

Managing carbon for yield and biology

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Almost a decade ago NSW farmer Alastair Starritt set out to find ‘a direction for enhancing carbon sequestration and soil health in broadacre agriculture’.

Eight years after completing his Nuffield scholarship study of this issue he is continuing to pursue that objective on the family property in the southern Riverina roughly mid-way between Echuca-Moama and Deniliquin, though he is now focused more on the role of carbon in soil health than carbon sequestration.

The Starritts’ 4,500ha holding, which includes some leased land, comprises 1,000ha of red gum and black box ‘forest country’ used for grazing and 3,500ha of arable land, 1,000ha of which is set up for flood irrigation using water from the Hume and Dartmouth reservoirs.

Alastair, with his wife Beau, brother Malcolm, sister-in-law Jaqueline and parents Ian and Victoria, run Womboota Pastoral, which despite the business name, has a significant cropping program that Alastair, a Roseworthy graduate, manages.

They also have one employee who works in the livestock enterprises – a Border Leicester stud, a Merino flock, a first-cross ewe flock for prime lamb production and a commercial beef herd. The cattle enterprise is operated on a trading basis, with females bought when the price is right and feed available then joined to produce calves for the meat market.

Most of their soils are sandy loam over clay but they also have areas of heavy black cracking soils, mostly as part of their ‘forest country’.

The cropping and livestock enterprises are closely integrated, with the arable land used for crop and pasture phases and the sheep run into crop stubbles soon after harvest, with legume stubbles of particular value because of their protein levels, which set up the ewes for joining in autumn. The cattle only ever graze pasture paddocks and the river flat ‘forest country’.

All of NSW is currently drought-declared but Alastair is hopeful his 2018 crops will



ALASTAIR STARRITT AIMS TO MAXIMISE THE AMOUNT OF CARBON IN HIS SOILS AND CAPITALISE ON THAT THROUGH IMPROVED CROP PERFORMANCE AND YIELD RELIABILITY.

yield reasonably well, given the conditions.

Annual rainfall in the Riverina is currently significantly below average, an increasingly common phenomenon, with this year’s growing season total likely to reach only about half the 250 to 300mm average of recent years, he said, but timing is everything and he is hopeful of getting wheat yields of around 1.8 to 2t/ha if there is enough timely rain to bring his growing season rainfall up to around 220mm.

“The one thing our experience has shown is that we have to be flexible, because no two years are the same. There’s a lot of gut feel involved but ahead of seeding we look at the forecast, the soil moisture levels, market opportunities and global pricing trends and make the best decisions we can.

“We use the moisture and weather information to establish what we think are the achievable yields given those conditions and adjust the nutrition inputs accordingly, focusing on tuning the N, P and K levels and making sure we have the key trace elements right.

“How things worked out in the previous season is also a consideration, though it can be hard to settle on the right approach.

“Last year we applied a lot of nutrient but the crops ran out of moisture and didn’t reach full yield potential so this year, with that in mind and the dry conditions, we didn’t apply any liquid fertiliser at seeding.”

In the mid to long term he is looking to achieve wheat yields of 2kg/mm of available moisture but at present is reaching at about half that in most seasons. In tonnage terms he usually targets wheat yields of 3.5 to 4t/ha in good seasons.

‘Erratic summer thunderstorms’ are part of the rainfall landscape at Womboota and much of the property received about 70mm of rain in January this year. While most of that moisture made it into their soils there was no significant rain between then and seeding and much of the January moisture was well down in the profile come seeding time.

Despite this year’s low rainfall most cropping paddocks are ‘reasonably green’

but there has been limited pasture feed for the stock since May so they are being hand-fed, which is enabling them to hold condition, with the first draft of new-season lambs despatched to market in early September.

Alastair makes the point that the current situation is by no means novel – ‘we’ve been here before’ – but acknowledges that he and his family are better placed than many producers further north. However, with summer rapidly approaching, Womboota is heading into a six-month period during which there will be little or no chance of crop or pasture growth, although the lucerne in some of their pasture mixes could produce some grazing if they get rain over summer.

Carbon

Alastair embarked on his Nuffield study in the hope of finding a way in which farmers would be able to profit directly from sequestering carbon as part of their farming systems.

The family had been no-till and zero-till for about 20 years and considered they were applying ‘best practice’, but despite this Alastair felt they had reached the yield ceiling imposed by their available moisture.

“We were struggling to come up with a business model that would enable us to remain sustainable. We were applying the best available knowledge and technology but were still financially stressed so I was looking to find an incentive, a new way forward.

“We were reducing our physical emissions and were sequestering carbon in the environment but were getting no credit for it and I was hoping I’d find a carbon-based way of generating a financial reward for what farmers were doing. That might be a third party who would pay for the storage of carbon in the farming environment or a market system that would provide a premium for produce grown using farming systems that resulted in high carbon storage.

“What I found was a whole new world where people were asking basic questions like ‘what is carbon?’

“It was proving very difficult to accurately measure carbon storage in natural systems or to achieve agreement on what should be taken into account in any formula to calculate sequestered carbon. It also soon became evident that emissions from electricity generation and heavy industry

were having far greater impact than anything agriculture was doing or could do.

“It all proved too complicated, too big and too hard and the idea of rewarding farmers for carbon sequestration was abandoned at an international level at about the time I was completing my report. That might change as measurement methods and protocols are developed and refined but the reality is that Australian agriculture is largely carbon neutral because we require carbon sequestration to operate and what we store in our soils largely balances out the emissions from growing and transporting the food we produce.

“In reality we were already getting rewards in the paddock through improved crop performance, yield reliability and similar resulting from improving soil carbon levels by growing crops with big root systems and producing and retaining big stubbles.”

Biologicals

Alastair and Malcolm were early adopters of biological farming concepts, which they implemented about 20 years ago, a decade or so after heading down the no-till path.

In the early stages they used a boom spray to apply foliar biological preparations to crops and pastures, often several times a season. This was in addition to applying lime, sulphate of ammonia blends and a variety of phosphates and manures that were broadcast ahead of seeding. After that initial phase they began to focus on using liquids at seeding time, partly because of the lower labour and energy requirements.

Alastair currently applies a commercial biological stimulant with a significant zinc content that he ‘tweaks’ with some refinements of his own in-furrow at seeding, while continuing to explore the potential of a variety of liquid fertilisers and other inputs in an on-going search for ways to improve his crops and soils and in the hope of finding the ‘purple patch’; something other comments suggest he feels is a challenge.

These days biological farming, like no-till/zero till, is just part of the management package on Womboota.

“Biological farming has been put to one side a bit lately. Now we just really try to ramp up production however we can but with a carbon-negative footprint.

“With cropping and livestock enterprises working side-by-side we have land use

diversity. We aim to maximise ground cover and retain as much stubble as possible, apply nutrition where needed and use selective grazing to balance out problem areas and as a weed management tool. Having enough fodder for consistent livestock numbers is always a challenge especially in a tight spring.”

Elements they have added or integrated over the years include maximising residues and other cover on the soil surface, ‘bulking up’ crops and pastures as much as possible and addressing nutrient ‘lock up’ by balancing calcium:magnesium ratio in their soils with a view to ensuring nutrients applied in fertilisers are accessible to crops and pastures.

“We found that in lower-rainfall years we were not getting the maximum return from our fertiliser investment so we set out to find a more reliable system that would enable us to get better results from our inputs in a range of conditions.

“It can be hard in years like this. If it looks like it’s going to be a good season it seems easier to invest in inputs but if conditions are harder we try to tune inputs to the conditions and apply just what we need. It’s not just the inputs; it’s also the practical issues like the labour needed to apply them.”

Alastair places a high priority on maximising establishment and early growth in crops and pastures.

“Most of our soils are not very deep so yield potential really comes down to establishment. We need an even crop with good early root development and growth.



ALASTAIR IS WORKING TO IMPROVE THE STRUCTURE AND DEPTH OF HIS SOILS BY MAXIMISING ROOT MASS AND USING DEEP-ROOTED SPECIES TO ‘OPEN UP’ THE SUB-SOIL.

If that enables the plants to access moisture deeper in the soil profile that's good, but what happens in the top 600mm is the key.

"Any deeper moisture is a bonus provided the crop or pasture's early root growth is good enough to allow it to access that deeper moisture."

His focus on establishment has seen Alastair adopt a variety of seeding systems over the years, ranging from tines to discs and combinations of the two, including having a knife point tine set to work at depth ahead of a disc seeding mechanism. That configuration enabled him to loosen the soil in the seed row to encourage seedling root development and run a fertiliser band at depth before the seed was placed at the required depth, a liquid biological stimulant applied over the top and the slot closed.

He has also tried a configuration with a tine running mid-row between disc openers.

In recent seasons he has been using a 12m Primary Sales Precision Seeder with knife point openers followed by parallelogram-mounted seed plates and press wheels on 220mm spacing but is toying with going back to discs.

His ideal would be a seeder that can be converted from disc to tine as needed to suit paddock conditions, and maybe crops, without having to go back to the machinery shed to be re-configured.

"I am very wary of hair-pinning, which in our experience is an issue with discs, particularly in damp conditions. A machine with disc and tine capabilities

would enable us to switch from one to the other depending on weather and paddock conditions and other considerations."

Alastair is currently exploring whether he can use the Primary Sales machine's 'skip row' capability, which allows tines to be 'pinned up' so they don't engage with the soil, to enable him to easily mid-row plant in heavy stubbles. However, he has no desire to go to 440mm row spacing because it would increase the risk of greater weed pressure and weed population build up.

He identifies savings in tractor power and so energy use as a key benefit of being able to change from tines to discs quickly and easily, with herbicide incorporation also an important consideration.

"Seeding is an inherently simple operation that involves no more than placing a little seed and some fertiliser into the soil.

"If the soil structure is good that requires very little soil disturbance. In heavy soils with poorer structure we might need to work to 100mm below the seed to maximise early root development and seedling growth but in good soil conditions working to that depth is over-kill and a waste of fuel.

"Chemical incorporation is also a factor and a tine generally gives better incorporation of soil-activated pre-emergents than most disc set ups.

"However, we look likely to be growing more hay and the soil surface is much better, with less clods, after seeding with discs than after a tined machine."

Data

Alastair's machinery and equipment has paddock zoning and variable rate capability but he is not fixed on using that approach because it is not clear what he might want to achieve from it in his conditions, since most paddocks are fenced according to soil type and there is little significant variation in soil within most paddocks on Womboota.

He has recently signed up with Agworld, a web-based management and data program he hopes will enable him to bring together and make use of all the information he has available, but is keen not to get locked in the office on the computer all day.

"I haven't been able to find a service that brings everything together. I'm sure it's out there but I haven't been able to find it.

"I'm hoping this will enable me to overlay different data layers like yield mapping and biomass readings, which provide an indication of photosynthesis activity, soil map history, soil test results and moisture probe readings.

"It can't be too complicated or time-consuming, so the trick is to identify what information is going to be useful."

When it comes to soil testing Alastair is more interested in soil structure than nutrition levels.

"There is no point in having lots of nutrient in a soil if plant roots can't get to it but there is no way to measure soil structure except by digging holes and physically examining what is under the soil surface.

"We need to get rainfall into the soil and the roots need to be able to get to that moisture, and available nutrients, in the soil."

N, P and K are not likely to travel far in his river-flat soils, he said, but getting an accurate soil pH reading and interpreting it correctly can be challenging.

His observations suggest the soil structure on Womboota has improved significantly over the past 30 years or so.

"We don't see any ponding in wet conditions now, or clodding like we used to, and we certainly don't have any 'Sunday soils' like we did in the '70s or '80s. We did pull up some clods when we dry-sowed some paddocks this season but the soil itself is quite friable. The clods break up when you step on them, which certainly didn't happen 20 years ago, when they were practically bricks.

IRRIGATION FRUSTRATION

Womboota's 1,000ha of flood irrigation country is proving something of a frustration for Alastair and his family, who bought into the irrigation scheme and invested in the infrastructure to minimise production risk.

However, the lack of reliable access to water due to dry conditions and the impact of the management regime imposed under the Murray-Darling Basin Plan mean they are seeing little return on their investment and almost no positive effect on their risk profile.

While crops they are able to support with supplementary irrigation yield significantly more than rain-fed crops grown with only rainfall – in the order of seven to 8t/ha instead of three or four – they are finding their 'irrigation' investment often offers little when it is needed most. In the current drought conditions, for example, they currently have zero irrigation water allocation.

When they can access water they use it in autumn to lay down soil moisture for winter crops and pastures and in spring to 'finish' crops short of water and improve pasture growth ahead of summer.



MOST SOILS ON WOMBOOTA ARE RELATIVELY SHALLOW SO GOOD EARLY ROOT DEVELOPMENT AND GROWTH ARE CRITICAL.

“And we seem to need less rain to see a benefit. We used to need 20mm or so to see any real effect but now two or three millimetres will make a difference. If you get right down to soil level in the crop pasture you can see why. The cover holds the moisture and you can actually start to see how the environment is working.”

The crops on Womboota are sown on 220mm spacing, based largely on the results in a Birchip Cropping Group trial of some years ago that explored the interaction between row spacing and weed pressure.

“The wider the row spacing the more weed pressure there was so we decided to close our rows up as much as we could to reduce the amount of sunlight able to reach weeds in crop.

“Our present spacing works well in our environment for most of our current crops including hay, which looks likely to become more important in our program, but it is a bit of a conundrum because we are looking at chick peas and lentils, and 220mm is really too close for those.

“It also makes inter-row sowing with tines a challenge, which is one of the reasons I’m thinking about discs again. There are pros and cons.”

Weeds

Alastair aims to tackle weeds at every opportunity, and in the cropping phase looks for good establishment and early growth to maximise crop competition pressure on weed populations.

He places a high priority on timely control of summer weeds in his cropping paddocks to conserve moisture for the subsequent winter crop but his most problematic weed is annual ryegrass, against which he uses a variety of measures including grazing pressure during the pasture phase.

“Consistent grazing pressure can be a valuable management tool because sheep will preferentially graze ryegrass out of legume pastures. There will always still be some ryegrass but well-timed grazing at an adequate stocking rate keeps it down and significantly reduces renewal of the bank of weed seeds in the soil.”

But he still uses chemicals – ‘there’s no real option as long as cultivation is off the agenda’ – and is working through harvest-time weed seed management options, with chaff lining and narrow windrow burning high on the list.

All those methods are overlaid on cropping and pasture sequences that are also influenced by weed management objectives.

The cropping program currently comprises wheat, barley and oats, vetch, peas, beans, an occasional crop of lupins and canola, with the rotation determined by factors including weed pressure, seasonal conditions and market opportunities.

They also grow some grazing brassicas.

Most of Womboota’s pastures are mixtures of sub-clover and perennial ryegrass, which is grazed out after the first year to ensure a legume-dominant stand for the remaining period under pasture, shaftal and balansa clover or sub-clover and lucerne, depending mainly on soil type.

Arable paddocks typically spend six to eight years under pasture then six to eight years in crop, depending on factors including seasonal conditions and weed pressure. Having such long crop and pasture sequences allows Alastair time to use a variety of herbicides and non-chemical weed control methods.

In the pasture phase there can be several successive years in which no herbicide is used, which increases the chance of spays having maximum impact when he begins

using chemicals again after such a break.

The diversity of crops grown at Womboota ensures Alastair has a multiple different chemical control options, some of which can be used during the growing season so he is not only targeting seedlings at seeding, which is often the case for growers with narrow, cereal-dominant cropping rotations.

In recent years he has begun using sequences of two and three successive years of break crops so he can exert maximum selective pressure on grass weeds, particularly annual ryegrass.

Covers

Alastair became aware of mixed-species ‘covers’ during his Nuffield research and has tried this approach on Womboota with some success, but only in pasture stands on the ‘forest’ country where he established a mix of clovers, lucerne, sorghum, brassicas and cereals by cultivating, broadcasting the seed then harrowing, with the primary aim of improving soil structure.

In cropping paddocks he occasionally uses a mixture of peas, beans and oats as a green manure with the aim of similar soil improvement.

“Those heavy forest soils crack when they are dry and hold moisture well once they are wet but some are bordering on sodic. We were looking to improve soil structure by maximising root mass and having the deep-rooted species ‘open up’ the sub-soil a bit.

“We found that the cereals came up first, followed by the brassicas and clovers then the lucerne, which was ideal because it minimised the grazing pressure on the young lucerne.

“Based on what we have observed that combination is a good fit for our grazing country in the right conditions. It certainly performed better and was more productive than our standard clover and rye blend and has also improved the soil profile.

“Our pattern of sporadic rain events over summer in particular mean we really need a combination of deep and shallow-rooted species, and lucerne being a summer-active perennial means there is a chance of fresh summer grazing after a storm.”



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