The CABI Podcast: Fall Armyworm

Audio Transcript

Laura
In 2016, fall armyworm arrived on the shores of West Africa. This voracious pest has since spread across Africa into Asia, the Pacific and, Australia. It has had a devastating impact on crop yields in invaded countries and has the potential for further spread and economic damage.

Roger
In early 2016 it first appeared in West Africa, in several countries in West Africa. CABI started – well, CABI identified Fall Armyworm in Ghana in 2017, I think. So, we've been working on it since then.

Laura
Welcome to another episode of the CABI podcast. This series we're focusing on invasive species.

I'm Laura.

On this episode we're focusing on the invasive species, the Fall Armyworm, with CABI experts Dr Roger Day and Dr Ivan Rwomushana.

Roger
So, my name is Roger Day and I'm in charge of the Action on Invasives programme which is looking to address the whole problem of invasive species, not just Fall Armyworm. I'm an entomologist by training and been working in invasive species for something like 40 years now, in both Asia and Africa.

Ivan
My name is Rwomushana Ivan. I'm a senior scientist for invasive species management, currently based at CABI business centre in Nairobi. My background is entomology. I've been working on Fall Armyworm management for the last couple of years. regularly looking at integrated pest management and forecasting gradually on the largest solutions for dealing with this particular pest.

Laura
The fall armyworm is known as a plant pest that causes damage to a wide variety of crops. But, what is the fall armyworm?

Roger
The fall armyworm is actually a moth species but the Armyworm itself is the caterpillar, the larva of the moth; so, it looks a little bit like a worm although it's not a real worm.

Laura
Fall armyworm caterpillars are similar to other related species, such as the black armyworm, *Spodoptera exempta,* which can be found in Africa south of the Sahara. Identifying the fall armyworm can be difficult, but there are some features to look out for.

Ivan
There are several features that can be used to identify fall armyworm. There is the most typical one that farmers know, or most extension people know is the Y shape on the head. And so, once you see that mark on the head, combined with four raised dots on the second last segment of the caterpillar which form a kind of a square. Those are the two typical signs that you can use to identify fall armyworm.

Laura
Spodoptera frugiperda, or fall armyworm, can now be found throughout much of Africa, Asia and now Australia and the Pacific, however the species is actually native to the Americas.

Roger
It's called the fall armyworm, I think, because it was first reported in northern America, the north-eastern area, where it was seen during the autumn, the fall so that's why it's called fall armyworm although it doesn't actually live all the year in that part of the world. It's a tropical species which in the winter in America is confined to the southern parts of Florida and Texas, and also lives in central and southern America.

Laura
So, how did a moth travel all the way from the Americas to West Africa?

Roger
Well, how it reached West Africa is an open question. It probably couldn't fly that far, although it can fly long distances on the prevailing wind. It's been recorded flying several hundred kilometres in a night with a favourable wind. But it's likely that it reached West Africa on a boat or a plane, some kind of transport as a contaminant.

Laura
We know the fall armyworm has potential to spread rapidly. Should other countries or continents be worried? Where else does the species pose a threat to?

Roger
I guess there's the other Pacific islands. There's been some work looking at whether it could invade Europe and / or North Africa, and certainly there are fringes of the North African coast and the southern European countries which look like they might be suitable for fall armyworm.

So those are potential areas of invasion. And the other thing, of course, that can happen is that as in the Americas, as in North America, it doesn't need to be able to survive all year round if it can migrate each season.

So, in the United States, as I said, it only survives in southern Florida and Texas but each year it migrates generation by generation all the way up, to even reaching Canada in some years. So, there are probably areas of Europe that could be invaded seasonally if major populations established in Northern Africa so that's a potential concern.

Interestingly, this seasonal pattern is being observed in China. So, in southwest China where it's warmer, the armyworm seems to be able to survive most of the year. In northeast China, where a lot of the maize is grown, it doesn't survive year-round, but it's seen migrating in there each season.

Laura
Not only does fall armyworm spread quickly, but once introduced to an area, it is an incredibly successful invasive pest, as Ivan explains.

Roger
It is a very successful pest for a number of reasons, and the first one is that it has a very wide host range. It has been reported to feed on more than 80 plant hosts. And secondly the conditions upon which it can survive are quite varied and they're wide. It can survive at low temperatures, at high temperatures, at medium temperatures, at different elevations and so it has a very wide scope of environments in which it can survive. And typically, when it comes to areas where it is not native, like Africa, for instance, there are not many natural enemies that can keep it in check.

Laura
And fall armyworm's impact can be devastating for farmers, particularly smallholders who rely on cereal crops like maize for food security.

Ivan
Smallholder farmers are the most affected by this pest because it typically feeds on the food crops that they feed on a daily basis. It's been known to attack maize fields and wheat fields. And so, it feeds on the same food that small typical smallholder farmers could actually feed on.

And to give you an example of Kenya, there's evidence that shows that when it infests a maize field the farmers can get up to 33 percent losses and this has been estimated to about one million tonnes annually in Kenya alone.

Laura
So, with their prolific ability to reproduce and spread, controlling the invasive pest is difficult for smallholders and methods used are not always effective, economical or safe, as Ivan explains.

Ivan
When fall armyworm first infected Africa and other countries where it has been reported recently, the first approach has likely been the use of pesticides. Typically, farmers pick on any product that they can get their hands on to contain the problem, but in a number of cases the pesticides have not been found to be effective. And of course, we do know the negative impacts of using pesticides to control the pest.

Initially you see a decline in the pest population but over time then you typically are seeing no change, and so we think that it's not a sustainable way of managing the pests. And besides the kind of pesticide being used are normally highly hazardous and so we think use of products that are lower risk and less toxic would be useful.

Laura
So, what about in its native region? How is fall armyworm controlled there?

Roger
In the – it's interesting, in the Americas where the pest originates, it is a problem there and that's slightly unusual in that often invasive species are not much of a problem where they originate. But in this case the fall armyworm is a significant pest in the Americas, and the two main control methods they use there are pesticides and genetically modified maize or corn.

Pesticides have the problem that's – problems that Ivan's talked about including the fact that the pest has evolved resistance to several sorts of pesticides. And genetically modified corn works quite well. It contains genes from a bacterium called bacillus thuringiensis which produce a toxin poisonous to all sorts of caterpillars and other insects. So, these genetically modified crops are resistant to the pest, if you like, and that works quite well in the Americas. Although, interestingly, there are cases where the armyworm has evolved resistance to the genetically modified crops, and once again feed on them so the plant breeders are now adding more genes to boost the resistance of these crops.

Laura
However, switching to genetically modified crops to beat fall armyworm is not an option for most farmers in Africa and Asia, as Roger explains.

Roger
Well, in many countries in Africa and Asia genetically modified crops are still not commercialised. The regulatory systems are still getting set up and some approvals to use GM crops have been granted. So, this is a technology that we'll probably see expanding in coming years, but it's still not common in Africa, only one or two countries use GM crops at the moment, South Africa being one of them where they've used GM maize to manage fall armyworm.

Laura
The rapid spread of fall armyworm, requires the development of new and sustainable control methods. Ivan explains how other low risk methods of fighting fall armyworm are proving successful.

Ivan
There's also been some recent research that has looked at two approaches. One is intercropping of maize, sorghum, cereal with legume, like beans and groundnut. And there's some evidence that shows that when you do inter-cropping with some of these legumes, you get less infestation, less damage in your maize fields. And so, we think that's a useful piece of data, especially in African cropping systems where a lot of farmers typically intercrop their maize with a number of other legumes.

And there's another method that has been developed by scientists at ICIPE, called Push Pull, where typically you intercrop maize with a plant. Normally it is a brachiaria or some other desmodium, that's supposed to push the fall armyworm out from the maize field.

Laura
Whilst intercropping can have a positive impact on fall armyworm numbers, biological control is also an option for invasive species management.

Roger
So, usually when we talk about biological control, we mean using other living organisms to control a pest and the other living organisms are what we call natural enemies. These can be of several sorts including other insects which either parasitize or prey on the fall armyworm. There are also various different microbes which are like diseases which infect and kill the armyworm.

Laura
What different biocontrol approaches are being used against fall armyworm?

Roger
So, the first approach is that we can say there are, see that there are natural enemies where fall armyworm is in Africa and Asia, that are already attacking the fall armyworm and we can try and conserve those or encourage them so we should avoid killing them which of course pesticides do. We can manage the habitat to encourage their proliferation so avoiding killing the existing natural enemies and encouraging them to breed.

Another approach is to mass rear large numbers of the natural enemies and release them into the field when you've got a problem. This is called augmentation, and this is typically

done for fall armyworm with very tiny wasps which lay their eggs inside the eggs of fall armyworm and by parasitizing the Armyworm egg, it obviously kills it.

Laura
Biopesticides are a type of biocontrol. They are a form of pesticide derived from natural materials such as animals, plants, bacteria, and certain minerals.

Ivan
We're seeing biopesticides being used as well. These are products that are based on either fungi, bacteria, or virus and typically it's sprayed in the fields on the caterpillar. And typically, how they would work is that they cause the caterpillar to get infected with a virus or the fungi or the bacteria, and after a certain period of time because when they're sick they start to consume less of the crop and eventually die off.

Laura
And some of these biocontrols are being piloted in Africa.

Ivan
We have been trialling some of these methods in Africa to see how effective they might be against fall armyworm. Typically, how they work is that the caterpillar would pick up the parasite through feeding, and get infected with a virus and once its infected it stops feeding and eventually it will die off.

Also in Kenya, recently, there's been a pheromone for mating disruptions has been registered for use against fall armyworm, and typically how this works is that when you apply the pheromone in the field, it releases certain info chemicals that confuse – the info chemicals get into the environment, into the maize field and they confuse the males from finding the females, and so if the males can't find the females it means the females, the females' eggs will not be fertilised. And so, when they lay eggs they will actually not hatch. And so, in the long run, you end up having a less population of fall armyworm in the field. So, this is now registered in Kenya and available for use for farmers who want to deploy it for biocontrol in their fields.

Laura
As mentioned, one reason why fall armyworm is such a successful invasive pest is its lack of enemies in invaded areas. However, it does have natural enemies in native regions.

Roger
There's an approach called classical or introduction biological control where we look in the area where the pest originates, so in this case in the Americas, and see which natural enemies are attacking it there. And if they're present and important there but not present in the invaded areas, so absent from Africa or Asia, then we can consider introducing those species to the invaded area.

Obviously, that can only be done with its – lots of safety tests to make sure that the introduced natural enemy doesn't attack non-target hosts. So, we're doing lots of host-specificity testing but that's quite an effective approach when it works well.

Laura
Two of fall armyworm's natural enemies in its native central America are types of parasitic wasps. Research is now being carried out to see if these wasps can be used in the biocontrol of fall armyworm in invaded regions.

Roger
Yes. So, on the use of parasitic wasps, we've been doing surveys in Central America for natural enemies there and two species have been identified which look potentially suitable for introducing to Africa and Asia.

And one of those species an ichneumonid wasp has been tested against some non-target species in our centre in Switzerland. And we've now shipped it to both Pakistan and Benin where further tests will be done in quarantine facilities to check its effectiveness and show that it's not going to attack non-target species. If those tests are successful, then we shall then apply for permission to release into the natural environment.

On the augmentation, there was another very interesting discovery. One of the species that was talked about when fall armyworm first arrived in Africa as a potential biocontrol agent to introduce to Africa, a tiny little wasp that parasitizes fall armyworm eggs.

When researchers started looking at what was already present in Africa, they discovered that this species was there, even though as far as we know, nobody ever introduced it. So that emphasises the importance of doing studies on what natural enemies you already have before you start considering ways to use natural enemies.

So instead of having to introduce that species, we're now looking at ways of mass rearing it, and releasing it in very large numbers to suppress the fall armyworm populations. We're talking about hundreds of thousands of insects being released quite regularly.

Laura
With all this research in to fall armyworm, do you think there'll come a time when fall armyworm is eradicated from invaded regions?

Roger
No. I mean, eradicating any pest is pretty difficult and with fall armyworm it's almost impossible because it breeds so rapidly and spreads so fast. Eradication is easier and most feasible if you have a pest which is not moving very rapidly so that you're dealing with it in a small area. So, on islands, eradication is usually more effective but in the case of fall armyworm, I think we can more or less say no.

Laura
What can fall armyworm teach us about managing invasive species in the future?

Roger
Quite a lot, I think. One lesson might be, expect the unexpected. When fall armyworm first arrived in West Africa nobody was particular looking for it. Nobody had realised that it was a potential risk, and it took quite a long time before it was even confirmed to be the fall armyworm.

Now I think the response in Africa could have been better if countries had been not necessarily expecting fall armyworm because it's hard to always identify what might be coming your way next, but at least to have systems set up so that when something new arrives, you can respond quickly and effectively.

Laura
And how has CABI been involved in helping countries prepare for the unexpected?

Roger
And that's one of the things we've tried to encourage countries to do under our Action on Invasives programme is to develop preparedness or contingency plans so that when the unexpected happens, you don't get caught in a panic and then have to start thinking, So who's going to do what? If you've already got some generic plans made, you can respond more effectively when the unexpected happens.

And CABI's actually developed some tools, including one called the Horizon Scanning Tool to help countries do this, to try and work out what are the most risky invasives out there in other countries, which could be coming their way sometime. And then of course you can't prepare for every single potential invader, but you can identify the high-risk ones and maybe concentrate some effort on planning what to do if they arrive. But as I said, you also need these generic plans so whatever arrives, you can respond quickly and effectively.

Ivan
Also, to add to that, before fall armyworm, invasive species were not really a key breaker for a number of African countries or countries where CABI works. But I think that fall armyworm has raised to the fore the importance of invasive species in the country's priorities. And CABI has supported a number of countries and specifically, I can mention here Ghana, Zambia, and also Kenya to develop, to initiate what we call technical working groups on invasive species and so these are structures that are going to be set up within a specific government institution.

And their role will be to basically discuss issues of invasive species and try to come up with strategies and get all the sector players involved in terms of dealing with an invasive species. So, in a way, it has helped a lot of countries to organise the key importance of invasive species and coming up with systems to better be prepared next time to address any invasive that threatens to affect these countries.

Laura
Thank you to our guests Dr Roger Day and Dr Ivan Rwomushana.

To find out more about CABI's work on fall armyworm, visit cabi.org/fallarmyworm

For more info about CABI and our wider work, please visit cabi.org

This podcast is a CABI production and was presented by Laura Hollis and edited by Tom Swindley.