Evaluation: Pacific Response to Coconut Rhinoceros Beetle Programme

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Acronyms

BCA	Biocontrol Agent
BECC	Biosecurity Emergency Coordinating Committee
BSI	Biosecurity Solomon Islands
BV	Biosecurity Vanuatu
COVID-19	The disease caused by the SARs-CoV II virus
CRB	Coconut Rhinoceros Beetle
CRB-G	A generalised category denoting CRB clades that are resistant to strains of OrNV currently in the Pacific.
CRB-S	A generalised category denoting CRB clades from 20th Century Pacific Incursions
DFAT	Australia's Department of Foreign Affairs and Trade
DGA	Direct Grant Agreement
EDF	European Development Fund
FAO	United Nations Food and Agriculture Organisation
FAOSTAT	FAO Statistics Website https://www.fao.org/faostat/en/#home
GFA	Grant Funding Agreement
GPPOL	Guadalcanal Plains Palm Oil Ltd
GPS	Global Positioning System
HH	Households
IPM	Integrated Pest Management
KIK	Papua New Guinea's Kokonas Indastri Koporesen (PNG)
KPSI	Kokonut Pacific Solomon Islands
LRD	SPC's Land Resources Division
MAL	Solomon Islands' Ministry of Agriculture and Livestock (SI)
MALFFB	Vanuatu's Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity
MEL	Monitoring, Evaluation and Learning
MERL	Monitoring, Evaluation, Research and Learning
MFAT	New Zealand's Ministry of Foreign Affairs and Trade
NAQIA	Papua New Guinea's National Agriculture Quarantine and Inspection Authority
NARES	National Agricultural Research and Extension System
NARI	Papua New Guinea's National Agricultural Research Institute
OPRA	Oil Palm Research Association Inc
OrNV	Oryctes nudivirus
PESC	Pacific Ecological Security Conference
PF	New Zealand Aid's Partnership Fund
PHAMA Plus	The Pacific Horticulture and Agriculture Market Access Programme (DFAT and MFAT)
PIC	Pacific Island Country
PPPO	Pacific Plant Protection Organisation
RBD	Refined, Bleached and Deodorised
RTMPP	Regional Technical Meeting on Plant Protection
SPC	The Pacific Community
TOC	Theory of Change
USDA	United States Department of Agriculture
VARTC	Vanuatu Agricultural Research and Technical Centre

NB: Unless otherwise denoted all currency figures are in New Zealand Dollars

This report represents the views of the Mazi Group and does not necessarily reflect the views of MFAT.

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Figure 1: Coconut Rhinoceros Beetle (Oryctes rhinoceros) Mt Diamond Adventist Secondary School, PNG.

Executive Summary

Coconut Rhinoceros Beetle (CRB) (*Oryctes rhinoceros*) is a major pest of coconut and oil palm. It originally invaded the Pacific region at the beginning of last century, but was eventually kept in check by the introduction of a viral biocontrol agent (*Oryctes nudivirus - OrNV*). Since 2007, however, invasions of a new strain of beetle that is poorly controlled by the existing strains of virus has been spreading rapidly. In the south Pacific region this new wave of invasion centred on Melanesia. MFAT led the response to this new threat with an initiative combining biocontrol and biosecurity interventions.

The *Pacific Response to Coconut Rhinoceros Beetle Programme* (*CRB Response Programme*) is a large, $18 million, five-year initiative that commenced in October 2019, and is due to end in December 2024. It has the following four goals to:

Goal 1. Limit the spread of CRB to new islands and locations, and contain it.
Goal 2. Reduce existing populations in areas where it has already invaded to lessen impact on coconut and oil palm industries.
Goal 3. Find and develop long term solutions to management of the pest through biocontrol and integrated pest management.
Goal 4. Enhance Pacific Island regional capacity in the detection and response management to incursions of invasive pests.

Implementation arrangements have been spread across three main delivery partners including AgResearch, the Land Resources Division (within the Pacific Community) (SPC-LRD), and the Ministry of Agriculture and Livestock (MAL) (Solomon Islands). These three then further partnered with six local delivery agencies across Papua New Guinea, Solomon Islands, and Vanuatu. These complex management agreements were overseen by a Programme Manager directly engaged by MFAT. This Evaluation was commissioned in December 2023 and was completed in June 2024.

Relevance

CRB presents an existential threat to Pacific coconut and oil palm livelihoods systems at all levels. The economic, cultural, tourism, food security, and environmental impacts of uncontrolled CRB infestations will not only undermine the agricultural economies and livelihoods of the countries in which it is currently spreading, but threaten those of the wider Pacific, and tropical countries globally.

The decision for New Zealand to help combat the re-emergence of CRB in the Pacific and particularly in Melanesia was therefore highly relevant to its vision to "*support prosperity and stability in the Pacific and beyond*".

Furthermore, the options for Pacific Governments, businesses, and communities to manage CRB without a biocontrol are minimal. Hence, for New Zealand to focus its funding on finding an effective biocontrol agent (BCA), while at the same time slowing the spread of the beetle, could not have been more relevant. A strong, donor-supported, regional response is the only viable option to combating invasive pests in the Pacific.

Effectiveness

The *CRB Response Programme's* Goals, while appropriate, were aspirational statements. These Goals needed to be underpinned by outcomes that more clearly defined the level of practice change that could reasonably be delivered in the five years. Moreover, because the outcomes were not developed upfront, unrealistic expectations were created amongst the stakeholders. For example, some stakeholders did not appreciate that the establishment of effective BCAs and IPM can, at times, be a decade's long process. While considerable efforts were made in 2021 to develop a Theory of Change (TOC) and Monitoring and Evaluation Framework (MEL), the subsequent ownership and use of these tools was limited. While the Evaluation Team considers that commendable progress has been made towards each of the four Goals, an improved logic would have helped the Programme to better structure its delivery arrangements, adapt to evolving needs, and communicate its achievements.

The Programme was also significantly impacted by the COVID-19 pandemic. While MFAT was able to compensate to some extent by extending parts of the Programme[1], and while innovations by the delivery partners helped to mitigate the worst of the impacts, the delivery of Goals 1 and 2 of the Programme was nevertheless reduced.

For Goal 1, the lockdowns and travel restrictions meant that the *CRB Response Programme* could only partially limit the spread of CRB. Delimiting surveys indicate that between 2019 and 2023 CRB incursions expanded by around 5,500 km2 (or 50%), while the infection localities (islands and/or regions) increased from 10 to 16. For Goal 2, the management work undertaken where CRB was already established did not appreciably reduce its impact in coconut or for smallholder oil palm farmers. The programme was more successful, however, in the commercial oil palm sector, where it helped to dramatically reduce the damage caused by the beetle, and hence to maintain the viability of the oil palm plantations. The difference was the capacity of the large oil palm plantations to invest in the costly and labour-intensive pest management strategies that were needed, these being options that were well outside the capabilities of smallholder coconut and oil palm farmers.

Figure 2: : Local researchers in Solomon Islands infect CRB with new viral biocontrol agents.

Broader success was achieved for Goal 3. The foundational work undertaken resulted in significant breakthroughs, including the identification of two novel BCAs. Firstly, a strain of OrNV was identified that widely infects beetle populations in field trials on Efate (Vanuatu) and Ghizo (Solomon Islands) and, based on genomic studies, will likely be effective as a classical biocontrol

[1] By 12 months for SPC and 2 years for MAL.

agent[2] against most Melanesian beetle populations. Secondly, a new strain of entomopathogenic fungi offers scope as an inundative biocontrol agent[3] for ongoing management of outbreak populations especially by killing CRB larvae developing in breeding sites. Should further testing of these BCAs confirm their efficacy, then this will not only combat the current outbreaks of CRB in the Pacific, but will prevent its further global spread. Success would mean both a massive return on investment for New Zealand's International Development Cooperation programme, and significant recognition for its contribution.

Partner capacity to sustain work across these three areas is progressing (Goal 4). The programme has successfully embedded core technical skills in its partner agencies. The collaboration between the international, regional, and national partners was solid, and specialists in all three target countries now have the knowledge, skills, and contacts to continue meaningful collaboration on the biocontrol work (provided the core contracted staff receive tenure).

Efficiency

The biocontrol dimensions of the *CRB Response Programme* received the greatest operational funding (72%), biosecurity received a more modest 28%. This relative imbalance reflects the high costs associated with undertaking core biocontrol research.

The co-contribution from partner agencies was solid, but largely sourced from within their existing budgets. It is unfortunate that as a result of the COVID-19 pandemic, budgetary constraints meant that partner Governments were unable to mobilise additional resources to help deal more effectively with such a major biosecurity emergency.

While the risks faced by biocontrol investments are high, the modest economic analysis undertaken by the project showed the potential long-term benefits in the Pacific for commercial copra production alone to be almost $300 million per year. If the substantial impact of uncontrolled CRB on oil palm production, the wider coconut and oil palm value chains, food security, the environment, culture, and tourism were also considered, then the benefits of success are likely to be much more substantial.

Sustainability

The *CRB Response Programme* made meaningful progress across all four Goals, but more needs to be done if it is to be fully sustainable. The major constraint on the Programme's sustainability relates to the external risk imposed by the varying leadership, management, and legislative frameworks of the partner countries, on which the CRB Programme has peripheral influence at best.

Future Opportunities

The Evaluation Team has prioritised options for future work based on:

1. **The pest-specific components needed to sustain and complete the current *CRB Response Programme*'s achievements.**

[2] A classical BCA will perpetuate in the environment once it is released and established.
[3] An inundative biocontrol agent is applied directly to a pest population in large volumes (e.g. a bio-pesticide). The BCA may not persist but require regular re-applications.

There are four recommendations for future work that align with the programme's existing Goals. However, the significant scope these entail, and the resource constraints faced by MFAT, may mean that some components will need to be deferred, else undertaken by an alternative donor. If this is the case, then MFAT should focus its follow-on contribution on Component 3, to confirm the efficacy of the novel BCAs in both their stand-alone use, and within the emerging IPM frameworks.

- *Component 1: Regional and national stakeholders limit and contain the spread of CRB*: It is proposed that in the longer term this needs to be addressed by a Pacific-wide emergency response mechanism to invasive species, and not handled on a pest-by-pest basis. In the interim, follow-on support is needed to ensure that the biosecurity agencies in the three Melanesian partner countries protect the remaining CRB-free, but high-risk sites. A modest regional facility is also needed to rapidly characterise new Pacific invasions.
- *Component 2: Local stakeholders manage CRB through IPM strategies tailored to their specific needs and livelihoods*: Follow-on work needs to integrate CRB management technologies into broader IPM strategies. The scope of this work is long term and substantial if taken to its logical conclusions, while even the initial stages would be significant and costly. Delivery would also require a broader suite of delivery partners than those that currently exists. This work may particularly need to be deferred, or undertaken by an alternative donor.
- *Component 3: Local stakeholders have ready access to effective novel BCAs and genomic analysis capacity to help them manage CRB*. Ongoing support is needed for AgResearch, SPC-LRD, and their national partners to confirm the wide-spread efficacy of the emerging BCAs for CRB. Once proven, mechanisms are needed to then multiply, distribute, and apply these effective strains both locally and across the Pacific. Genomic characterisation of CRB and BCAs needs to be progressed to confirm the nature of new outbreaks, map spread, and target management options.
- *Component 4: Melanesian agencies and sector stakeholders have the capacity to detect and manage CRB*. Capacity development needs to be focused on the national agencies, on other local stakeholders, and on strengthening the multi-agency taskforce approach to ensure broad awareness and engagement. Capacity building needs to cover both technical skills and strategic, programme management skills relating to both biosecurity and biocontrol interventions.

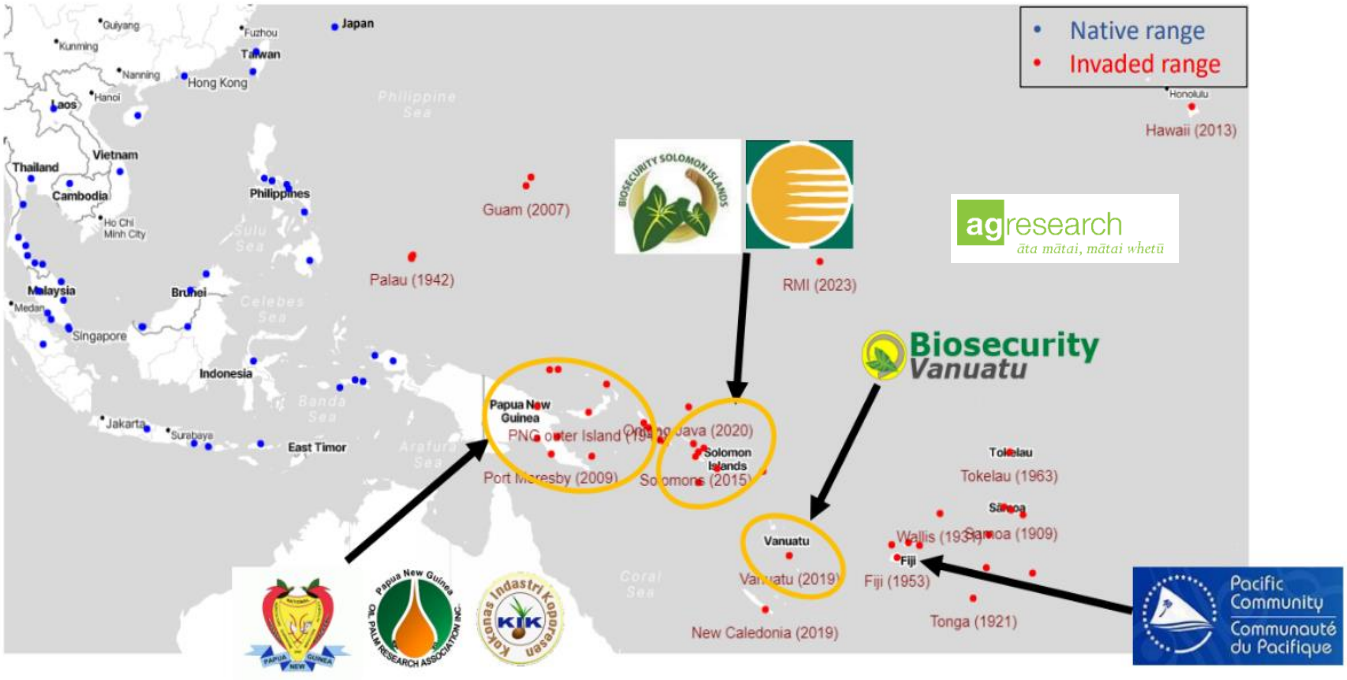
  This work should be complemented by strengthened resources for monitoring, evaluation, and learning (MEL), and for coordination.

2. **The broader issues that are beyond the scope of a CRB follow-on response, and are best addressed by broad biosecurity mechanisms rather than a pest specific programme.**

- The *CRB Response Programme* faced constraints due to gaps in legislative frameworks and organisational structures, as well as the varied leadership, planning, and management capacities of the national biosecurity agencies. MFAT should alert other Pacific biosecurity capacity programmes to the challenges the *CRB Response Programme* faced. Alternatively, MFAT may consider establishing or broadening its own mechanisms to address these foundational needs.

- Pest incursions are escalating across the Pacific, risking national and regional economies, livelihoods, and environments. The biosecurity response to CRB has shown the weaknesses in addressing these incursions on a pest-by-pest basis. The Pacific needs a coordinated, dedicated, long-term, optimally sized, and reliable 'emergency response facility' that can rapidly deliver the 'surge capacity' needed by Pacific countries to combat new pest incursions.

Figure 3: Map showing CRB spread, and collaboration agencies involved in the CRB Response Programme. The geographic focus of the Programme is circled in yellow and coincides with the 21st Century invasions. (Courtesy of AgResearch)



1 Introduction

Both coconut and oil palm are susceptible to damage and death caused by the coconut rhinoceros beetle (CRB, *Oryctes rhinoceros*) (Figure 1). This destructive pest is endemic to South and South-East Asia and was unintentionally introduced into the Pacific in 1909, first affecting Samoa. Between 1909 and 1989 waves of infestations resulted in the beetle spreading to thirteen major islands in eight Pacific Island nations. Beginning in the 1970s, these incursions were gradually kept in check by a strain of the *Oryctes* nudivirus (OrNV), a biocontrol that was introduced from the beetle's native range. Such virus-susceptible populations of CRB were broadly referred to as CRB-S.

OrNV continued to work well as a biocontrol until 2007, at which point CRB began to gradually re-emerge as a critical pest for coconut and oil palm. This resurgence was driven by three issues:

- The appearance in the north Pacific of a new haplotype of CRB that proved to be resistant to the existing strains of OrNV[4] already used as a biocontrol agent (BCA) in the Pacific islands.
- The reintroduction of several strains of CRB into the Pacific and their subsequent spread, potentially through increases in international and inter-island logistics (sea and air). Importantly, these reintroduced populations arrived without virus infection.
- Increasingly severe tropical storms linked to climate change. Storm damage results in significant palm death, with the abundance of decaying trunks acting as breeding sites that allow existing or newly arrived populations of CRB to rapidly increase.

CRB infestations in the south Pacific are currently focused on Papua New Guinea, Solomon Islands and Vanuatu in the Melanesian region. These fresh infestations were first detected in Port Moresby in 2009 and subsequently in Honiara in 2015. CRB then spread widely in both Papua New Guinea and Solomon Islands before new infestations were detected on the island of Efate, Vanuatu (2019) and in New Caledonia (2019). Recent confirmed infections in Timor Leste in 2021 (Paudel & Jackson, 2023) and the Marshall Islands (RMI) (2023) reflect that there is some ongoing spread in the Micronesian region and more broadly. To date, however, the Polynesian region remains largely free of this new wave of incursions, apart from Hawaii.

Regional biosecurity agencies responded appropriately to these incursions. In September 2015, the *Pacific Plant Protection Organisation* (PPPO) approved a Pacific regional commitment to combat CRB-G at the 8th PPPO Board Meeting in Nadi, Fiji. Concurrently, the *Regional Technical Meeting on Plant Protection* (RTMPP) at its 16th meeting in Nadi, Fiji, established a *Pacific Regional CRB Coordinating Committee* to harmonise the national efforts and solicit funding to support a response.

The FAO, DFAT, and MFAT then scoped the problem and provided initial support. Subsequently, MFAT became the lead donor through two projects:

- A two-year (2018-2020), $1.2 million, Partnership-Fund activity, *Improving Pest Management of Coconut Rhinoceros Beetles in Solomon Islands and Papua New Guinea* (PF9-548), that was implemented by AgResearch. This project initiated the

[4] See page 17 for a more nuanced understanding of the complexities of CRB clades.

search for potential biocontrol agents (BCAs), mapped incursions, and supported Papua New Guinea and Solomon Islands stakeholders in their response efforts.

- An eighteen-month (2018-2019), $1 million, bilateral contract, that was implemented by the *Land Resources Division* of the (*Secretariat of the) Pacific Community* (SPC-LRD). This project supported an immediate Solomon Islands response to limit the spread of CRB-G by cleaning up infected areas (especially by the felling of dead palms and by otherwise reducing CRB breeding sites) and raising awareness.

By late 2018, however, it was apparent that these initiatives were insufficient to address the severity of the CRB incursions. MFAT therefore designed a much larger, $18 million, five-year initiative[5] that integrated the previous elements and introduced new ones. The *Pacific Response to Coconut Rhinoceros Beetle Programme* commenced in October 2019, is due to end in December 2024, and has the following four goals to:

Goal 1. Limit the spread of CRB-G to new islands and locations, and contain it.
Goal 2. Reduce existing populations in areas where it has already invaded to lessen impact on coconut and oil palm industries.
Goal 3. Find and develop long term solutions to management of the pest through biocontrol and integrated pest management.
Goal 4. Enhance Pacific Island regional capacity in the detection and response management to incursions of invasive pests.

Initially, the *CRB Response Programme* included three sub-contracted components that were focused on Papua New Guinea and Solomon Islands where CRB was well established. These were:

Component 1. Support for research efforts to identify new biocontrol options and associated integrated pest management (IPM) practices that can suppress and control CRB populations. This was signed in Oct 2019 and was implemented by AgResearch[6] under an eventual $11.45 million, five-year contract.
Component 2. Support for regional CRB biosecurity and surveillance to limit the further spread of CRB. Efforts were focused on improving information, communication, and awareness. This was signed in Oct 2019, and implemented by SPC-LRD under an eventual $3.4 million, five-year contract.
Component 3. Support for the Solomon Island government's CRB surveillance and sanitation programmes. This was signed in Jan 2021, and implemented by the Solomon Island's government under an eventual $1.066 million, four-year direct grant.

Given the scope and complexity of the Programme's implementation arrangements, MFAT also engaged a full time Programme Manager to improve coherence and help manage risks. This arrangement was finalised in January 2020 under an eventual $1.5 million, five-year contract. The Programme Manager was based in-country (Honiara) until December 2023, before moving to Wellington.

The identification of CRB on Efate in 2019 resulted in the expansion of the Programme's initial cover to Vanuatu, support for which included the direct funding by MFAT for a Programme

[5] Initially designed as a four-year Programme, it was extended due to delays resulting from the COVID-19 pandemic.
[6] A New Zealand Crown Research Institute (CRI).

Coordinator to work with Biosecurity Vanuatu (BV). This arrangement was signed in Nov 2021, and implemented by BV under an eventual VUV3.927 million[7] direct grant.

In addition, both AgResearch and SPC-LRD have subcontracted arrangements in place that support local delivery partners in Papua New Guinea, Solomon Islands, and Vanuatu (see Box as well as Figure 3 below. Figure 10 in Section 6 shows the detailed funding mechanisms).

CRB Response Programme national partners

Papua New Guinea

* *National Agricultural Quarantine and Inspection Authority (NAQIA)*
* *Kokonas Indastri Koporesen (KIK)*
* *Oil Palm Research Association Inc. (OPRA)*

Solomon Islands

* *Ministry of Agriculture and Livestock and particularly Biosecurity Solomon Islands (MAL – BSI)*
* *Kokonut Pacific Solomon Islands (KPSI)*

Vanuatu

* *Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (MALFFB) and particularly Biosecurity Vanuatu (BV)*

2 Programme Evaluation

This End-of-Programme Evaluation of MFAT's *Pacific Response to Coconut Rhinoceros Beetle Programme* was commissioned by MFAT in late November 2023. The Evaluation's objectives are listed in the adjacent box, while its outcomes will be used by MFAT to:

1. Assess the relevance, efficiency, effectiveness, coherence, impact, and sustainability of its *CRB Response Programme*;
2. Inform decisions on whether to proceed with a further phase of the *CRB Response Programme*; and
3. Identify how that further phase could be improved to increase its effectiveness, efficiency, impact, coherence, and sustainability.

The Evaluation was conducted by three regionally relevant specialists: a Team Leader based in Dunedin (New Zealand); an Invasive Species

Evaluation Objectives

Objective 1*: To assess the extent to which managing the spread of CRB-G in the Pacific remains a priority for both the New Zealand International Development Cooperation Programme, and its partner countries in the Pacific (Relevance, Coherence)*

Objective 2*: To examine the progress being made in achieving the CRB Response Programme's outputs and outcomes (Effectiveness, Impact)*

Objective 3*: To assess the efficiency and sustainability of the CRB Response Programme (Efficiency, Sustainability)*

Objective 4: *To identify the key learnings of the CRB Response Programme to strengthen the impact of any future phase (Lessons learned for improvement)*

[7] Approximately NZ$55,000.

Entomologist based in Savusavu (Fiji); and a Systems Specialist based in Pacific Harbour (Fiji).

The Evaluation was run in two phases. Phase 1 (Planning) commenced in mid-December 2023, and culminated in late January 2024 with the approval of a detailed Evaluation Plan, and a review of the programme's technical literature (Mazi Group, 2024a).

Phase 2 (Delivery) included in-depth interviews, field missions, and analysis prior to the submission of this draft Evaluation on 21 May 2024.

Three in-person missions were undertaken:

1. New Zealand: 29 January to 2 February 2024 to engage with key programme managers and implementing partners in MFAT and AgResearch.
2. Papua New Guinea and Solomon Islands: 17 February to 2 March to visit key sites, engage with the local delivery partners, and attend the PNG CRB Task Force meeting held in Madang on 21 and 22 February 2024.
3. Vanuatu and Fiji: 11 to 19 March 2024 to visit key sites in Vanuatu, engage with the local delivery partners, and lead a workshop with SPC-LRD on 18 March 2024 in Fiji.

Mission summaries were prepared for Papua New Guinea (Mazi Group, 2024b), Solomon Islands (Mazi Group, 2024c), and Vanuatu (Mazi Group, 2024d). These were discussed with the relevant in-country personnel, sent to the implementing partners for comment, and submitted to MFAT's Evaluation Steering Committee, with whom the Evaluation Team constructively engaged throughout the planning and delivery of the Evaluation.

Subsequent to the field missions that occurred in February and March, the Evaluation Team undertook remote interviews during April with additional key informants. Overall, the Team engaged in discussions with 145 stakeholders from 43 organisations including Donor, Government, Private Sector, and Community representatives (see Annex 2).

Implementation of the Evaluation went smoothly, and largely in accordance with the Evaluation Plan. No significant limitations were encountered.

3 Relevance and coherence

3.1 Is combatting CRB still an important problem for the coconut and oil palm sectors in the Pacific?

CRB presents an existential threat to Pacific coconut and oil palm livelihoods systems at all levels. The economic, cultural, tourism, food security, and environmental impacts of uncontrolled CRB infestations will not only undermine the agricultural economies and livelihoods of the countries in which it is currently spreading, but threaten those of the wider Pacific, and tropical countries globally.

Coconut is a traditional foundation of many livelihoods within the Pacific region, providing food, materials, and shelter, and significantly contributing to cultural identity, aesthetics, and ecosystem services[8]. At the last Papua New Guinea census (2011) almost 25% of households[9]

[8] Including nutrient recycling, erosion control, improved infiltration, wind protection, and canopy shade for both natural and agroforestry systems.
[9] 329,693 HH representing 1.85 million people.

grew coconut for household use (food and materials), while 10% of households[10] also grew coconut for income (KIK, 2016).

Furthermore, extensive corporate plantings of both coconut and oil palm were established last century to meet world demand for lauric oils. It was, however, oil palm that came to dominate commercially due to its much greater productivity and profitability. In Papua New Guinea and Solomon Islands the oil palm sector is still viable and concentrated around corporate estates. The formal coconut sector on the other hand has been in steady decline for over two decades, not only due to its lower profitability but to the weak competitiveness of Pacific countries within the global marketplace (McGregor & Sheely, 2017) (Burkitbayeva & Davis, 2023). As a result, many of the estate plantings of coconut have been abandoned by their corporate owners, and ownership has passed to smallholder producers who now minimally manage the increasingly senile and low productivity plantings. These smallholders supply the aggregation businesses that are still exporting copra and/or crude[11] coconut oil. In some locations, there has been a limited revival in smallholder production of coconut to supply the higher value niche market for virgin coconut oil, usually locally refined, for use in food and cosmetic products. For many such smallholders the impacts of CRB are being somewhat moderated by surplus capacity, and/or options for alternative crops or livelihoods.

Figure 4: Farmers coconut plantation devastated by CRB (Efate, Vanuatu, March 2024)

Irrespective of the downturn in the formal coconut sector, it is clear that the economic, cultural, tourism, food security, and environmental impacts of uncontrolled CRB infestations pose a major threat to Pacific coconut and oil palm livelihoods systems at all levels. It therefore seems unfortunate that the Programme has conducted only one assessment of the impact of CRB, this being a small preliminary economic model (Dake, 2021) that was solely focused on the predicted regional impacts of CRB on coconut production[12]. This model predicts that across 19

[10] 134,655 HH representing 750,000 people.
[11] Minimally processed coconut oil that is exported predominantly to the Philippines and Indonesia for further refining, including bleaching and deodorising (RBD).
[12] Note that the study focused on on-farm production only (using 2018 FAOSTAT data), and did not include the impacts on processing, demand, incomes, employment, downstream value addition, or inter-industry influences. Nor did it include cultural, social, and environmental impacts.

major Pacific Island Countries (PICs) the formal coconut sector could, in the longer term (up to 20 years), face 48 per cent losses (estimated at $358 million/year[13]) if CRB remains uncontrolled, but that effective biocontrol could reduce these losses to 9 per cent (estimated at $65 million/year)[14].

These figures are already alarming, yet are undoubtedly an underestimate of the total impacts that CRB would have on the coconut and oil palm sectors if all of its economic, social, environmental, and cultural effects were taken into consideration.

Importantly, the impacts of CRB are not felt homogenously. Much of the discussion on CRB impacts by programme stakeholders focused on the formal sectors in which the economic impacts of CRB are yet to escalate to the levels predicted. Yet while the estate and smallholder plantings of both oil and coconut palm are undeniably important for the economies of the larger islands, it is within the informal coconut sector, especially on the smaller and more remote islands, that CRB is likely to have its deepest societal impacts. There are over 1,000 inhabited small islands across Melanesia, the diets of the local communities are largely based around coconut, and these communities have little in the way of the safety nets that are elsewhere provided by surplus capacity or alternative livelihoods. Solid research identifies that many of these small islands are already on the threshold of food insecurity (Bourke, 2019) (Swete Kelly, 2019). CRB incursions are therefore likely to be having a disproportionately severe impact on the food security and nutrition of these communities when compared with the 'mainland' communities, a fact that most national programme partners have not taken into account when prioritising their biosecurity or management options.

The Evaluation finds it unfortunate that the Programme did not collect more nuanced data in the region on the immediate and ongoing impacts of CRB incursions on the different commercial, smallholder, and indigenous livelihood systems that are dependent on coconut and oil palm[15]. Any future work should consider a comprehensive analysis of the impact of CRB incursions and their management across the range of economic, environmental, and social situations, as a basis for better targeting interventions and for measuring their progress and impact (see Recommendation 4).

3.2 Is the CRB response still a priority for Pacific stakeholders?

Governments, Industry and Communities all regard CRB as hugely relevant to sector performance, their viability, their livelihoods, and their lifestyles. Operationalising this relevance has, however, varied for different stakeholders due to the availability of resources and/or viable options.

Technicians and biosecurity agencies see CRB as highly relevant, but have had difficulty advocating with their Governments for supplementary support due to budgetary constraints. Similarly, the commercial sector and the communities all see CRB as highly relevant, but have again been constrained in their responses.

The *CRB Response Programme* has tracked the damage levels of CRB incursions into new islands for both coconut and oil palm. The observations for coconut show that between 40 per

[13] Dake estimated the loss at $US212m/yr
[14] Dake estimated the loss at $US38m/yr
[15] The Programme Manager does plan to undertake some limited qualitative assessments in the remaining months of the Programme.

cent and 90 per cent of palms show damage within two to three years of initial incursion, and that between 50 per cent and 80 per cent of palms die within five to ten years without intervention (Marshall, 2024). These damage levels align with those that occurred during the previous (20th century) incursions into the Pacific.

The risks posed by CRB are not exaggerated, and over the years several regional technical forums (see box) have attempted to raise the alarm. Yet despite the concerns of technical staff, the political responses to the incursions were mixed and generally minimal. The supplementary resources and regulation that are necessary to meet the threats have rarely materialised, and it is particularly concerning that neither the Papua New Guinea nor the Solomon Islands biosecurity agencies have received supplementary Government funds to help tackle the current incursions or halt the beetle's spread.

Significant CRB Responses by Regional Agencies

Sep 2015: *Regional Commitment by the Pacific Plant Protection Organisation (PPPO) (8th PPPO Board Meeting, Nadi, Fiji)*
Sep 2015: *Pacific Regional CRB Coordinating Committee established under the Regional Technical Meeting on Plant Protection (RTMPP) to coordinate national efforts and solicit funding. (16th RTMPP Nadi, Fiji)*
Sept 2017: *Sub-regional consultative meetings (Suva Fiji)*
Dec 2019: *Sub-regional consultative meeting (Kolonia, Federated States of Micronesia)*
Mar 2023: *Pacific Islands Heads of Agriculture and Forestry (HOAFs) call for action to address the issue (Suva, Fiji)*
Oct 2023: *Sub-regional consultative meeting (Honiara, Solomon Islands)*

Part of the reason for these limited supplementary resources was the severely limiting impacts of the COVID-19 pandemic on the already tight budgets, while the lockdowns also curtailed the activities of the national biosecurity staff and the Programme's international specialists. CRB incursions therefore progressed, the beetle inevitably gained a stronger foothold than it otherwise would have, and it may be that but for the pandemic some of the infestations would currently be better controlled.

Hence it is not surprising that a late 2022 survey across 24 Pacific states revealed that biosecurity staff from countries already dealing with new CRB-incursions, scored their preparedness as either "limited", or "some", while those from uninfected countries scored their preparedness as "none" or "minimal" (PESC, 2022). To progress the response, regional technical experts collaborated during the Oct 2022 *Pacific Ecological Security Conference*[16] held in Palau to produce a *Strategic Action Plan for Coconut Rhinoceros Beetle* (PESC, 2022).

As for the private sector across Melanesia, there was significant variation in the level of concern it showed for the emergence of a resurgent CRB. The Evaluation noted that the oil palm sector was deeply concerned and thus heavily engaged with the *CRB Response Programme*, but that the coconut sector's concerns were much more variable, and its engagement much more subdued (see also Sections 4.3.1 and 4.3.2).

[16] Supported by USDA, East West Centre, and SPC-LRD.

3.3 Relevance for New Zealand's IDC programme

The decision for New Zealand to help combat the re-emergence of CRB in the Pacific and particularly in Melanesia was therefore highly relevant to its vision to "support prosperity and stability in the Pacific and beyond".

CRB not only presents an existential threat to the agricultural economies and livelihoods of the countries in which it is currently spreading, but to those of the wider Pacific, and to tropical countries more generally. The decision for New Zealand to help combat the re-emergence of CRB in the Pacific and particularly in Melanesia was therefore highly relevant to its vision to "*support prosperity and stability in the Pacific and beyond*".

Due to climate change, the range of many species is extending across the globe, including that of invasive pests, and CRB's recently established footholds in Melanesia and Micronesia are already widely impacting on lifestyles and livelihoods, particularly of the most vulnerable.

There are two further interrelated issues that are highly relevant to MFAT's engagement. Firstly, a strong, donor-supported, regional response is the only viable option for combating invasive pests in the Pacific. Most regional Governments being small lack the capacity to independently manage an emergency response. Yet the evidence shows that if significant donor support can be rapidly mobilised in tandem with a mutual commitment from Government, then local agencies can be sufficiently empowered to achieve outcomes that would otherwise have seemed impossible. The partnership between DFAT, MFAT, and NAQIA to contain the 2020 African Swine Fever outbreak in the highlands of Papua New Guinea is a recent example of one such effective partnership (PHAMA Plus, 2021). Moreover, the fact that it occurred during the COVID-19 lockdowns says volumes about what can be achieved through partnership and commitment even when circumstances are fraught.

Secondly, as this Evaluation will argue, the options for Pacific Governments, businesses, and communities to manage CRB without a biocontrol, are minimal. Hence, for New Zealand to focus its funding on finding an effective biocontrol agent (BCA) could not be more relevant. Investments in the development of BCAs are inherently risky, needing as they do long-term commitments with no guarantee of success. Pleasingly, New Zealand's *CRB Response Programme* is showing promise. While ongoing work is needed to confirm the effectiveness of the new BCAs identified, success in this arena would mean both a massive return on investment for New Zealand Aid, and significant global recognition for its contribution (see Recommendation 1).

3.4 Coherence of donor and stakeholder response

The CRB Response Programme engaged with other agencies, programmes, and donors working on invasive pests to ensure the coherence of their work.

All partners engaged in the *CRB Response Programme* at the regional (AgResearch and SPC-LRD) and national levels have long-term experience with invasive pests, and excellent contacts across the region and globally. The Programme's links with other regional CRB initiatives (see box) were therefore strong, and included the cross fertilisation of information, and collaboration in key regional forums, conferences, and workshops.

In addition, the appointment of a Programme Manager was particularly useful in building coherence with other MFAT programmes, and in ensuring the Programme's alignment with other donor initiatives.

The important role that the *CRB Response Programme* has played in building coherence is further confirmed by its active and timely engagement in regional forums, such as the October 2022 *Pacific Ecological Security Conference* and the July 2024 *Coconut Pest Conference*. These engagements reflect the profile of the Programme's partners, and their capacity to constructively contribute to key regional debates.

Linkages with Other Programmes and Agencies

- *MFAT's **Enhanced Pacific Biosecurity Partnership** (EPBP) and **Enhanced Pacific Market Access Partnership** (EPMAP;)*
  *SPC's **Pasifika NiuNet**: a new collaborative platform for an integrated approach to coconut research and development in the Pacific;*
- *SPC-LRD's EU-funded **Coconut Industry Development for the Pacific** (CIDP) project; its biosecurity initiatives under the EU-funded **Pacific Regional Integration Support** (PRISE) Programme; and the Tuvalu-based **Coconut Sector Rehabilitation Programme**;*
- *DAFF's DFAT-supported **Pacific Biosecurity Strengthening Programme**;*
- *The DFAT/MFAT co-funded **Pacific Horticulture and Agriculture Market Access Programme** (PHAMA Plus);*
- *The ACIAR-funded **HORT/2016/185** and **HORT/2017/025** projects, both of which are being implemented in partnership with the University of Queensland (UQ), Australia;*
- *CSIRO's DFAT-supported CRB metagenomic research programme;*
- *The U.S. Departments of Agriculture, Defence, and the Interior, all of which provided short-term grants to help with the biosecurity concerns of regional governments;*
- *FAO's **Technical Cooperation Programme** (TCP).*

4 Effectiveness and Impact

4.1 Was the *CRB Response Programme* design and logic appropriate?

The CRB Response Programme's Goals, while appropriate, were aspirational statements. While these Goals remain important in moving forward, for the work that has already been undertaken, the underpinning of the goals with clearer outcomes that better defined the level of practice change that could reasonably be expected, may have had more pragmatic results, and may have been better understood by stakeholders.

The design of the *CRB Response Programme* was expedited through MFAT's emergency response process. Initially, a range of MFAT staff worked with partners to try and integrate their ideas into a cohesive logic, which would have been challenging enough with just the one partner, yet the Programme had three delivery partners, and six in-country partners. As such, apart from the four Goals, the conceptual underpinnings of the design were less solid than was needed.

As a result, the contracts signed with the delivery partners simply re-stated the Goals, and then focused on the defined Outputs (many of which were continuations of those defined for MFAT's previous initiatives in 2018). Linking the Goals and the Outputs were some preliminary

Outcomes that were "discussed with the partner" but ultimately left ill-defined. The expedited process therefore meant that the Programme lacked an intermediate logic to capture the anticipated change pathway, the cross linkages between components, the changes in beneficiary practice needed to achieve each Goal, and the meaningful monitoring and evaluation practices that were needed to track progress.

Because MFAT appreciated that further effort was needed to develop a coherent programme logic, a review was envisaged for 12 months. However, delays caused by the COVID-19 pandemic and contract startup meant that progress slowed, and that the planned review never eventuated. The insufficient logic in the original contracts has therefore remained largely unchanged throughout the *CRB Response Programme*.

It was not until MFAT's appointment of a dedicated Programme Manager in 2020 that significant effort was put into clarifying the Programme's Theory of Change (TOC), and building a Monitoring, Evaluation, and Learning (MEL) Framework that integrated the various contracted components (see Annex 3). Both the Programme Manager and the MFAT Lead Adviser worked on developing a TOC and MEL Framework in late 2021, and these have been used since 2022. The four original goals agreed with the implementing partners (and reflected in their contracts) formed the basis of the TOC. However, the late arrival of the MEL Framework meant that extensive retrofitting was required, which is ever a fraught process that seldom delivers clarity. The MEL Framework in this case needed to be fitted to the Outputs already agreed and the limited monitoring data already available, and was further constrained by the minimal resources allocated for the MERL activities. Although reporting against the MEL framework has been required since 2022, the ownership and coherence of the reporting varies considerably between the partners.

Overall, the challenges to the design and logic of the *CRB Response Programme* have meant that:

1. The *CRB Response Programme's* Goals, while appropriate, are aspirational statements. These Goals needed to be underpinned by clear outcomes that defined the level of practice change that could reasonably be expected. However, because these outcomes were not developed upfront, unrealistic expectations were created amongst the stakeholders. For example, the delivery of BCAs, and the integration of BCAs into relevant and realistic IPM packages (Goal 3), can take decades, and some stakeholder's expectations of Programme completion were seen to be unrealistic.
2. This lack of a shared understanding of 'what does success look like?' and 'how can we measure it?', has understandably led to a tendency at all levels to report on activities and Outputs, rather than on progress towards Outcomes, and on Impact.
3. While most Outputs were being appropriately delivered by the contractors and there was good evidence of adaptive management at the Output level, the lack of clear Outcomes meant that the changes in practice expected of public agencies, communities, farmers, and businesses were not defined and not measured. Consequently, the Programme lacked the means to appreciate the differing needs of the stakeholders, the impacts of CRB on varying livelihoods and value chains, and the likely relevance of the proposed tools.
4. Work became concentrated around the pre-existing partners, and the opportunity to consider broader partnerships (e.g. to include research, extension, or private sector) to better deliver beneficiary changes was constrained once the contracts were in place.

5. Monitoring and Evaluation have focused on the Outputs, and hence the data that was needed to track practice change, and progress in achieving the Goals, was patchy at best.
6. Overall, the Programme has few dedicated MEL resources.
7. The retrofitted TOC and MEL did not succeed in clarifying high-level expectations, and was poorly supported and owned by SPC, AgResearch, or MAL. It was not used to communicate the programme logic to stakeholders. No programme partner used either framework to help explain the Programme to the Evaluation Team. Furthermore, it was inevitable that the frameworks did not replace the existing reporting structure, but instead added a second, parallel requirement.

Finally, future work should include upfront and ongoing investment in MERL. It will be important that the potential partners be brought together prior to contracting to agree the overarching programme logic, and the resulting components, roles, and responsibilities. Resources should be included to support all MERL requirements. Development investments globally commit between 3% and 6% of their budgets to effective MERL reporting and communication, and it is suggested that any future investment aims for this level of investment (see Recommendation 3).

4.2 Was the spread of CRB contained and limited (Goal1)?

The CRB Response Programme could only partially limit the spread of CRB. Delimiting surveys indicate that between 2019 and 2023 the new CRB incursions expanded by around 5,500 km2 (or 50%), while the infection localities (islands and/or regions) increased from 10 to 16. Nevertheless, these were still commendable achievements that locally slowed the spread of the beetle, and that limited its expansion within the wider south Pacific.

Goal 1 of the *CRB Response Programme* was to *limit the spread of CRB-G to new islands and locations, and contain it*, in pursuit of which the Programme provided focused support to each country's biosecurity agency. Biosecurity efforts supported by the Programme included pheromone trapping, damage assessments, delimitation surveys, movement restrictions, regulation, and awareness campaigns. These efforts achieved some success in containing and limiting the spread of CRB. Five of the notable interim achievements were:

1. The Vanuatu Government through Biosecurity Vanuatu (BV) instituted targeted public awareness campaigns, surveillance of the main port and of shipping in Port Vila, and restrictions on ship lighting and on nighttime departures[17]. These

Figure 5: NAQIA staff demonstrate a CRB pheromone trap and artificial breeding site at the Pacific Adventist University in Papua New Guinea.

[17]Lights risk attracting beetles which can then 'hitch-hike' to new areas.

measures contained CRB to Efate and its immediate islands for five years, thereby preventing CRB incursion into the main coconut production islands of Malakula and Santo. Critical elements of this success were the broad political support for the response, the good leadership within BV, and the *CRB Response Programme's* engagement of a dedicated in-country coordinator and of up to 20 casual technicians to deliver the port surveillance, movement regulations, trapping, and sanitation. Given the limited resources, it was somewhat surprising that this worked as well as it did for as long as it did, there unfortunately being an outbreak of CRB that was detected on Santo in early May 2024.

2. KIK established a buffer zone around its Madang Coconut Germplasm repository that protected this important global resource[18] from CRB incursions.
3. The Programme's local and regional awareness campaigns resulted in early detection of new outbreaks (e.g. Efate, Vanuatu, in 2019; the Madang region of PNG in 2020; Dili, Timor Leste, in 2021; Majuro, Marshall Islands, in 2023; and Santo, Vanuatu, in 2024) allowing for early intervention and management.
4. Although there was significant spread of CRB between 2009 and 2020 that enabled it to become established on 12 new Pacific islands and/or countries, since 2021 the spread has slowed, only three further cases having been reported. It is possible that the *CRB Response Programme* contributed to this deceleration, particularly through its support for awareness campaigns of the pest and its infection pathways.
5. SPC and its local Partners have coordinated a modest awareness-raising campaign for growers, communities, and the general public in all three countries. The public messaging aspects were largely appropriate (see box on next page), and included information on identification, and the actions (cut, kill, burn) that can be undertaken by coconut growers and communities to help mitigate the threat. While the coverage and impact of the overall awareness campaign is yet to be assessed[19], it was apparent to the Evaluation Team during the Focus Group discussions with the local communities that there was a generally good level of understanding of the causes of CRB infestations, and of its life cycle and impacts. For the communities whose livelihoods were threatened by CRB, the beetle was an important talking point, and there were examples of initial messaging being widely promulgated by word-of-mouth. Importantly, these coconut communities were eager to share their own often insightful observations on the beetle's spread, on varietal susceptibility, on particular hot-spots, and on the potential roads to recovery. Only in PNG was there any evidence of misinformation, this related to a perceived correlation of beetle invasion with cell-phone towers.

Yet despite these successes, delimiting surveys indicate that between 2019 and 2023 the new CRB incursions expanded by around 5,500 km^2 (or 50%), while the infection localities (islands and/or regions) increased from 10 to 16.

The *CRB Response Programme's* progress might therefore seem modest, yet this needs putting into context. Although the Programme's initial work commenced in 2018, its major funding did not kick off until 2019, barely six months before domestic and international travel lockdowns were imposed due to the COVID-19 pandemic. These travel restrictions significantly affected

[18] Though noting that the collection's value has already been severely compromised by the nearby outbreak of Bogia Coconut Syndrome, a lethal phytoplasma disease that effectively prevents distribution of germplasm from this site.
[19] SPC-LRD plans a survey for later 2024

the Programme's implementation. For coconut, in fact, the major sanitation efforts at the community level were unable to begin in earnest until late 2022, and it is still too early to appreciate their impacts.

Furthermore, it was clear to the Evaluation Team that despite the handicaps the programme has faced, the work so far has firmly established the foundational tools and protocols that will be essential for future advocacy, planning, containment, and management (see box).

Foundational CRB Management Tools

* *Standardised tools for estimating palm damage and implementing CRB delimiting surveys.*
* *GPS tagged photographic monitoring of selected areas/sites for early detection and monitoring of damage.*
* *Clear guidelines for trapping and collection of specimens, and kits for sampling tissue for analysis.*
* *Improved, laboratory diagnostic methods to simplify molecular determination and virus detection.*
* *Improved molecular biology protocols to speed up sample throughput and analysis.*
* *Remote surveying of publicly available web-based photographs from selected sites for indications of damage from CRB attack.*
* *The establishment of an online CRB Database for shared information management between partners. This database records, maps, and shares monitoring information on CRB spread, damage assessments, and sanitation efforts.*

Through these tools the project has already:

1. Delineated the various clades of CRB in all three countries, including their emergence and spread over time, and their current geographic distributions. There are still a few gaps remaining, yet this work has significantly contributed to a real-time situational awareness of CRB's progress across the Pacific, to identifying invasion pathways, and to appreciating the complex interplay of CRB diversity with strains of the nudivirus. Hence, it is work that will provide a solid basis for the deployment of biological control tactics in the years to come.
2. Developed a solid understanding of the modes in which CRB spreads (which are largely associated with human activity, and particularly with the land and sea transport of goods and machinery). This has helped the biosecurity agencies target their efforts, such as the surveillance and the regulations imposed by BV on the port in Efate.
3. Significantly sped up the identification and characterisation of CRB when new incursions occur - it took several months to characterise invading CRB populations in Solomon Islands (2015), less than a month in Vanuatu (2019), and a few days in the Marshall Islands (2023).

However, despite these successes, the Evaluation Team also noted that in the achievement of Goal 1, there were aspects of the Programme's response that could have been improved, or logically enhanced:

1. In all three countries the initial biosecurity responses were assisted by Emergency Declarations and/or Ministerial Orders. These provisions were purposefully responsive and short term, aiming as they did to establish immediate powers for the biosecurity agencies to scope the problem and consider their options. Yet the legislation that backed these emergency tools was insufficient to effectively manage the domestic quarantine restrictions that were needed to contain the beetle. For example, in Solomon Islands, BSI was unable to restrict the domestic movement of high-risk materials (e.g. composts), undertake the needed surveillance, or issue sanctions.

Furthermore, the Ministerial Order that was issued in Vanuatu to fill some of the regulatory gaps was only applied to Efate, and did not allow for:

a. The surveillance/ regulation of cabotage (air/sea) movements across Vanuatu more generally;
b. The surveillance/ regulation of international shipping trade between Solomon Islands, Papua New Guinea, and Vanuatu;
c. Inspections and surveillance of high-risk vessels arriving in the islands of Malakula and Santo (which are particularly vulnerable given their dependence on coconut).

While all three countries are now working to close these regulatory gaps[20], wider regional assistance to all Pacific countries to review and strengthen their domestic quarantine regulations is considered essential, not only to contain CRB, but to exclude or contain other invasive pests that are threatening the region (see Recommendation 7).

2. The emphasis of the *CRB Response Programme,* and the largest allocation of its funding by far, was on the development of BCAs and the associated biocontrol technologies that are necessary to manage incursions (see Section 4.4). In consequence, SPC-LRD focused on the tools (delimitation surveys, pheromone trapping, information, and awareness) to the exclusion at times of more fundamental constraints. For instance, the Evaluation Team noted that the area in which the biosecurity agencies were struggling most was in the development of the plans, procedures, and partnerships that were needed to strategically manage their biosecurity responses within the resources they had available. All three biosecurity agencies are, in fact, still struggling to keep the planning of their CRB responses both realistic and strategic. For example, BSI published a strategic response plan to CRB's spread in Solomon Islands that was overly ambitious and beyond its limited resources. The plan was largely reactive, and was constrained by the lack of domestic quarantine regulations, while the repeal of the biosecurity 'emergency' declaration in 2021, the COVID-19 pandemic, and the Pacific Games held in Honiara in 2023, further diminished both the government's and the public's focus on the CRB threat, and the perception of the risk being posed. This experience demonstrates the need for strong, ongoing local leadership, planned advocacy, and coordination if the beetle's spread is to be effectively curbed. While some of these issues are beyond the scope of the *CRB Response Programme,* it seems clear that greater support for the strategic planning of the biosecurity agencies would have helped them to better manage these issues, and to focus their limited resources on to high-priority areas (see Recommendation 7).
3. The mapping undertaken by the Programme identified confirmed sightings. However, from a biosecurity perspective it is equally important to clearly define CRB Free, and CRB Uncertain areas, as this helps to focus limited resources on to protecting vulnerable areas. The Programme plans to expand its mapping accordingly.
4. Better resourcing and a broader vision for the public awareness campaign might have achieved stronger engagement. Messaging was very generic, and better profiling of audiences (producers; processors; policy makers; school children; and businesses (including shipping and wharf managers)) would have helped craft a more targeted and

[20] in Papua New Guinea a Biosecurity Policy was only gazetted in 2022/23, while a Biosecurity Bill is still being developed by NAQIA. In Vanuatu BV has drafted a Biosecurity Bill.

fit-for-purpose communications campaign, thereby enhancing the awareness and advocacy of more people, and catalysing more action (see Recommendation 5).

5. It is of particular note that the Permanent Secretaries of Agriculture in all three countries were well aware of CRB, but were unable to access timely updates on its spread, the measures being undertaken, or the progress of the work in biocontrol. These updates should have been provided regularly by the biosecurity agencies.

4.3 Were partners able to reduce existing CRB populations and lessen its impact on the coconut and oil palm industries (Goal 2)?

Management work in regions where CRB was established did not appreciably reduce its impact in coconut. However, the programme had significant success in its work with the commercial oil palm sector, where it helped to dramatically reduce the damage, and thus maintain the viability of the oil palm plantations.

Currently Available Management Options

a) Monitoring: regular visual damage assessment, and delimiting surveys.
b) Monitoring and Control: pheromone trapping for monitoring and control.
c) Control: rapid disposal of palm-logs or organic waste that may act as larval breeding sites (e.g. chain sawing and/or mulching often combined with burning or burying).
d) Control: hand picking and disposal of adults and larvae.
e) Control: the judicious use of pesticides.

SPC-LRD and AgResearch have usefully collaborated to deliver a management manual for CRB (SPC, 2020) that provides biosecurity officers with some of the basic tools that are necessary to contain and limit the beetle's spread (see box). These tools, however, require significant investment in money, time, effort, and equipment if they are to be effective on their own. Hence, the major focus of the *CRB Response Programme* was on the search for effective BCAs (see Section 4.4).

While awaiting the outcomes of the BCA work, the interim efforts to reduce the spread and limit the impacts of the beetle were very different for coconut and oil palm. Hence these will now be separately discussed.

4.3.1 Management in coconut

Assessment of the coconut sector reveals significant disconnects between the producers (who are largely smallholders), the processors, and the consumers. This made it difficult for the *CRB Response Programme* to engage, as invitations were often met with weak participation by any of these groups.

Both anecdotal evidence and the Evaluation interviews suggest that those most impacted by the CRB incursions are likely to be individual farmers, farm-families, and rural communities in "hot-spot" areas. Interviewed communities reported that incomes had fallen, and that the supply of coconuts and coconut products for home consumption had greatly reduced, the most severely impacted being those who had grown coconuts on at least a semi-commercial basis.

These smallholder and village coconut farmers do not have the resources or management focus to deal with existing CRB incursions, but are keeping a keen eye on developments. Much of the sanitation work so far has been managed by the biosecurity agencies on behalf of the farmers (e.g. BSI worked across 40 hot-spots in 8 Provinces in Solomon Islands to destroy around 3,000 dead or dying palms), with the help in some circumstances of smallholders who were engaged

contractually to help with the clean-ups. Yet despite the work to reduce the breeding sites available for CRB through the cutting of dead and dying palms, and the stacking and burning of logs[21], farmers reported no short-term reduction in CRB damage, and were sceptical of the benefits given the labour-intensive nature of the efforts. All in all, most communities appear to be taking the view that the clean-up is something "the government should do", there being little evidence of ownership of the problem, or contribution to a solution. It is a rare coconut farmer who is sufficiently motivated to continue with the sanitation efforts independently.

Hence, most of the coconut farmers seemed resigned to the decline in coconut, regarding it as an inevitability, and attempting to adapt their livelihoods accordingly (e.g. through vegetable farming). Clearly, this is a mindset that favours the spread of CRB in the coconut areas, and makes containment of the beetle without a new classical biocontrol that much less likely. Pending an effective biocontrol, the Programme needs to concentrate its efforts on those farmers who have few alternative livelihoods and coping mechanisms. However, without formal studies of what the livelihood impacts and the coping mechanisms are, it will be difficult for the Programme to either identify the groups most at risk, or assess the opportunities for useful, cost-effective intervention.

Commercial private sector partners (copra traders and processors; virgin coconut oil producers) are in a better position than most producers are, able as they are to modify their business models and thus sustain their viability with minimal disruption. A major copra exporter from Solomon Islands indicated that CRB has had little impact on their business due to the ubiquitous nature of coconut, the "hot-spot" nature of the current CRB incursions, and the significant areas of abandoned or minimally managed estates that were providing smallholders with excess productive capacity. If unable to buy from one community, copra buyers were able to buy from a different community, and a different island if necessary - although this situation may not last in the long term.

Consumer supply chains for fresh coconuts that link rural communities with urban markets (e.g. for drinking) were seen to be suffering more than the supply chains for processed coconut products, the price increases for fresh coconuts being in the range of three- to five-fold. Nevertheless, most of these chains continued to operate, with the nuts being once again sourced from further afield when this was necessary.

It is appreciated that several attempts were made to engage with the wider coconut sector in all three countries (e.g. through the Solomon Island's Coconut Working Group) but that the response was muted. Over time, a few partners emerged, yet it clearly would have been beneficial for the Programme if many more communities, processors, and wider stakeholders could have been engaged. Three examples that emerged during the Evaluation that may provide future options include:

1. In Solomon Islands, the Programme partnered with a Virgin Coconut Oil (VCO) producer, *Kokonut Pacific Solomon Islands* (KPSI), to raise the awareness of its supplier communities, and to monitor beetle populations and progress using pheromone traps. Yet while the trapping data was regularly supplied to the Programme, KPSI did not receive any feedback on the results, or on the implications.

[21] The Evaluation Team noted, however, that the burning of many of these piles was delayed or incomplete, and that the remaining rotting logs were continuing to provide active breeding sites.

2. One major exporter and processor in Vanuatu expressed how panicked they were by the thought of the spread of CRB from Efate to the major production islands of Malakula and Santo. Faced with such a serious threat, they felt frustrated that they were not better consulted, or given the opportunity to directly contribute to the country's biosecurity response.
3. Similarly, senior staff of the Vanuatu Agricultural Research and Technical Centre (VARTC), itself based in Santo, expressed frustration that they were not kept informed by the Programme, nor were they directly engaged in its efforts (e.g. helping Biosecurity Vanuatu to regularly check and maintain the network of pheromone traps in Santo as a 'trip wire' to detect possible incursions).

Figure 6: Mark Ero (SPC-LRD) inspects cut coconut logs felled as part of sanitation efforts. Failure to subsequently burn these logs can compromise sanitation efforts by multiplying breeding sites.

4.3.2 Management in Oil Palm

Unlike the coconut sector, the oil palm sector was intensively engaged with the *CRB Response Programme*, the presence of the *Oil Palm Research Association* (OPRA) as a formal delivery partner being instrumental to this success. Nevertheless, it was only the estate-managed oil palm operators who had the skills and resources to implement effective management programmes using the existing tools.

The experience of the *Guadalcanal Plains Palm Oil Ltd* (GPPOL) provides an important case study (Chris, Gende, & Pokana, 2023). When CRB populations reached eastern Guadalcanal, the commercial oil palm sector was in a very susceptible phase. A huge replanting scheme had generated stockpiles of old palm debris, which provided prime breeding grounds for CRB, while the large areas of establishing palms were also very susceptible. Significant damage to over 25% of palms was associated with the initial incursion of CRB into Guadalcanal, and this posed an existential threat to GPPOL's previously successful business.

Figure 7: GPPOL technical staff manage IPM practices on the estate.

Under guidance from the Programme's Partners - OPRA, AgResearch, and SPC-LRD - GPPOL invested hugely in cleaning up and in other methods of sanitation. Residues from cleared palms were mechanically chipped, fallowed, and ploughed-in, before replanting. Mass-trapping, the hand-picking of enormous numbers of beetles from the breeding sites, continuous monitoring, and the targeted use of pesticides were also used to combat the beetle in a multi-million-dollar private-sector response that was technically supported by the *CRB Response Programme*. GPPOL now considers that CRB damage has reduced to around 1 to 3%, which is well within the economic threshold of 5%. The *CRB Response Programme*'s contribution to the restoration of the profitability of oil palm production in Solomon Islands can therefore be regarded as a significant 'impact' of the program.

The smallholder oil palm sector was less responsive, lacking as it did the resources that can be commanded by the more formal oil palm sector. The estate managers in Papua New Guinea worked constructively with their smallholder neighbours to monitor spread and plan management. GPPOL's engagement with smallholders was, however, more muted. Yet given the threat posed, and the likely impact on profits, it seemed surprising that GPPOL did not have a stronger sense of urgency about minimising CRB populations in neighbouring smallholder fields. The Programme therefore needs more effective mechanisms to enhance the smallholder oil palm sector's management of CRB.

4.4 Were partners able to develop long term biocontrol and IPM solutions (Goal 3)?

The foundational work undertaken so far has identified two novel BCAs. Firstly, a strain of OrNV shows early potential as a classical biocontrol agent against most Melanesian beetle populations. Secondly, a new strain of entomopathogenic fungi offers scope to help manage future outbreak populations. Success in this work would mean both a massive return on investment for New Zealand's International Development Cooperation programme, and significant recognition for its contribution.

AgResearch, in collaboration with SPC-LRD and in-country partners, have identified two candidate novel BCAs that show very promising results against CRB in field trials in the partner countries. The two options are an OrNV classical biocontrol; and an inundative biocontrol using an entomopathogenic fungus. Further work is needed to confirm the effectiveness of these as BCAs and how they might be incorporated into fit-for-purpose IPM systems (see Recommendation 17.1.1.3).

Oryctes Nudivirus (OrNV): A primary goal of the *CRB Response Programme* was to find an effective classical biocontrol for CRB infestations, with the benchmark being the strains of the *Oryctes* nudivirus that so successfully kept the pest in check for three decades in the Pacific. Investigations by AgResearch and others (Moore & Marshall, 2014) showed that the damaging CRB-G invasion into Melanesia originated from CRB populations in Asia and the north-west Pacific (Philippines), where it was being naturally controlled by local pathogens, particularly by local strains of OrNV. However, for unknown reasons, the incursions into the Pacific arrived pathogen free, and the beetles then multiplied unchecked due to the lack of existing Pacific strains of OrNV on the newly infected islands.

AgResearch's subsequent efforts to collect novel BCAs from Asia were curtailed by the COVID-19 travel restrictions. Serendipitously, however, the agency had been collecting a range of different OrNV isolates since the 1970s, some originating from the beetle's native range (including the Philippines), and others from across the Pacific, these isolates being maintained at its Lincoln laboratory[22]. It was eight isolates from this collection that the Programme then tested. Pleasingly, results have identified that one of these OrNV isolates - V23B - shows virulence against most populations of CRB in Melanesia.

Initial V23B releases between July 2022 and December 2023 in Solomon Islands (Ghizo) and Vanuatu (Efate) proved promising. Following eleven releases on Efate totalling 417 V23B-infected beetles, OrNV was consistently recovered from around one third of the beetles that were subsequently assessed on the island. There have been anecdotal reports that patches of palm were recovering in parts of Efate and on nearby Ifira Island, and while the reasons for this could be many[23], there is a growing optimism that CRB can now be subdued, and its spread managed (Paudel, et al., 2024). Furthermore, recent biodiversity studies of CRB based on nuclear DNA[24], confirms the earlier groupings based on mitochondrial DNA markers, and shows that most CRB populations in Solomon Islands, Vanuatu, and parts of Papua New Guinea are similar. This raises expectations that V23B will be effective in all of these areas. Wider releases of V23B across all three countries are now planned for before December 2024. However, it is still to be shown whether the virus can control beetle populations sufficiently that palm damage is reduced to acceptable levels and definitive results cannot be expected within the life of the current programme.

There is also another factor that puts celebrations on hold - there is one population of CRB around Port Moresby that V23B does not kill. Recent CRB full genome analysis confirms that this strain of CRB is different to those found elsewhere in the region. However, KIK and AgResearch had already identified a small CRB population around Madang that was not spreading as expected, and that showed signs of OrNV infection. A recent bioassay undertaken by NAQIA staff shows that a crude gut macerate collected from some of the infected beetles near Madang, caused high mortality when fed to the recalcitrant beetles collected near Port Moresby. If confirmed, then this new viral strain will need to be isolated, characterized and further evaluated in bioassays and field releases. Possibly, this strain of OrNV can complement V23B, thus targeting a greater range of the beetle's genotypes.

[22] The OrNV isolates held and maintained by AgResearch are stored as purified virus stocks.
[23] This could be due to population cycling, the impact of management activities, or the spread of virus.
[24] Using Genotyping-by-Sequencing -GBS.

Entomopathogenic fungi: Some fungi are strongly entomopathogenic, killing or disabling insects, and occurring across a wide range of ecosystems. Commercially available preparations (e.g. ORY-X Biopesticide®) of *Metarhizium* spp., especially *M. majus,* are already in use in Asia as inundative biological control agents for suppressing CRB in breeding sites. However, the testing and field trials undertaken by AgResearch and its local partners indicated that these commercial preparations were sometimes of poor quality, and that local Pacific isolates were likely to be more effective. The testing of *Metarhizium* spp. isolates from PNG (4), Solomon Islands (4), and elsewhere (3) have since confirmed this. One of the isolates from Guadalcanal - F717 - showed excellent virulence in two laboratory bioassays[25] (Villamizar, et al., 2022). Subsequent larger scale field trials of F717 in coconut and oil palm has confirmed the significant mortality of beetle larvae, while fungus-infected beetles were also recovered from the wider population (Figure 8). Furthermore, entomopathogenic fungi occur widely in nature making for a large potential pool of local isolates. Thus the pipeline for ongoing screening seems assured.

Figure 8: Large field-trials of Metarhizium are being conducted at GPPOL.

These fungi offer potential as biological insecticides, and could form part of a broader IPM strategy. While it is currently too early to estimate the contribution that fungal BCAs could make to the suppression of CRB populations in the Pacific, as already noted they are already being used in large scale commercial operations in Asia. These operations have found that a major drawback to using the fungus is the need to apply it regularly to the breeding sites (e.g. rotting palm-logs or compost heaps). The process therefore requires careful targeting and consistency, and thus the full engagement of the grower, if the BCA is to be effective in an ongoing fashion.

The Programme's work with the fungus is progressing to establish multiplication facilities at Government laboratories in all three countries. However, the Evaluation Team is concerned that these facilities may not operate sustainably, nor at the scale that will be necessary to provide the preparations to the extent that will be needed. As such, alternative business models to establish complementary supply options should be considered once the effectiveness of the BCA is established. Based on experience elsewhere, with other pests, a 'cottage industry' approach might be considered as an option, both as a means to boost the supply of the BCA and to stimulate the involvement of the farmers and their community.

Molecular Studies: Molecular studies undertaken by AgResearch were used to characterise both CRB and the BCAs currently being investigated – the OrNV and *Metarhizium* populations –

[25] 100% mortality after 2 to 4 weeks.

as well as to map the progress of the CRB incursions. The initial CRB characterisation used molecular markers from the mitochondrial COI gene[26], a technique that is rapid yet maintains relative accuracy. This resulted in the early differentiation of five different clades of CRB across Melanesia, which for the purposes of simplicity were clustered into two groups, CRB-G and CRB-S. However, robust scientific criticism of the appropriateness of mitochondrial studies stimulated AgResearch to better define the spectrum of CRB clades across Melanesia and elsewhere, and to clarify their likely susceptibility to the various OrNV strains. This provided a more accurate (and also a more complex) picture of CRB that was subsequently corroborated by the GBS studies, and that is proving useful in the understanding of what is happening with CRB - which clades are spreading, and the paths being taken. It is also particularly useful for the ongoing host-pathogen studies that are investigating the susceptibilities of the various genotypes of beetle to the various strains of viral and fungal BCAs.

4.4.1 Integrated Pest Management

In those areas where CRB is now firmly established, it is no longer a biosecurity problem, and must be managed as part of the farming systems. As such, the role of the biosecurity agencies must decrease, while the roles of the villagers, smallholders, commercial growers, and research and extension agencies must increase.

Clearly, what is needed is an Integrated Pest Management (IPM) approach. Yet any IPM programme must be carefully nuanced by taking into account farmers' needs and capacities. Currently, there are a few tools that can be readily incorporated into an effective IPM programme – most notably, a focus on sanitation and cleanup to prevent population explosions. Yet while these have been effective for estate-based oil palm, the tools are not viable at the smallholder level. The critical component that is currently lacking is therefore the availability of effective BCAs. Without effective BCAs, it is unlikely that any IPM programme will be able to keep CRB damage below the economic thresholds for coconut and smallholder oil palm.

There is also a need for a fundamental change in mind-set - the smallholders and industry players will need to be convinced that the IPM strategies that incorporate the BCAs (once confirmed) are both viable and effective. It is hoped that growers will then be more willing to undertake sanitation cleanups, such as *Metarhizium* spp applications on breeding sites and log piles after storms. This may be particularly effective for those who are isolated from the abandoned/minimally managed estates (see Recommendation 1 and particularly Section 7.1.1.2).

4.5 What capacity do in-country partners have to detect, respond to, and manage CRB (Goal 4)?

Specialists in all three target countries now have the knowledge, skills, and contacts to continue meaningful collaboration, but efforts are needed to retain the trained staff.

Overall, the *CRB Response Programme* was moderately successful in meeting the immediate capacity needs of the six national partners in terms of partnerships, personnel, knowledge, and finance. The Programme's successes in terms of both partnerships and capacity building will now be discussed, as will some of the challenges, .

[26] Mitochondrial RNA is only passed on through the female lineage.

4.5.1 Partnerships

The Programme's support to the biosecurity agencies of Vanuatu and Solomon Islands assumed that they would take responsibility for both the biosecurity and biocontrol aspects of the response to CRB[27]. Yet this was contrary to the usual practice in the Pacific - while the biosecurity agencies can take the lead on some aspects of biocontrol (e.g. classical biocontrol of invasive weeds), it is usually the agricultural research and extension services that coordinate the biocontrol of invasive agricultural pests, and that develop and promote the adoption of IPM strategies. It was only in Papua New Guinea, and in oil palm more generally, that formal arrangements were put in place to purposefully engage more widely with agricultural research, extension, and industry bodies. Yet even in Papua New Guinea, the partnerships did not include the National Agricultural Research Institute, which could have contributed expertise such as the molecular characterization of pathogens. As a result of these arrangements:

1. The engagement of research and extension groups in Solomon Islands and Vanuatu was limited (although in Solomon Islands at least one researcher is currently working on *Metarhizium* multiplication). Discussions with stakeholders revealed that some of this resulted from ongoing internal politics, limited resources, and the siloing of roles. However, some of it was the result of the alienation felt by the groups due to the Programme's decision to partner with the biosecurity agencies (particularly for the biocontrol work). Future work, especially where CRB is now established, must engage more broadly with the National Agricultural Research and Extension Systems (NARES) to progress CRB biocontrol, and implement farmer-centric IPM. This will require sensitive negotiation and management, particularly as many of the key research skills and links are now embedded within BSI and BV (see Recommendation 1 Section 7.1.1.2).
2. BSI and BV had fewer networks when partnering with commercial, smallholder, and village stakeholders than other NARES agencies. In Solomon Islands, other staff from within MAL did help BSI to facilitate local engagement. However, the biosecurity agency itself had no prior local relationships, a factor that appears to have worked in favour of direct implementation. It was only in Papua New Guinea, as well as in oil palm more generally, where the formal up-front relationships were already in place, that the Programme was able to support more meaningful and sustainable sector partnerships.
3. The Papua New Guinea Task Force played a unique role in harmonizing

Figure 9: The Papua New Guinea CRB Taskforce met in Madang with the Evaluation Team.

[27] Although there is one MAL researcher who is engaged on *Metarhizium* multiplication in Honiara.

agency efforts and resources to manage the response to CRB. This coalition discussed and debated the containment strategy, collaborated on surveillance, helped test management and biocontrol options, and regularly shared information. As a result, Papua New Guinea is now well-placed to transition from a CRB biosecurity response to a CRB management posture. Although efforts were also made to develop a Task Force in Solomon Islands, the logical institutions were weaker, more siloed, and were also disenfranchised by the already established relationship with BSI. Nevertheless, recent times have seen local institutions such as OPRA/GPPOL, KPSI, and MAL Research increasingly engaging with the Programme, which may provide a basis for more formalised relationships in the future. Given its success in Papua New Guinea, future support to strengthening the Task Force approach at both the national and regional levels is warranted (see Recommendation 6).

4.5.2 Organisational capacity, personnel, and skills

1. In all three countries, the program established key roles for biocontrol and biosecurity, and delivered significant training on the necessary techniques, tools, and processes for both disciplines (see box). Additional longer-term training provided to biocontrol professionals at the AgResearch laboratories was also significant. The Evaluation Team was particularly impressed by the way the *CRB Response Programme* used on-line training tools, videos, and models to deliver effective remote training during the travel restrictions imposed by the COVID-19 pandemic. There is strong evidence that the staff trained were more effective and motivated in their biocontrol and biosecurity roles as a result of these trainings. As already noted, however, more could have been done to support the agencies' biosecurity managers to develop strategically relevant biosecurity plans targeted at minimising CRB impact based on risk, and in line with the available resources.

Skills delivered by the CRB Response Programme

Core biosecurity skills

* *conduct 'delimiting' surveys.*
* *maintain pheromone-baited flight traps.*
* *record ongoing CRB damage and recovery in palms*
* *map the boundaries of current/recent incursions*
* *use Kobo Toolbox and GIS mapping to input data into national and regional databases.*

Core biocontrol skills

* *understand the principles of biological control.*
* *collect samples (of beetles) for characterization purposes.*
* *conduct bioassays of potential BCAs.*
* *prepare infected beetles for release (OrNV).*
* *bulk-up fungal BCAs for treatment of breeding sites.*
* *monitor recovered CRB for evidence of BCA establishment.*

2. In the Papua New Guinea agencies full-time staff took on many of the necessary roles. In contrast, many positions in the Vanuatu and Solomon Islands agencies were filled under contract, and these positions are still aligned with project funding. The Programme worked diligently to try to ensure the sustainable transition of these contracted personnel and their skills, and some solid progress was made. The transition of staff is dependent, however, on the national agencies establishing additional positions. The Evaluation Team received solid assurances from the agencies of both Solomon Islands and Vanuatu that processes were in place to engage these staff (e.g. as part of the Solomon Island's Agriculture New Day Strategy, and of Vanuatu's new

Biosecurity Bill). However, these processes are politically fraught, and at a high risk of delay. Realistically, neither country is likely to be sufficiently progressed by late 2024 to confirm the positions and give tenure to staff. As a result, work in the final months of 2024 needs to establish bridging mechanisms and/or alternative arrangements if core skills are to be sustained.

3. The higher-level leadership, management, administrative, and organisational constraints confronting the biosecurity agencies present a critical risk that needs to be creatively managed. For the most part, Papua New Guinea and Vanuatu successfully adapted to the challenges as these arose[28]. BSI, however, was more disadvantaged, facing as it has significant staff turnover, appointment delays, long-term vacancies for key positions (e.g. Country Coordinator and Communications Officer), and past and pending leadership changes. While the *CRB Response Programme* Manager dedicated significant time to helping BSI manage this situation, most of the challenges faced were beyond the scope of the Programme.
4. Sampling and molecular characterization of beetles has allowed the partners, with the close support of AgResearch, to map the CRB incursions by clade. Currently, AgResearch undertakes the molecular diagnostic studies, and solid protocols are in place to collect, prepare, and send samples to New Zealand for analysis. Yet while this arrangement has worked well, and AgResearch is clearly respected, ideally it would be helpful to develop at least some capacity for DNA extraction and molecular characterization at a regional level. This would increase local ownership, boost confidence, and reduce the time-lag in obtaining results. It would also be particularly feasible in Papua New Guinea, where OPRA[29] and NARI already has some capacity in this arena. Similarly, an expanded role for SPC-LRD in some aspects of molecular diagnostics could be envisaged, building on SPC-LRD's existing capacity, and establishing a regional resource[30]. However, any transfer over time to the regional and national agencies of these laboratory skills, does not negate the need for international agencies such as AgResearch to maintain their basic research, genomic analysis, and BCA collections. A balanced business case that demonstrates the efficiency gains and longer-term benefits is therefore needed.

4.6 Has the Programme Manager role helped in the delivery and implementation of the activity?

The position of Programme Manager has been a successful addition to the Programme and invaluable in helping to improve the Programme's coherence, communication, coordination, and transparency.

Given the complexities of the *CRB Response Programme*, MFAT appointed a Programme Manager to oversee delivery. Recruitment commenced in July 2019, although delays in selection meant that the position was not filled until January 2020. Due to the need felt by MFAT to closely monitor the initial stages of its grant relationship with MAL, the position was Honiara-based until December 2023, since which time it has been Wellington-based. The Programme

[28] e.g. *CRB Response Programme* funding delays jeopardised the ongoing engagement of BV's surveillance contractors. However, BV was able to mobilise EDF 11 funding to fill most of the gap.
[29] OPRA staff, trained by the project, are carrying out simple analyses under programme supervision.
[30] LRD is currently looking at a business plan for it regional plant health laboratory and is considering the inclusion of a molecular diagnostics facilities.

Manager's responsibilities have been broad, covering strategic planning, oversight of delivery and finances, delivery partner oversight and coordination, stakeholder liaison, contractual support, reporting, and relationship management.

The position of Programme Manager has been a successful addition to the Programme and much appreciated. MFAT's staff in Honiara and Wellington have relied heavily on the Manager to provide key information, to manage development and contractual concerns with the implementation team, and to act as the primary liaison with its national and international development partners. The Evaluation Team notes that the position of Programme Manager has been invaluable in helping to improve the Programme's coherence, communication, coordination, and transparency. Yet it also notes that the role has been dissipated by the need for the Manager to attend to the Programme's day-to-day operational demands (such as logistics, relationships, accountability, administration, and general problem solving). This was particularly evident in Honiara, where the Manager was repeatedly asked to compensate for the gaps in the national team. It was, however, less of a challenge in Papua New Guinea and Vanuatu where the increasingly capable national coordinators were able to absorb much of the Programme's day-to-day administrative load.

While the role of Programme Manager proved indispensable for the effective functioning of the Programme, it has required significant resources (roughly 9% of budget), and the appointment's continuation into a future phase will depend on the complexity of the eventual implementation arrangements. Should a multi-country, multi-partner structure be maintained, then the role should continue (see Recommendation 2).

4.7 How effectively has the *CRB Response Programme* adapted to external challenges?

While the delivery of Goals 1 and 2 were compromised by the COVID-19 pandemic, as well as by natural disasters in Vanuatu, the CRB Response Programme responded well and creatively to help mitigate the resulting damage.

The *CRB Response Programme* was significantly impacted by the COVID-19 pandemic. In addition, delivery in Vanuatu was affected in early 2023 by two destructive Category 4 tropical cyclones (Judy and Kevin), and by a 6.5 magnitude earthquake. Overall, these externalities have significantly constrained the Programme's delivery. While MFAT has been able to compensate to some extent by extending key components of the Programme by 12 months[31], and while innovations by the delivery partners have helped to mitigate the worst of the impacts, these events have significantly reduced progress towards achieving Goals 1 and 2 of the Programme.

COVID-19 lockdowns and travel restrictions severely limited delivery during 2020 and 2021 in all three countries. Most importantly, it compromised the work of the biosecurity agencies to combat the spread of CRB and contain it to the sites of incursion (Goals 1and 2). As a result, CRB spread widely during this time in Papua New Guinea and Solomon Islands.

Sanitation efforts within Efate were also constrained by the combined impacts of the pandemic and of natural disasters. The Programme responded well to the cyclone damage by providing additional support to contain the spread of CRB on Efate. With this support, BV was able to stop the spread of CRB beyond Efate for many years, however, the beetles multiplied rapidly in

[31] SPC and MAL contracts were extended.

the plentiful breeding sites provided by the cyclone-felled palms, and spread inexorably across Efate itself and its neighbouring islands.

Furthermore, the collection of potential novel BCAs (Goal 3) from the home range of the beetle was impeded by the pandemic. As discussed (see also Section 4.4), AgReseach was able to compensate by accessing OrNV isolates from a prior collection. However, the need to undertake a primary collection mission still remains.

Capacity building (Goal 4) was less dramatically affected. During the pandemic, both AgResearch and SPC-LRD were able to progress much of their capacity building and operational work through the innovative use of remote technologies (see also Section 4.5.2).

5 Sustainability

The CRB Response Programme has made meaningful progress across all four Goals, but much remains to be done if it is to be fully sustainable.

While partners in Melanesia are now better placed to limit, contain, and manage the spread of CRB (Goals 1 and 2), a concerted effort is needed to limit domestic spread within high impact sites (see Section 3.1). Appropriate IPM strategies must also be developed to enable the work to evolve from a biosecurity to a management focus (see Section 4.4.1). Work on novel BCAs (Goal 3) also needs ongoing effort if efficacy at scale is to be confirmed (see Section 4.4).

One threat to the Programme's sustainability is the uncertainty regarding whether or not the contracted staff will be eventually absorbed into the national agencies (see Section 4.5.2). The loss of the improved technical and operational skills (Goal 4) will be considerable if permanent positions for these staff are not created.

A significant external threat to the Programme's sustainability relates to the constraints imposed by the varying leadership, management, and legislative frameworks of the partner countries, on which the CRB Programme has peripheral influence at best.

More widely across the Pacific, the CRB Programme has demonstrated that no country's Government has the current resources to mount an emergency response to invasive pests at the necessary scale, and that supplementary surge capacity, supported by governments and underpinned by donors, will be essential into the foreseeable future. The Programme therefore provides an important case study of the challenges that such a response is likely to face.

The Programme's eventual sustainability will be dependent on:

1. An active and systematic surveillance program for CRB being in place across the region.
2. Funding mechanisms to rapidly mobilise the "surge capacity" that will be necessary to provide the biosecurity agencies with the resources and staff needed to plan, manage, and implement the emergency and follow-up responses. This surge capacity must come from Government and/or donors (see Recommendation 8).
3. More realistic biosecurity plans that focus as much on limiting "impact" as on limiting "spread", and that include greater private sector and community input.
4. Pre-existing biosecurity legislation in place to manage identified risk pathways, both at borders and within countries (especially relating to movement between islands in archipelago countries).

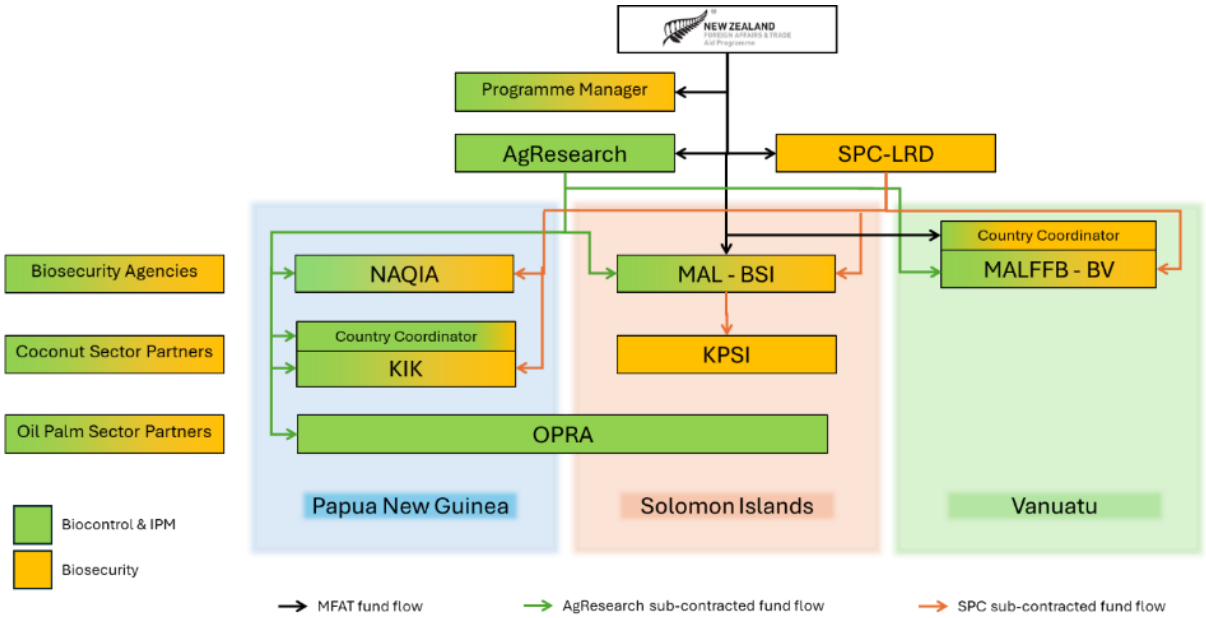
5. The ongoing confirmation of biocontrol and management technologies, combined with a farmer-centric approach to developing feasible IPM strategies.

6 How efficiently has the programme been delivered?

The CRB Response Programme's delivery mechanisms have adaptively evolved to meet the challenges. This has led to a complexity that needs to be addressed by any future engagement. While the Programme has been costly, the Evaluation Team considers the cost is justified given the potential returns from success. The focus of investment on the urgent biocontrol needs has seen solid progress. Even modest assessments show that successful biocontrol would deliver benefits well in excess of $300 million per year.

The *CRB Response Programme's* implementation arrangements have evolved organically as the Programme has progressed. As outlined in Section 1, there were initially three main partnership agreements (with AgResearch, SPC-LRD, and MAL). Over time, further supplementary agreements were implemented by MFAT, AgResearch and SPC-LRD to facilitate fund flow and support in-country partners. This generated a complex matrix of funding and management arrangements, many of which have proven fit-for-purpose, but some of which have underperformed. The resulting scenario is outlined in Figure 10. MFAT staff commented that the *CRB Response Programme* is one of the most complex managed by the Development Economy Division, it being this complexity that was central to its decision to engage a dedicated Programme Manager.

Figure 10: Delivery partnerships and mechanisms used in the CRB Response Programme



While adaptive programming is essential for development programmes, and a common feature of MFAT's implementation practices, the complex funding pathways and differing financial management systems that evolved within the *CRB Response Programme* were not efficient. As can be seen, the major biosecurity agencies each managed two or three different funding streams. While the rationales for each of these streams seem reasonably clear, the financial management processes (e.g. procurement and reconciliation) were all different, and the

biosecurity agencies struggled with the varying requirements, and especially with the Grant Funding arrangements.

MFAT took direct control of the Grant Funding to MAL to address concerns about the difficulties MAL was experiencing in complying with SPC-LRD's processes. However, this approach did not appreciably improve efficiency. The Grant Funding support to MAL took time to establish due to delays in the approval of Solomon Island's budget; the subsequent releases of funds by Treasury to BSI were also sometimes delayed; while payments in the original MOU and Grant Fund Agreement were too focused in any case on outputs rather than on meaningful changes. MFAT worked through two contract variations to address these issues, and especially to simplify the reporting. Yet MAL struggled even so to expend the funds released, while its reconciliation and progress reporting also required regular Programme Manager oversight.

Furthermore, there were significant delays by SPC-LRD in setting up their Direct Grant Agreements with the in-country partners in general, much of this being due to its onerous contract approval and reconciliation requirements. To circumvent this, SPC-LRD made the decision in 2024 to move towards direct procurement (e.g. with NAQIA) – a move that is more responsive, but requires extra time for SPC-LRD to manage the procurement processes.

Future support must therefore work towards establishing funding processes that are streamlined, consistent, transparent, and both easy to use and to manage.

6.1 What have been the main costs?

The total budget envelope for the *CRB Response Programme* was $18 million over what was eventually five years. The biosecurity component received 28% of the resources (roughly $5.5 million), and the biocontrol component 72% (roughly $12 million) (Figure 12a).

Figure 12b shows the funds directly managed by each partner. The contributions to Papua New Guinea and Solomon Islands were roughly equal (although in the case of Papua New Guinea the funds were shared between three partners). The latecomer, Vanuatu, received considerably less, but was nonetheless able to leverage this to achieve significant success.

6.1.1 Biosecurity costs

Partner Government agencies have declared CRB as a top priority, and have applied considerable in-kind staff time and resources as a contribution to the programme. Direct supplementary co-investment from the partner Governments to tackle the CRB incursions has, however, been limited. Although it is important to acknowledge that onerous and unexpected budgetary stresses were faced by the three governments during the COVID-19 pandemic years, MFAT could consider leveraging at least some supplementary commitment from its partner Governments in future, especially with regards the core biosecurity responses.

SPC-LRD could also have improved its cost efficiencies. SPC-LRD continues to struggle with limited core funding, hence most CRB Programme staff have been appointed on contract. This is not ideal as it risks sustainable delivery. Moreover, programme specific appointments are being increasingly called on to tackle concerns outside of their mandates.

There were also delays in appointments that resulted in the agency's support being not always as timely as necessary. The strengthening of its working relationships with local agencies would have also bettered the outcomes. It was reported that a few SPC-LRD missions (e.g. its delimitation surveys) were undertaken by the Fiji-based SPC-LRD staff. Yet some costs could

have been moderated, and core national skills strengthened, if SPC-LRD had relied more on the local partner biosecurity agencies to undertake these tasks.

6.1.2 Biocontrol costs

Figure 12a shows the proportionally high level of funding spent by the Programme on biocontrol, while Figure 12b shows the proportion of funds directly managed by each partner. The Evaluation Team considers that the significant investment made by MFAT in biocontrol is largely relevant, appropriate, and justified (see also Section 3.3). The incursions of CRB into the region can only be combatted in the long term through the development of novel BCAs, which necessitates the engagement of international agencies with the skills necessary to undertake the specialist research – in this case AgResearch. The fact that these undertakings are expensive, and that success is not guaranteed, helps justify the use of grant funding mechanisms. MFAT's support has helped speed up delivery by making available advanced research resources that are well beyond the capacity of most of its Pacific partners.

Figure 12a: Relative resourcing of the CRB Response Programme

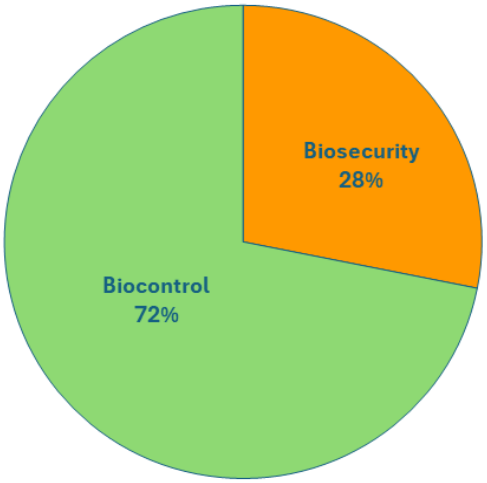
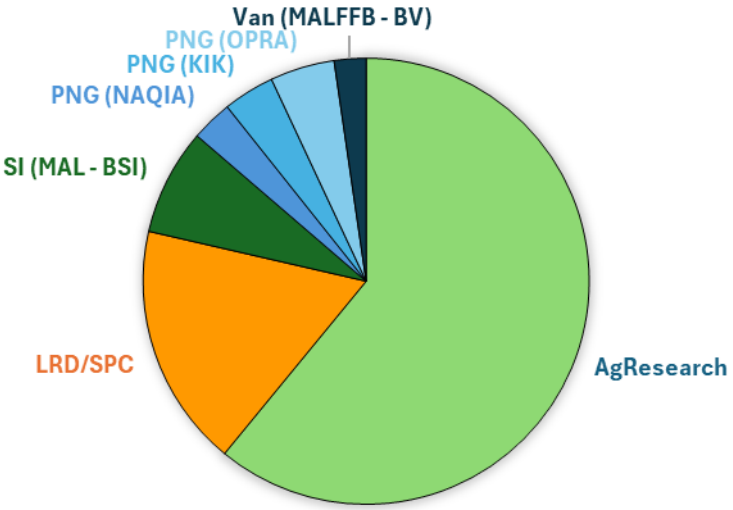


Figure 12b: CRB fund flows to delivery partners



While the risks of such investments are high, the modest economic analysis that was undertaken by the project showed the potential long-term benefits in the Pacific for commercial copra production alone to be almost $300 million per year. This, though, was likely to be a significant underestimate of the overall benefits, given that it did not take into account the substantial economic loss and damage of uncontrolled CRB on oil palm production, on the wider coconut and oil palm value chains, on food security, on the environment, or on landscape aesthetics, and thus on culture and tourism. Nor did it discuss the much greater losses that would be associated with the global spread[32] of CRB.

[32] There are early reports of CRB incursions into Mexico (Jackson, Rincon, Villamizar, & Paudel, 2022).

6.2 Governance

The Programme was overseen by a steering committee whose membership included representatives from MFAT, the implementing partners, and the national agencies, and that was facilitated by the Programme Manager who also prepared the minutes.

The Evaluation Team considers that the Steering Committee was largely ineffective. Despite MFAT's best endeavours, it was challenging to get national representatives to attend Steering Committee meetings, possibly because of competing commitments for busy Permanent Secretaries. Nevertheless, partner countries could have nominated other staff to attend.

Several Committee members commented that they remained unclear as to the Committee's purpose, or of what their roles were, despite the fact that there were TOR for the group, and no Committee member ever raised his or her concerns with the chairperson. MFAT also observed that during Steering Committee meetings it was hard to elicit commentary from the implementing partner representatives. MFAT is therefore re-thinking Steering Committee membership and processes in going forward.

A Technical Advisory Group (TAG), consisting of technical specialists from the regional partners, was also established at the outset. However, this only duplicated the discussions already being handled by the PNG Taskforce and the *Pacific Regional CRB Coordinating Committee* established by the RMTPP. As a result the TAG was disbanded after 12 months.

Future work therefore needs to better plan appropriate oversight and advisory roles and committees, with clear Terms of Reference (see Recommendation 6).

7 Future implications and engagement.

The lack of clarity in the Programme Outcomes, and the resulting uncertainty as to the level of progress that could reasonably be expected, created unrealistic expectations amongst stakeholders, some of whom did not appreciate that the establishment of effective BCAs and IPM can, at times, be a decades-long process.

Nevertheless, the foundational work undertaken so far has resulted in breakthroughs that, should further testing of the BCAs confirm their efficacy, will not only combat the current outbreaks of CRB in the Pacific, but will help to reduce the risk of its further global spread.

The fact that the Programme has already identified promising BCAs, and is already researching ways in which these can be incorporated into future IPM strategies, is an enormous achievement in a relatively short time, especially given the constraints imposed on implementation by the COVID-19 pandemic.

Furthermore, the knowledge that has been generated on beetle and viral diversity is not only proving to be invaluable in understanding the current behaviour of the beetle, but will allow for the more rapid delivery of upgraded BCAs should future resistant strains of the beetle emerge, or evolving strains invade new areas.

In contrast to the biocontrol aspects of the *CRB Response Programme*, the biosecurity component has, however, been less effective than expected over the Programme's five years. The reasons for this have been many: the design's lack of clarity, the limited and slow

mobilisation of staff and funding, the disparate delivery partnerships, the flagging of political commitment, and the delays caused by the COVID-19 lockdowns.

Lastly, the collaboration between the international, regional, and national partners was solid, and specialists in all three target countries now have the knowledge, skills, and contacts to continue meaningful collaboration on the biocontrol work (provided the core contracted staff receive tenure).

7.1 Should New Zealand's IDC programme consider future support for the *CRB Response Programme*?

As explained in Section 3.3, the Evaluation considers that combatting CRB was and remains highly relevant to New Zealand's International Development Cooperation (IDC) policy. Lessons and the Evaluation's recommendations that need to be taken into consideration in determining the shape of any future programme are discussed below.

Because it is likely, however, that the resourcing available for future work will be at a lower level than that available for the current *CRB Response Programme*, the Evaluation Team has prioritised options for future work based on:

1. Clarifying the pest-specific components that will be needed to consolidate the current *CRB Response Programme's* achievements, and that will best be delivered through a follow-on collaboration between MFAT, New Zealand agencies, and the regional organisations (see Section 7.1.1).
2. Clarifying those issues that are beyond the scope of a CRB follow-on response, and are best addressed by broad biosecurity mechanisms rather than a pest-specific programme (see Section 7.1.2).

7.1.1 Issues that could form the basis of further New Zealand support to a CRB response.

Recommendation 1. New Zealand should consider follow-on support for its national partners to combat CRB in areas where additional work is needed to consolidate gains, confirm the broad-based efficacy of the BCAs, and deliver these to the affected communities and sectors (refer Section 3.3).

Recommendations for this work focus on four possible components that align with the existing Goals of the Programme. The following discussion outlines the logical next steps to complete delivery against each of these components. However, the significant scope that these steps would entail, along with MFAT resource constraints, may mean that some components are either deferred, or undertaken by an alternative donor. In this case, MFAT should focus its follow-on contribution on Component 3, to confirm the efficacy of the novel BCAs in both their stand-alone use, and within the emerging IPM frameworks.

7.1.1.1 Component 1 Regional and national stakeholders limit and contain the spread of CRB.

Better management of all invasive pest control across the Pacific is a major emerging need. Handling every new incursion on a pest-by-pest basis is inefficient. Nor does it adequately deal with the fundamental gaps in biosecurity capacity. It is therefore to be hoped that, in the medium term, this need could be addressed by a new multi-donor Pacific-wide emergency response mechanism to manage invasive species (see Recommendation 8).

In the interim, however, follow-on support is needed to ensure that the biosecurity agencies in the three Melanesian countries protect the remaining CRB-free, but high-risk sites (especially small island communities, and those commercial production areas that are not yet affected).

A modest facility is also needed that can support any country facing a new invasion by rapidly confirming incursions, and by providing the initial training and equipment that is vital for ongoing surveillance.

7.1.1.2 Component 2. Local stakeholders manage CRB through IPM strategies tailored to their specific needs and livelihoods.

Where CRB is now established, the work associated with Component 2 needs to transition from biosecurity to management. Taken to its logical conclusions, this would be a substantial undertaking that may be beyond MFAT's immediate resources.

Follow-on work needs to escalate efforts to integrate CRB management technologies (e.g. BCAs, agronomy practices, selective pesticide applications, surveillance, trapping, and sanitation) into broader IPM strategies. These strategies should move beyond the current focus on tools and tactics, towards emphasizing farmers' implementation capacity and ownership. As such, the strategies should address threats in general (not just CRB), and must be nuanced to the needs and capacities of the various beneficiary groups (see Table 1).

Any future work in coconut might be better considered as part of a wider, much more ambitious coconut rehabilitation/rejuvenation effort for smallholder coconut livelihoods/value chains. Such an effort would combine IPM with replanting schemes, improved germplasm, and value-addition. Tools such as the ADOPT® package[33] might also be helpful when considering the useability of the potential IPM packages.

The currently successful IPM work for oil palm needs to be further enhanced by the addition of classical and inundative BCAs once these are confirmed. These practices also need to be extended to the neglected smallholder sector.

Importantly, the IPM work also needs to engage more broadly with the *National Agricultural Research and Extension System* (NARES) and similar sector stakeholders to progress CRB biocontrol, and to implement farmer-centric IPM. This will require sensitive negotiation and management as many of the key CRB research skills and links are currently embedded within BSI and BV. Yet the availability and accessibility of IPM services can only be boosted if other national research and extension agencies, universities, and private sector organisations are actively partnered with in participatory development and adoption.

As can be seen, the scope of this work taken to its logical conclusions is both long term and substantial, and even the initial stages would be significant and costly. Delivery would also require a broader suite of delivery partners than currently exists.

Hence, MFAT resource constraints may mean that this work is either deferred, or undertaken by an alternative donor.

[33] ADOPT is tool designed by CSIRO to help users analyse the constraints to adoption of an agricultural innovation https://adopt.csiro.au/.

7.1.1.3 Component 3. Local stakeholders have ready access to effective novel BCAs and genomic analysis capacity to help them manage CRB.

This Component should be the core of MFAT's follow-on work, and should focus on confirming the efficacy of the BCA tools with its partners in NARES, allowing for their stand-alone use, and easier integration into the emerging IPM work. Ongoing support is needed for AgResearch, SPC-LRD, and their national partners to continue with their efforts to develop BCAs that can effectively target CRB. This will include:

1. Ongoing support to genomic studies that sequence and characterise CRB and BCA genotypes as a tool to elucidating the complex interactions between invasion pathways, CRB populations, and BCAs. This work should not be geographically constrained.
2. Confirming the virulence of the promising BCA isolates against the various CRB clades within the current Melanesian livelihood systems. Biological studies are also needed to understand the modes of infection, the causes of pathogenicity and resistance, and other key processes.
3. Establishing mechanisms to multiply, distribute, and apply effective strains of BCAs for the control of CRB populations across the Pacific. It is important to make a distinction between the development of the OrNV as a classical biocontrol agent, which is likely to be considered a Global Public Good, and that of the entomopathogenic fungi, which is likely to be used inundatively as part of an IPM strategy, and thus is more likely to be made available as a commercial product or as part of a range of locally owned products.

Figure 13: Beetles infected with the new V23B OrNV strain are released on Efate (Vanuatu).

7.1.1.4 Component 4. Melanesian agencies and sector stakeholders have the capacity to detect and manage CRB.

Support for the Programme's Melanesian partners must continue. Importantly, the current programme should work with its partner agencies in the remaining months to establish a sustainability plan for the key technical positions[34] (see Section 4.5.2).

In the future, the current work to establish key positions, skills, and networks, could be further enhanced by:

1. Strengthening the Task Force approach at the national and regional levels.
2. A gradual transfer of biocontrol skills to the regional and national agencies to improve ownership and responsiveness. While there will remain a need for the international agencies (such as AgResearch) to maintain their basic research, genomic analysis, and

[34] While retaining all trained staff would be preferred, the reality is that this may not be possible. The critical priority would be to retain the biocontrol technical staff.

BCA collections for the foreseeable future, the mind-set of these agencies needs to evolve towards taking a supporting role rather than leading the effort. Decisions (what skills and what partner) should be guided by clear participatory discussions with all of the relevant NARES agencies before agreements are confirmed.

3. Broadening communication to provide regular updates on spread, on success stories, and on BCAs and their use across both Melanesia and the wider Pacific.

7.1.1.5 Programme Management, MERL and communication

Recommendation 2. Should a multi-country, multi-partner structure be maintained, then MFAT should engage a Team Leader to improve program oversight, delivery, cohesion, reporting, and communications.

The Programme Manager role should be renamed as the Team Leader to elevate future expectations of the role, and help refocus the responsibilities from the day-to-day onto the Programme's strategic coherence, its TOC and MERL activities, its delivery, and its overarching strategic reporting. Thus the Team Leader would report on the achievements against the higher Programme logic and Goals, while each delivery agency would maintain its contractual responsibility for delivery, and report on its own achievements and challenges. The position of Team Leader could also be complemented by the formal recognition of a Country Coordinator in each partner country to take on the day-to-day in-country management.

Recommendation 3. Any future work must include enhanced upfront and ongoing investment in MERL, including dedicated resources to support partners develop and implement an agreed MERL Framework (refer Section 4.1).

The design of the MERL aspects of any follow-on work would be best facilitated by a MERL professional who understands both the Programme and the business case needs of MFAT, and who can act as a bridge between MFAT staff and its partners. It is proposed that this MERL expert could:

Step 1. Work with MFAT staff and the technical specialists to clarify the higher-level goals and define realistic expected outcomes.
Step 2. Consider the best implementing partners to deliver components against this logic.
Step 3. Workshop these ideas with MFAT and the selected partners.
Step 4. Develop a preliminary logic and confirm this with partners.
Step 5. Support each partner to prepare the overarching logic and supporting details for each component of their agreed MERL Framework.

The resourcing for MERL in any future Programme needs to be substantially increased. As mentioned in Section 4.6, there is potential for the Programme Manager/Team Leader to eventually manage these tasks. The focus should be on ensuring that: partners capture their agreed indicators; collaboratively assess progress; support adaptive management; and take responsibility for reporting the overall progress against the Outcomes and Goals.

Recommendation 4. Future MERL work should include a nuanced analysis of the economic, environmental, and social impacts of the CRB incursions on the various livelihood groups and their management practices (refer Section 3.1).

The potential domains that a nuanced study could explore are summarised in Table 1. However, in practice it will be important to further subdivide some of these groups, such as distinguishing

between communities and smallholders who have good access to markets (and for whom coconut may therefore be a cash crop) and those in remote rural areas and outer islands (for whom coconut is more likely to be fundamental to their food security and to 'provisioning' in general). Studies could collect longitudinal data at several sentinel sites to gauge the impacts of CRB, and gain a better sense of the cycles of infection and recovery; the resulting damage; the impacts on production, sale, and consumption; and the community coping mechanisms. A more nuanced evidence base could:

1. Spur a level of Government and Donor understanding of CRB that is commensurate with the risks being posed;
2. Help target the limited biosecurity resources to high-risk areas; and
3. Target and guide the development of appropriate IPM efforts within specific livelihood systems.

Table 1: Livelihood groups confronted by CRB

	Coconut	Oil Palm
Villagers		
Smallholder		
Estates		
Amenity		

Furthermore, while data during the Programme has mostly been promptly captured on a shared "cloud-based" platform, further work is needed to improve the rigour and usability of these data sets if this information is to better track progress and guide further intervention. Significant work is also needed to prepare succinct but meaningful management information and summaries that can be regularly shared (or are directly accessible) by national and regional managers.

7.1.1.6 Awareness and communication

Recommendation 5. The public awareness, data sharing, and communication of progress and impact need to be better resourced and more sophisticated.

The focus of awareness-building should be on stimulating behaviour change within key audiences, consistent with the Programme's TOC (which would need to be correspondingly elaborated). Messaging could be improved by better profiling the needs of different audiences (policy makers, managers, producers, processors, school children, businesses), and tailoring messages and other communications accordingly. This could improve opportunities for advocacy, and better the engagement of the stakeholders. Importantly, ongoing monitoring is essential not only to gain a clearer appreciation of coverage, but to understand the resulting impacts (or lack thereof) on behaviours. This area of investment should be guided by a communication strategy (rather than the current narrow 'awareness' approach), that is informed by its own Theory of Change (albeit one that is nested within the Programme's overall TOC).

7.1.1.7 Oversight

Recommendation 6. In future, programme oversight, including the associated structures and roles, needs better planning and clear Terms of Reference.

In a programme that engages with multiple partners, it is useful to establish an across-agency steering group for management oversight. This should, however, be largely focused on:

1. Higher level programme progress and not on specifics.
2. Higher level risks.
3. Compliance of the partners with their MERL commitments.
4. Ensuring the transparency and efficiency of the contractual and financial processes.

Contractual management and compliance issues should not be raised at the Steering Committee, but should be jointly handled by the MFAT Managers, a Programme Manager/Team Leader (if appointed), and the specific contract partner.

Technical oversight will best be handled by the partners themselves, through Task Force structures to be established at the country level. MFAT could also consider directly convening a regional Task Force to ensure that its managers are kept up to date with progress.

7.1.2 Issues that are beyond the scope of the pest-specific CRB follow-on work

Recommendation 7. MFAT could consider parallel investments that address the significant Pacific domestic quarantine legislative gaps, and strengthen the leadership, planning, and other core capacities of the relevant agencies (refer Section 4.2).

In some cases, inadequacies in legislative frameworks, organisational structures, leadership, planning, and management of the national biosecurity agencies have constrained the progress of the *CRB Response Programme*. Yet these are issues that cannot be dealt with within the narrow context of a pest-specific response, but can only be dealt with through broad regional or national biosecurity capacity building programmes, such as those that are currently being managed by Australia, New Zealand, the European Union, and the United Nations. MFAT should therefore consider alerting these programmes to the challenges the *CRB Response Programme* has faced, and advocate for focused support on the identified critical gaps. Alternatively, MFAT may consider establishing or broadening its own mechanisms to address these foundational needs.

Recommendation 8. MFAT could work with other regional development partners and regional agencies to advocate for a long term, emergency response mechanism that can rapidly deliver the 'surge capacity' that is essential for Pacific countries to effectively combat new pest incursions.

As elsewhere, pest incursions are escalating across the Pacific, risking national and regional economies, livelihoods, and environments. The experience of CRB and other recent pest incursions[35] confirms the challenges being faced by Pacific countries when dealing with invasive pests. For the most part, the emergency responses were delivered on a pest-by-pest basis, were inadequately designed and coordinated, were delayed in their rollouts, were under resourced, were too short-term, and were disparately delivered. Seldom has a response contained and managed an invasive pest, let alone achieved eradication. Long-term, ongoing, optimally sized, and reliable mechanisms are therefore needed to improve the preparedness of the biosecurity agencies, and to enable them to quickly access additional resources. This surge capacity would have four main elements:

1. Ongoing and coordinated surveillance at high-risks sites (such as ports) across the region;
2. Clear upfront emergency plans, processes, and structures to immediately deal with the advent of any invasive pest;
3. A regional technical response capacity that can collaborate with the national biosecurity agencies as soon as an incursion is detected to confirm, characterise, and assess

[35] Such as Coffee Berry Borer, Fall Army Worm, and a variety of invasive ants and termites.

options for an emergency response (with an emphasis on understanding and limiting the impact as much as on containing the spread).

4. Additional resources, possibly in the form of a substantial regional "sinking fund", to enable the agencies to engage the personnel that are needed to enact the emergency response protocols, as well as the tools, materials, and activities needed to combat new incursions into new areas, new islands, or new Pacific countries.

In principle, some of these plans and processes have already been established, under the auspices of the PPPO, and hosted by SPC-LRD. To be effective, however, these now need to be enhanced and harmonised, which is a very large undertaking that is well beyond the scope of a programme that is specifically focused on the spread of CRB. Regional groups such as SPC-LRD, MPI, and DAFF are equally concerned about the inadequacies of the region's current state of preparedness, and agree that without a more coordinated regional response invasive pests will continue to threaten the economies across Oceania. Logically, a long-term commitment by the better-placed regional partners - New Zealand and Australia - in the development of the necessary protocols seems the most feasible option. Segments within the USDA are also strongly advocating for this need, but have struggled to influence its funding priorities.

Both donors and regional governments could contribute to the sinking fund. The resulting "Emergency Response Facility" could be managed by a group such as SPC, according to clear management protocols pre-agreed by its members. Because some Pacific countries (e.g. Papua New Guinea and Fiji) already have significant in-house biosecurity capacity and resources, eligibility criteria for the sinking fund may be varied. It is to the advantage of all, however, if supplementary arrangements are in place to enable the stronger national agencies or regional organizations (especially SPC) to come to the aid of their weaker neighbours. Furthermore, the response needed to some pests (e.g. Foot and Mouth Disease) may well be beyond such a Facility's capacity. Hence, the fund may need to be targeted to specific threats.

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Annex 2: Organisations Consulted

Stakeholder Organization	Managers consulted (n)	Staff or members consulted (n)
MFAT - Wellington	3	1
MFAT – Papua New Guinea	1	1
MFAT – Solomon Islands	1	1
MFAT – Vanuatu	1	1
MFAT - CRB Programme Manager	1	0
Department of Foreign Affairs and Trade (Australia)	1	0
Department of Agriculture, Forestry and Fisheries (Australia)	1	0
Australian Centre for International Agricultural Research	1	0
US Department of Agriculture (Pacific)	1	0
Food and Agriculture Organization of the United Nations (Sub-Regional Office, Samoa)	1	0
AgResearch	4	9
Pacific Community – Land Resources Division (SPC-LRD)	3	7
Ministry of Agriculture and Livestock – Biosecurity Solomon Islands	2	8
Biosecurity Advisor (Solomon Islands)	1	0
Ministry of Agriculture and Livestock – Research and Extension Solomon Islands	0	1
Commodity Export Marketing Authority (CEMA) Solomon Islands	1	0
Ministry of Agriculture, Livestock, Forestry, Fisheries and Biosecurity (Vanuatu)	1	0
Biosecurity Vanuatu	2	7
Vanuatu Agricultural Research and Technical Centre (VARTC)	2	0
Vanuatu Provincial Administrators	2	0
Ministry of Trade (Vanuatu)	1	1
Ministry of Agriculture (Papua New Guinea)	1	5
National Agricultural Research Institute, Papua New Guinea	0	1
National Agriculture and Quarantine Inspection Authority, PNG	2	5
Oil Palm Research Association (OPRA), PNG	1	3
Kokonas Indastri Koporesen (KIK), PNG	1	3
Biosecurity Authority of Fiji	0	1
Biosecurity - Tonga	1	1
Biosecurity - Samoa	1	0
Biosecurity – Cook Islands	1	1
Guadalcanal Plains Palm Oil Ltd (GPPOL)	1	1

Stakeholder Organization	Managers consulted (n)	Staff or members consulted (n)
Kokonut Pacific Solomon Islands (KPSI)	1	1
South Sea Cargo (Vanuatu)	1	0
Vanuatu Primary Producers Association (VPPA)	0	5
Solomon Island Copra Exporters	1	0
Coconut Industry Working Group (Solomon Islands)	1	5
Communities in PNG (Madang)	1	3
Communities in Solomon Islands (Guadalcanal)	2	12
Communities in Vanuatu (Efate)	2	2
University of Queensland	1	0
PHAMA Plus/Kalang	2	4
Australia Papua New Guinea Economic Partnership	1	1
Strongim Bisnis (Solomon Islands)	1	0
TOTAL	**54**	**91**

Annex 3: *CRB Response Programme* Theory of Change