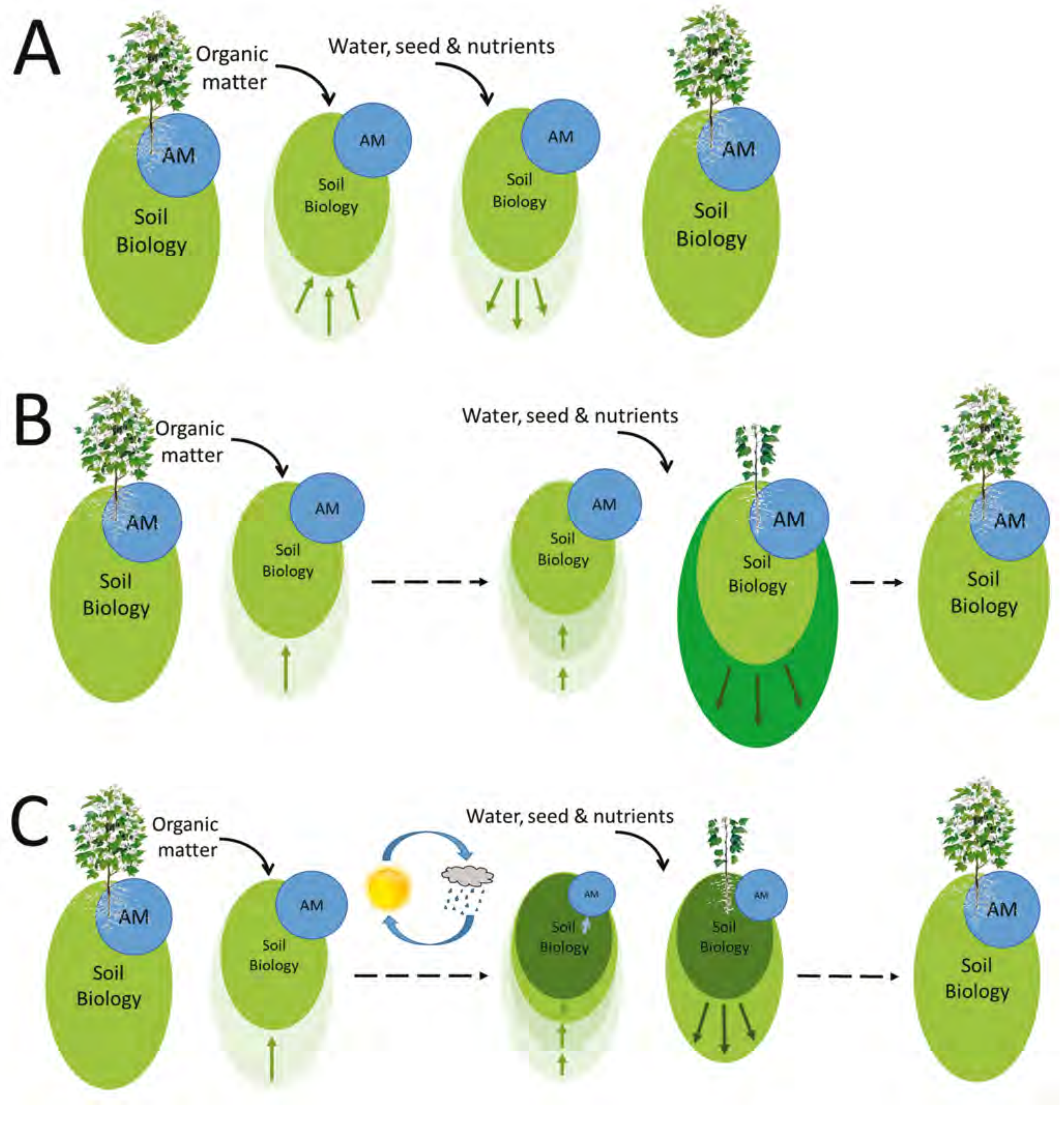
FIGURE 1: Schematic view of the soil biology under (A) a normal cropping cycle, where the biology might decrease and recover between crops.
Under drought (B), where the prolonged lack of water in the system leads to a further decline in the soil biology, while AM survive. Upon water returning to the system, the biology responds rapidly on the available flush of carbon and nutrients, to the detriment of the crop, but the system recovers.
During a drought with wetting and drying cycles (C), the biology is stimulated with each wetting event, living off the organic matter in the soil, but with each cycle this organic matter declines.
With no new organic matter/plant inputs the overall biology declines, which includes the AM. When growing conditions return the system takes longer to return to normal and we see more pronounced long fallow disorder and AM colonisation issues as a symptom.



Shifting the blame and altering beliefs

So we know that more work is needed, but what if we offered an interim 'post drought long fallow disorder option as to why your crops might seem slow' that does not blame AM as the cause for your consideration? Having a plausible alternative might just help you realise that actually, some of these other environmental issues are plausible and AM fungi might finally get off the hook as the sole culprit!

To do this we need you to answer these three questions:

- Where in your soil do you find active microbial populations?
- When you apply mineral fertiliser, how much ends up in the plant and where does most of the rest go?
- What is better at harvesting nutrients in the soil, germinating plants or microbes?

So in answering these you would have come up with something like:

- Microbes are everywhere and active throughout the root zone. I know this because I've heard Oliver, Gupta and Katherine talk about it.
- About 30 per cent of the fertiliser I apply gets into the plant, but it can sometimes get a bit higher. Hopefully the remainder ends up in the soil biology, otherwise I might be losing it to the environment.
- Microbes are way better and faster at harvesting nutrients. I've just told you they are everywhere and active, and look at how much of my fertiliser they look after and recycle for me. Bugs are way better than plants!

Awesome answers. Top marks all round. So now let's apply what you know to the soil, drought, AM and the possibility of smaller plants after these fallows.

Soil biology and drought

When soils dry out, some of the biology can enter a survival stage. Some bacteria and fungi produce drought resistant spores. Nematodes and other invertebrates undergo anhydrobiosis and 'sleep' until it becomes wet again. Some though, just won't make it.

This dead biology does nothing until the soil becomes wet again, at which point it decomposes rapidly, releasing nutrients and causing a flush of growth in the surviving soil biology. The resultant feasting of the soil biology on this nutrient flush is accompanied by rapid growth and a reduction in available nutrients. So if you are a germinating seed with a pathetic root system in this environment, you are going to grow slow (Figure 1).

The good news though is that the feasting can't last forever. Over time the soil biology will return to a more balanced system in which our crops have a better chance of getting the nutrients they need and, hopefully, that slow start due to long fallow disorder becomes a distant memory. This is also important as these crops provide new sources of food and organic matter that the system needs.

When we get wetting followed by drying, with no plant input to the system the flush of biology does not get the new crop inputs it needs to survive. As a result, the soil biology reduces with each successive wet/dry cycle, as the organic matter pool is used up. In these instances, AM spores may well germinate, but die having not found a plant host, reducing the propagule load.

So, now that all makes perfect sense, the next time someone tells you that long fallow disorder is an AM only issue perhaps you can ask them the same questions and highlight 30 years of industry research to the contrary? In the meantime….

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Water productivity benchmarking 2017–18 results

By Ben Crawley[1] and David Perovic[2]

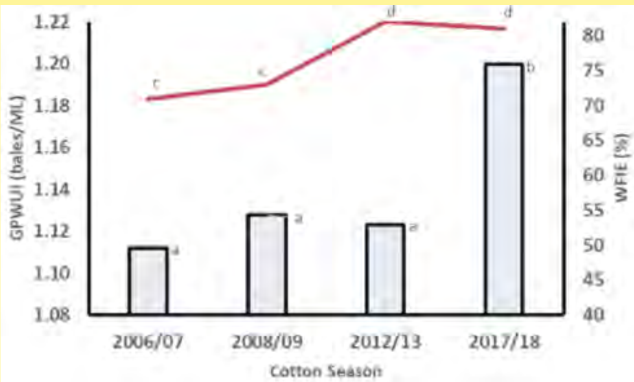
THE NSW DPI Agriculture Water Productivity Benchmarking team has finalised the water productivity benchmarking results for irrigated cotton for the 2017–18 season. The work is part of the 10 year benchmarking project, which has monitored the water productivity of irrigated cotton to help facilitate continuous improvement in water use efficiency and establish a benchmark that growers can compare their performance against.

The team, which consists of researchers from Narrabri, Trangie, Wagga and Yanco, calculated the water productivity of over 57 farms, consisting of 240 fields, 18,673 hectares, 232,194 bales of cotton which makes up approximately eight per cent of the irrigated industry.

The team used surveys and interviews to collect data from 45 growers and agronomists and used this data to calculate a water balance and the gross productive water use index (GPWUI) for each farm. GPWUI measures the number of ginned bales per meg. This includes water losses through evaporation and deep drainage from storages, channels, drains and from the field during irrigations.

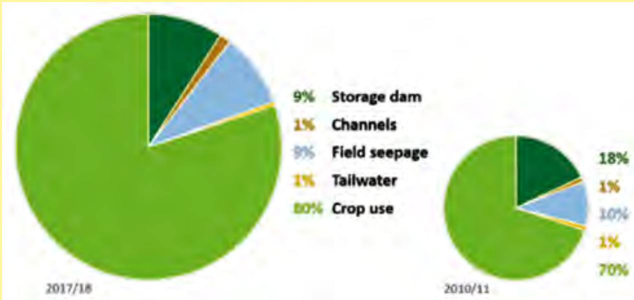
The team also calculated whole farm irrigation efficiency (WFIE), which is a measure of how efficiently water is being used. A high WFIE indicates high efficiency as most of the water is taken up by the crop and not lost through evaporation or deep drainage. WFIE can also be influenced by rainfall, and tends to be higher in drier years because a greater proportion of crop water-needs are met by irrigation. So rainfall needs to be taken into account before making interpretations between seasons.

FIGURE 1: Comparison of the Gross Product Water Use Index (GWPUI), blue columns, and Whole Farm efficiency (WFIE), red line, over previous Water Productivity Benchmarking surveys



Different letters represent significant differences in analysis of variance.

FIGURE 2: Fate of irrigation water on the farm from our work in 2017–18 compared to previous industry data from 2010–11



Published in CRDC and CA (2014).

The work by the team has found that cotton growers have continued to improve water productivity from previous years. Water productivity (GPWUI) increased significantly, from:

- 1.12 to 1.14 bales per ML in 2006–07, 2008–09 and 2012–13, to
- 1.20 bales per ML in 2017–18 (see Figure 1).

Whole farm irrigation efficiency (WFIE) also increased significantly from around:

- 70 per cent in 2006–07 and 2008–09, and
- 83 and 81 per cent in 2012–13 and 2017–18, respectively (see Figure 1).

The GPWUI and WFIE results are presented in Figure 1. Figure 2 also visually demonstrates the increase in efficiency from the 2010–11 season as more water is now taken up by the crop with losses from the storage, channels, tailwater drains and field usage reduced.

The next step for the team is to develop more efficient and streamlined processes to increase participant numbers for both irrigated and dryland cotton and make industry water productivity benchmarking an annual process. The team has also undertaken analysis to establish long term water productivity trends, from back to the 1980s, and to identify practices growers can implement to improve water productivity.

If you are a grower or agronomist who is interested in water productivity and you'd like to participate in benchmarking please contact the team through the details below.

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