

RESIDUAL SPRAYING AGAINST AEDES VECTORS IN THE PACIFIC

Training of Trainers Workshop

9-13 October 2023 | Cairns, Australia



Workshop Report

Rationale

Residual spraying is the process by which a long-lasting insecticide is applied to the common resting sites of mosquitoes inside houses and other buildings (known as indoor residual spraying, IRS) and outside in harbourage areas (known as outdoor residual spraying, ORS). These interventions aim to cause *Aedes* mosquitoes that land on treated surfaces to die, preventing further transmission of dengue, Chikungunya and Zika viruses to humans.

To effectively protect communities, spray operations must ensure high coverage of households, structures and harbourages, with high quality and safe application of insecticides. Low-quality spraying can jeopardise the residual spray program. Training of spray operators is therefore important. It is essential that every spray operator demonstrates competency before moving to the field and performing residual spraying without supervision.

This workshop was designed to develop a cohort of trainers in the Pacific to assist in building spray operator capacity to conduct quality, safe and effective residual spraying. While malaria-endemic countries of the region have used this intervention against *Anopheles* mosquitoes, there is less experience in use against *Aedes*. This workshop therefore aimed to support the use of this intervention to combat *Aedes*-borne diseases in the Pacific.

Workshop Overview

The training-of-trainers workshop was held from 9 to 13 October 2023 in Cairns, Australia. Sessions were held at 3 locations: The Boathouse at James Cook University (JCU), Cool Waters Resort, and Goomboora Park.

Objectives

By the end of the workshop, the objective was for participants to be able to:

1. Recount key requirements for quality, safe and effective residual spraying indoors and in harbourage sites of *Aedes* vectors
2. Understand and teach:
 - How to sensitise householders and prepare houses for spraying
 - How to target spraying to specific locations and areas within locations
 - Correct spraying techniques for hand-compression sprayers and motorised backpack mist-blowers
 - Correct handling, use, maintenance and disposal of spraying equipment and supplies
 - Correct completion of spray activities, including tracking/reporting

Schedule

Sessions were held over 5 days and included classroom learning, practical demonstrations and hands-on participation. There was an emphasis on ensuring participants had opportunities to practice teaching of the concepts, processes and techniques related to residual spraying.

Attendees

In attendance at the workshop were 18 participants from 12 Pacific Island Countries and areas, 11 facilitators from three organizations (JCU, Queensland Health and Goizper Group), and 3 additional persons from JCU for administrative and technical support. Females comprised 44% (n=8) of participants and 36% (n=5) of facilitators.

Participants

Country	Name
American Samoa	Villa Tafaumu
Cook Islands	Nelson Ngaiorae
Cook Islands	Paul Maaka
Fiji	Tulia Kuruduadua
Fiji	Vineshwaran Rama
Kiribati	Bungia Kaitaake Kirata
Nauru	Felila Peter
Palau	Felton E Ngiraingas
Papua New Guinea	Mavis Abaya
Samoa	Alosio Tagiilima
Samoa	Paulo Pemita Seuseu
Solomon Islands	Charlie Iro'ofa
Solomon Islands	Rolex Havea
Tonga	Siaola Mahe
Tuvalu	Miliesi Kapuafe
Tuvalu	Monica Malua
Vanuatu	Christie Makikon
Vanuatu	Johnny Nausein

Facilitators

Organization	Name
James Cook University	Tom Burkot
James Cook University	Tessa Knox
James Cook University	Amanda Murphy
James Cook University	Xanthe Lawson
Queensland Health	Joe Davis
Queensland Health	Rodney Bellwood
Queensland Health	Barry Bennett
Queensland Health	Jason Anderson
Queensland Health	Ian Waring
Goizper Group	Iñigo Garmendia
Goizper Group	Yap Teck Keong

Administrative and Technical Support

Organization	Name
James Cook University	Sally McDonald
James Cook University	Lynne Saunders
James Cook University	Mick Townsend

Overview of workshop schedule

Key

Classroom learning	Practical demonstrations	Hands-on participation	Practice teaching
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	Monday 9 October	Tuesday 10 October	Wednesday 11 October	Thursday 12 October	Friday 13 October
09:00-09:15	Opening	Review of Day 1	Review of Day 2	Review of Day 3	Review of Day 4
09:15-10:30	Introduction	S9a: Spray equipment and insecticides: hand-compression sprayer	S6: Daily preparations and tasks	S23: Spray skills observation	Practice teaching skills
	Facilitation concepts & approaches	S10: Starting up: hand-compression sprayer	S7: Preparing spray units		
10:30-10:45	BREAK	BREAK	BREAK	BREAK	BREAK
10:45-12:30	Pre-workshop test	S11: Practice with starting up: hand-compression sprayer	S13: Practice indoor spray technique S15: Practice treatment of outdoor harbourages S17: Practice spraying beyond house and yard	S22 (cont) S21: Supervision and data management	S26: Review session Code of conduct
	S0: Trainer refresher on Aedes vectors	S19: Sprayer cleaning and maintenance Check discharge rate		S22: Practice using forms	Closing Post-workshop test
12:30-13:30	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
13:30-15:30	S1: Introduction to residual spraying	S12: Indoor spray technique	S13, S15, S17 (cont)	S8: Practice communicating with the community	
	S2: Overview of residual spraying against Aedes	S13: Practice indoor spray technique			
	S3: Health and safety	S9b: Spray equipment and insecticides: backpack mist-blower			
15:30-15:45	BREAK	BREAK	BREAK	BREAK	
15:45-17:00	S4: PPE	S14: Outdoor harbourage treatment	S18: End of day clean up	S24: Spraying in difficult situations	
	S5: Practice with PPE	S15: Practice outdoor treatment		S25: Practice troubleshooting	
	Walking tour	S16: Beyond the yard			

Resources

The following key resources were used during the workshop:



PacMOSSI Spray Operator Workshop Facilitator Guide*: Maps out workshop information, preparations, requirements and sessions. Module format, so it can be adapted to the needs of the participants. Includes Annexes with workshop and data resources.



PacMOSSI Spray Operator Field Guide*: Principal technical resource. Simple overview of key technical content covered in sessions. To be used as a reference guide during field operations.



SPC/WHO Manual for Aedes Vector Surveillance and Control in the Pacific: Reference manual for technical details. Designed for programme managers, operational staff and collaborating partners responsible for planning, implementing, monitoring, and evaluating national vector control programmes.



Videos: For Goizper hand-compression sprayers and cover a range of topics (assembly, starting up, cleaning, troubleshooting). Available at: <https://www.youtube.com/playlist?list=PL1G4UAa7dm-q1qWfSZa88gOsobnOD27qL>

PacMOSSI Spray Operator Workshop Presentations*: Detailed technical content for classroom sessions. To be compiled online to be adapted for use at in-country workshops.

* **Note** that documents were piloted at the training with feedback to be used to finalise and circulate electronic and hard copies to all participants after the workshop.

Workshop Outcomes

Pre-Workshop Vector Control and Spraying Situation Assessment

A pre-workshop survey of trainees was conducted to assess recent *Aedes* control methods, current residual spraying practices and related resources. Online survey responses were received from 19 individuals from 13 countries in advance of the workshop. (One respondent was unable to attend the workshop). Responses were discussed during the workshop, with any inconsistencies or inaccuracies corrected. Results of the survey are presented below.

Overview of survey responses (n=19): vector control methods

Country		Methods used against Aedes (last 5y)								Residual spraying against Aedes			
Name	Res- ponses	Indoor residual spraying of insecticides	Outdoor harbourage spraying of residual insecticides	Indoor ULV fogging or space spraying	Outdoor ULV fogging or space spraying	Release of Wolbachia -infected <i>Ae. aegypti</i>	Larval source reduction	Larviciding	Distribute personal topical repellents	Distribute insecticide-treated nets	Being done now?	Plans to start?	Current strategy against Aedes
American Samoa	1	x						x			No	No	na
Cook Islands	2	x	x		x		x	x			Yes	na	In houses and neighbouring areas in response to a suspected or confirmed case
Fiji	2				x	x	x	x	x		No	No	na
Kiribati	1					x	x			x	No	Yes	na
Nauru	1				x						No	No	na
Palau	2	x	x	x	x		x	x	x		Yes	na	In houses and neighbouring areas in response to a suspected or confirmed case
Papua New Guinea	1	x									Yes	na	In houses and neighbouring areas in response to a suspected or confirmed case
Samoa	2	x	x								Yes	na	In houses and neighbouring areas in response to a suspected or confirmed case
Solomon Islands	2										Yes	na	Targeted routinely to high-risk areas or transmission foci
Tonga	1		x		x		x	x	x	x	Yes	na	Response to request from community; In outdoor areas or houses and neighbouring areas in response to a suspected or confirmed case
Tuvalu	2	x	x		x		x	x	x	x	Yes	na	Targeted routinely to high-risk areas or transmission foci
Vanuatu	2	x				x	x	x			Yes	na	In houses and neighbouring areas in response to a suspected or confirmed case

Overview of survey responses (n=19): vector control resources

Country	Number of personnel			Equipment & insecticides				Products used for spraying (residual spraying and other)
	Name	Working in Aedes vector control	Trained as spray operators	Need to be trained as spray operators	Hand-compression sprayer	Motorised backpack mist-blower	ULV fogger/space sprayer	
American Samoa	6 to 10	na	na	None	1 to 5	None	None	Not sure
Cook Islands	6 to 10	6 to 10	6 to 10	6 to 10	6 to 10	None	1 to 5	Key Delta Aqua (deltamethrin), Strike-Out (chlorpyrifos), Recruit (imidacloprid)
Fiji	1 to 2	na	na	1 to 5	More than 20	More than 20	None	Not sure
Kiribati	3 to 5	na	1 to 5	None	None	None	None	None
Nauru	6 to 10			1 to 5	1 to 5	None	None	Biflex AquaMax (bifenthrin)
Palau	1 to 2	11 to 20	6 to 10	1 to 5	1 to 5	1 to 5	1 to 5	D-Fense SC (deltamethrin)
Papua New Guinea	1 to 2	6 to 10	More than 20	6 to 10	None	None	None	Fludora fusion (deltamethrin, clothianidin)
Samoa	3 to 5	None	More than 20	1 to 5	6 to 10	None	None	Icon 10 CS (lambda-cyhalothrin), Claw (bifenthrin)
Solomon Islands	1 to 2	More than 20	More than 20	More than 20	None; 1 to 5	None	1 to 5	K-Othrine WG250 (deltamethrin), Ficam WP (bendiocarb)
Tonga	3 to 5	None	1 to 5	1 to 5	1 to 5	1 to 5	None	Aqua K-Othrine (deltamethrin), bifenthrin etc.
Tuvalu	6 to 10	1 to 5	1 to 5; 6 to 10	1 to 5	None	1 to 5	None	Ficam WP (bendiocarb); Aqua K-Othrine (deltamethrin)
Vanuatu	1 to 2	None; 1 to 5	1 to 5; 6 to 10	11 to 20	None	None	None	Actellic 50 EC, Actellic 300CS (pirimiphos-methyl)

Workshop Proceedings

Each session was opened with an indication of objectives and finished with a review of key concepts or conclusions and related discussions. The main topics covered during the workshop were:

1. Learning and facilitation approaches
2. Theory of vector biology and mosquito control
3. Demonstration and practice of residual spraying techniques for controlling *Aedes*:
 - a. IRS using Goizper hand-compression sprayers
 - b. ORS of vegetation using Stihl mist-blowers
4. Spray challenges, maintenance and troubleshooting
5. Health and safety (including personal protective equipment, PPE)
6. Supervision and data management
7. Communicating with the community.

The main conclusions and discussion points for each topic are summarised below.

Learning and facilitation approaches

The key points covered were:

- Understanding how adults learn
- Identifying which techniques help Pacific Islanders to learn best:
 - More practical and less theoretical: learning by doing 'with our own hands'
 - Ongoing learning/mentoring is important
- Practice makes perfect! Repetition and helping your colleagues learn will build confidence and competence.

Theory of vector biology and mosquito control

The key points covered were:

- There is no one perfect method for mosquito control
- The appropriate methods will depend on the vector species being targeted (indoors/outdoors) - this requires a good understanding of their biology and resting places
- Residual spray can be applied for different purposes in different areas, locations, structures, surfaces
- Residual spray programs must be adaptive to the situation
- Mosquito behaviours/distributions are not static.

*Indoor residual spraying (ORS-*Aedes*) using Goizper sprayers*

The key points covered were:

- Targets indoor-resting mosquitoes, such as *Ae. aegypti*
- Aims to cover the lower 1.5m of the walls and under/behind furniture and in dark areas
- Keep nozzle 45cm from the wall with one swath taking approximately 3.5 seconds
- Need to adapt the application speed/technique for use under/around furniture - use a faster application speed if the nozzle is closer than 45cm.

Outdoor residual spraying of vegetation (ORS-Aedes) using Stihl mist-blowers

The key points covered were:

- Residual spraying of peri-domestic areas is called barrier spraying or harbourage spraying
- Targets outdoor-resting vectors such as *Ae. albopictus*, *Ae. polynesiensis* and *Ae. hensilli*
- Spray technique aims to cover the lower 2m of vegetation, and to penetrate up to 3m deep into the vegetation.
- Vegetation targeted is very close to buildings or residences where humans reside.

Spray challenges, maintenance and troubleshooting

The key points covered were:

- Main challenges include personal factors (e.g. timing or appropriateness of access), extreme or unpredictable weather conditions (e.g. heat, rain, wind) or disasters, pets and wildlife (e.g. vicious dogs), environmental hazards (e.g. unsafe or difficult access), political issues
- Householders may not be at home or refuse the spraying
- Parts to repair and maintain the sprayers may be challenging to access locally - spray operators should understand basic cleaning and maintenance (e.g., weekly calibration).

Health and safety (including PPE)

The key points covered were:

- Do not use insecticide near food or food preparation areas (or while eating or smoking), and wash hands and face after spraying
- Ensure you are hydrated before starting spraying and monitor yourself and your colleagues for symptoms of insecticide exposure or fatigue/overheating
- The best way to protect the spray operator is to wear PPE at all times that there may be contact with insecticide
- Different types of chemicals have different safety/toxicity considerations. It is important to understand the appropriate use of each chemical – both the chemical itself and the technique to apply it

Supervision and data management

The key points covered were:

- Good record keeping is important to ensure effective and efficient spray operations, and can be used to report spray team performance (e.g., amount of insecticides used and reasons for refusal of spraying)
- Two types of forms need to be completed accurately: the household spray card and daily spray record (adapted to each country)
- These forms inform accurate planning and reporting at the national level, and are compiled for reporting national statistics.

Communicating with the community

The key points covered were:

- It is important to communicate different types of information to the community before, during and after spraying
- Common concerns to address with the community include:
 - Queries on why operators wear PPE
 - Health risks to babies, pregnant women or unwell family members
 - Risks of spraying versus not spraying
 - Reducing challenges for the spray team, such as access issues, vicious dogs, environmental hazards

Media coverage

A media release was developed (see [here](#)), with selected participants and facilitators interviewed by [7News Cairns](#) and [ABC Radio Pacific Beat](#).

Assessments

Spray Operator Skills Test

Participants were assessed by facilitators on their ability to demonstrate key skills as taught and practiced during the workshop. This included filling sprayers and performing 3 consecutive sprays. This assessment was conducted on the second last day of the workshop to enable corrective actions and guidance to be provided to participants. All participants received a rating of 10 out of 10 for the skills test.

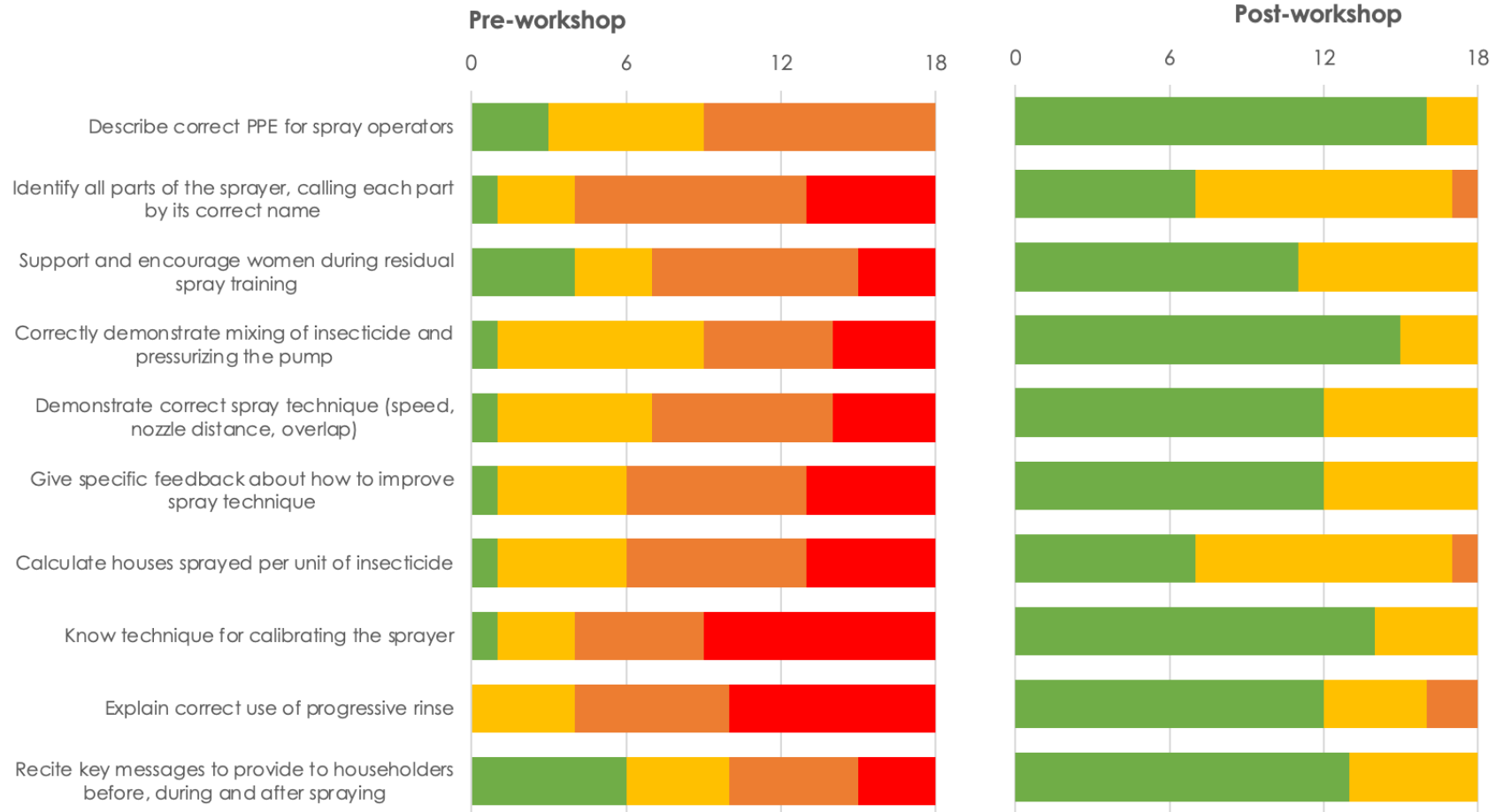
Pre- and Post-Workshop Tests

To assess the effectiveness of the workshop, participants were issued a standardised written assessment at the beginning and at the end of the workshop. This included a self-assessment of competence in 10 domains related to spraying and 12 multiple-choice questions.

For the self-assessment, every participant (n=18) reported an overall improvement in competence. On average, those participants who had high prior experience (i.e. at least 8 spray rounds) improved in 6 of 10 domains, whereas those with less experience (i.e. less than 8 spray rounds) improved in 8 domains. This indicated that the self-assessed competence of the participants increased substantially even if they had prior experience with residual spraying.

For the multiple-choice questions, the average score was 5.3 out of 12 before the workshop. This increased to 10.2 out of 12 for the post-workshop test (which used the same questions). Every participant (n=18) improved on their score between the pre- and post-workshop assessment, irrespective of the number of residual spray rounds they had completed prior to the workshop. This confirmed that participants with all levels of prior experience improved their technical knowledge during the workshop.

Self-reported competence in 10 domains related to residual spraying before and after the workshop.



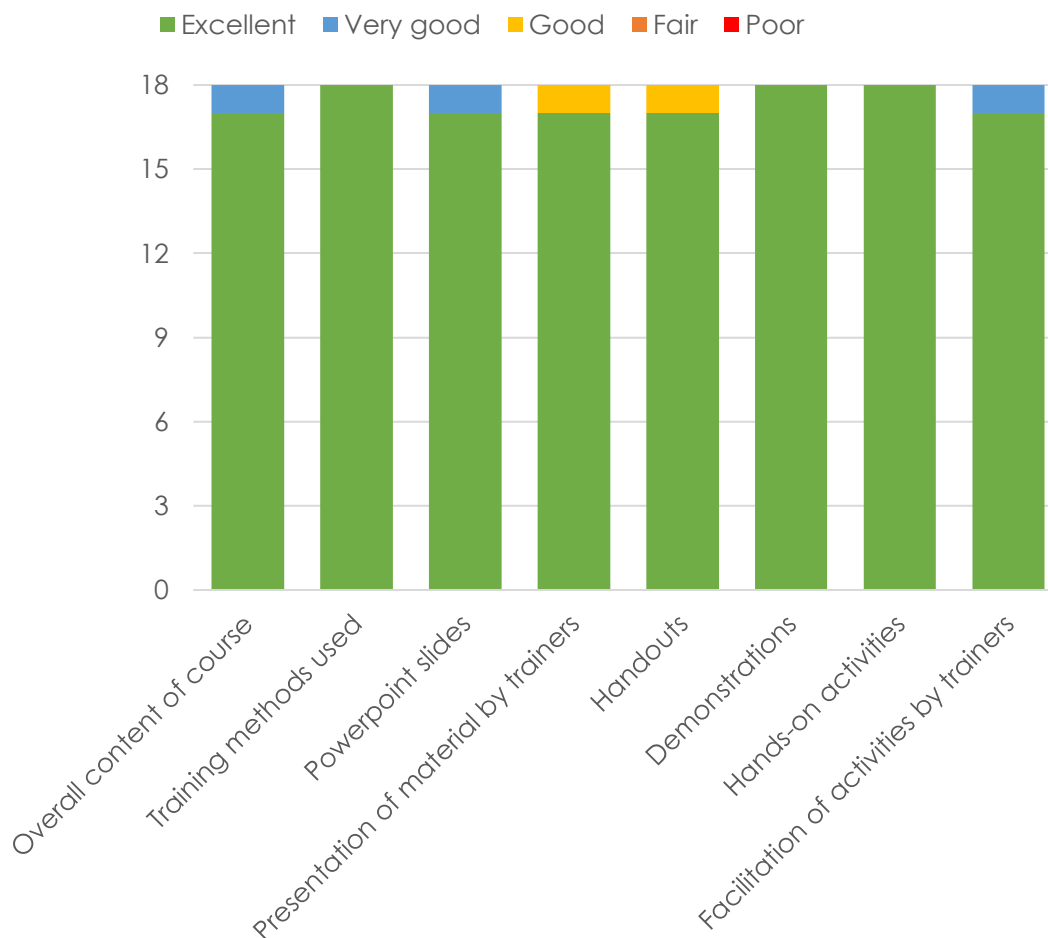
Workshop Evaluation

Participants completed an evaluation of the workshop at the conclusion of the technical program. The evaluation included rating various workshop components and providing written feedback on the relevance of content and suggestions for strengthening the course.

Participants rated all components as excellent (n=17), with the exception of one participant who rated 5 of the 8 components as very good or good. Some participants (n=7) indicated more information was needed on the types of chemicals available for residual spraying and how to access/procure or use/mix them. All content was considered as relevant, without any topics indicated as 'not useful' by participants. The information that was commonly considered most useful (n=10) was the comparison of IRS and ORS, and how and when each is used. Participants indicated appreciation of the demonstrations and hands-on sessions included in the program.

The most common response regarding how the course could be strengthened was for the duration to be extended and the content to be expanded, particularly to allow more time for practical 'hands on' sessions (n=10).

Ratings of 8 workshop components by participants (n=18).



Conclusions

Participants emphasised the importance of ensuring that activities related to strengthening vector surveillance and control continue in the Pacific, as aligned with the *Global vector control response (2017-2030)*. It was stressed that future trainings and activities build on the high-quality support provided through the PacMOSSI project since its initiation in 2019.

During the final plenary session, feedback was sought from participants on how PacMOSSI activities could be further expanded to best support Ministries of Health in the Pacific to enhance vector surveillance and control. The following were indicated as priorities for which PacMOSSI may be able to provide some support, including for advocacy, training or the contribution of other technical or financial resources.

Summary of participant feedback on priority needs for potential future PacMOSSI support to vector control in the Pacific.

Activity	Priority	Timeframe
Provision of extra items to support residual spraying (spare parts, spill kit, first aid kit)	High	1-2 months
Advocate for supply of insecticides for residual spraying (and larvicides, if appropriate)	High	6-12 months
Technical assistance to support the delivery of in-country workshops for spray operators	High	12-24 months
Development of templates for procedures for indoor spraying, yard inspections and outdoor spraying (based on Qld Health documents)	High	1-2 months
Update of residual spraying materials, including Field Guide, Facilitator Guide and Aedes forms (in Excel)	Medium	1-2 months
Identify options to embed vector surveillance and control training into established education programs such as for EHOs (e.g. FNU, NUS) or to upskill EHOs by integrating components into national trainings	High	12-24 months
Evaluate PacMOSSI trainings to determine how effective they have been and identify any training gaps or improvements required	High	12 months
Design of curriculum for in-country certification of spray operators in order to improve regulation of pesticide use	Medium	6-12 months

Technical assistance to adapt curriculum and certification processes to meet individual country requirements and situations	Medium	12-24 months
Training on GIS tools for vector surveillance and control (for selected countries who have not yet received this support)	High	12-24 months
Financial and technical support to expand surveillance of Aedes vectors to update the regional map on species distributions	Medium	12-36 months
Coordinate expertise- and experience-sharing in vector surveillance and control across Pacific Island Countries (cross-country collaboration, training and mentoring)	High	12-24 months
Technical assistance to develop templates for communication materials for vector control (to be adapted to country contexts)	High	12-24 months
Assessment of regulatory requirements in Pacific Island Countries for insecticides for public health use	Medium to high	12-24 months
Assessment of efficacy and effectiveness of residual spraying through operational research grants	High	ongoing
Support for the identification of Aedes vectors and insecticide resistance testing, including for training, in-country technical assistance, mentoring and provision of test kits	Medium to high	ongoing

Closing

The final session concluded with facilitators thanking participants for the active and positive engagement throughout the entire workshop program. It was acknowledged by participants and facilitators that further work is required in each country to ensure that Aedes control is optimised based on the processes and techniques covered during the workshop.

Completion certificates were issued to all participants, who were deemed by facilitators to have exhibited satisfactory knowledge and skills on residual spraying.

A vote of thanks was issued by participants for the hard work of the facilitators and support staff to ensure the workshop was useful, well-organised and enjoyable.

Selected images from the workshop











Images of all participants receiving completion certificates are available here:
https://drive.google.com/drive/folders/1DUUaS-62K10xOA52Gi3ncu26A3-0zwSI?usp=drive_link