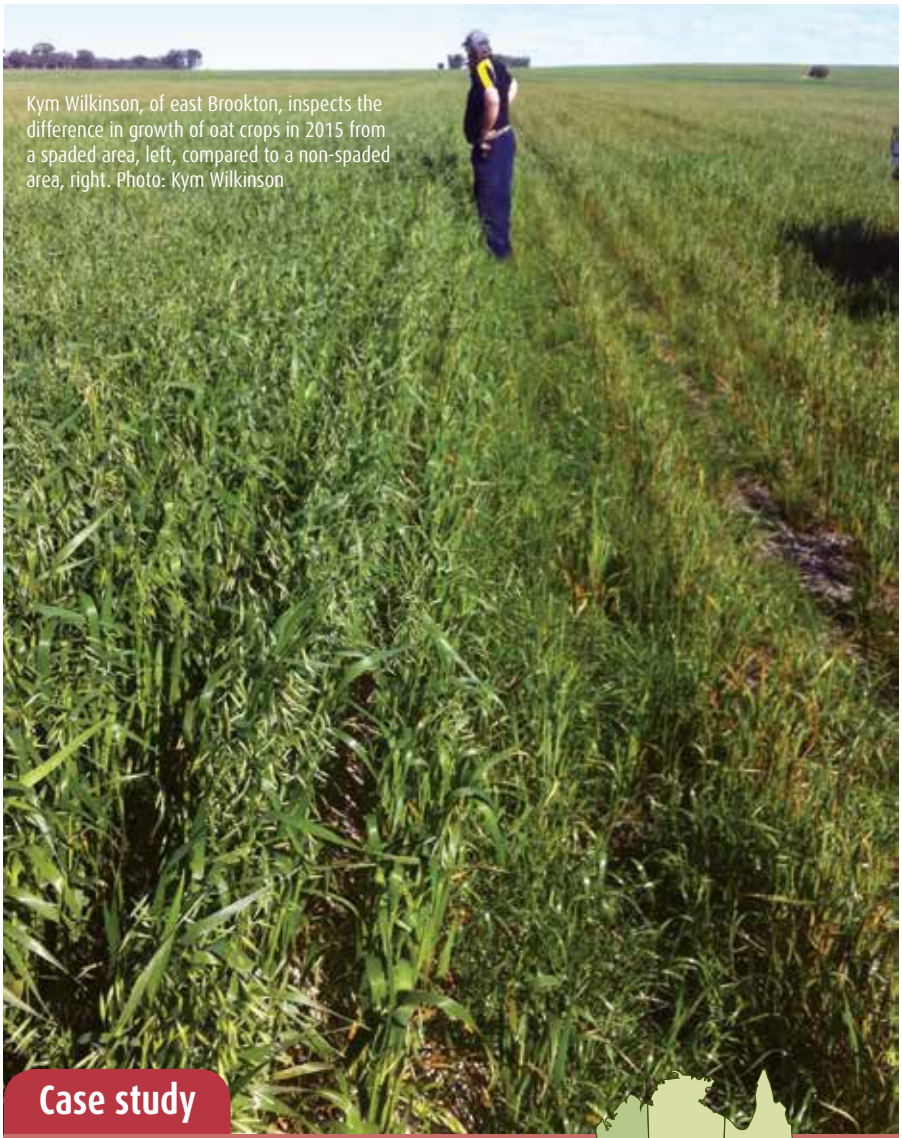
Delving deep to help alleviate spring frost risks

Manipulating the soil heat bank using agronomic tactics such as spading/deep mixing, soil inversion and stubble management has been successful in reducing cereal spring frost risk in some trials in the western region.



Kym Wilkinson, of east Brookton, inspects the difference in growth of oat crops in 2015 from a spaded area, left, compared to a non-spaded area, right. Photo: Kym Wilkinson

Case study

Owners: Kym and Fleur Wilkinson
Location: East Brookton
Farm size: 3000ha arable
Enterprises: 100 per cent cropping
Average annual rainfall: 300mm
Predominant Soil Types: Duplex, sand-over-clay
2016 crop program: 1120ha wheat, 325ha canola, 815ha barley, 345ha oats, 355ha lupins

The principle behind this research is that by storing more heat in the soil during the day, it will then be re-radiated into the crop canopy at night and lift the ambient temperature at crop head height. This can reduce the potential damage to the head from frost.

Storing more heat in the soil can be achieved by increasing soil moisture levels, incorporating darker soil components – such as clay – in the topsoil and lowering stubble loads.

Western Australian growers Kym and Fleur Wilkinson have started a rotary spading program to address water repellency issues on deep sandplain soils at their east Brookton property – but this is also likely to have a positive spin-off in helping to manage long-term frost risk.

Since 2014, the Wilkinsons have treated 633 hectares of sandy soil with a rotary spader and are reaping productivity gains of up to one tonne per hectare in higher wheat yields and up to 3t/ha more hay from treated areas.

It is expected the clay-rich topsoil created from the spading process will also reduce the impact of severe frosts that hit during the cereal flowering and grain fill windows by storing more day-time heat in the soil bank and releasing this at night to increase temperatures at crop canopy height.

The spading process reduces the reflectance of heat/light by mixing darker soil into the top layers of white sand.

History indicates the Wilkinsons will experience a severe spring frost event about once every four-five years.

Kym said wheat crops were hard hit in 1998, 2005, 2008 and 2012 and he estimated that they lost an average of 10% of their total 3000ha cropping program to frost every year.

"In 1998, we had several paddocks of wheat that we thought would yield about 2.6t/ha before they got frosted, but at that harvest yielded 1.6t/ha on average," he said.

"Then in 2005, in the same area of the farm, we had a total wipeout of frosted wheat crops on 160ha that was not even ▶

worth harvesting – but we still did so that we could get the air seeder through it the following year.

"That same year, wheat sown into lupin stubble higher up in the landscape yielded over 3t/ha."

Kym estimated the 2012 frost – which was severe, prolonged and hit right in the cereal flowering window – cost the business about $600,000.

He said this frost wiped up to 1.25t/ha off wheat yields, with the total wheat program producing an average yield of only 0.85t/ha.

This was down from the peak average wheat yield of 2.8t/ha (achieved in 2007).

The Wilkinsons had a reprieve from severe spring frosts in 2013 and 2014, when wheat yields climbed to average 2.85t/ha and 2.17t/ha respectively.

But average yields fell back to 1.9t/ha in 2015 on the back of moisture and heat stress – rather than frost events – at the end of the growing season.

"Our experience in the past decade clearly shows the significant impact frost is having on our cropping productivity and costs per hectare in wheat yield losses," Kym said.

FROST RISK PLANNING

The Wilkinson's integrated frost management plan starts with wheat and barley variety choice and time of sowing.

Included in the crop mix are: the short season Mace and longer season Magenta wheat; La Trobe , Scope and some Spartacus barley varieties; ATR Stingray canola; and Carrolup oats.

"To spread the flowering window – and our stem frost risk – we mix up sowing time by sowing some short season wheat early and some late and some longer season wheat early and some later," Kym said.

"If we get a very early start to sowing – as we did in 2016 – we will slow down towards the end of the wheat program.

"Historically we always aimed to start sowing on April 25, but in recent years this has come forward to about April 15 if conditions are good."

Kym and Fleur have not mapped the frost-prone areas of their property, but know from experience what these are. They tend to sow flatter, downslope areas later in the program if feasible with machinery and paddock logistics.

During the growing season, these more frost-prone areas receive the same in-crop nutrition regime and treatments as other cropped areas.

Post-frost event risk management strategies include a plan to cut affected crops for hay, although they have only done this on a limited basis to date.

Kym said this would be a viable strategy if needed, as the business already produces export hay and has equipment, contract balers and ready markets available.

SPADING TO AMELIORATE SOIL CONSTRAINTS

In 2014, the Wilkinsons experimented with 30ha of rotary spading to address water repellency on some of their worst performing sandplain area.

They had tried clay spreading in the early-2000s, but found this was expensive and did not deliver high enough yield responses to be cost effective.

Kym said the first year of spading looked promising and they subsequently treated 200ha in 2015 and another 400ha in 2016 after purchasing an Imants 57SX spader.

They are targeting areas with a high subsurface clay content at a depth of 30-40cm and are also incorporating lime at a rate of 3t/ha.

"What we are achieving in one-pass is incorporation of lime through the topsoil, down to 30-40cm, disbursement of the non-wetting topsoil and bringing up the clay-rich subsoil to the surface," Kym said.

"We are seeing cereal yield increases of up to 1t/ha and up to 3t/ha more hay produced on these areas in the first year or two of treatment."

Research in WA has shown these yield gains are achieved by the spading operation aiding water infiltration, reducing compaction and changing the distribution of organic matter and nutrients.

The spades lift seams of subsoil to the surface, creating more preferred pathways for water entry and improving the water holding capacity of the soil.

Department of Agriculture and Food WA (DAFWA) researchers have found rotary spading can be more successful than complete soil inversion (such as with a mouldboard plough or deep ripper) at incorporating clay and/or lime into the soil.

This is because the mouldboard plough completely buries these amendments, rather than mixing them through the working depth.

Trials have shown rotary spaders are one of the few tools able to effectively incorporate high rates of clay rich subsoil.

It is estimated about two thirds of the topsoil is buried through spading and the remaining third is mixed through the topsoil.

DAFWA recommends growers using spading need to take care not to bury the clay subsoil so deep that the effect of the clay in ameliorating top soil water repellence is lost.

MACHINERY MATTERS

The Imants 57SX spader used by the Wilkinsons is 4.5 metres wide, pulled at a speed of 7 kilometres per hour and cultivates to a depth of 30-40cm.

It is towed with a 320 horsepower front-wheel-assist tractor, which Kym said is more than the spader needs most of the time, but occasionally it has caused the tractor to stall.

He says the tractor size is needed to lift the spader, rather than pull it, as it weighs more than five tonnes. Three point linkage capacity is critical.

"Spading machines are now available with tyres on the rear, which would provide a much better finish," he said.

"We did consider mounting land packers on the back of our machine, but that was a difficult exercise and added more weight."

Kym said the spader leaves the ground smooth, which can be problematic on soils that tend to get eroded by wind, but the incorporated clay helped to contain this.

Kym and Fleur Wilkinson have treated 300ha this year with a new Imants 57SX spading machine to help address soil constraints. Photo: Kym Wilkinson

"We found seeding in spaded areas in 2016 was a little problematic, due to wet conditions that resulted in us getting bogged 14 times in four days over 270ha," he said.

"But, once sown, the country settles down a lot and we look forward to the benefits of this process in coming years – or hopefully generations.

"Hopefully spading is a once in a lifetime treatment that will last forever.

"Time will tell, but it is a nice feeling to be able to 'change' your soil – something we have never been able to do before."

SPADING AND FROST

Kym said lack of severe frosts in the past two spring seasons has meant they have not been able to gauge any definitive benefits of spading in reducing crop damage following frost events.

But he expected in future, it would be an important risk management tool.

"The spading brings the rich, dark clay to the surface and this will hold more daytime heat in the soil for longer than the lighter sandplain soil," he said.

Kym repeated that is was exciting to "change the soil" something we have never been able to do before. FA

Getting bogged in early 2016 at the Wilkinson's east Brookton property.

Note: Managing frost risk in WA's lower rainfall zones is a key R&D priority for the GRDC and its Regional Cropping Solutions Network (RCSN) Kwinana East group.

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