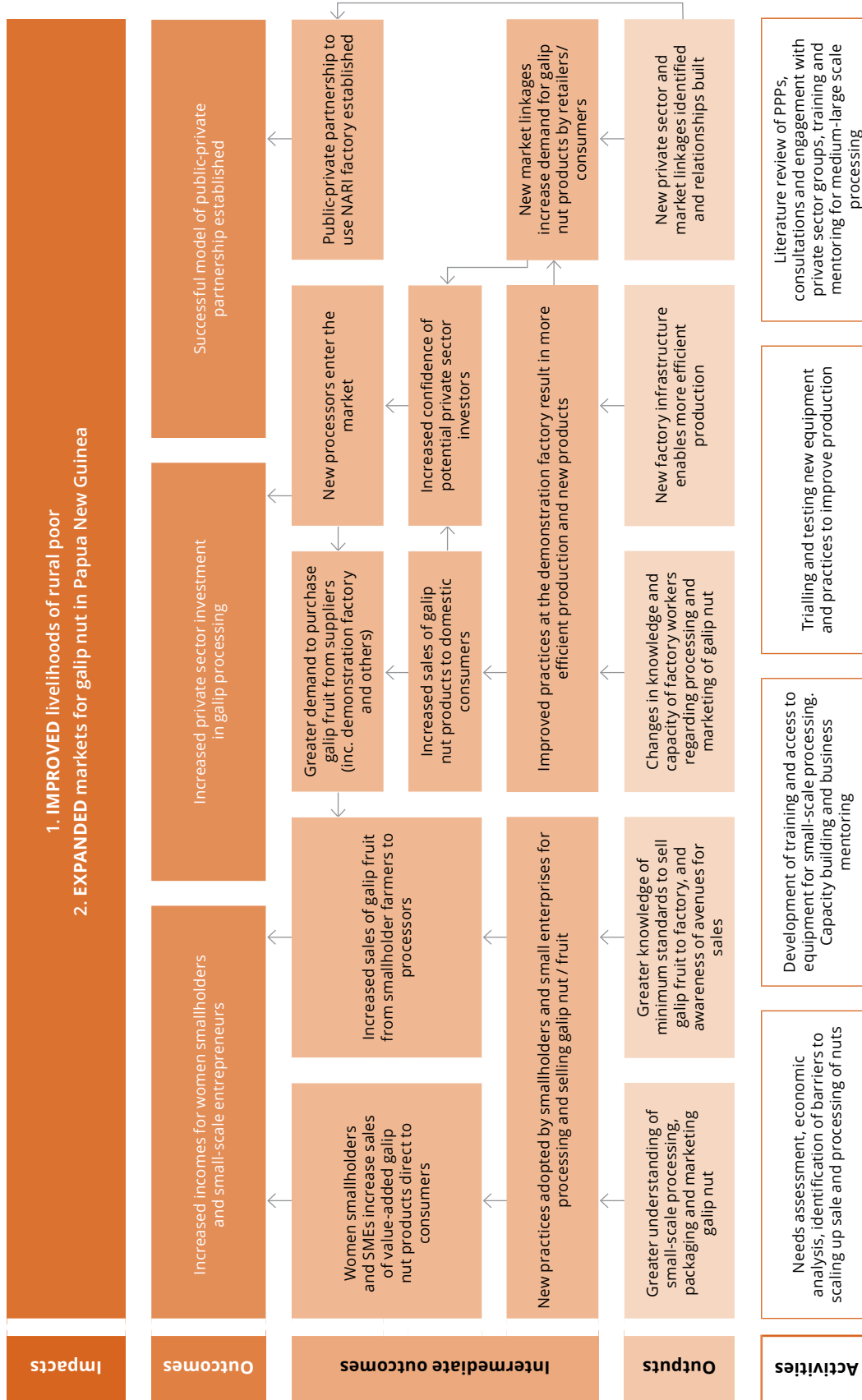


Appendices

Appendix 4.1: Stakeholders consulted

Name	Role	Organisation
Professor Helen Wallace	Professor in Agricultural Ecology, (Project Leader)	Griffith University
Dr Birte Komolong	Program Director, Agriculture Systems	National Agricultural Research Institute
Mr Godfrey Hannet	Research Associate	National Agricultural Research Institute
Mrs Dalsie Hannet	Junior Scientist	National Agricultural Research Institute
Mrs Dorothy Luana	Managing Director	Devine Management Services Ltd
Mr Brett Hodges	Research Associate	University of the Sunshine Coast
Ms Emma Kill	Social Researcher	University of the Sunshine Coast
Mr Theo Simos	Marketing Specialist	University of Adelaide
Mr Tio Nevenimo	Production Scientist	Previously National Agricultural Research Institute; now International Fund for Agricultural Development (galip nut industry)

Appendix 4.2: Theory of change





Appendix 4.3: Project team members

#	Team member	Gender	International/National Researchers
1	Professor Helen Wallace	F	International
2	Mr Bruce Randall	M	International
3	Dr Jen Carter	F	International
4	Dr Elektra Grant	F	International
5	Dr Graham Ashford	M	International
6	Professor Stephen Trueman	M	International
7	Mr Stefan Lippistch	M	International
8	Mr Kim Jones	M	International
9	Mrs Votasi Mackenzie-Reur	F	National
10	Dr Chris Searle	M	International
11	Ms Jo Roberts	F	International
12	Mr Theo Simos	M	International
13	Mr Craig Johns	M	International
14	Dr Nora Omot	M	National
15	Mrs Dalsie Hannett	F	National
16	Mr Tio Nevenimo	M	National
17	Mr Godfrey Hannett	M	National
18	Ms Isodora Ramita	F	National
19	Mr Seniorl Anzu	M	National

Appendix 4.4: Research outputs

Publication	Peer- reviewed	Author (gender, nation)
Journal articles		
Bai SH, Brooks P, Gama R, Nevenimo T, Hannett G, Hannett D, Randall B, Walton D, Grant E and Wallace HM (2019) 'Nutritional quality of almond, canarium, cashew and pistachio and their oil photooxidative stability', <i>Journal of Food Science and Technology</i> , 56:792–798.	Yes	Bai (female, Australia) Brooks (male, Australia) Gama (male, Zimbabwe) Nevenimo (male, PNG) Hannett G (male, PNG) Hannett D (female, PNG) Randall (male, Australia) Walton (male, Australia) Grant (female, Australia) Wallace (female, Australia)
Bai SH, Darby I, Nevenimo T, Hannett G, Hannett D, Poienou M, Grant E, Brooks P, Walton D, Randall B and Wallace HM (2017) 'Effects of roasting on kernel peroxide value, free fatty acid, fatty acid composition and crude protein content', <i>PLoS one</i> , 12:9.	Yes	Bai (female, Australia) Darby (male, Australia) Nevenimo (male, PNG) Hannett G (male, PNG) Hannett D (female, PNG) Poienou (male, PNG) Grant (female, Australia) Brooks (male, Australia)
Bai SH, Nevenimo T, Hannett G, Hannett D, Jones K, Trueman SJ, Grant EL, Walton D, Randall B and Wallace HM (2019) 'Freezing, roasting and salt dipping impacts on peroxide value, free fatty acid and fatty acid concentrations of nut kernels', <i>Acta Horticulturae</i> . 1256:71–75.	Yes	Bai (female, Australia) Nevenimo (male, PNG) Hannett, G. (male, PNG) Hannett, D. (female, PNG) Jones (Male, Australia) Trueman (male, Australia) Grant (female, Australia) Walton (male, Australia) Randall (male, Australia) Wallace (female, Australia)
Bai SH, Tahmasbian I, Zhou J, Nevenimo T, Hannett G, Walton D, Randall B, Gama T and Wallace HM (2018) 'A non-destructive determination of peroxide values, total nitrogen and mineral nutrients in an edible tree nut using hyperspectral imaging', <i>Computers and Electronics in Agriculture</i> , 151:492–500.	Yes	Bai (female, Australia) Tahmasbian (male, Australia) Zhou (male, Australia) Nevenimo (male, PNG) Hannett (male, PNG) Walton (male, Australia) Randall (Male, Australia) Gama (female, Zimbabwe) Wallace (Female, Australia)



Publication	Peer- reviewed	Author (gender, nation)
Bai SH, Trueman SJ, Nevenimo T, Hannett G, Randall B and Wallace HM (2019) 'The effects of tree spacing regime and tree species composition on mineral nutrient composition of cocoa beans and canarium nuts in 8-year-old cocoa plantations', <i>Environmental Science and Pollution Research</i> , 26:22021–22029.	Yes	Bai (female, Australia) Trueman (male, Australia) Nevenimo (male, PNG) Hannett (male, PNG) Randall (male, Australia) Wallace (female, Australia)
Bai SH, Trueman SJ, Nevenimo T, Hannett G, Bapiwai P, Poienou M and Wallace HM (2017) 'Effects of shade-tree species and spacing on soil and leaf nutrient concentrations in cocoa plantations at 8 years after establishment', <i>Agriculture, Ecosystems & Environment</i> , 246:134–143.	Yes	Bai (female, Australia) Trueman (male, Australia) Nevenimo (male, PNG) Hannett G (male, PNG) Bapiwai (male, PNG) Poienou (male, PNG) Wallace (female, Australia)
Han Y, Liu Z, Khoshelham K and Bai SH (2021) 'Quality estimation of nuts using deep learning classification of hyperspectral imagery', <i>Computers and Electronics in Agriculture</i> , 180:105868.	Yes	Han (male, China) Liu (male, China) Khoshelham (male, Australia) Bai (female, Australia)
Hannett G, Singh K, Fidelis C, Farrar MB, Muqaddas B and Bai SH (2021) 'Effects of biochar, compost, and biochar-compost on soil total nitrogen and available phosphorus concentrations in a corn field in Papua New Guinea', <i>Environmental Science and Pollution Research</i> , 28(21):27411–27419.	Yes	Hannett, G (male, PNG) Singh (female, Australia) Fidelis (male, PNG) Farrar (male, Australia) Muqaddas (female, Australia) Bai (female, Australia)
Malmir M, Tahmasbian I, Xu Z, Farrar MB and Bai SH (2020) 'Prediction of macronutrients in plant leaves using chemometric analysis and wavelength selection', <i>Journal of Soils and Sediments</i> , 20(1):249–259.	Yes	Malmir (male, Iran) Tahmasbian (male, Australia) Xu (male, Australia) Farrar (male, Australia) Bai (female, Australia)
Malmir M, Tahmasbian I, Xu Z, Farrar MB and Bai SH (2019) 'Prediction of soil macro-and micro-elements in sieved and ground air-dried soils using laboratory-based hyperspectral imaging technique', <i>Geoderma</i> , 340:70–80.	Yes	Malmir (male, Iran) Tahmasbian (male, Australia) Xu (male, Australia) Farrar (male, Australia) Bai (female, Australia)
Tahmasbian I, Wallace HM, Gama T and Bai SH (2021) 'An automated non-destructive prediction of peroxide value and free fatty acid level in mixed nut samples', <i>LWT – Food Science and Technology</i> , 143:110893.	Yes	Bai (female, Australia) Wallace (female, Australia) Gama (female, Zimbabwe) Tahmasbian (male, Australia)

Appendix 4.4: Research outputs (cont.)

Publication	Peer- reviewed	Author (gender, nation)
Conference Papers		
Bai S, Wallace H (2021) 'Underutilized forest food systems', ANH Academy Week, Pakistan.	No	Bai (female, Australia) Wallace (female, Australia)
Jones K, Nevenimo T, Hodges B, Bai S, Hannet G, Hannet D, Grant E, Randall B and Wallace H (2017) 'Construction and operation of an energy efficient, solar assisted, drying system for <i>canarium</i> nuts', VI International Conference Postharvest Unlimited, Spain.	Yes	Bai (female, Australia) Jones (male, Australia) Hodges (male, Australia) Nevenimo (male, PNG) Hannett G (male, PNG) Hannett D (female, PNG) Randall (male, Australia) Grant (female, Australia) Wallace (female, Australia)
Bai S, Trueman S, Wilson R, Keller A, Hannet G and Wallace H (2018) 'Nutrient competition of cacao and coffee with shade trees', <i>International Agroforestry Conference</i> , Nepal.	No	Bai (female, Australia) Trueman (male, Australia) Keller (male, Germany) Hannett, G (male, PNG) Wilson (female, Australia) Wallace (female, Australia)
Bai S, Trueman S, Wilson R, Keller A, Hannet G and Wallace H (2019) 'Root studies in agroforestry systems – a case study of coffee and cocoa trees', 4th World Congress on Agroforestry, France.	No	Bai (female, Australia) Trueman (male, Australia) Kellwer (male, Germany) Hannett, G (male, PNG) Wilson (female, Australia) Wallace (female, Australia)



Appendix 4.5: Project evaluation framework

The data and process used for addressing each of the key evaluation questions (KEQs) is summarised in the table. Bold questions are high priority and were explored in more depth.

Key Evaluation Question	Evidence/information required	Data sources	Data collection and analysis approach
1. What was the project's theory of change; and how did this evolve during implementation? <ul style="list-style-type: none"> - Was the theory of change appropriate to the project context and desired results? 	<ul style="list-style-type: none"> Documented theory of change at project commencement Information on subsequent changes Information on project context Perspectives of key stakeholders regarding appropriateness of the theory of change 	<ul style="list-style-type: none"> Project concept / design documents and variations Project progress reports, annual plans, etc. Key stakeholders (project managers and collaborating partners, program manager/ coordinator, government authorities, producers, businesses) 	<ul style="list-style-type: none"> Desk review of available documents Interviews with key stakeholders Triangulation of findings from different sources Project verification workshops
2. What outcomes (intended and unintended) has the project achieved or contributed to? <ul style="list-style-type: none"> - What was the unique knowledge contribution of the project/cluster that was/is expected to influence practice/policy? - To what extent is there evidence of adoption of new practices based on research process and findings? 	<ul style="list-style-type: none"> Robust, documented evidence of progress towards planned outputs and outcomes (including progress along adoption pathways), and any unintended consequences Theory of change assessment from KEQ1 Perspectives of key stakeholders, to test/validate written reporting, including 'next users' of research outputs 	<ul style="list-style-type: none"> Annual and/or final reports Mid-term and/or final reviews Key stakeholders (as above) 	<ul style="list-style-type: none"> Desk review of available documents Interviews with key stakeholders Triangulation of findings from different sources Project verification workshops ACIAR progress assessment and analysis tools (e.g. Table 13 and Table 14)
3. How did project activities and outputs contribute to the outcomes achieved? <ul style="list-style-type: none"> - To what extent and how did they differ from what was planned? 	<ul style="list-style-type: none"> Theory of change assessment from KEQ1 Documented evidence of impact pathways, as per KEQ2 Perspectives of key stakeholders including 'next users' of research outputs 	<ul style="list-style-type: none"> Annual and/or final reports Mid-term and/or final reviews Key stakeholders (as above) 	<ul style="list-style-type: none"> Documentation review, stakeholder interviews, triangulation, verification workshops Analysis of adoption and impact pathways, including 'next users' (e.g. Table 13 and Table 14)

Appendix 4.5: Project evaluation framework (cont.)

Key Evaluation Question	Evidence/Information required	Data sources	Data collection and analysis approach
<p>4. What strategies were adopted to address gender equity and social inclusion and how effective were these?</p> <ul style="list-style-type: none"> – How did the project impact men and women differently? 	<ul style="list-style-type: none"> • Evidence of analysis/awareness of the potential gender equity issues that may impact on the project • Evidence of steps taken to address the issues identified • Evidence of level of participation of women and men in research activities • Evidence on changes in women's and men's control of assets, resources and decision making, and to gender equity (e.g. through impacts on female researchers; gendered knowledge generation; influence on inclusivity within partner organisations) • Perspectives of key stakeholders 	<ul style="list-style-type: none"> • Documented gender strategy or analysis (if available) • Existing reports providing gender-disaggregated data and/or discussion of gender issues, for example, annual and/or final reports, mid-term and/or final reviews • Any existing gender audits or inclusion-focused reviews • Key stakeholders (as above) 	<ul style="list-style-type: none"> • Documentation review, stakeholder interviews, triangulation, verification workshops • Gender analysis to explore the level and type of participation of men and women, and influence on positive or harmful gender norms
<p>5. How did management arrangements impact delivery of the project?</p> <ul style="list-style-type: none"> – What other factors influenced project performance? 	<ul style="list-style-type: none"> • Any existing reporting and commentary on management arrangements • Perspectives of key stakeholders • Evidence of contextual factors external to the project that may have impacted performance 	<ul style="list-style-type: none"> • Annual and/or final reports • Mid-term and/or final reviews • Key stakeholders (as above) 	<ul style="list-style-type: none"> • Documentation review, stakeholder interviews, triangulation, verification workshops • ACIAR progress assessment tools (e.g. Table 14)
<p>6. How well did the project align with and contribute to the overall goals of its umbrella program?</p> <ul style="list-style-type: none"> – To what extent has the programmatic approach added value at project level? 	<ul style="list-style-type: none"> • Assessment of KEQs 1–5 • Information on program goal and approach • Relevant existing reporting and commentary • Perspectives of key stakeholders 	<ul style="list-style-type: none"> • Annual and/or final reports • Mid-term and/or final reviews • Key stakeholders (as above) 	<ul style="list-style-type: none"> • Assessment of consistency and value-add, based on analysis for KEQs 1–5 and supplementary program-level documentation, stakeholder interviews and verification workshops

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