

## **Final Report**

# **Podcast for fall armyworm management in Northern farming systems**

### **Delivery partner:**

Cotton Research & Development Corporation

### **Project code:**

MT19013

**Project:**

Podcast for fall armyworm management in Northern farming systems (MT19013)

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## FINAL REPORT

**CRDC ID:** PHA2003

**Project Title:** Podcasts for Fall Armyworm management in northern farming systems

**Confidential or for public release?** For Public Release

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## Part 1 – Contact Details & Submission Checklist

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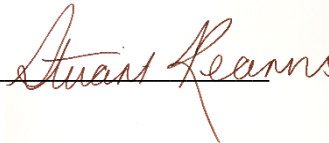
### Submission checklist.

*Please ensure all documentation has been completed and included with this final report:*

- Final report template (this document)
- Final Technical Report (see Part 3)
- NA Final Schedule 2: IP register
- NA Final financial report
- PDF of all journal articles (for CRDC's records)

**Signature of Research Provider Representative:**

**Date submitted:** \_\_\_13/4/2021\_\_\_\_\_



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## Part 2 - Monitoring & Evaluation

### Achievement against milestones in the Full Research Proposal

Milestone	Achieved/ Partially Achieved/ Not Achieved	Explanation
10-11 Podcasts finalised.	Achieved with modification.  (*Original plan was to have 1 interview / podcast, however 14 interviews were conducted and combined to 9 podcasts)	A series of 9 podcasts was produced throughout the project. Whilst 14 interviews were conducted, the project combined a number of these interviews to produce the 9 podcasts in an attempt to better integrate the knowledge that was captured. All podcasts made available via <a href="http://pbri.com.au/pbri-podcasts">pbri.com.au/pbri-podcasts</a>
Compilation of digital resources on FAW including podcasts etc into one online platform.	Achieved	Worked with CESAR, QDAF, CABI and GRDC to develop the Fall Armyworm Continuity Plan for high risk crops. Continuity Plan now forms the basis for the Fall Armyworm Portal on GRDC website <a href="http://www.grdc.com.au/fallarmyworm">www.grdc.com.au/fallarmyworm</a>
Gap analysis report compiled from discussions with PBRI members and GRDC FAW preparedness project.	Achieved	Through support from DAWE a National Fall Armyworm R&D Forum was held to identify and develop R&D priorities. Gap Analysis was developed and included in Forum Proceedings (attached) and will be discussed at PBRI FAW workshop on 27 April 2021.

### Outputs produced *(Please refer to examples document to assist in completing this section).*

Output	Description
Series of 9 Podcasts on local, national and international experiences in managing the impact of Fall Armyworm.	The podcast series featured interviews with growers and agronomists on their first-hand experience in managing new and emerging pests, leading Australian researchers on their latest findings and observations and international experts who share their experiences and learnings. Each episode is around 30 minutes in duration (something similar to “conversations’ on the ABC, and listeners can listen in any order they want.  14 people were interviewed on their experiences when dealing with Fall Armyworm, the challenges they faced and any lesson that we should heed.

**Outcomes from project outputs** (*Refer to examples document*).

Outcome	Description
Impacted industry organisations and PBRI members aware of the international and local perspectives in managing FAW.	This project provided a coordinated approach for Industry organisations and PBRI to gain awareness of international and emerging Australian perspectives on FAW.

**Part 3 – Technical Report**

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*Technical report provided at end of document*

**Part 4 – Summary for public release**

Project title:		
<b>Project details:</b>	CRDC project ID:	
	CRDC goal:	<i>1. Increase productivity and profitability on cotton farms</i>
	CRDC key focus area:	<i>1.3 Protection from biotic threats and environmental stresses</i>
	Principal researcher:	<i>Stuart Kearns</i>
	Organisation:	
	Start date:	<i>20 April 2020</i>
	End date:	<i>30 September 2020</i>
<b>Objectives</b>	<p>This project aimed to deliver a series of podcasts to inform growers and industry on the various ways FAW was having an impact and being managed in key locations internationally and locally in Australia.</p> <p>It also sought to pool relevant FAW information into one location.</p>	
<b>Background</b>	<p>Fall armyworm (FAW), <i>Spodoptera frugiperda</i> is a noctuid moth, native to the Americas. It was first reported in Australia in February 2020 and quickly established across parts of Northern Australia's tropical and sub-tropical regions, including North Queensland, Northern Territory, and northern parts of Western Australia. Eradication has been determined to be unfeasible and it is now classified as an established pest in these areas.</p> <p>Given COVID-19 restrictions this year, PHA, like most national organisations, had to change the ways in which it engaged with growers, researchers and biosecurity staff.</p> <p>Early project discussions and planning had the project delivering a series of regional face to face forums across northern Australia, from the Burdekin, Katherine and Kununurra. While there is nothing better than standing in the paddock or at a field day and engaging growers on the challenges they face, the reality of COVID meant we weren't able to do that.</p> <p>The project quickly changed tactics in light of the evolving pandemic and selected podcast as the primary delivery pathway for the information that was to be curated. This was the first attempt by PBRI and PHA to develop podcasts as the way of delivering information to industry.</p>	
<b>Research activities</b>	<p>The podcast series featured interviews with growers and agronomists on their first-hand experience in managing new and emerging pests, leading Australian researchers on their latest findings and observations and international experts who share their experiences and learnings. Each episode was around 30 minutes in duration (something similar to "conversations" on the ABC, and listeners can listen in any order they want.</p>	

	<p>14 people were interviewed on their experiences when dealing with Fall Armyworm, the challenges they faced and any lesson that we should heed.</p> <p>The podcasts were hosted on the PBRI website <a href="http://www.pbri.com.au/pbri-podcasts">www.pbri.com.au/pbri-podcasts</a> and were also made available to listeners to access directly through their favourite podcast app (ie Apple podcasts, Spotify, Google56 podcasts).</p> <p>Throughout the series, podcast host Chris Brown delved into the biology and behaviour of fall armyworm and explored how we could best prepare ourselves to minimise its impact.</p>																														
<b>Outputs</b>	<p>The project produced a series of 9 podcasts from 14 interviews on the experiences of dealing with Fall Armyworm, the challenges faced and lessons that Australia could learn from.</p> <p>Details of each podcast are provided in the Technical report in Part 3.</p> <table border="1" data-bbox="603 801 1396 1568"> <thead> <tr> <th>Number</th> <th>Episode</th> <th>Published On</th> </tr> </thead> <tbody> <tr> <td>9</td> <td><a href="#">Could fall armyworm have been present in o...</a></td> <td>30 October 2020 - 4:00 pm</td> </tr> <tr> <td>8</td> <td><a href="#">Trial observations and laboratory findings...</a></td> <td>30 October 2020 - 4:00 pm</td> </tr> <tr> <td>7</td> <td><a href="#">Field observations of fall armyworm in nor...</a></td> <td>30 October 2020 - 4:00 pm</td> </tr> <tr> <td>6</td> <td><a href="#">Scouting, developing thresholds and tips t...</a></td> <td>12 October 2020 - 4:30 pm</td> </tr> <tr> <td>5</td> <td><a href="#">Field observations of fall armyworm in nor...</a></td> <td>12 October 2020 - 4:15 pm</td> </tr> <tr> <td>4</td> <td><a href="#">FAO's global action for fall armyworm control</a></td> <td>12 October 2020 - 2:00 pm</td> </tr> <tr> <td>3</td> <td><a href="#">Active response to fall armyworm in South ...</a></td> <td>18 September 2020 - 11:00 am</td> </tr> <tr> <td>2</td> <td><a href="#">Applied fall armyworm management in row cr...</a></td> <td>18 September 2020 - 11:00 am</td> </tr> <tr> <td>1</td> <td><a href="#">Fall armyworm biology and ecology in subtr...</a></td> <td>18 September 2020 - 10:00 am</td> </tr> </tbody> </table>	Number	Episode	Published On	9	<a href="#">Could fall armyworm have been present in o...</a>	30 October 2020 - 4:00 pm	8	<a href="#">Trial observations and laboratory findings...</a>	30 October 2020 - 4:00 pm	7	<a href="#">Field observations of fall armyworm in nor...</a>	30 October 2020 - 4:00 pm	6	<a href="#">Scouting, developing thresholds and tips t...</a>	12 October 2020 - 4:30 pm	5	<a href="#">Field observations of fall armyworm in nor...</a>	12 October 2020 - 4:15 pm	4	<a href="#">FAO's global action for fall armyworm control</a>	12 October 2020 - 2:00 pm	3	<a href="#">Active response to fall armyworm in South ...</a>	18 September 2020 - 11:00 am	2	<a href="#">Applied fall armyworm management in row cr...</a>	18 September 2020 - 11:00 am	1	<a href="#">Fall armyworm biology and ecology in subtr...</a>	18 September 2020 - 10:00 am
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<b>Impacts</b>	<p><i>PHA monitored the use of the Fall Armyworm podcasts over time by measuring the downloads by episode and by month. The following metrics are an indication of the podcasts uptake as at 12 April 2021.</i></p> <p>There have been a total of 1,078 downloads (up from 653 downloads in December 2020)</p>																														
<b>Key publications</b>	<p><a href="https://www.pbri.com.au/pbri-podcasts/">https://www.pbri.com.au/pbri-podcasts/</a></p>																														



## Technical Report

### PODCAST SUMMARIES

A series of 'conversation' style Podcasts was produced on the recently established Fall Armyworm in Australia. It explored the experiences and observations of experts from around the globe and here in Australia as industry, government and the research community prepared to take on this invasive pest.

Throughout the series, host Chris Brown delved into the biology and behaviour of fall armyworm and explored how Australian growers could best prepare themselves to minimise its impact.

Each episode is around 30 minutes in duration (something similar to "conversations" on the ABC radio, and listeners can listen in any order they want.

The podcasts are hosted on the PBRI website (<https://www.pbri.com.au/pbri-podcasts/>) and also on the online platform, Fireside. Using this platform enabled listeners to access the podcasts directly through their favourite podcast app (ie [Apple podcasts](#), [Spotify](#), [Google56 podcasts](#)). For listeners that use Spotify, for example, can search for 'fall armyworm' within Spotify and be able to access all the podcasts as a series from their mobile device whether in they be in the car, tractor or at home.

#### ***EPISODE 1: FALL ARMYWORM BIOLOGY AND ECOLOGY IN SUBTROPICAL AND TEMPERATE US***

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To understand how fall armyworm behaves in different parts of the US, and what this may mean for Australia, we spoke with two American researchers on their work over the past 30 years.

Greg Nuessly from the University of Florida and Dominic Reisig from North Carolina State University discuss their work under subtropical conditions in southern Florida where it is a primary pest every year in the same crops, and in cool temperate conditions in North Carolina where it is more sporadic.

#### ***EPISODE 2: APPLIED FALL ARMYWORM MANAGEMENT IN ROW CROPS AND PASTURES IN TEXAS***

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Exploring the practical control strategies used in row crops and pastures across Texas, Extension specialist and IPM coordinator, David Kerns, from Texas A&M University talks about the different strains of FAW, the crops they effect and the tactics for control.

#### **WARNING**

This podcast discusses the overseas use of chlorantraniliprole on sorghum for fall armyworm. This use is **not approved in Australia** – read note below under important information / pesticide disclaimer.

Please note that an emergency use permit application submitted for the use of chlorantraniliprole in sorghum to control fall armyworm was **not approved** by the APVMA. Further, the APVMA considered that the proposed use presented an undue risk to trade, based on information received in response to a Trade Advice Notice (TAN) and the trade assessment of the proposed use.

#### ***EPISODE 3: ACTIVE RESPONSE TO FALL ARMYWORM IN SOUTH AFRICA***

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Working across governments, industry, languages and neighbouring countries was critical in minimise the impact of the fall armyworm outbreak in South Africa.

Jan-Hendrik Venter, from South Africa's Department of Agriculture, Forestry and Fisheries, talks about the approach taken in response to their fall armyworm incursion in 2017.

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***EPISODE 4: FAO'S GLOBAL ACTION FOR FALL ARMYWORM CONTROL***

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On this podcast we speak to FAO's Elisabetta Tagliati about the risks posed by fall armyworm to global food and feed security and FAO's efforts to develop international capacity and capability to manage the pest across 65 countries under a Global Action Plan.

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***EPISODE 5 : FIELD OBSERVATIONS OF FALL ARMYWORM IN NORTHERN AUSTRALIA***

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Since the recent arrival of fall armyworm in Australia, scientists, growers and agronomists across the north have been on a steep learning curve.

Home-grown entomologists Melina Miles and Paul Grundy from the Queensland Department of Agriculture and Fisheries speak about their observations and thoughts on how the pest is behaving in Australia and the likely implications for management.

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***EPISODE 6: FOOTPRINTS IN THE PADDOCK – APPROACHES TO SCOUTING, DEVELOPING THRESHOLDS AND TIPS TO FAMILIARISE YOURSELF WITH FALL ARMYWORM***

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We now have some valuable first-hand experience in dealing with fall armyworm in commercial crops in north Queensland.

Burdekin agronomist Brent Wilson from Nutien Ag Solutions at Home Hill and GRDC Seed of Light recipient Paul McIntosh from Pulse Australia and the Australian Herbicide Resistance Initiative share their insights into the need to manage resistance, developing thresholds, identifying fall armyworm, and where to look for them.

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***EPISODE 7 : FIELD OBSERVATIONS OF FALL ARMYWORM IN NORTHERN WESTERN AUSTRALIA***

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Following the establishment of fall armyworm populations in the Ord Valley in northern WA, researchers and agronomists have been working together to monitor its behaviour, feeding habits and potential spread throughout cropping areas of Western Australia.

Senior research scientist with WA's Department of Primary Industries and Regional Development, Helen Spafford, and Ord River District Cooperative (ORDCO) agronomists, Penny Goldsmith discuss what they are observing in the Ord Valley and around Broome and the challenges growers are facing as they approach harvest.

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***EPISODE 8: TRIAL OBSERVATIONS AND LABORATORY FINDINGS ON FALL ARMYWORM IN THE NORTHERN TERRITORY***

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Since the first detection of fall armyworm in Australia researchers and agronomists have been quick to come together and establish field trials and laboratory experiments to help understand its likely impact on crops and production systems in the top end.

Northern Territory's Department of Primary Industry and Resources Senior Principal Entomologist, Brian Thistleton and Senior Entomologist, Praise Justo-Tadle give us an insight into what they are recording in some of their field trials and lab experiments on fall armyworm and what growers should be looking out for in the lead up to the wet season.

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***EPISODE 9: COULD FALL ARMYWORM HAVE BEEN PRESENT IN OUR REGION FOR LONGER THAN FIRST THOUGHT? TRACING THE SPREAD.***

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Fall armyworm was detected in Australia in early 2020 but could it have been here a lot longer.

Senior Research Scientist with CSIRO, WeeTek Tay delves into the genetics of fall armyworm and its different global populations so we can better understand their spread patterns and biosecurity pathways.

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**Monitoring uptake of fall armyworm podcasts using Fireside metrics.**

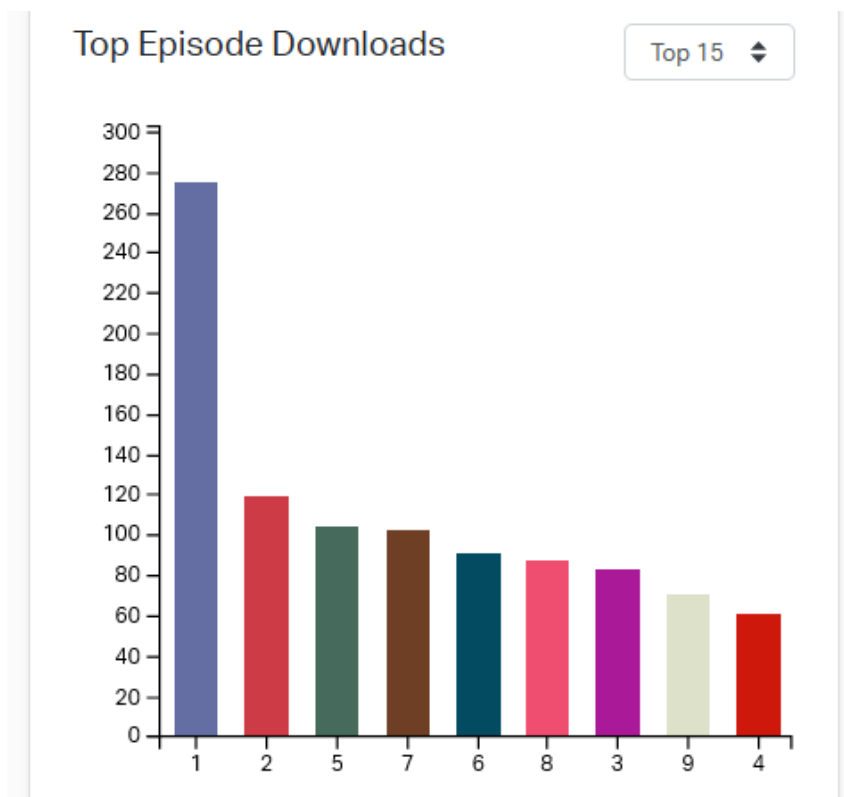
The following metrics are an indication of the podcasts uptake as at 12 April 2021.

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There have been a total of 1,078 downloads (up from 653 downloads in December 2020)

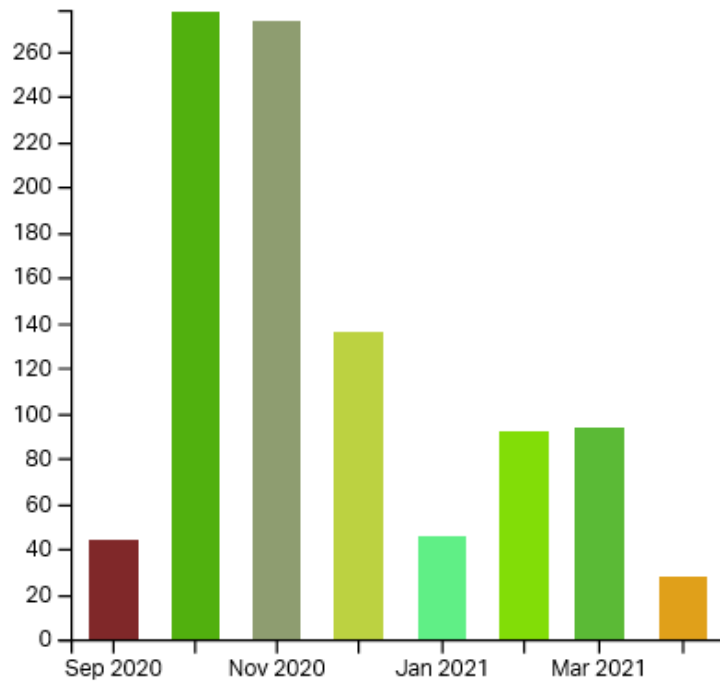
The publishing of episodes within the series were staggered to assist with marketing of upcoming podcasts and so that industry could stage their listening of the podcasts.

Number	Title of podcast	Published	Downloads
7	<a href="#">Field observations of fall armyworm in nor...</a>	2020-10-30	107
9	<a href="#">Could fall armyworm have been present in o...</a>	2020-10-30	76
8	<a href="#">Trial observations and laboratory findings...</a>	2020-10-30	91
6	<a href="#">Scouting, developing thresholds and tips t...</a>	2020-10-12	101
5	<a href="#">Field observations of fall armyworm in nor...</a>	2020-10-12	113
4	<a href="#">FAO's global action for fall armyworm control</a>	2020-10-12	68
3	<a href="#">Active response to fall armyworm in South ...</a>	2020-09-18	94
2	<a href="#">Applied fall armyworm management in row cr...</a>	2020-09-18	135
1	<a href="#">Fall armyworm biology and ecology in subtr...</a>	2020-09-18	293



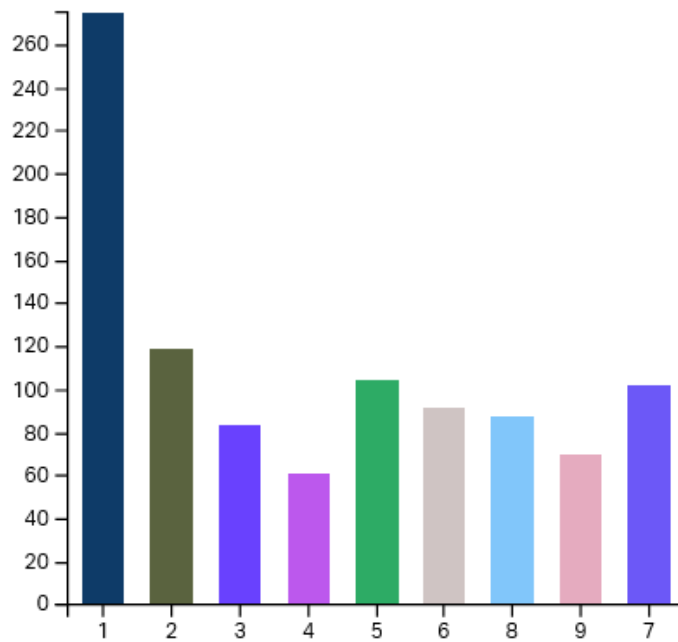
### Downloads by Month

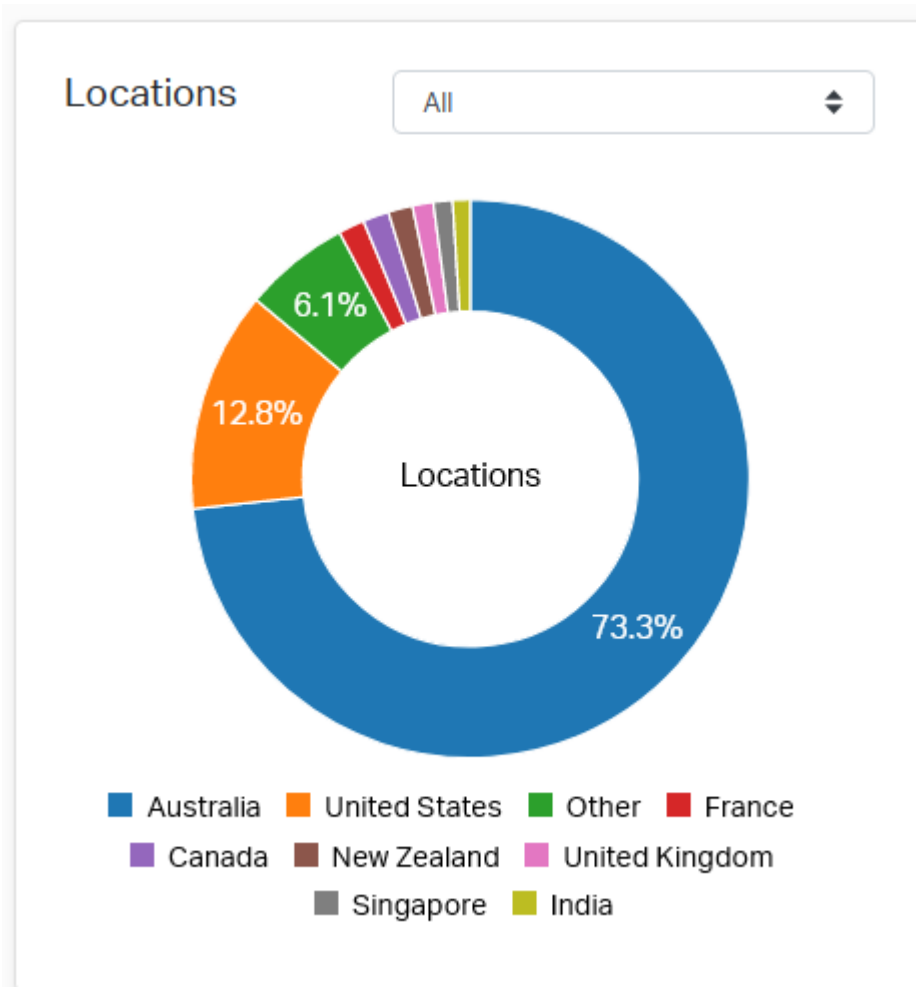
Last 12 Months



### Recent Episode Downloads

Latest 15





PHA would like to acknowledge the international experts, and the Australian researchers and agronomists that gave their time and allowed us to interview them to ensure that their experiences were shared and heard.

## **COMPILATION OF DIGITAL RESOURCES**

PHA worked with CESAR, QDAF, CABI and GRDC to develop a Fall Armyworm Continuity Plan for high risk crops in Australia. The plan was developed for use by professionals, specialists and consultants in preparing more localised and industry specific communication and extension material. The plan focuses on the crops thought to be at higher risk and provides relevant background information on the current knowledge and status of FAW in Australia, key considerations in developing localised management strategies, and future research and development for Australian plant industries.

The intended purpose of the plan was to provide a reference point and a basis for industries to build upon in designing resistance management strategies, area wide management plans and crop specific management manuals together with other extension materials such as audio and visual products for the management of FAW within Australian broadacre farming systems.

The plan is national in scope and will evolve quickly as our knowledge on FAW grows. Updated versions of the plan will no doubt be published by the RDCs as new findings come to light.

The Continuity Plan now forms the basis for the Fall Armyworm Portal on GRDC website [www.grdc.com.au/fallarmyworm](http://www.grdc.com.au/fallarmyworm) that also includes identification and threshold resources, summaries of APVMA permits for FAW control and management options for growers.

## **GAP ANALYSIS REPORT**

Through support from DAWE, a National Fall Armyworm R&D Forum was held to identify and develop National R&D priorities. A R&D Gap Analysis was developed and included in Forum Proceedings (attached) and will be discussed at PBRI FAW workshop on 27 April 2021.

The following new ideas, gaps and opportunities for consideration were identified by Forum participants.

### ***FAW GENETIC RESEARCH.***

- Adapt FAW LAMP technique from Kim et al. for identification so that results can be used for modelling and understanding seasonal impact.
- Relate resistance genotypes to field outcomes and develop multiplex approaches to differentiate FAW from endemic species.
- Develop a better understanding through a survey of FAW genetic diversity from different populations and identify the different 'strains' (including defining what constitute a FAW 'strain'). Analysing any correlation between resistance phenotypes/genotypes may be expensive via field trials, and so sample size needs to be taken into consideration when designing experiments.
- Expand the existing High Throughput Systems (HTS) and bioinformatic analytical pipelines from Silverleaf Whitefly (species identification) and Red legged earth mite (resistance gene detection)work. to include Noctuids. This approach would provide the ability to detect novel invasive species in field conditions.
- Adopting a High Throughput System (HTS) approach from existing protocols used for silverleaf whitefly and red legged earth mites would also help to monitor and track resistances and can take advantage of diverse global populations of various noctuids (*Spodoptera* spp. and FAW populations, *Helicoverpa* spp.) currently available from previous global genomic work.
- Expand the use of Whole Genome Sequencing (WGS) data and relevant bioinformatics to detect on-going/new arrivals to assist with resistance monitoring and biosecurity preparedness.
- Investigate Whole Genome Sequencing (WGS) data for targets to disrupt FAW lifecycle, sterility, premature death, etc.
- Explore potential application of Bio-clay, bio-pesticides or GM traits.
- Determine if there are FAW strains other than rice, corn and hybrid strains.
- Undertaking genetic research to improve our understanding of resistances is high priority followed by the need to accurately identify species in the field and then monitoring population change in genetics over time.

### ***INSECTICIDE RESISTANCE.***

- Developing linkages with commercial organisations will be important. RDCs are linked in well with commercial life science companies and technology developers and in developing new actives; Existing Pest control activities; GRDC – has a dedicated person in chemical regulation; Market failure needs to be addressed; The use of Viruses in managing FAW is of incredible interest though they are understandably hard to get into Australia
- Develop a cross industry/cross species resistance management strategy and plan.
- There is an ongoing need for longer term investment and coordination across projects in resistance management – this includes having management

strategies in place to be able to rapidly detect insecticide resistance across species. FAW will impact upon many different commodities. This will be important for the successful ongoing management of *H. armigera* and other pests in the landscape. Activities would include having balanced resistance risk investment portfolio, the development of area wide windowing and sustainable, long term product management.

- There is a need to determine the possible impacts resulting from the implementation of certain management options in specific industries on other industries; e.g. use of insecticides in hay and withholding periods; need to ensure other industries are connected.
- Rapid assessment tool for growers to assess efficacy without investing in whole spray. Rapid on farm tool - is this pesticide going to work on the particular strain of FAW present?
- Refinement and utilisation of the FAO's - monitoring smartphone app for FAW surveillance and monitoring of population movements and the diagnostics app that FAO developed with Penn State University (PlantVillage Nuru) that helps growers recognise fall armyworm throughout its lifecycle (and the damage and symptoms caused) when not connected to the internet.
- Potential for GM traits as a management tool in the most impacted crops.
- Understanding what happens if we get Bt resistant alleles. Either through exposure in Australia or new in Australia (exotic incursion).
- It is expected that we are going to get new alleles from overseas - every season /constantly and so monitoring of populations including genetic monitoring to better understand the different pieces of the FAW puzzle will be increasingly important. Completing a full genome analysis on FAW will also be required to understand how the pieces connect together.
- Need to develop a longer term proactive insecticide strategy given concerns about new resistant alleles continuing to come into the country.
- Better coordination, connection and networking among research programs including near neighbour and broader international collaboration.
- Need more on farm and area wide management options/tools including direct management interventions for growers as well as suppression and systems management to reduce population pressure. Tools such as biological control options; host plant resistance; IPM and Area Wide Management strategies are required, not just Integrated pesticide management.
- Need to consider how to build a resilient system that can cope with new resistance alleles continually coming in (IPM).
- What constitutes field resistance and perceived laboratory resistance; Link right; Risk if information coming out of genetic program.
- Extension and communication; e.g. messaging to growers - if spray failures is it resistance? Is it an application method.
- Cross industry/cross species resistance management strategies and research that underpins to support establishment of that (which will be informed by gaps analysis).
- Important to understand baseline to support strategy development -
- e.g. build on CSIRO molecular work - increase depth and sample number and include more samples to pick up more diversity and more geographic range samples and look at bioinformatic tool to quickly identify source of specimens (biosecurity pathways).
- Bigger picture IPM strategy - long term management; how do we deal with resistance evolving or arriving; including extension.
- Cross industry/cross species resistance management strategies and research that underpins to support establishment of that (including IPM).
- Going to be a species - new genetics on a yearly basis. Need to get a handle on what we have now the better.

- IPM strategies - medium priority.
- Crop life strategy is available and has been developed as a generic approach for sweet corn but could be adapted for use in FAW across the different production zones; IRAC strategy in Bt and non BT maize; could be good model system.

#### **COMMERCIAL AND NATIVE PLANT HOSTS**

- Investigate the relationship between pheromone trap data and FAW management decisions to guide commencement of crop scouting, or reflect in-crop density? International experience together with local experience on *Helicoverpa* indicates that pheromone traps are not good predictors of pest pressure in-crop but are useful indicators of local activity.
- Coordination across the four theme areas for FAW RD&E – and especially where there are common interests across the themes.
- Develop understanding on the varietal impacts of key crops and host plant resistance (HPR) on their susceptibility to FAW - Australian-grown varieties of maize, sorghum, sweet corn rather than international varieties.
- Establish whether there is any varietal difference in FAW damage. If confirmed, then host plant preference studies should be undertaken on selected varieties of major crops (including sugarcane) – as within a lot of annual crops there is a range of widely planted varieties and new varieties released annually. Screening for host plant preference of currently used varieties and varieties prior to commercial release would benefit future release programs.
- Establish linkages to economic threshold development research. QAAFI (Rodriguez, Eyres) has an interest in HPR of maize and has commenced trials in this area.
- Establish linkages to modelling, specifically where host availability/distribution is a key component of the model/s.
- Develop localised practical management tactics for minimising crop loss and development of insecticide resistance in crops currently impacted by FAW (sorghum, sweetcorn, maize, and others as they emerge as impacted). Includes thresholds, evaluation of insecticide/biopesticide/natural enemies, development of resistance management strategies).
- Conduct preliminary survey in selected major sugarcane producing regions, particularly those regions which contain a mosaic of other likely crop hosts (e.g. maize) and grasses to understand pest/plant interaction as this is unclear at present.
- Validate Australia host plant list - including commercial, native flora and those with amenity important. Basis for prioritising this work will be subject to priorities of industry (in the first instance).
- Undertake a longer term landscape approach to FAW surveillance and monitoring, rather than species-specific approach - incorporates complexity associated with seasonality/regional and the spectrum of feeding preference. Doesn't limit the study to just commercial or non-commercial vegetation. This approach will need to consider the likelihood that the distribution, host list, and impact of FAW is likely to change over time following the initial incursion. Collection of data in just the first few year's post incursion may not be reflective of the relationships longer-term.
- Establish in-crop surveillance and monitoring methods for use in tall and dense, hard to inspect crops such as maize and sugarcane.
- Coordinate a database/online industry notice board on the national distribution of FAW by region and crop. Potentially facilitates planning for management and risk determination for industry. Requires ground truthing of indicators (predictive modelling, pheromone trap data).



- Conduct field surveys to determine incidence of FAW in the landscape: agricultural, non-crop vegetation, extensive grasslands - sources for population build-up and migration.
- Develop and implement a nationally coordinated and locally delivered (flexible for regional differences) FAW communication program - extension of on-the-ground management information for growers/advisors.
- Survey and test locally occurring entomopathogens (viruses, fungi and bacteria) for use in FAW management. NPV virus product 'Fawligen'® is currently registered in Brazil, the USA, Zambia, Ivory Coast, Bangladesh and Sri Lanka, with many more registrations in progress. Access is being sought to import the strain into Australia.

#### ***MODELLING OF SEASONAL IMPACTS ON POPULATION DYNAMICS.***

- Identify the potential of resistance genes spreading throughout Australia and develop resistance management strategies informed by simulation modelling.
- Determine the feasibility of containing the spread of resistance genes – by trying to keep it localised and not spreading. Can predictive modelling from overseas be used here with appropriate validation and addition of Australian data?
- Monitor for new incursions (natural and human assisted- ports, etc...)? - and arrival of resistance genes.
- Establish linkages with field-based entomologists and industry participants who are collecting samples to encourage two-way relationship between modelling and field data.
- Modelling natural dispersal to Australia from PNG and from Australia to New Zealand.
- Establish economic thresholds to aid effective management, reduce IPM disruption, and resistance issues. Thresholds will need to be adapted to Australian conditions, costs and hosts.
- Investigate the potential of integrating FAW population models with crop models such as APSIM (as CESAR/SARDI has done with Russian wheat aphid).
- Need to ascertain how transferable the knowledge around locust wind dispersal may be to FAW wind dispersal.
- Need to understand if there is any relationship between drought cycles and FAW population dynamics.
- Is conferring pesticide resistance conditional on environmental parameters. Could FAW be more resistant at particular temperatures, moisture conditions or on a particular host? Overlaying such a model with the geospatial environment models might help to identify areas where resistance was likely to emerge.
- Could FAW outbreaks be worse after droughts?
- Management of FAW may require large scale management intervention – that would need to include environmental managers.
- Identify potential impacts through overlap of predicted seasonal activity in Australia and regional growing seasons for different commodities - linking crop susceptibility and suitability with estimated FAW seasonal abundance and distribution.
- Need to develop understanding on population drivers, what temperatures, what host species, how suitable they are - availability etc.
- Intervention thresholds under Australian conditions need to be developed not only in those crops at economic risk – sweet corn, maize, sorghum and maybe cotton but other crops such as sugarcane and horticultural crops that may be impacted. These thresholds will be a key component of any future IPM and IRM strategies.

- Could biological controls and natural (biotic and abiotic factors) suppression be modelled to improve grower understanding and confidence in IPM and Area Wide strategies?
- Formally record data and information being generated from field observations (mainly commercial farms), such as host range, pesticide efficacy, population levels, impact of weather, etc. to assist those making research and pest management decisions.
- Undertake scouting and pheromone trap monitoring across a broader range of commercial crops (including sugarcane). There may be an opportunity for not for profit or industry groups to participate.