Growing maize and sorghum in central 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 by at risk industries about the arrival and spread of this pest in central Queensland (CQ), where favourable environmental conditions are expected to exist for most of the year, excluding the winter months.

First experiences with FAW

FAW arrived in Australia in early 2020 but weren't detected in large numbers in CQ until spring (October / November) that year. All agronomists surveyed first saw FAW in mid-season vegetative sorghum crops, however some mentioned reports from grower clients of detections over winter.

Confident identification of FAW was challenging in this first season as multiple caterpillar species were present in crops. The most numerous was *Helicoverpa armigera* (cotton bollworm), accounting for more than half the observed larvae.

Despite the significant numbers of FAW detected in vegetative sorghum crops, no agronomist felt the need to spray to prevent damage. This decision was justified as sorghum crops that suffered FAW damage at the vegetative stage did not subsequently sustain any economic loss.

However, the experience with maize crops across the region was a different story, with estimated yield losses ranging from 0.5–1.5t/ha in dryland crops to losses over 3t/ha in irrigated crops.

Growers and agronomists in CQ regularly manage a range of insect pests in cotton, chickpea, sorghum and mungbean and are well equipped to respond to FAW damage. Consequently, there were few reports of excessive spraying, or the use of ineffective chemistry. Control programs for FAW in maize ranged from 2-4 sprays, with common timings at around the 2 leaf, 8 leaf and post-tassel stages of crop development. Despite these treatments, yield losses were incurred across the region. Growers and agronomists believe this yield loss resulted from a combination of heavy FAW pressure at the seedling stage resulting in uneven plant stand due to seedling loss; many growers opted to not grow maize in the most recent season as a result of their experiences in this first year.

> *"I saw most FAW in sorghum in the middle of the growing season when it was in its vegetative stage, was plenty of insect pressure in general, probably 40% FAW 60% Helis" – Agronomist, Emerald*

Seedling maize with early signs of FAW infestation

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. Despite high density FAW infestations in sorghum crops across the region (5-15/m^2), there was no evidence of economic loss.
3. Maize's traditional planting window in central Queensland is a high pressure FAW environment.
4. The need to control FAW from emergence creates a significant logistical challenge because of competing demands of summer crop planting.

Adopting lessons in FAW management

Central Queensland growers and agronomists have now experienced two maize growing seasons with high FAW pressure, and many avoided maize in the second season due to the challenges and poor outcomes from the first.

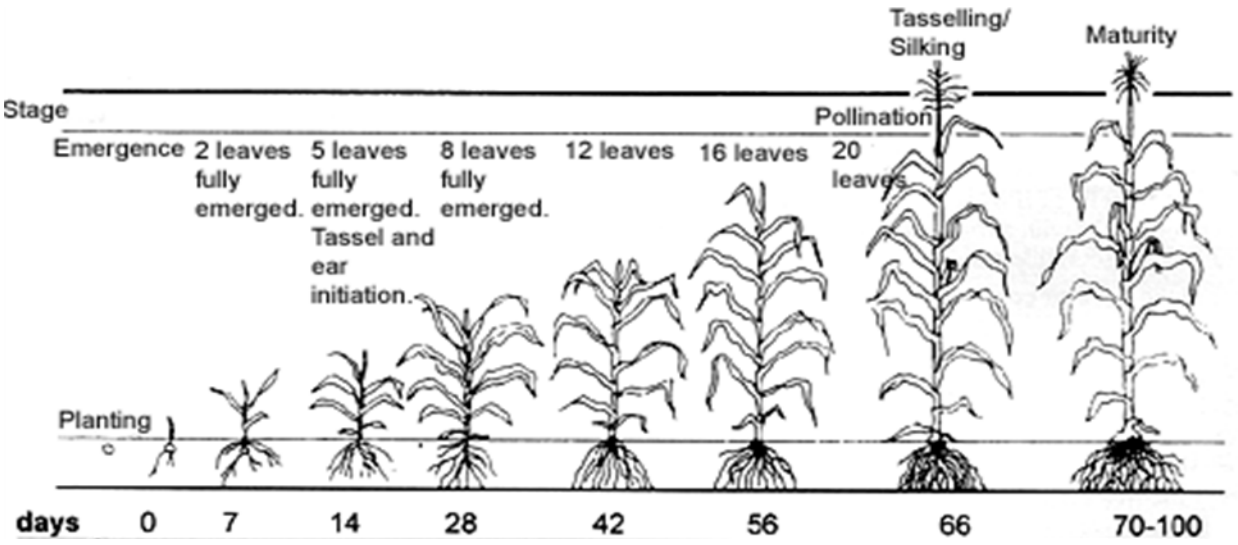
"Had 4 varieties in this year and one was distinctly different with less FAW per plant despite being in same area and planted at same time" Agronomist, Theodore

DAF pheromone trapping data shows FAW pressure building as the spring-summer season progresses. Over the past two seasons, early sown crops (Sept-Oct) experienced much lower levels of damage than later sown crops (Dec-Jan plant). A seed dressing that removes the need for a spray at emergence would also be a valuable management option.

Some growers have observed varietal differences in FAW damage between crops, question why some maize varieties are less attractive than others, and particularly what options these observations may unlock, i.e. trap crops, or future breeding for host plant resistance to FAW.

The success of the time of sowing trials has a small number of growers who had stopped maize considering planting it in upcoming seasons, however current high cotton prices are very tempting for irrigated growers—offering strong gross margins with lower, (or at least a known), insect risk.

In a case study focusing on north Queensland maize growers, the somewhat closed-loop market they have with local processors made it possible to negotiate a price increase in response to the higher risk and lower expected yields caused by FAW. Growers in central Queensland are more exposed to global grain prices, which means that even under scenarios where excellent FAW control is achieved, maize is expected to be $60-$200/ha less profitable than it would have previously been, largely because of the increased cost of managing FAW.



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

What does the future hold?

Growers and agronomists in central Queensland have largely had poor outcomes with maize crops since the arrival of FAW. The combination of expected higher control costs and lower yields has severely impacted the profitability of maize in this region.

At a gross margin level, the expected returns from maize in rainfed environments have fallen from ~$400 /ha to as low as minus $126/ha (Table 1), with the decline in profitability ranging from $180-$500/ha. While irrigated maize growers would still expect to generate positive gross margins, they are facing declining income of up to $1100/ha because of FAW damage to crops planted in the traditional planting window.

Maize growers and agronomists interviewed for this case study were all clear that maize has traditionally been a minor crop for their area compared to other crop choices such as sorghum. Irrigated growers and agronomists all commented that FAW challenges, in conjunction with good cotton prices had pushed producers to swap to cotton, in many instances for the first time.

Overall, there was a feeling that while some maize would still be grown, adopting a sowing window that exposed the crop to lower FAW pressure would be critical. There is also a perception that the majority of growers who have decided to plant a crop other than maize, are unlikely to return to maize (barring exceptional circumstances e.g. high maize prices).

"100% of my grower clients that used to grow maize chose not to this year. I might have one give it a go next year with a July plant, to try and get it pretty mature before October when FAW pressure really starts to increase" – Agronomist, Springsure

Given the apparently negligible impact of FAW on sorghum crops to date, it is unlikely there will be major changes to the area of sorghum grown in response to FAW occurrence.

While there was a general level of comfort with available control options and information, growers and agronomists raised several issues that they believe need to be dealt with for effective long term FAW management.

Both agronomists and growers raised the risk of insecticide resistance development resulting from the over-use of current chemistry, particularly chlorantraniliprole (Altacor®, Vantacor®). Overuse of this chemistry is a result of perceived effectiveness and price (= cost effectiveness) compared with other available options. Agronomists specifically noted that chlorantraniliprole is widely used in major crops such as chickpeas in central Queensland for the control of *Helicoverpa armigera* and were worried that increased pressure on the chemistry may reduce its effectiveness against this major pest.

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

	Pre-FAW (dryland)	Post FAW (dryland)	Pre FAW (irrigated)	Post FAW (irrigated)
Yield (t/ha)	3	1.5 - 2.7	8	5
Price ($/t)	$300	$300	$300	300
Total income	**$900**	**$450-$810**	**$2,400**	**$1,500**
Fallow	$56	$56	$139	$139
Planting	$120	$120	$120	$120
Nutrition	$120	$120	$320	$320
Crop protection	**$66**	**$146**	**$66**	**$266**
Harvesting	$110	$110	$110	$110
Other	$23	$23	$210	$210
Post-harvest	$1	$1	$3	$3
Total costs ($/ha)	**$496**	**$576**	**$968**	**$1,168**
Gross margin	**$404**	**-$126-$234**	**$1,432**	**$332**

Helicoverpa larva and damage to maize cob

There was interest in the use of a seed dressing which could reduce the risk of early season damage and the need for the early spray (at 2 leaf). Flow on benefits of effective early season control would include a slowing of the rate of FAW population build in crops, with associated reductions in mid to late season crop damage.

Researcher comments

The experience in central Queensland highlights the importance of research that defines when FAW damage will result in crop loss, and when it will not. The susceptibility of emerging crops to severe defoliation and plant death is now well understood, and management practices (early post emergence spray) reflects this. The impact of defoliation during the vegetative and reproductive stages is less clear.

The dominance of transgenic Bt maize in other countries where FAW is a major pest has meant thresholds for conventional maize crops are not well developed, and empirical research under Australian growing conditions is needed.

Clear guidelines that quantify how much damage can be tolerated, and when control actions are warranted, are urgently needed to give growers and their advisors confidence that they can manage FAW with a positive economic return. This work, along with improved understanding of regional population dynamics, relative efficacy of available control options, insecticide resistance status, the impact of natural enemies and options that may supress local population build up, are currently underway in Australia.

Mid vegetative maize, severely damaged by FAW