



Australian Government

Cotton Research and
Development Corporation

TRAVEL, CONFERENCE or SCIENTIFIC EXCHANGE REPORT 2016

Part 1 - Summary Details

Please use your TAB key to complete Parts 1 & 2.

CRDC Project Number: CSP1702

Project Title: Visit to ACRI by Dr Steven Naranjo, USDA, Arizona

Project Commencement Date: 3/12/2016 **Project Completion Date:** 9/12/2016

CRDC Research Program: 1 Farmers

Part 2 – Contact Details

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Principal Applicant: Dr Steven Naranjo, Center Director

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Supervisor: Dr Lewis Wilson

Organisation: CSIRO Agriculture

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Signature of Research Provider Representative: _____

Date Submitted: _____

Part 3 – Travel, Conference or Scientific Exchange Report

(Maximum two pages)

1. A brief description of the purpose of the travel.

Dr Naranjo will be visiting Australia in late November 2016 to attend the annual conference of the Australian Entomological Society. Seeing as he will be in Australia he has expressed an interest in visiting Dr Lewis Wilson and others at the Australian Cotton Research Institute, Narrabri. Dr Naranjo is an internationally recognised expert in IPM in cotton systems. In particular he has extensive skills in research and management of silver leaf whitefly and was one of the architects of the approach used to manage this pest in Arizona. He has been instrumental in assisting that production system to develop an effective management system that has restored Arizona's reputation for producing non-sticky cotton. Dr Naranjo also co-authored with Dr Richard Sequeira a publication which used extensive whitefly distribution data to arrive at a scientifically valid sampling protocol, the basis for the system used in Australia.

2. What were the:

a) major findings and outcomes

Dr Naranjo met with Dr Wilson and Tanya Smith and reviewed life history studies complete as a component of an earlier project and went through the strengths and weaknesses of the data and approaches to analysis. Dr Naranjo provided a template which Lewis used for one of the life history data sets. This identified how the data needed to be re-organised and the outcome will be understanding which life stages incur the most mortality and likely sources. Lewis will complete analysis in due course. We also had many discussions about the development of SLW populations and the role of natural enemies and other sources of mortality (weather, climate, dislodgement, food quality). Dr Naranjo's research suggests that generalist predators have the biggest effect on SLW parasitism in Arizona cotton systems, while Richard believes that parasites exert the biggest influence in Australian systems, at least in the CQld systems. To help resolve this we have included scoring nymphs for parasitism and beat sheet counts of beneficial abundance at each sampling event.

Lewis and Tanya met with Richard in December 2016 to review data collected on SLW distribution and abundance the previous season to validate sampling strategies for central and southern regions. Based on this analysis new plans were developed for 2016-17 which included sampling adults at nodes 5, 8, and 11 or 14, scoring nymphs by sector for each leaf. We will also record details of crop growth and microclimate data (temperature and RH) above the crop and at levels in the crop corresponding with main-stem nodes leaves 5, 8, and 11 or 14 (below the terminal). This was reviewed with Dr Naranjo who agreed that including nymphs into the threshold calculation would add greater precision and confidence in spray decisions. We discussed how this might be done and agreed to include the 'disc' counts alongside the sector counts for nymphs to test how well correlated they were. Dr Naranjo also outlined progress toward including the potential effect of predators into the threshold for SLW in Arizona, and to this end the data we collect from the beat sheets will be valuable (see above).

Lewis assisted Susan in organising a SLW Workshop in Moree in early December (see Appendix 1). This was attended by a range of research and extension staff as well as several key consultants. The workshop teased out the research progress, issues and opportunities/priorities for future R, D and E around (i) Management decisions before

the matrix (ii) management decisions in the matrix and (iii) decisions when the SLW Management system hasn't worked. Outcomes have been summarised by Susan (See Appendix 2). Susan also identified some key actions (See appendix 3). Overall the workshop was very valuable and productive and highlighted the value of getting research, extension and industry together to review an issue.

b) other highlights

Dr Naranjo also had discussion with a range of other research staff at ACRI including Dr Simone Heimoana, Dr Sharon Downes, Dr Robert Mensah and Dr Mary Whitehouse.

3. Detail the persons and institutions visited, giving full title, position details, location, duration of visit and purpose of visit to these people/places. (NB:- Please provide full names of institutions, not just acronyms.)

Person	Agency	Location
Dr Lewis Wilson	CSIRO	ACRI
Dr Simone Heimoana	CSIRO	ACRI
Ms Tanya Smith	CSIRO	ACRI
Dr Sharon Downes	CSIRO	ACRI
Dr Mary Whitehouse	CSIRO	ACRI
Dr Robert Mensah	NSW DPI	ACRI

4. a) Are there any potential areas worth following up as a result of the travel?
See Appendix 2 and 3 below. For the CSIRO research effort details are explained above.

b) Any relevance or possible impact on the Australian Cotton Industry?

Dr Naranjo's visit was very timely as it has enabled Tanya, Richard and Lewis to adjust the sampling work to answer a broader range of questions. Ultimately this will help in developing improved sampling and threshold recommendations for Australian cotton systems. Similarly, discussions with Simone Heimoana helped her better understand the honeydew contamination issues experiences in Arizona following SLW outbreak years and this will assist her in designing experiments to look at effects of Honeydew and associated sooty moulds on grades.

5. How do you intend to share the knowledge you have gained with other people in the cotton industry?

See appendix 3 for some actions put forward for immediate action and communication to industry.

7. Please list expenditure incurred. (Double click inside the table to enter the data)

Please email your report 30 days after travel/conference to: research@crdc.com.au

Appendix 1.

SLW Review meeting

Moree Town & Country Club

5 Frome Street, Moree New South Wales 2400

7th December 2016

9:00am – 4:30pm

Silverleaf whitefly has been identified as a high priority issue for the Australian cotton industry. The aim of this meeting is to review current SLW research as well as experiences with monitoring and management practices to inform R&D direction and prioritise extension messages for SLW.

CRDC and CSIRO have supported Steve Naranjo, USDA to visit and support review of recent research. Dr Naranjo is an internationally recognised expert in IPM in cotton systems. In particular, he has extensive skills in research and management of silver leaf whitefly and was one of the architects of the approach used to manage this pest in Arizona. He has been instrumental in assisting that production system to develop an effective management system that has restored Arizona's reputation for producing non-sticky cotton. Dr Naranjo co-authored with Dr Richard Sequeira a publication which used extensive whitefly distribution data to arrive at a scientifically valid sampling protocol, the basis for the system used in Australia.

Because of the interactive nature of this meeting, numbers are limited and it is not possible to attend via videolink. We are hoping to produce a video from the meeting to allow the presentation components of the meeting to be distributed wider.

Please RSVP to susan.maas@crdc.com.au by the 30th November.

Proposed participant list:

- Ben Dawson – CCA director (Gwydir)
- Bill Back – CCA (Namoi)
- Campbell Muldoon (Maquarie)
- Dave Kelly, (Mac)
- Dave Palarto, (CQ)
- Emma Ayliffe (South)
- Jamie Hopkinson (QDAF),
- Jamie Iker – CCA director (CQ)
- Jamie Street, (St George)
- Kieran O'Keeffe, CottonInfo rep
- Lewis Wilson (CSIRO)
- Liz Lobsey – CCA (Downs)
- Mike Stone, (Gwydir)
- Paul Grundy (QDAF),
- Phil Glover (Sumitomo)
- Richard Malone (South)
- Richard Sequiera (QDAF)
- Rob Eveleigh (CSD)
- Rob Holmes, (Gwydir)
- Robert Mensah (NSW DPI)
- Sandra McDougall (NSW DPI)
- Sandra Williams (CottonInfo)
- Simone Heimoana (CSIRO)
- Steve /Anna Madden, (Namoi)
- Stuart Doyle CCA President (Gwydir)
- Susan Maas, (CRDC)
- Tanya Smith (CSIRO)
- Tim Richards – CCA Vice Pres. (Mac)

Proposed Agenda

Start time	Agenda item	Speaker
9:00	Welcome & overview of the day	Susan Maas
9:10	Introduction and key challenge for SLW management	All
9:30	Session 1: Avoiding the problem. Management decisions before the matrix"	
9:30	Consultant experience - avoiding the problem	TBC
9:40	The Arizona IPM experience	Steve Naranjo
10:00	Role of early season beneficials	Tanya Smith
10:10	Whole of season management	Lewis Wilson
10:20	Future tools for IPM	Robert Mensah
10:30	What is the biggest challenges when it comes to preserving beneficials "early season";	Facilitated: Paul Grundy
11:00	Group into R, D or E;	
11:20	Morning Tea	
11:35	Session 2: Sampling x threshold = management decision Management decisions in the matrix	
11:35	Consultant experience - using the matrix	TBC
11:45	Arizona experience - Sampling & decision making	Steve Naranjo
11:55	Development of threshold matrix & validation in Central regions	Richard Sequeira
12:15	What is the biggest challenges when it comes to making a SLW management decision?	Facilitated: Lewis Wilson
13:00	Group into R, D & E;	
13:20	Lunch	
13:50	Session 3: When it all goes wrong - Decisions when the SLW management decision haven't worked	
13:50	Arizona - problems	Steve Naranjo
14:05	Honeydew and Sooty mould	Simone Heimoana
14:20	SLW Resistance status	Jamie Hopkinson
14:35	What do we need to know about the problems?	Sandra Williams to facilitate
15:15	Group into R, D & E; discuss commonalities	
15:35	Next step	Susan Maas
16:00	Close	Lewis Wilson
16:10	Afternoon tea	

Appendix 2.

SLW Meeting minutes

Moree Town & Country Club

5 Frome Street, Moree New South Wales 2400

7th December 2016

Participants:

- Ben Dawson – CCA director (Gwydir)
- Dave Kelly, (Mac)
- Emma Ayliffe (South)
- Jamie Hopkinson (QDAF),
- Kieran O’Keeffe, CottonInfo rep
- Lewis Wilson (CSIRO)
- Mike Stone, (Gwydir)
- Paul Grundy (QDAF),
- Phil Glover (Sumitoma)
- Richard Sequiera (QDAF)
- Robert Mensah (NSW DPI)
- Sandra McDougall (NSW DPI)
- Simone Heimoana (CSIRO)
- Susan Maas, (CRDC)
- Tanya Smith (CSIRO)

Session 1: Avoiding the problem. Management decisions before the matrix

Consultant experiences:

Southern:

- Early season pests such as thrips is often coupled with other constrains (root disease/cold temperatures) and concern about delays to maturity tend to lead to use of broad spectrum products early.
- Product selection based on quick and nasty but short residual
- 2015/16 season there was first where there was large problems with SLW, particularly in rank and late crops. Attributed to extended hot finish.
- Decision making needs to be more dynamic; respond more to forecasted situations;
- Horticulture – SLW has gotten worse in last 5 years – correlation with cotton
- Need understanding on the cross commodity perspective

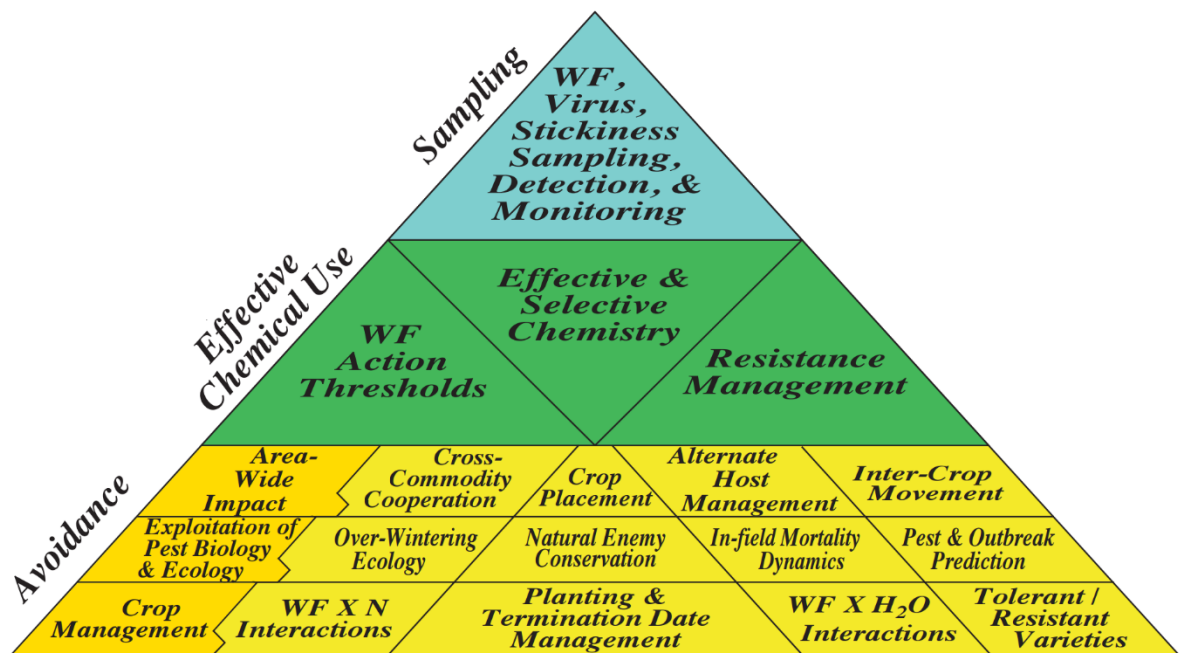
Northern

- Mirid management, eg. Fipronil – disruptive on beneficials. Some movement towards softer products. Perhaps increased opportunities for oil.
- Northern NSW –predators come in early but don’t seem to survive; and parasitoids can be too late
- Operational challenges on large farms results in increased usage of insecticides with other operations. IPM Tactics that fit with operational challenges needed.
- Wide planting window is a concern.

The Arizona IPM Experience – Steve Naranjo, USDA

Key pests

- *Pectinophora gossypiella*, SLW, *Lygus hesperus*
- Sporadic and minor pests – cotton bollworm, tobacco budworm, armyworms, loopers, cotton leaf perforator, saltmarsh caterpillar, cutworms
- Flea hoppers, plant bugs, stink bugs, cotton aphid thrips spider mites;
- 2012 – Brown Stink bug – Peter Ellsworth – study found there was no benefit to attempting control with broad spectrums (profitability) so now largely reliant on biological control;



(<http://www.cottoninc.com/fiber/AgriculturalDisciplines/Entomology/Whitefly/WhiteFlyManagementArizona2006/WhiteFlyManagementArizona2006.pdf>)

- Benefit from IPM = >\$451M saved from IPM; Lowest cost 36yrs; 21 M lb a.i. reduction
- In terms of beneficial for SLW - Predators do heavy lifting, Parasitoids do less;
- Dust/sand storms provide environmental suppression of SLW
- Predators include Big eyed bug, related to impeded dance fly, Spider – crab spider – whitefly suppression;
- Predators overwinter in year round alfalfa; which is not treated for pest issues;
- Parasitoids – stay quite local and don't move as much as predators; recolonization movements are small; Big impact where they can move in from nearby;
- Bioresidual – Predator/prey ratio being used to develop a dynamic threshold;
- Cross commodity guidelines for neonicotinoid insecticide in Arizona
- Stink bug doubled number of sprays SLW up 44%

Role of early season beneficials Tanya Smith

- Research has improved recognising predation
 - Closed/open cage/no cage
 - Closed cage – 70% survival;
 - Open cage - 10% survival
- James Harwood developed primers for detecting SLW & CSIRO have tested Australian insects to see if they are predators of SLW;
- Monitored quantity of insect and proportion that tested positive to SLW in molecular test; Useful for identifying predators, however not reliable for quantifying.
- Supported by ecological studies - have demonstrated how pests feed. Eg Brown smudge bug feed from side; Evident that previous nymphs allocated as missing or just dead were probably predated.

Whole of season management Lewis Wilson

- Parasitism and predator timing likely to vary year to year and regions
- Probably predators keep SLW at bay until they are disturbed;
- Thrips are predator.
- Research simulated thrips damage (eg tipped out) to look at compensation capacity.
- Research need – revisiting past in Bollgard 3 – how important is tipping/damage
- Trials on effect of mirid sprays on SLW and honeydew
- Beneficial disruption index – Rank using BDI – and compared to beneficials;
- Seasonal host use – adults and nymphs. Summarised in fact sheet.

Future tools for IPM Robert Mensah

- Selectivity to reduce impact on beneficials.
- SLW adult movement – relationship between adults and nymphs/leaf found density Dependency. Adults move when numbers are high; should we be looking at nymphs?
- Sero-X efficacy data on SLW adults/leaf; Two consecutive sprays to target two life stages;
- Large scale trial results from Canopy oil in Goondiwindi 2010/11 Alcheringa;
- Volatiles/oil suppresses odour of crop – masked effect of crop so pest doesn't recognise as host

Session 2: Sampling x threshold = management decision in the matrix

Arizona experience - Sampling & decision making Steve Naranjo

- Increased tendency for long season crops;
- Plans for short season crops
- Growth regulator to keep plants compact;
- Distribution of SLW in plant;
- Initially adults, Focus on large (3rd and 4th instar) – based on set location on leaf;
- 40% leaf discs infested (with 1 nymph)
- Distribution does change over season
- Time of day effects – population move lower in canopy over time.
- Sampling recommended in morning;
- Migration event – need adult knockdown product
- Biological control and economic threshold – Inaction level/beneficial threshold
- **Save money the easy way with biocontrol Making whitefly enemies count**

Insert matrix:

Stage I Decision Matrix		Adult Counts	
		< 40% infested leaves	40–57% infested leaves
Large Nymph Counts	less than 40% infested disks	Wait. Re-sample in 3–7 days	Wait; Re-sample in 3 days; or use a selective Stage II adulticide; or apply Knack
	at least 40% infested disks	Wait; re-sample in 3 days; or apply Courier or Oberon	Use a Stage I material

Matrix

Adults Fewer than 3 per leaf or at least 3-5 per leaf

Only want to use an IGR on a population that is increasing;

- Stage I Chemistry (Full Selectivity)
 - Timing: 40% disks infested with ≥ 1 large nymph and 40% leaves infested with ≥ 3 adults
 - nymphal active
 - buprofezin, pyriproxyfen, spiromesifen
- Stage II Chemistry (Partial Selectivity)
 - Timing: 57% leaves infested with ≥ 3 adults
 - Spiromesifen, acetamiprid, dinotefuran, thiamethoxam, other non-pyrethroids
- Stage III Synergized Pyrethroids (see Stage II timing)
 - Pyrethroid combinations

Development of threshold matrix & validation in Central regions Richard Sequeira

- Original CQ research included nymph discs and adult populations.
- No correlation between nymph discs and population/honeydew;
- Adult – sampling at 5th and 8th leaf;
- Richard- Lewis & Tanya - Comparing distribution of whitefly between CQLD and central cotton regions
- Weekly Sampling strategy - scoring the numbers of adult SLW at main stem node 5 and node 8 below the plant terminal for 100 plants and collecting these leaves and scoring the number of large nymphs (3rd and 4th instar) for each sector on the leaf.
- In the CQLD area, SLW are more abundant on node 8 than on node 5 and as the season progresses this gets closer to 1:1. So node 5 becomes more accurate. However, in the NSW data there is no clear trend and node 5 is a closer representation of node 8 through most of the season. This suggests that sampling at node 5 is effective.

- Sampling time early (8-9 am) midday (11-2 pm) or late (3-5pm) - both node 5 and node 8, but especially node 5, samples taken in the afternoon are likely to underestimate SLW abundance.
- Observe the difference between the green line and other lines from early February onwards. We intend to collect more data in 2016-17 to confirm this result, with an emphasis on commercial high yielding crops.
- Possible relationship between ambient humidity and SLW distribution

Consultant perspective:

- Sampling wise – consistent numbers before 10am; But it is difficult to get consistent after;
- Technique for adults is difficult
- Monitoring crops – not triggering threshold Example – around 1650 (Cutout) and two weeks after treatment. 2-3 weeks defoliated after
- Challenge - Big crops and such a long time from first open cotton to defoliation;
- Matrix – seems to be too little too late;
- A lot of inundation from broad acre weeds that get sprayed about the same time.
- Big long season crop – matrix doesn't work
- Matrix was never designed for inundation;
- Matrix reflects presence of beneficials in CQ;
- If you aren't monitoring nymphs, you can't tell what population is doing.;
- Need 5 rules of thumb

Session 3: When it all goes wrong

Arizona - problems Steve Naranjo

How to avoid problems

- Plant and terminate as early as economically feasible
- Minimize water stress – nitrogen becomes more available
- Manage crop nutritional needs
- Use well adapted varieties;
- Conserve natural enemies, Maximise bio-residual
- Recognise conditions favourable for whitefly
- **“Green = whitefly”**
- Cross commodity – area wide;
- Minimize placement of cotton next to whitefly attractive crops (eg. Melons)
- Effective management of WF on all affected crops
- Manage crop residues, weed control
- Encourage cooperation across commodities;

Honeydew and Sooty mould Simone Heimoana

- UV radiation – Photodegradation is very slow;
- Rainfall – 20mm will wash off around 80% of honeydew sugars
- Nightdew – can have a small effect – moisture activates micro organisms
- Monitored colour impact - project looking at - +/- rainfall +/- honeydew
- Grower comment about financial penalty of colour bigger than sticky
- *Extension – make sure growers are aware of Cost implication for sticky cotton;
- Scored each boll for sooty mould

SLW Resistance status Jamie Hopkinson

- LC value from 2014 -2016 – Increase in tolerance of pyriproxyfen plus first detection of resistance.
- Resistant individuals monitor by looking at hatch egg; Important to understand how resistance works.
- Cyantraniliprole (Exirel) not commercially available in cotton
- Skope – Emamectin doing more of the work
- Shield – dramatic change from 2014-2015 towards resistance; 2016 come back down. Probably not reliable for suppression claim

Threats/Opportunities and R,D & E

Threat/challenge	Opportunity	Research	Extension messages
Early pest management in all crops, including high yielding crops, and short season regions	New tools coming	Demonstration on potential for oil to suppress SLW;	Whitefly message by 20 th January; Simple message – 5 points;
Wide planting window	Registration of products – Applaud (registered for tomato and numerous fruit) and others	Nymph threshold and associated sampling plan	SLW training for South
Operational needs		Early pest management in all crops, including high yielding crops, and short season regions	Early season management – linking first spray with the consequent whitefly;
Longer time that cotton is open;		How do new products that are registered for mirids – mirid efficacy and impact on beneficials; Economics as well; Cost benefit	Spraying for Helicoverpa;
Influxes from weeds		D&E - Demonstration of Early interventions (eg. Sero X, oils) that can be implemented to reduce the build up; Integrating whitefly suppression with early season operations and managing other pests;	Clarity about the pest, spray situation in South. Eg regular CCA meetings;
Other crop hosts in farming system		Canopy size – same yield for 24 nodes	More coordinated area wide groups – maybe start with whitefly centric. What people are finding, spray program; 11th January IPM support groups Good to involve non-cotton growers
Half rates? Low rate products?		Is there a negative effect from dimethoate on 2-4 node crop, day degree point after a certain point where dimethoate can't be used; Lewis already knows the answer – as soon as you have plant you have beneficials; How resilient is the system what is the capacity to rebuild beneficials early in the season	Coordinated demonstration trial with consultants and growers and researchers; what is best option possible; Oils at different rates; Biologicals,

		Southern system – Horticulture and cotton system	Cross commodity coordination
		What is mortality in crop? Over number of years and regions;	Identifying predation
		Clarity of product efficacy for stage 3.	Windowing Admiral? Consideration for regional area wide and then for TIMS
		Including beneficials in the decision making like in Arizona;	Review Pest guide threshold levels
		Arizona group – tried to use enzymes to break down sticky; Lesson was pray for rain; Fibre quality Texas A&M Eric – how much sticky cotton is needed for sticky; Minicards; thermometers;	What is the recommendation if it doesn't rain?

Appendix 3.

Actions going forward from Susan Maas (Program Manager CRDC):

Short term

- Based on meeting – work with Sandra to review of whitefly information including review of whitefly threshold matrix open cotton section
- Develop 5 key communication points – suggestion from Phil:
 - Matrix – applicable up until open cotton and then base decisions on honeydew risk/presence;
 - Try and check before 10 am
 - Start observing nymphs – where and what they are doing
 - Defoliation date needs to be part of decision.
 - Manage resistance risk

Medium term

- Jamie has already looked at the potential to get a permit for Applaud. This is potentially achievable and has been scheduled as an agenda item for the IRMS review meeting in 2017.
- Investigating with Lewis, Simone & Richard the potential to include nymph monitoring in current research with the aim of having nymphs included in future threshold.
- Investigating with Jamie the potential to collect parasitism data as part of resistance monitoring
- Mirid threshold review part of existing investment planning.
- Encourage Simone to look at Arizona experiences with sticky cotton in the Colour project
- Encouraging CottonInfo support to encourage coordinated whitefly management.

Long term

- CRDC will utilise the R,D&E gaps identified to inform investment discussions/planning. This will include providing the table to the panels ahead of the May strategy meeting.