

# USING IN-SHED SPRINKLERS IN POULTRY SHEDS

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## THE PROBLEM

High relative humidity affects thermal comfort of the birds and is likely to contribute to wetter litter. One source of high relative humidity in tunnel-ventilated meat chicken sheds is the use of evaporative cooling pads ('cool pads'). We went looking for another method of cooling poultry sheds that would complement current shed design and husbandry practices, but not increase the relative humidity.

## IN-SHED SPRINKLER SYSTEMS FOR COOLING

We found information about an in-shed sprinkler system that had been developed and tested at the University of Arkansas' commercial poultry farm (Arkansas, USA) (Liang et al., 2010; Liang et al., 2012; Liang et al., 2014; Tabler et al., 2008). The effect of direct surface wetting to cool meat chickens has also been investigated (Czarick and Fairchild, 2017a, b; Tao and Xin, 2003). Fundamentally, low-pressure, in-shed sprinkler systems use several rows of sprinklers that are suspended from the ceiling and run the length of the shed. The sprinklers are activated for very short periods of time (5–30 seconds) at regular intervals (5–60 minutes) when cooling is required, based on shed air temperature as well as bird age and density.

Some of the reported differences between direct surface wetting using low-pressure sprinklers compared to cool pads included:

- Significantly less water used for cooling (50–85% less water)
- Lower in-shed humidity during cooling
- Similar litter conditions, tending towards drier litter
- Slightly more electricity use for ventilation fans (about 4–5% more)
- Similar growth rate, feed conversion ratio, mortality
- Lower installation cost.

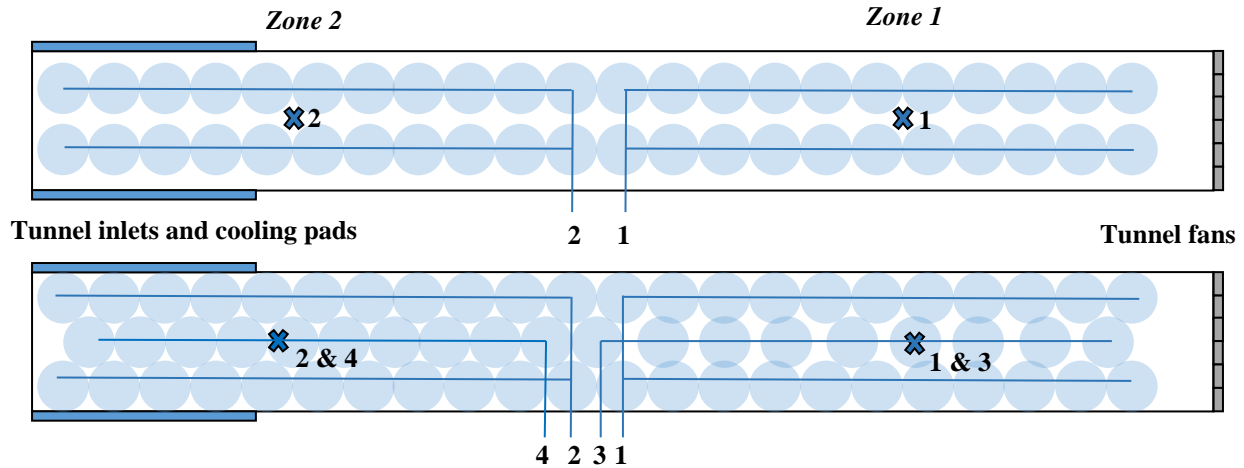
These findings were based on repeated tests over multiple years and different seasons and indicated that there were several advantages to using in-shed sprinklers. We were surprised that the technology had not been trialled on Australian farms. With the hope of realising some of the reported benefits, we set out to install some sprinkler systems and get practical experience with installation, configuration and operation.

## INSTALLING THE SPRINKLER SYSTEMS

We installed sprinkler systems (Weeden Sprinkler System<sup>®</sup>, Weeden Environments<sup>®</sup>, Canada) on two meat chicken farms (*Farm A* and *Farm B*) in southeastern Queensland (in two sheds on *Farm A* and one shed on *Farm B*). Installation cost approximately \$5000–8000 per shed and required 1–2 days for a couple of workers to install.

The sprinkler systems were installed as per the manufacturer's instructions (Figure 1). In summary, two PVC pipes were installed along the ceiling, running the full length of the shed, approximately 3.5–3.7 m from the side walls. Sprinklers were suspended every 6 m along these pipes. On *Farm B* a third line was installed along the centreline of the shed, in the roof apex, with sprinklers installed mid-way between ceiling baffles, approximately 8 m apart. We

decided to add this third line to improve spray uniformity along the middle of the shed during tunnel ventilation, when the higher airspeed narrows the width of the spray patterns. The systems were installed with two independent temperature sensors and solenoid valves in the front and back halves of the shed. This enabled the temperatures at both ends of the shed to be monitored and sprinklers in each zone activated according to the conditions.

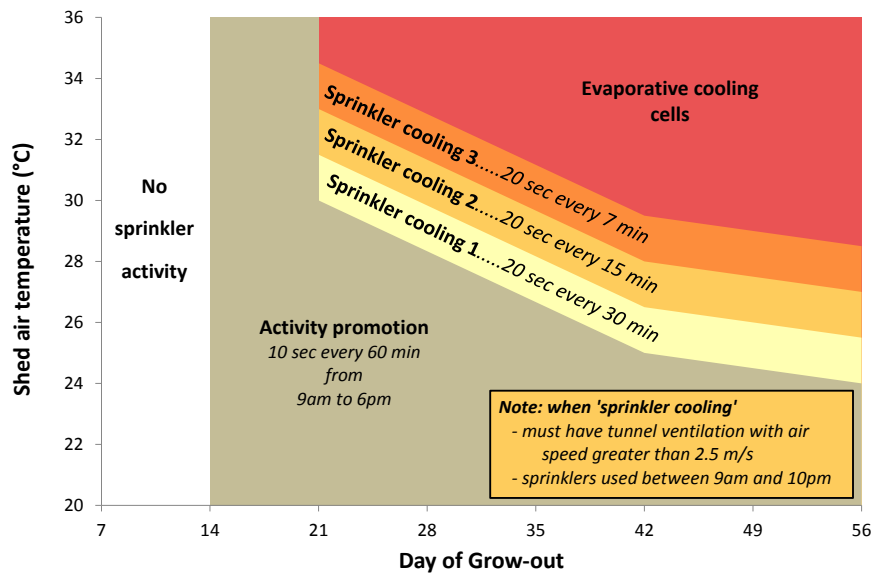


**Figure 1.** Schematic installation for sprinklers and pipework at Farm A (*top*) and Farm B (*bottom*). Circles represent sprinkler position; lines represent pipework; crosses represent temperature sensors; numbers indicate the zone for temperature sensors and sprinkler-line solenoid valves.

The sprinkler system was operated for promoting bird activity and for cooling (Figure 2):

- **Activity promotion** started after day 14 and provided regular application of water regardless of air temperature. This application of water has been shown to stimulate bird movement. In this mode, sprinklers were activated for 10 sec every 60 min during daylight hours. Each application uses 10–15 L of water.
- The controller automatically changed to **cooling** mode when the in-shed air temperature increased above a ‘main set point’ (MSP, approximately 31 °C on day 21, decreasing to 25 °C on day 42). For cooling mode to be effective, the shed must be in tunnel ventilation mode with at least 2.5 m/s wind speed. Cooling mode was only allowed between 9am and 10pm after day 21. As air temperature rose above the MSP, frequency of water application by the sprinklers automatically increased through three levels of cooling:
  - o Level 1 started at the MSP, applying water for 20 sec every 30 min. (each 20 sec application used 20-30 L of water)
  - o Level 2 started at 1.5–2.0 °C above the MSP, applying water for 20 sec every 15 min.
  - o Level 3 started at 3.5–4.0 °C above the MSP, applying water for 20 sec every 7 min.
- When air temperature continued to rise to 5–6 °C above the MSP, cool pads were then used.

During the trial, growers were encouraged to adjust the settings based on their assessment of bird thermal comfort, weather, and litter conditions. All settings within the sprinkler controller were adjustable by the grower (days, times, temperature set points, sprinkler duration and frequency).



**Figure 2.** Example configuration of the sprinkler controller in activity promotion and cooling modes when used in conjunction with cool pads.

In addition to the sprinkler systems, we installed temperature and relative humidity sensors to measure in-shed conditions, and water meters on the cool pad and sprinkler systems to record water use. Sensors and meters were also installed in neighbouring sheds ('Cool pad' shed) and used as a comparison to the sheds with the sprinklers ('Sprinkler + cool pad' shed). Our focus with this trial was to measure potential water savings, litter conditions, temperature, relative humidity and how the birds respond to direct water spraying based on observations by farm staff.

### WATER SAVINGS

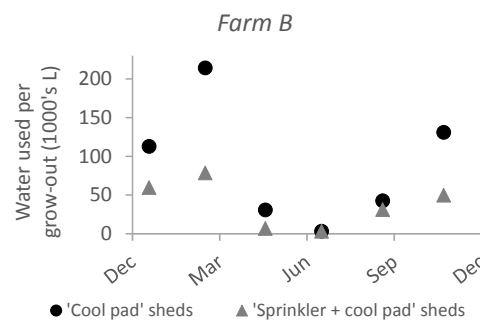
Water use was reduced by using sprinklers to provide evaporative cooling and by delaying the use of cool pads. At *Farm B* (Figure 3), the average saving of water over six grow-outs was 56%, ranging from 3% during a winter grow-out to 78% during summer–autumn grow-out.

At *Farm A*, our understanding of water usage was confounded by inconsistent use of the sprinklers. During the first grow-out (placed late October 2016), 34% water saving was achieved. In subsequent grow-outs, staggered placement dates in the trial sheds, heat-waves and damp litter meant that the sprinklers were not used in the manner described above.

### LITTER CONDITIONS

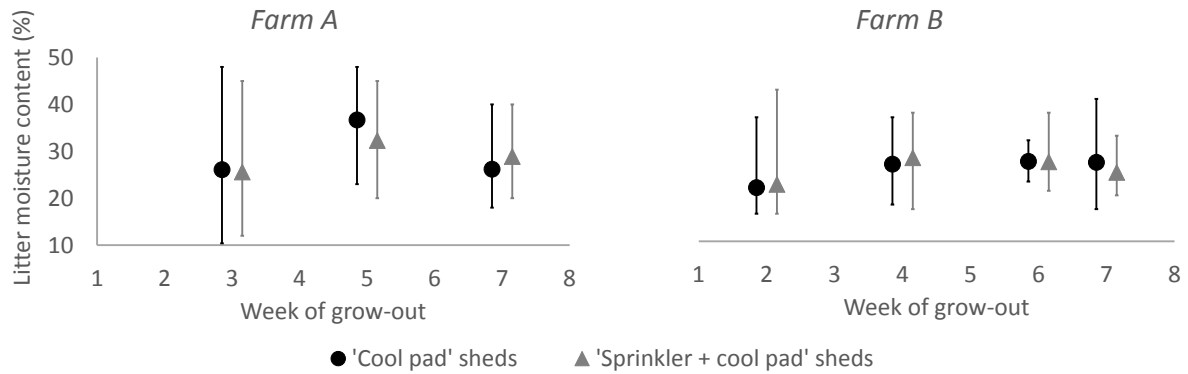
We did not observe any consistent differences in litter conditions with the use of the sprinklers for activity promotion and cooling (Figure 4). We believe this was due to several factors:

- The sprinkled water evaporated before the next application. This was based on visible observation of droplets on shed surfaces.
- Bird coverage of the floor reduced the amount of water landing on the litter. One exception was after thin-outs, when large areas of the floor may be exposed.



**Figure 3.** Water usage for evaporative cooling at *Farm B* during six grow-outs. Dates represent the middle of the grow-out.

- Growers at both farms paid attention to their litter conditions, and altered sprinkling times if they thought the sprinklers would unnecessarily add water to the litter. Neither grower considered the sprinklers to be the cause of damp litter, instead pointing to other causes (e.g. damp bedding deliveries, seepage, drinkers, watery droppings and humid weather). In the case of *Farm A*, the grower regularly turned off the sprinkler systems, sometimes using them for only a part of the grow-out (e.g. days 14-28 and then after day 40), and in one grow-out the sprinklers were not used at all.



**Figure 4.** Litter moisture content in the trial sheds (mean values from six grow-outs, with litter samples being combined from multiple sub-samples collected in 3–4 transects across the shed width). Whiskers represent the range of driest to wettest litter.

### COOLING EFFECT OF SPRINKLERS

Temperature differences were observed between using sprinklers and cool pads. When using water for cooling, air temperatures were warmer in the sprinkler shed but relative humidity was lower, sometimes by 10–15 percentage points (e.g. 80% RH in the cool pad shed and 65–70% in the sprinkler shed). We used thermal imaging to observe the direct cooling effect of water spray on the bird's feathers (Figure 5). When using thermal imagery, it is important to remember that the visible temperature is not the bird's core temperature, but the feather temperature. As the water evaporates, the cooling effect reduces until the sprinklers are activated again. By comparison, cool pads reduce the temperature of the air entering the shed, and this may help to avoid heat accumulating in shed surfaces.



**Figure 5.** Thermal images at *Farm B*, looking towards the tunnel ventilation fans (day 40, ambient conditions 30 °C, RH 60%, temperature scale shows dark colour at 26 °C to light colour at 35 °C): *left*—before sprinkler application; *centre*—following sprinkling by all three rows of sprinklers; *right*—cool pad shed for comparison.

### DISCUSSION AND CONCLUSIONS

The on-farm trial has finished, but at the time of writing we are still analysing the data. So far, we have observed the following:

- Litter is not consistently wetter with the use of the sprinklers.

- When the sprinklers were turned on, the birds stood up and appeared to use the drinkers and feeders.
- Growers have coordinated the sprinkler and ventilation controllers to delay the use of cool pads. Water savings depend on how much the grower wants to rely on the sprinkler system for cooling. Water savings ranging from 3% (winter) to 78% (late summer) were observed when the sprinkler system and cool pads were operated as recommended.
- Lower in-shed relative humidity, and higher air temperatures (as expected), when using the sprinklers compared to cool pads. The birds appear equally comfortable. Temperature alarm settings need to be adjusted to avoid false alarms.
- Growers commented that birds near the tunnel inlets at times appeared warmer, presumably due to low airspeed and warm/hot incoming air. Conversely, birds close to the tunnel ventilation fans at times appeared cooler with the use of sprinklers compared to cool pads.
- Regular sprinkling causes dust to stick to some shed surfaces, including cables, feed lines, drinker lines and fan grills. Fan grills in particular may need more regular attention, but it may be possible to reduce dust accumulation by adjusting the closest sprinklers to reduce spray drifting into the fans.
- Installation in Australian sheds may need to consider sprinkler position in relation to ceiling baffles (i.e. position sprinklers mid-way between baffles, assuming they are not too far apart, rather than keeping with 6 m spacing).

Our trial did not measure feed usage and growth rates. Now that we have more experience with in-shed sprinklers, we are well placed for future trials to measure production related values.

So why might you consider installing the sprinkler systems? The most obvious benefit is water savings. Any farm with limited water, or where accessing or treating the water is expensive, should consider the potential value of installing in-shed sprinklers in their sheds. Another possible reason to install in-shed sprinklers might be as a backup system. One of our trial growers used the sprinklers when the pump on the cool pads burned-out during a heat wave. The flexibility of in-shed sprinklers allows growers to decide how much they want to delay the use of cool pads, as they consider and plan for the weather, litter conditions and bird comfort.

## ACKNOWLEDGEMENTS

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