**Transcript – ACPPO Webinar - Locusts**

September 19, 2024

**Vivian-Smith, Gabrielle** 0:09  
Welcome everyone, and I'd like to acknowledge the traditional owners and custodians of country throughout Australia and also acknowledge their continuing connection to land, waters and community.  
I pay my respects to the people, the cultures, the elders, past and present, and I extend that recognition to traditional custodians for the other lands on which we are gathered today.  
And to all Aboriginal and Torres Strait Islander people who are attending our webinar today.  
So firstly, just a little bit of housekeeping, so if you could please turn off your video and mute your microphone to improve bandwidth as we usually have a lot of people attending, unless of course asking questions at the end of the seminar.  
The webinar’s being recorded.  
We find it really works if you can put your questions in the chat as you think of them or put your hand up after the presentation to ask a question.  
And now I have the pleasure of being able to introduce our speaker today.  
So our webinar is about the Australian Plague Locust Commission.  
And our speaker is Heath McRae.  
Heath is the deputy director and operations manager within the Australian Plague Locust Commission. He started with the APLC a long time ago, way back in 1993, and was a full time employee there for around 22 years.  
Participating in and eventually leading survey and control operations during some of Australia's largest locust outbreak years.  
So during his first two seasons of operations from 1992 to 93 and 1993 to 94, the Australian Plague Locust Commission recorded two of its largest aerial spraying operations, 340,000 and 300,000 hectares, respectfully.  
And we also had the 2004-5 local season 10 years later, which exceeded this.  
With around 450,000 hectares of locust affected land that was treated at that time, Mr. McRae was the assistant operations manager and training officer.  
So Heath is going to talk about some of his more recent experience from 2020 to 2022 and during the COVID-19 outbreak global outbreak.  
Here there was also desert locust outbreaks.   
Locusts were described as being on a rampage through East Africa, the Arabian Peninsula and South Asia, and Heath joined the United Nations Food and Agriculture Organization early in 2020 and led the aerial operations in Kenya and later in Somalia drawing on his wealth of locust experience from Australia and over the years to help curb this worst ever Desert locust upsurge that Kenya had seen in 70 years, Ethiopia and Somalia in 25 years.  
So we're going to learn a little bit more about that today and Heath's webinar title is new and old technology innovations and lessons learned during the recent desert Locust Upsurge 2019 to 2022.  
So I'm going to hand over now with a warm welcome to Heath. Over to you, Heath.

**McRae, Heath** 3:50  
Thank you very much, Gabrielle.  
I'll just share my screen now and get the PowerPoint up.  
So that took everyone can see the first screen there with the topic introduction.

**Vivian-Smith, Gabrielle** 4:18  
Yes, it's looking good. Thanks, Heath.

**McRae, Heath** 4:20  
OK, great. Fantastic.  
Thanks for that update, Gabriel.  
Yes, thanks very much, Gabriel for that introduction and as was stated, so we'll be looking at the new and old technology as well as sort of old knowledge and new knowledge that we learn to innovate and learn from the lessons that we came across during the that recent desert locust upsurge that started in 2019 and basically ended just after the end of 2022.  
So just to set the scene for those that maybe didn't follow what was happening over there then.  
It really sort of started off in that in the desert empty quarter area of Saudi Arabia and Oman and also in parts of Yemen, which was hit by a very strong cyclone in 2018.  
That resulted in very heavy rainfall and vegetation flourishing through that normally sort of desert area, and that enabled the locust population in those areas to increase by 400 fold over in that short period in 2018, in October.  
That population again increased by 8000 fold following a second cyclone. So by March 2019 swarms of locusts from those areas flew into southern Iran, India and Pakistan.  
And then a little bit later, swarms moved into Yemen, where civil war at the time ended any sorts of operations in with the Yemen population.  
So then the swarms from Yemen basically moved down into Ethiopia and Somalia and in October 2019 and a little later then on into Kenya.  
So by 2020 - this information is from the Desert Locust Information Service with FAO. So by February 2020, Somalia, Ethiopia were experiencing the worst desert locust outbreak they've seen in 25 years and Kenya the worst they had seen in 70 years.  
So you can see from that, that the outbreak reach for that period from FAO, the really strong concentration of desert locust swarms in the Somalia, certainly Ethiopia and Kenya, but by that time said it also further to set the scene.  
Because I've obviously worked with Australian plague Locust for such a long time.  
And taking that knowledge across to Africa and working with the teams there, their experience with desert locust operations, there are some similarities, but also some significant differences between the two species.  
So the Australian plague locust Corticus terminifera over on the left of those pictures you can see there. And then the desert locust. Schuster gregaria, is quite a large insect.  
Their life cycle is very similar though.  
And from eggs, they'll hatch out and there'll be 5 nymphal stages that move through over one month to one and a half months time to fledging adults.  
Those adults will then mature over several weeks.  
For the plague locust, there could be several months for the desert locust to mature and then become laying adults to then start that cycle over again.  
They are both gregarious, so obviously the differences between locusts and grasshoppers, grasshoppers tend to be solitary. Locusts can go from a solitary phase to a gregarious phase. Once numbers start to build up.  
So both the Australian plague Locust and the desert locust, gregarious, have both their adult and juvenile stage.  
So the juvenile stage, they form these very dense congregations, we call bands and as adults where they're able to fly, they form these flying swarms.  
In Australia in very good green conditions the hopper bands form these very, very obvious dark areas which you can see in the top sort of left picture there, which are quite easy to detect from the air.  
Usually a fixed wing aircraft will be used flying up above 1000 to 2000 feet above ground.  
And that technique for spotting dense congregations of hopper bands in Australia has been used since the 1960s, when it was first discovered that they could be seen from those heights. Now the desert locust, the juvenile nymphs behave a bit differently.  
So while they are gregarious, they the hopper bands, they form a typically much smaller, so instead of 10s of kilometers in size. They typically only about 10 meters to sort of 100 meters, sort of in length.  
And their densities aren't quite up to the same density per square metre as the Australian plague Locust.  
So you can see the difference in the two pictures there, the Australian plague Locust. Very obvious.  
Those dark bands through the centre of the picture.  
Upwards of 5000 to 10,000 individual locusts per metre squared.  
To the desert locust, which these are sort of mid in state. You can see the faint sort of yellowish areas in the scattered vegetation there.  
So these are from 13 stars. They become that quite yellow colour so.  
Hard to detect, but not impossible to detect.  
There as adults again, there's some differences.  
So the Australian plague locust adult. Well, they can form very large swarms of 10s of kilometers in size.  
Their density tends to only be between 5:00 and sort of 50 individuals per meter squared. In those flying swarms, so also the locust itself is a bit smaller than the desert locust about less than half the size and weight.  
Australian plague locust swarms tend to be settled on the ground most of the time. They don't fly as strongly moving swarms all the often.  
And so for surveillance, they require quite a big effort of both ground level and low aerial reconnaissance where we actually need to use helicopters in Australia to get down only sort of 10 metres above the ground to try and flush these swarms up, to detect them and work out their area so they are both difficult to map and control, the adult swarms in Australia.  
The desert locust swarm, is quite different.  
They're very, very strong flyers, especially during the day.  
Their swarm sizes, they do get very, very large swarms, as I think I said in one of my introductions that some of the swarms coming into Somalia, Ethiopia and Kenya were the size of New York City.  
And there can be hundreds of individuals per meter squared. They do have a behaviour where they roost in the evenings and through the night and early morning.  
So those densities even increase, so you can see the picture there down on the left where the tops of the trees are covered in immature adult locusts, and they're all roosting in very dense formations, then the photo over on the left is showing a little bit earlier in the morning, where they're starting to raise their temperature based on the daytime temperature, and they're starting to lift off.  
And start their daytime movements.  
So during my work over in Kenya and Somalia, there were three real main areas of innovation and adaption.  
So the first one based on aerial surveillance and control techniques.  
The second area was the use of the free mobile phone apps that we have access to these days.  
And using those in combination with some geographical information systems which which we're very lucky to have access to in Kenya.  
And then combined with that was the successful use of two low environmental impact insecticides, which I'll talk about a little bit later on now and I just want to know about this photo that I've got there with the giraffe in the background.  
So this was my main control centre in the centre of Kenya, which is the Laywa Conservancy.   
During COVID, it was locked down.  
So it was basically just the control team that was stationed there.  
With the Laywa Ranger staff, who were the owners of the geographical information system that was adapted and used for locusts at the time, so you can see our air tractor parked on the edge of the airstrip there, and it was pretty typical to see all the wildlife around during our morning departures from the airport.  
So the aerial surveillance side of things. So in Australia, as I mentioned before, we've used fixed wing aerial surveillance extensively to detect and map the juvenile hopper bands. And these typically during an outbreak are very visible for a three-week period. And because they're quite small they don't move very fast, so you can see up at down in the bottom there, there's a paddock that's infested with some popper bands. Yep.

So back on Slide 7, where I was talking about the very dense roosting.  
Desert locust adult swarm so you can see the dark patch in the trees there.  
So that's hundreds of individuals in a meter squared, roosting on tops of those trees, both in the early evening, so a lot later in the afternoon.  
And they’ll roost like that overnight and through the morning.  
The Cabbie stock photo I've got there is showing the swarm staying to lift off again.  
Probably around about 10:00 the following morning as the day starts to warm up there, they start to become mobile and fly again.  
So moved on to Slide 8 and that's where I was talking about the really uncomfortable conditions I had based out of the Laywa Conservancy where the mornings were driving out to the airstrip you can see with the yellow air tractor is parked.  
Down there, the giraffes, the elephants, the rhinoceroses and everything. Sort of walking past to see what was happening every morning.  
And yeah, so the three main areas I'll be covering is the aerial surveillance control techniques, the use of those free mobile phone apps, the GIS system and a combination of the two low environmental impact.  
So slide 9.  
Now there are surveillance sites down in the bottom left again.  
I'll highlight the hopper bands that can be seen in Australia.  
Very, very dense at times. You can even see the eaten out areas very distinctly. And so this is taken from about 1500 feet AGL.  
And they don't move very fast, so it's a great opportunity for us to be able to detect them and treat them over that three-week period.  
In Africa, the desert locust is also very visible from high altitudes, but only as those adult swarms and because of their behavior where they roost in such high gregarious numbers in the tops of the vegetation.  
And they'll roost like that until mid morning, where they'll become quite mobile.  
And they are very, very strong flyers as a locust.  
And they can travel just during the day. Sixty to 100 kilometres in a day, just quite different to the Australian plague Locust, which will really only travel those sorts of distances once they're fully mature, only for short period of time.  
Move on to slide 10 on how we sort of combine that knowledge to develop aerial surveillance and control.  
So the operation requirements obviously need to be able to find or know where the areas we need to survey were. So having very good surveillance, both air and ground teams and a reporting network that would report back to our team's running the geographical information system for mapping and the tracking of both the locations of swarms and their movements through the day.  
Early morning surveillance was critical to be able to find them early enough to send those coordinates through to the spray aircraft to treat them.  
And then as I said, finding the swarms and treating them before 10:00 in the morning, which gives you a very small window in the morning, any untreated swarms would need to be marked and then tracked for follow up so we could find them quite quickly the next morning if need be.  
So this diagram on the right is basically really just showing the control operations that we followed to be able to control those roosting swarms.  
So early morning surveillance and target marking and spraying in the morning, then reviewing those targets and movements and information through the headquarters.  
Then in the later afternoon, about two hours before sunset, some of the teams would go out to see, try and find where the swarms would move towards, and remembering they can move 60 or typically moving 60 to 80 kilometres in a day so they could be at times quite hard to find again once they had left and started to move. They really needed to be tracked as close to sunset as possible.  
Because then was when the aircraft had to land before, before it got dark.  
We didn't any lights around our airstrip or landing area.  
Let's move on to slide 11.  
There are very strong benefits of treating early morning roosting swarms. Obviously much safer to treat because they're not mobile. They're down sitting on the tops of the vegetation.  
You can keep your spray height quite consistent, which is important with the drift hazards we have these days.  
Obviously, the more risk there is for some of the chemical to drift off target.  
It's really hard to keep track of which parts have been sprayed and which haven't been sprayed, so a roosting swarm the whole area can be treated in just one spray operation.  
They do form smaller targets, so they were up to 10% smaller in size.  
And then, of course, the morning temperatures and wind conditions are much better for spraying.  
They can see the two different situations there and imagine spraying the target on the left is much easier than trying to have an aircraft out. Treating that flying swarm there which has started to move by 10:00 in the morning, we'll go through to  
Slide 12, which is going into the new technology we had used and adapted to our use. So it hadn't really been any significant locust control for 10 years, so obviously all this, phone apps and mapping software had advanced quite a bit.  
The pilots had a really good team that had been using these for other applications over the years, so we'd come up with ideas during the daily meetings and measure map was one of the good ones that was used, another free app that was on mobile phones. The teams could go out. See those roosting swarms and they could map exactly the area that that swarm was roosting in.  
And those coordinates were easily downloaded and sent by WhatsApp back to the control teams on the ground.  
And within 10 minutes the spray aircraft was up and heading towards that coordinates.  
So that really made it a big difference in being able to get the teams out there to spray those areas before 10 O clock in the morning.  
Tracking the swarms during the day was very, very difficult, but we found that the Windy app really helped get the surveillance teams heading in the right direction to locate the swarms that have been seen starting to move in the morning.  
And the teams became very, very good at, like, OK, this swarm would move, say 5 kilometers within the hour before sunset.  
And towards the end of, especially in 2021, there were very, very few swarms that disappeared and got away from us because of the tracking ability with that application. The good thing with Somalia and Kenya was there wasn't really anywhere where there wasn't mobile phone access - they had significant improvements with mobile phone towers throughout the area, so slide 13.  
Obviously the considerations for this was well trained aerial and ground survey and control teams.  
The survey teams all equipped with both accurate GPS equipment and the mobile mapping software.  
Also, information coming through feeding both ways to the FAO, Desert Locust Information Service team, which provided you know both the overall forecast.  
As well as some early warning for locusts moving out of one area into another area, moving one country into another country.  
Then the in country operations geographical information system that was used supported by 51° that were the Ranger operations team based at based out of Laywe Conservancy looked after all the conservancies through Kenya so that we later use that geographic information system across the Horn of Africa, in both Ethiopia and Somalia, for monitoring and overseeing operations for the desert locust in those areas.  
The weather information was very critical for tracking the swarm movements and then building an understanding of the regions where these locusts are moving through. So in some areas they've moved very quickly. Other areas that get caught in some of the mountain ranges and they move in other sort of directions.  
So, building an understanding, and locally - had quite a difference as well, so I mentioned the FAO Desert Locust Information Service so they kept track of everything that was happening across the Horn of Africa, Yemen, and parts of Africa.  
So here it's showing, by the end of middle of 2020, the first invasion of Desert Locust had basically been stopped.  
A few had moved into Uganda and South Sudan and then sort of petered away.  
But there was the 2nd invasion following the war, Cyclone activity and heavy rainfall up in the Gulf of Aden and Somalia, which created further successful breeding of generations in Somalia and Ethiopia, and then a second invasion occurring towards Kenya at the end of 2020.  
So the information from the DLIS helped us set up our control centres for early intervention of swarms coming across so you can see over on the right, there is the Kenyan Somali border.  
And we had two arrow control teams, one based at Wojia up in the North, one in Garissa to the South and then a central team that was sort of a roving team between, say Marou on the map, but it's actually sort of is Isaiah was more the central area and up, then up towards Mars, a bit in the north.  
I'm just moving on to slide 15 now, which shows the geographic information system that we used that showed all of the aircraft movements and this is an example of where we'd introduced fixed wing aircraft.  
Previously just been using the helicopters that really only have about three hour endurance and could only travel less than sort of 300-400 kilometers in that sort of fuel load, and with limited access to fuel through the area, there's only certain areas like they could get to.  
So we did bring in fixed wing surveillance aircraft to track the swarms where they were moving to and where they were roosting and it really allowed us to cover pretty well all of that Kenya area.  
It also gave us the ability to check off from the insecure Somali border where we didn't really want to go more than within 20 nautical miles.  
Because of just because of the insecurities there and it also freed up the helicopters for target marking.  
So the use of the long range surveillance aircraft did make a big difference as well.  
And then this is the Earth Ranger GIS.  
It also obviously helped us both for mapping where the swarms were and where they'd come in, and then how far they were moving. You can see here some examples of when the swarms first moved into Kenya.  
With our first marked and generally were able to mark them and treat them within their first day of coming in. If we did miss them, then there be that information be passed on to the team, sort of further into the East and they'd be able to track them and treat them by the next day.  
Now the measure map software is you can sort of see here. We used it for mapping the size of the swarms in the morning or usually all the mapping was done by 8:00 that was sent through to the spray aircraft and the exact coordinates were given.  
And because the swarms aren't moving, they can basically spray that area without having to visually see the swarms themselves.  
So it made a huge difference being able to treat those early morning roosting swarms.  
So unlike 2020, during the second invasion of 2021, basically no swarms reached northwestern Kenya, Uganda, or South Sudan.  
So the lessons learnt during that 2020 period?  
And the latest technology used helped us ensure that the second Locust invasion into Kenya was basically halted within two months.  
You can see sort of the change down there for those months were that the locust basically were all controlled.  
So February was obviously a peak. We did have very large swarms in January. So it doesn't really show the size of these swarms that moved in, which were several 1000 hectares in size by the time they got into the central part of Kenya there.  
Was sort of leftover remnants of only less than 100 hectares in size.  
So even though it shows quite a lot of swarm activity in the centre, they were much smaller than what we were controlling sort of coming in. Then by April, barely anything left at all.  
To the second part, is my work over in Somalia where we used some low environmental impact type insecticides.  
So one is the an insect growth regulator which we use for a barrier or regular blanket type treatment only on the desert locust hopper bands because insect growth regulator only works on the nymphs that need to malt to go through to the next stage.  
Then the biological insecticide, Nova Scrib macromocrine used against immature desert locust swarms.  
And then the efficacy assessments and how we're actually able to do efficacy assessments on adult swarms, which are very mobile and usually very hard to.  
If the slow acting biological is actually working on them.  
So my slide 20 now.  
So it's a growth regulator towards the end of May 2021 in Somalia.  
Our surveillance teams indicated there was over 100,000 hectares infested with high density early instar desert locust nymphs.  
There was limited insecticide in the country.  
We had 50,000 litres of the insect growth regulator teflubenzaon and we had about 4000kg of the biological metarisium. The teflubenzrun it was 30 grams of active ingredient per liter, which hadn't been used as a barrier treatment before, so it made things a little interesting.  
Barrier treatments had been used by FAO before, but at larger type treatments of 500 meters and 700 meter spray runs apart in the 90s and the 2000s.  
But again, because haven't been any locust outbreaks for such a long time Teflubenzran hadn't been tested in Australia.  
We used a different product, but also for a barrier treatment, fipronil and had been used very, very successfully 2005 to 2010.  
So it was that knowledge that I sort of brought along and we used with the lower active ingredient IGR teflubenzaron, where we chose to use a 300 metre irregular BL blanket and I'll show you examples of that shortly.  
So over at that three-week period, which is all we really had to control that large area of pop bands we use that about 50,000 litres of the IGI to protect 150,000 hectares and we achieved 98% mortality in eight to 10 days after spray, which was fantastic result.  
So this sort of shows the area. As I said, desert Locust Hopper bands are very, very difficult to detect because they're occurring even in desert locations.  
It's even after heavy rainfall can have scattered vegetations you can see from the picture down there, which is the northern part of Somalia.  
And because they're quite small and dispersed over large areas need to be able to find them and cover sort of thousands of hectares be able to do that.  
So what we found with low level helicopter survey the helicopter getting down between 20 and 50 feet above the ground.  
And still traveling along quite quickly at 80 knots speed, we could detect these little congregations of desert Locust Hopper bands between 7:00 in the morning and up to about 10:30 in the morning.  
We designed a surveillance with the part that let us detect as many hopper bands as we could.  
But also enable speed to survey such large areas quickly, which was about one kilometre apart.  
All Hopper band seen with GPS marked as you can see in the photo example there.  
And then these were sent back to the Control Center, where the teams would mark the area to be treated over the next few days, as you remember, the hopper bands aren't moving very fast, so once they're marked, you know you have several days to treat that area before they're likely to move out of it.  
So this is showing the helicopter about 20 to 50 feet.  
So the bands were detectable.  
Hopefully you can see a little bit there.  
So again the yellowish patches.  
So not easy to see, but the teams really did a great job.  
They got their eye in and they were able to detect these little patches of hopper bands very quickly and quite readily and then plot them for us in the control centre. So you can see here the barrier treatment technique that was used.  
We use between initially a 300m barrier treatment, but after it's such good success, we did go to a 500 meter treatment which we found work just as well which was fantastic.  
So the idea is the aircraft would spray one run and they would leave a 300 metre space between the next run.  
So you only have a high deposition over a much a smaller area and an area with low deposition of insecticide or no insecticide at all.  
And IGR is designed to stay on the vegetation for several days, meaning the locust would move through feed on the vegetation and get enough of a dose. That would stop them from being able to go through to the next nymphal stage, because it basically inhibited their production of chitin, which an insect growth regulator does.  
So you can see here that the little yellow patches of bands out on the left can see an example of what the spray runs would look like.  
The locust would move in random directions, so very rarely would we find would they move actually between unsprayed areas.  
And up in the top you can see where the points of the hopper bands are all marked by the helicopter surveillance and where the spray aircraft did all their runs at 300 metre track spacing to cover those.  
And this is the result.  
Another great use of GIS mapping obviously is we can do the post spray assessment.  
This is almost a 19,000 hectare area that was treated in just one morning.  
180 bands in pretreatment.  
Eight days post treatment where the helicopter went back and flew exactly the same lines, but also looked outside as well to make sure there wasn't no locusts moved out and we had 98% control efficacy just within those eight days.  
A fantastic result over the three-week period, 31st of May to the 20th of June 2021, we use 48,000 litres of IGR to protect 145,000 hectares.  
You can see that's the three-week period.  
Where large areas were treated and protected and as I've noted before, we had really excellent results. And then to follow up with the biological control agent, which is Metarhizium.  
So operational planning to track monitoring, reduce resprays of swarms is quite difficult.  
This is as, I said, these are quite slow acting.  
And so having a technique to make sure that it's actually working on mobile swarms really did have to be developed.  
So the use of Metarhizium it was the first use of Metarhizium with such a large scale, certainly against adult locusts.  
Its success in 2021 can really be contributed to several factors, so the use of the insect growth regulator for a start to really reduce the number and size of adult swarms made them manageable.  
We weren't trying to treat 10,000 hectare swarms, we're only treating swarms less than 1000 hectares in size.  
The swarms treated were all treated early in the morning. The lessons we learned in in Kenya and how to track the swarms.  
Find them and mark them for treating early in the morning certainly helped.  
And then the mapping and use of the weather apps to track those treated swarms afterwards so we could observe the effects both in the field and then using cage efficacy assessments as well to show that it was actually working and how long it would take to work and the mortality that was achieved.  
Operational planning to track, monitor and reduce response of swarms.  
On slide 29, now swarms can be highly mobile and Metarhizium even under ideal night time temperatures 28 to 32°C can take a week to get to achieve the 50% mortality.  
So our teams really aim to concentrate aerial spraying of all swarms within a designated area over several days. Once we thought we'd treated all those areas, we'd move into another area that was maybe 50-60 kilometres away.  
And just treat all swarms in that area.  
Swarms in each treated area were monitored when able to over weeks period.  
So any retreatment, if it needed to occur.  
Usually the swarms would be 80 to 90% smaller, which showed that it was really successful if the swarm was still quite large, then basically we knew that that swarm hadn't been treated with the Metarhizium yet.  
But I think, well, yes, we're on slide 30 now.  
So this is sort of showing the effort of over one week period.  
So again, using the GIS system we it could show us how surveillance effort, where the swarms were that were being treated, the dates they were treated and so forth.  
So again, the next slide shows a little bit more detail.  
So these immature desert locust swarms treated while roosting between 7:00 and 10:00 o’clock in the morning on the 13th of July, we treated almost a three and a half thousand hectare.  
And then again, because of reports of swarms affecting some subsistence cropping, there's another swarm treated on the 17th of July, 2400 hectares. Whether or not that was the same swarm or part of a swarm that was being treated, we weren't sure. But you know that’s the sort of risk you do take, but certainly by the 23rd of July which was which was ten days after we treated in that main area.  
There were no other reports of swarm.  
And the teams did find only one swarm again following the wind direction, and several reports over time.  
Where we observed mortality in the field and the resulting swarm in that area was only 200 hectares inside was compared to the 3 1/2 and 2 1/2 thousand hectares.  
Quite a significant size difference, obviously.  
So slide 32. So this is one of the Somali field operatives that I worked with and where we landed with this, this low density 200 hectare swarm.  
Really quite unusual to see impacts in the field. As you can see.  
Mortality there happening on the ground.  
These were collected, taken back to the accommodation and within three days was showing that the locust had died from the Metarhizium.  
Where they've been dissected there and we can see the spores that have growing inside.  
Slide 33 is really showing the efficacy during that period.  
So we'd have cage samples obviously as well when able.  
Mortality, which is which is pretty common with the Metarhizium, which is really great.  
It's consistently showing this when applied correctly that after 10 days we're over 50% mortality, certainly by the two week mark. We're over 80% mortality.  
Which again was some excellent results.  
So almost at the end here now.  
So the Somali success story in particular, so those operations carried out in Somalia especially during 20/21, showed that large scale control using a combination of a biopesticide and a more specific insecticide such as insect growth regulator barrier treatment can provide results equivalent to those of conventional pesticides with the much lower risk to environment, human and animal health.  
While Metarhizium is slow acting.  
Treated locusts do have a reduced feeding and movement.  
And they provide much easier targets for prey. And as was shown in Somalia, reduced ability to migrate.  
So by the end of 2020, one there were no significant swarm movements into Ethiopia or Kenya.  
And then, which was yet fantastic. Also the higher initial costs of biopesticides is going to be offset by the lower cost to the environment, honey production.  
And at the end of campaign, disposal of unused chemicals, which is, which has been a big issue in in the past with large scale control operations.  
Yes. So thank you very much.  
That's it for that presentation.  
Well, this is my team in Kenya up in Marzabit County.  
So yeah, so I'll hand over to any questions there now and.

**Vivian-Smith, Gabrielle** 47:17  
Thank you very much, Heath.  
That was absolutely fascinating.  
So I'm gonna kick off with the first question and we've probably got only got time for about three or four questions. But you know, it seems like you've got to really scale up very, very quickly and develop a high degree of capacity and capability for the survey work ,spotting work and then the treatment work and the operational complexity must be quite significant.  
Are there any sort of take homes for Australia with this successful operation that you wanna share with us?

**McRae, Heath** 47:57  
Yes, certainly.  
Oh, things have changed a lot since the last locust operations have occurred.  
So certainly our technology is very advanced.  
Guess the take home message is well, well for me is that you know, things can be scaled up quite quickly with the right teams.  
The right knowledge and the right sort of preparation and an operation set up.  
Yeah, that's probably my main sort of take home with this one.  
You know, we will need those teams and that knowledge to say how this software is now available or this group's using this software.

**Vivian-Smith, Gabrielle** 48:39  
Thank you.  
So I've got one question here from Hailey, Sean, I think it is.  
How predictable are the locust swarm movements from day-to-day? And I think you touched on that a little bit, but is it a balance between, you know, knowledge that's gathered about what's going on in the ground versus predicting where things might go?  
You mentioned the windy app, but are there other factors there that we should be considered as well.

**McRae, Heath** 49:10  
It depended on the country and the type of geography as well, but certainly we found them very predictable.  
If they're out on the plains area where there's no sort of mountain ranges, then they would generally always follow the general direction of the wind and at a certain speed, so they were quite predictable there. Where they were caught in sort of mountain ranges. It came a little bit more difficult, but it's it really came down to the geography. Yeah, but you could build up that knowledge within quite a short period of time. You know how far and what direction are we moving in.

**Vivian-Smith, Gabrielle** 49:53  
OK. So we've got three questions and I'll try and kind of wrap them into one there around. Other predators?  
And one of the question the first question is around what happens to the dead grasshoppers that aren't consumed by prey?  
Could can they be used as protein supplements or does the application of insecticide rule that out and would collecting them for this purpose be too labour intensive to be practical?  
And then we have another question.  
Which touches on bats and are there any studies on bats to reduce locust numbers? And then the third question that sort of touches on this are there what are the implications for the environment, native animals with pesticide use?  
Assuming less with so with the organic one if locusts were left, would they eventually die out?  
So there's a bit of a package of questions there.  
Maybe if you can just touch on those very briefly.

**McRae, Heath** 51:01  
The locust as they die, they don't stay on the ground for very long.  
The locust that is sprayed with fast knock down chemicals.  
They'll tend to be predated on by ants. Some other sort of ground predators very very quickly.  
The other one was using locust as a protein source and that as well. So collecting them afterwards. Quite difficult. I mean it has been looked at.  
And it was used in Kenya.  
Quite a bit where teams would go out and collect locusts to use as protein.  
But it was very labour intensive and even with three days of collecting, they were able to harvest only a 2 hectare, sort of a sized area.  
So when you were talking about thousands of hectares of swarms, its limited and as you mentioned do have to be careful of it - has these swarms been treated with chemicals?  
So I mean, if you're using the biological, then fantastic, fine, there's no issues.  
Impacts on native animals.  
Yeah. So it's certainly with conventional pesticides, there's there's possible impacts and that's where it's really looking in the future to move more to use of biologicals and lower impact insecticides or more specific type insecticides such as your insect growth regulator.  
I think I might have missed the last one.

**Vivian-Smith, Gabrielle** 52:33  
The last one was around if we just left them there, would they die out?

**McRae, Heath** 52:39  
Look, they do go through a cycle.  
You could leave them there and they would die out eventually, like they normally do after several years.  
But then if we keep getting good weather conditions, then they could keep going up from in number and because they can migrate, they're not just going to die off in one area, they'll migrate into another area and affect neighbouring countries neighbouring villages.

**Vivian-Smith, Gabrielle** 53:12  
Right. So a huge thank you.  
There's lots of very positive comments in the chat, so I think people found your presentation very interesting.  
So if we could just give Heath a virtual round of applause. So big thank you Heath for sharing your invaluable experience and knowledge.  
Obviously we don't all get to share that kind of experience. So it's fantastic when you can, I guess, convey what you've learned and just what it was like take us there virtually through your presentation.  
So it was it was really, really interesting.

**McRae, Heath** 53:47  
Thank you.

**Vivian-Smith, Gabrielle** 53:48  
And then just to close off, I've got one last little announcement that's a plug for the next Australian Chief Plant Protection Office webinar. It's going to be on the 15th of October and we'll hear from Grains Research and Development Corporation, visiting fellow Dr. Thorsten Lagner. And so we are looking forward to that, there will be more information coming out on that presentation in the coming few weeks, so I encourage you all to keep an eye out for that.  
So thank you everyone for your great questions, participation and enthusiasm today for desert locusts and big final thanks to Heath and goodbye everyone.

**McRae, Heath** 54:32  
And my e-mail is at the end of the presentations too. If you want to go back and find that.