Digital IPM: managing insect pests in the age of big data

By Hazel Parry, Senior Research Scientist, CSIRO

AT A GLANCE...

Digital decision-support tools are now deployed in many aspects of agronomy, but what about insect pest management? We are now moving closer to integrated digital solutions that growers can rely on to protect their crops from insect pests.

CSIRO has a long history of extensive field studies to inform integrated pest management (IPM) in broadacre cropping including grains and cotton. For instance, our two-year study across Qld, NSW and WA for the GRDC in 2010-11, which collected nearly 30,000 insect samples in collaboration with QDAF and DPIRD.

The study showed how various weeds tend to host insect pests (the bad guys) and native plants host beneficial insects (the ones we want to attract) in grains landscapes. We have also conducted large-scale collaborative studies in cotton for CRDC over numerous years that helped us to understand where and when in the landscape *Helicoverpa* spp. lay their eggs. These studies inform IPM by increasing our understanding of insect behaviours, identifying when pests are likely to be most prolific or problematic.

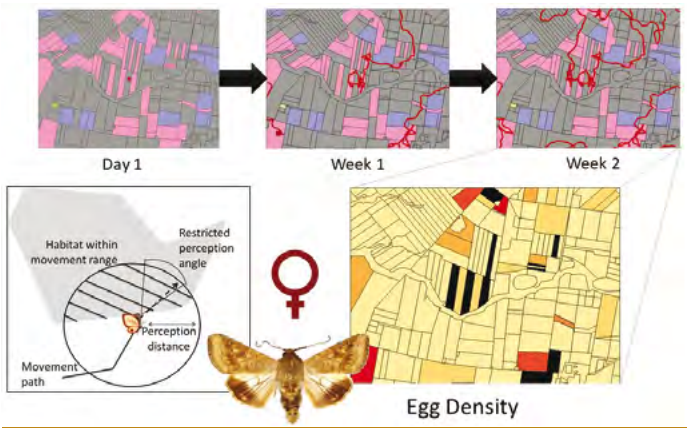

Illustration of the computer model I developed to simulate movement and egg laying behaviour of female Helicoverpa spp. in cotton landscapes of Australia.

But, manually collecting extensive field observations for months on end may soon be a thing of the past – and the reason why has very real, and very positive, implications for Australian farmers.

Counting pests has never been easier

Automated monitoring has boomed, with start-ups like RapidAim (a spin-out from our team at CSIRO) promising to deliver data on the presence of insect pests at much larger scales than would be possible from any manual field data collection effort, at a fraction of the cost.

Large crop protection companies like ADAMA are starting to deploy such automated monitoring systems, and soon we could experience a data deluge as sensor technology delivers insect pest information at a scale we have not had to deal with before. Digital approaches are being assisted by advances in Artificial Intelligence and Machine Learning (AI/ML), where images from traps collected remotely can be rapidly and automatically analysed for key insect pests, or drones can detect evidence of pest damage simply by flying across a crop field.

Moving from research to pest management, this technology also has the potential to transform the ways which agronomists assess insect pest outbreaks. For example, a new app developed by USQ that uses image-recognition to count whitefly pests in cotton has potential to reduce sampling times and increase consistency in sampling. The result would be faster IPM interventions, reduced crop losses, and increased farm profits.

From models to management

I only participate in the occasional field trial, and generally I spend my days in the office developing computer simulation models of insect pest population dynamics. I have used these models to consider, for example, what causes aphid populations

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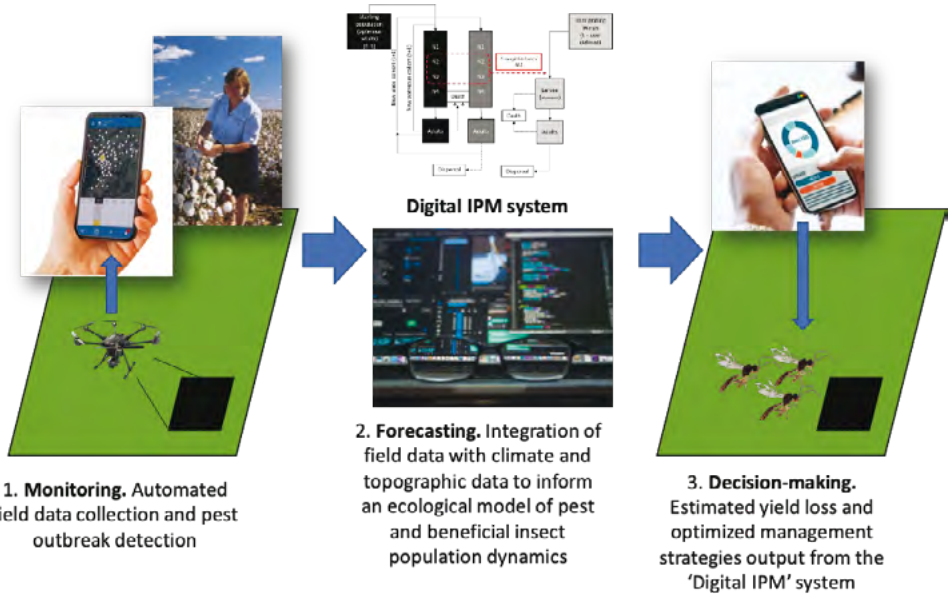

A schematic of 'Digital IPM': integration of monitoring, forecasting and decision-making across multiple devices and platforms to provide real-time pest management solutions.

to move across landscapes, how they might be affected by a changing climate, and their control by parasitic wasps. I have also used models to help understand the importance of refuges for managing resistance to Bt in Helicoverpa pests.

But more and more I ask myself: how can these models be used directly to help make real-time IPM decisions, rather than only for research?

A growing history of digital ag tools

Digital agriculture is widely acknowledged as a critically important 'emerging industry' in Australia. Access to digital technologies could boost efficiency and productivity, reduce uncertainty and radically improve the speed and accuracy of on-farm decision-making.

Using digital agriculture for pest and disease control across all Australian production sectors has been estimated to have the potential to unlock $1 billion of economic benefits due to improved market access and biosecurity. During the 1980s and 90s, as computers promised great potential there was a surge in 'decision-support tools' for pest management, but very few made it beyond a concept.

The Australian cotton industry led the way, but with early deployment of decision support tools that supported industry. First SIRATAC, then Entomologic, followed by CottonLOGIC. These tools assisted the adoption of Bt cotton for controlling Helicoverpa and the greater use of beneficial insects (particularly Trichogramma).

Despite early enthusiasm and some limited successes, Digital IPM tools still haven't reached anywhere near their potential. Today, many barriers are removed that limited past implementations: improved access to computers, powerful handheld devices, and the internet's increasing reach into remote areas.

A vision of the future

So, how might we see Digital IPM evolving in the not-too-distant future? Perhaps, picture this… a farmer stands in the middle of a cotton field. They pull out their mobile phone (or some future device that connects them to the 'Internet of Things (IoT)'), and it automatically detects their location. A notification flashes on their device, and they pull up a report based on the latest pest and beneficial insect monitoring data sent from the multiple sensors installed around the farm.

This shows that the drone that was flown over the lower paddock that morning for a daily sweep detected a small patch of damage that AI/ML image recognition algorithms have determined is due to aphids. The farmer opens the insect pest management app: data is then pulled from the Bureau of Meteorology as well as local weather monitoring stations and crop information to provide a computer model with a detailed short-term forecast to allow it to predict what is likely to happen next. This model indicates that conditions are such that there is a risk that aphid populations will grow and spread quickly with a significant impact on yield.

At the same time, according to the on-farm automated insect monitoring system, local populations of beneficial insects are currently low and insufficient to control the outbreak. The decision-support model advises localised release of parasitic wasps to boost the natural population for biocontrol, as it is still early enough that they are likely to suppress the population without any need for pesticide spray. The farmer heads off to the on-farm beneficial insect rearing facility to send the wasp release drone to the patch in the lower paddock, looking forward to a cold beer afterwards.

Making Digital IPM a reality

Does that sound fanciful? Do you feel like the promise of digital agriculture has been a letdown, particularly when it comes to insect pest management? The biggest failing of many digital agricultural products hasn't been that they aren't available or don't work. Rather, it's that for the most part they haven't yet properly talked to each other to provide end users (farmers or agronomists) with whole-of-system solutions.

The technology almost entirely exists already. The problem is you currently need to open and crosscheck data from a dozen different apps and widgets. Integrating these different capabilities is the final step of the Digital IPM puzzle. Today, we have novel enabling platforms at our disposal, such as CSIRO's Senaps: 'an Internet of Things (IoT) Application Enablement and Data Management cloud-based platform'. What that means, in plain English, is that we have a highly flexible digital framework for getting data from a wide range of sources or 'things' (from automated insect traps to weather stations). Within the same platform, data are analysed and then distributed via a multitude of other 'things', such as user-facing applications or decision-support tools.

There is increasing pressure to produce more with less, and we are faced with ongoing challenges of a changing climate leading to increasing and novel insect pest management problems. So, it is exciting to think that we are only just beginning to unlock the potential of digital technology for IPM that can help us to meet these challenges.

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