Growing maize in northern Queensland

Lessons from two years of farming with fall armyworm

First detected in northern Queensland in February 2020, fall armyworm (FAW; *Spodoptera frugiperda*) is now considered endemic. This is part of a series of case studies examining how Queensland agronomists and broadacre growers highly impacted by FAW have adapted.

FAW is a tropical species, and although able to establish in subtropical and temperate environments, tends to do so only during warmer months. International reports that uncontrolled FAW can cause more than 50% yield loss in maize and impact a wide range of other plant species caused understandable concern within at-risk industries regarding the arrival and spread of this pest, particularly in northern Queensland (NQ), where favourable environmental conditions for this tropical species would likely lead to year-round, high density FAW activity.

First experiences with FAW

FAW's detection in the middle of the 2020 maize season in northern Queensland took both growers and agronomists by surprise. An agronomist (who had clients that experienced yield losses of 40-50%) said *"We had no FAW in crop monitoring in the 2020 corn because it had never previously been needed. The damage was done before we had even detected them that year—there were up to 20 FAW per plant in some cases."* This experience was mirrored by other growers in the region: A maize grower added *"I saw reports that QAAFI had damage in their trial up north and Daniel Rodrigeuz and Joe Eyre offered to have a look at my place on the way past where they found big fat FAW in my crop."*

Widespread reporting of damage to the QAAFI trial site (along with stories of damage internationally) generated a significant response from growers who felt they needed to do something. The result was a lot of spraying that provided little benefit in terms of FAW control.

Key issues were:

- the use of ineffective chemistry (because of resistance in the incursive population)
- sprays that were uneconomic (i.e. the damage had already been done)
- multiple uses of the same ineffective chemistry.

> *"There were up to 10 sprays being put onto crops in 2020 chasing FAW; these were largely cheap knockdowns, however they were largely ineffective, and the level of failure probably just confirmed that these FAW were resistant to this older chemistry" – Agronomist*

In this initial phase there was no real understanding of FAW lifecycles or appropriate management responses. However, despite the challenges faced in the first year of detection there were some positives and learnings which would be rapidly adopted in following seasons.

Vegetative damage to maize by fall armyworm

Lessons learned so far:

1. Successful control of FAW can be achieved with chlorantraniliprole (e.g. Altacor®), spinetoram (e.g. Success® Neo) and emamectin benzoate (e.g. Affirm®).
2. Controlling FAW found in other crops (such as peanuts) is not challenging, due to good spray contact and low levels of damage. The only real damage is in maize and Rhodes grass where detection and control are more difficult.
3. Natural biological control agents (including predation and parasitism) are helping control FAW, particularly in maize, with the fungal pathogen Metarhizium prevalent after canopy closure.
4. Afternoon spraying was anecdotally observed to be more effective, perhaps because FAW is more active at night.

Adopting lessons in FAW management

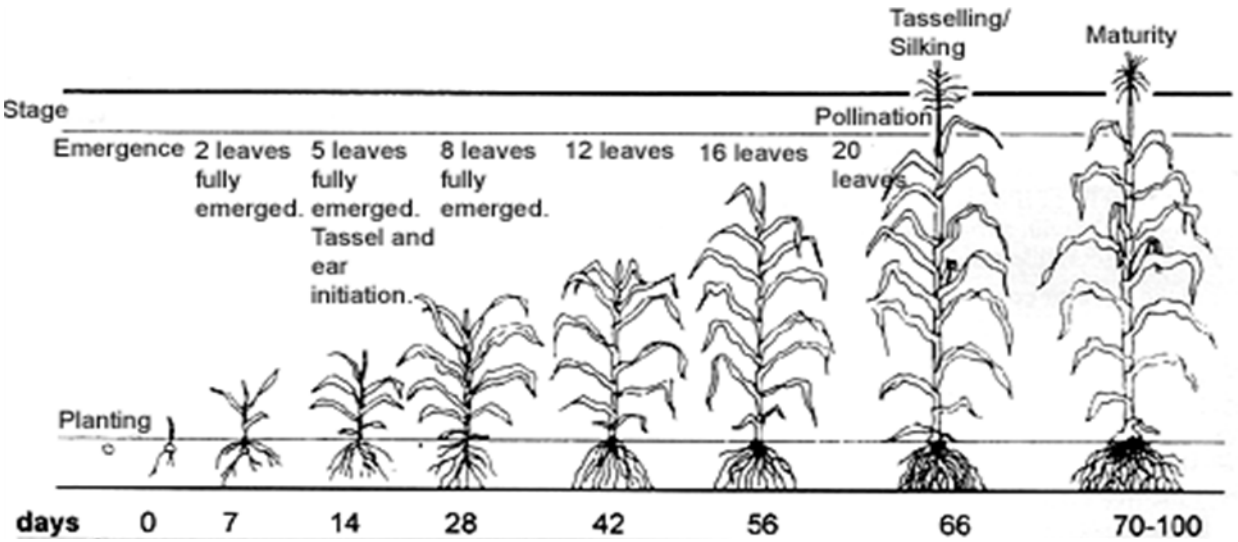
After the late detection in 2020, agronomists and growers made significant changes to their recommendations and practices, monitoring the crop once or twice per week from emergence to silking. A more thorough understanding of FAW's lifecycle and key windows for preventing yield damage supported their goal to achieve control with as few sprays (and costs) as possible.

Due to the year-round activity of FAW and the strong preference of FAW for maize, a first spray (either Altacor®, Affirm®, or Success Neo®) is recommended at the two-leaf stage, roughly a week after emergence. A follow-up spray at the 6-8 leaf stage is also common practice, driven by the rapid 21-day lifecycle of FAW in northern Queensland. If good control is achieved, further in-crop sprays may not be required. The need for a third spray typically depends on insect pressure and ranges from the pre-tassel to firming stage of crop development. Using this combination of in-crop scouting, rotating insecticide modes of action, and timely application to control FAW numbers before they can cause damage, reported crop damage now ranges from 0-10%.

Growers and agronomists believe that the 2022 season has been highly favourable for crop growth, enabling maize crops to grow through FAW pressure with limited damage, however they do wonder if less favourable seasons would result in greater damage.

All those surveyed mentioned trialling non-chemical options, including the attract and kill products (e.g. Magnet®), and biological controls such as Fawligen® (SfMNPV), however they were not convinced of their effectiveness, and uncertain of how to measure their impact.

"This year we did a knockdown at 2 leaf, Altacor® at 6-8 leaf, and applied Affirm® via plane at tassel" – Maize grower



Traditional corn growth stages and timings for northern NSW (Source: NSW DPI)

Magnet required re-application after rain, making it logistically difficult to deploy effectively when growing corn in the wet season in northern Queensland where rain can be daily, leading to uncertainty of its suitability as a long-term management option. While there was more confidence regarding the role of nucleopolyhedroviruses such as Fawligen® in controlling FAW in the long-term, and agronomists were still recommending its use (particularly early season to assist in early control of numbers), the best timing and how to quantify if it had been effective was still unknown.

What does the future hold?

Since the significant crop losses in 2020, growers and agronomists in northern Queensland have rapidly adapted their practices. Results from the 2021 season suggest that the implementation of readily available control methods are delivering good levels of control, and the outlook for continued corn production is promising. However, the long-term sustainability of the production system is causing some concern.

The costs associated with growing FAW-susceptible crops in northern Queensland have increased significantly by $80–200/ha. The risks of undetected, or sub-optimal control of FAW infestations resulting in yield loss have also increased. Compared in terms of gross margin, expected returns fall by between $200–320/ha, from $492/ha to $172–292/ha (Table 1). This fall is driven by both reduced yield (10%) and increased costs. It also does not account for potential insecticide failures or undetected infestations.

Growers interviewed for this case study believed that for maize to be a viable cropping option for them, they would need ~$80/t more than they had previously received for their crops. After voicing this to their local customers, growers reported that their customers were now offering them higher prices (and had confirmed those higher prices pre-sowing). While a good short-term development, some growers were conscious that global grain prices were high at the time and are unsure if their customers will be able to sustain the better price in coming years.

This ability to negotiate a higher price is likely to be limited to the Atherton tablelands and other nearby northern producers as distance to major grain growing regions makes it cost prohibitive to transport grain for livestock feed.

All growers and agronomists surveyed for this case study mentioned the high value of DAF's demonstration sites, particularly seeing corn crops at these sites with high levels of leaf damage still managing to produce good yields. They also placed a high level of value of farm walks, discussions with other growers, agronomists and researchers, and other knowledge-sharing opportunities regarding the management of FAW.

There was a general level of comfort that with current control methods and knowledge they could continue to grow crops susceptible to FAW, however issues which they believe will need to be dealt with for long term FAW control were raised.

Foremost was the risk of insecticide resistance development resulting from over-use of current chemistry (particularly chlorantraniliprole), which has arisen as a result of perceived effectiveness and price (= cost effectiveness) compared with other available options.

Table 1. Fall armyworm impact on maize gross margins in northern Qld using long term average costs and prices

	Pre-FAW	Post FAW	Post FAW with corn price increase
Yield (t/ha)	4	3.6	3.6
Price ($/t)	$300	$300	380
Total income	**$1,200**	**$1,080**	**$1,368**
Fallow management	$56	$56	$56
Planting	$174	$174	$174
Nutrition	$175	$175	$175
Crop protection	$66	$146-$266	$146-$266
Harvesting	$213	$213	$213
Other	$24	$24	$24
Total costs ($/ha)	**$708**	**$908**	**$908**
Gross margin ($/ha)	**$492**	**$172-$292**	**$460-$580**

"I saw Melina's trial and thought this won't yield at all, was surprised when we came back for the next field day and there were plenty of cobs, looked like it would yield quite well" – Maize grower

They also raised the need for a greater understanding of the relative strengths and weaknesses of available chemistry, with an emphasis on growth dilution/residual efficacy. Finally, there was an expressed desire for a greater understanding of how to get maximum value from existing biological options and investigate what other biological options may be available (e.g. Metarhizium) for commercial development.

FAW larva infected with Metarhizium fungus

Researcher comments

During the first season, maize (traditionally a crop without regular insect pests) suffered major losses from FAW, particularly at crop establishment. Growers and agronomists were not checking crops for pests regularly, they were relatively inexperienced in making effective insecticide decisions, and many had no means of applying insecticides in a timely way – instead they were very reliant on aerial application.

Ultimately, ineffective insecticides, late applications and missed infestations combined to result in major crop losses. In just one season, growers and their advisors have turned this situation around. There is now a high level of awareness of fall armyworm and how to recognise it, and crops are monitored routinely from emergence. DAF and NSW DPI research has clarified the status of insecticide resistance in Queensland FAW populations – providing certainty around which insecticides are ineffective and should be avoided.

Demonstration trials at the DAF research station at Kairi have allowed growers and agronomists to see in the field which chemical options provide control, how effective well-timed applications can be, and to observe the compensatory capacity of maize crops – all without having to sacrifice their own crops. Information, support and appropriate upskilling by growers and agronomists have all contributed to this rapid transformation.

Kairi demonstration trial site in February 2022