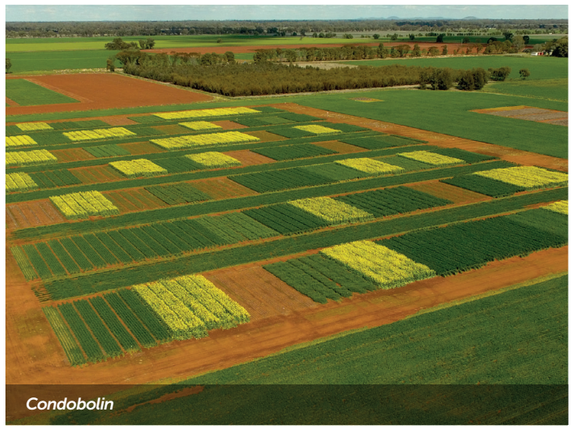

Greenethorpe


Wagga Wagga


Urana


Condobolin

Think ‘crop sequence’ rather than ‘this crop’ when managing water and nitrogen

Australian farmers have been enthusiastic adopters of crop benchmarking tools (e.g. French and Schultz, or Yield Prophet®) that compare the performance of individual crops to their water-limited potential.

However, rather than focusing on one season, it makes sense to consider the efficiency of water use across the crop sequence, to account for the legacy effects of one crop to the next, for example, water, nitrogen (N), weeds and disease.

In southern NSW, growers have achieved significant improvements in the water-use efficiency (WUE) and profitability of crops in recent years with improved crop sequences, better fallow management and new earlier sowing systems with suitable varieties (including grazed crops).

Diversifying the crop sequence to maintain profit and manage biotic constraints can increase the average profitability across three-to-four-year crop sequences by $150 to $200/ha compared with common sequences, even when individual crops were well managed. Gross margin can be as much as ~$400/ha higher in diverse crop sequences when measured against the lowest performing sequence choices.

Earlier sowing systems are also proving efficient and profitable for individual wheat and canola crops (including grazed crops), but the dry or low-N soils left by these higher-yielding crops may adversely impact affected crops in the following season/s.

John Kirkegaard, CSIRO


Early sown slower-maturing wheat grazed at the Greenethorpe site

The Project: Improving Farming Systems in Southern NSW

‘Improving farming systems efficiency in southern NSW’ is a GRDC-funded project involving CSIRO, NSW DPI, FarmLink and a number of local advisers. Led by John Kirkegaard, the project is investigating strategies to convert annual rainfall into more profit across a crop sequence, while managing costs, risk, soil fertility, weeds and diseases.

The project aims to improve whole farm profitability by identifying the agronomic factors that drive profit and adopting management practices that optimise returns. By employing a farming systems approach, researchers are evaluating the implications of strategic options (crop choice, time of sowing, fertiliser requirements) and tactical decisions (grazing, N topdressing) that a grower might make on farm, but monitoring the outcomes across the 3-4 year crop sequence.

FarmLink has been engaged to co-ordinate the grower communications efforts for the project in southern NSW. Our role is to ensure growers are aware of project activities and key outcomes in order to increase the potential impact of the program.

Central West Farming Systems has been subcontracted by FarmLink to undertake a subset of activities consistent with FarmLink's plan. This further expands the impact and penetration to their 330 members, across an additional 14 million hectares.

Research approach

The southern NSW farming systems project was established in July 2017 with 305 growers and advisors consulted on the plan. The project built on previous work demonstrating that the ‘gap’ in efficiency ($/ha/mm) of crop current systems (i.e. actual vs potential) was significant, despite good agronomy of individual crops.

To cover the range of soils and climates in southern NSW, sites were established at Wagga Wagga (core site), Greenethorpe (higher average rainfall), Condobolin (lower average rainfall) and Urana (different soil type).

The research team established a range of different sequences to compare with the common baseline of canola-wheat-wheat sequences typical of the area. These included more intensive cereal sequences (wheat and barley); a range of higher risk/value (lentil, chickpea) and lower risk/value (lupin, faba) legume options; and a flexible forage option (high density legume, mainly vetch) grazed, cut for hay or brown manured. The treatments generated different water and N-use patterns, as well as weed, disease and soil cover legacies which have been monitored by the team.

At each site, one or two local advisers were co-opted into the project team to establish the common or ‘baseline’ crop sequence and management strategies, as well as the potential improvements and modifications to the system that were of most interest to include at each site. The advisers have remained engaged throughout the project ensuring agronomic decisions are commercially relevant.

For some sequences, researchers included interactions of early sowing (March-early April) and timely sowing (mid-April-mid May) of the wheat and canola options. The early-sown options at Wagga and Greenethorpe were grazed by sheep in winter, a profitable management choice on mixed farms with significant implications for water and N use in the region.

The various systems essentially focus on three main variables:

Diverse crop sequences:

Previous research revealed that diversity of crops and practices underpinned higher profitability, while managing weeds, diseases and risk. The intensive continuous canola-wheat sequences with short or absent pasture phases, common in southern NSW were profitable in the short term, but were unsustainable due to weed and disease pressure, and were declining in N-fertility. Diverse legume options (high-value pulse, low value-pulse, hay, graze and brown manure options) all had potential, but had not been considered in a systems context.

Early sowing:

Early sowing of slower-maturing wheat and canola – both for grazing and grain – could improve water-use efficiency, but the potential legacy of dry and N-depleted soils following those crops was of concern. Understanding where earlier sowing added value, and where to adjust crop sequences to accommodate these crops, were the next steps to maximise the benefits of these options, especially in medium and low rainfall systems.

Nitrogen:

Finally, agronomists had become increasingly aware that water and N always co-limit yield. Maintaining adequate N supply from fertiliser or legume sources is vital to optimise WUE, arrest soil organic matter decline and close the yield gap. N decisions are important profit drivers, but an over-emphasis on single-year responses (that is, the NUE of individual crops) rather than systems thinking was leading to reduced yield and SOM decline. Monitoring the impact of N strategies in diverse crop sequences was a key focus for the project. We compared the Baseline more conservative N strategy that assumes Decile 2 seasonal finish after July, with a more optimistic Decile 7 seasonal finish – adjusting top-dressed N amounts in each assuming those seasonal outcomes.

Tony Swan discusses diverse crop sequences – Greenethorpe site

Impacts on profitability

At the outset of the project, there was no published data that explored the potential to increase system-level efficiency and profit ($/ha/mm) with interactions of different crop sequences, sowing dates and N-management strategies over a 3-4 year time-frame.

Through their research, consultations and modelling, the project team predicted significant potential to increase the annual profit of existing canola-wheat-wheat systems (by up to $250/ha), and to increase system WUE from $1.5/ha/mm to $2.5/ha/mm with improved decisions on sequence, sowing dates and N management.

This was the significant opportunity that this project has targeted on behalf of southern NSW growers since 2017.

KEY FINDINGS & INSIGHTS

The 2018 and 2019 seasons were consecutive Decile 1-2 seasons across all four sites, while the 2020 season (and seasons since) have been Decile 8-10 (described by many as the "best season in memory"). Despite this extreme variability across the years, important outcomes in relation to project objectives were:

- **Profitability of systems.** Depending on the site and system (sequence x sowing time x N strategy) and despite two consecutive Decile 1-2 years, the average annual 3-yr gross margins (2018-2020) ranged from **$200/ha to $1200/ha.** Some systems were quite resilient (stable in ranking across years).
- **Confirmation of the opportunity for improved efficiency at the systems scale.** The three-year average annual gross margin calculated for the systems from 2018-20 revealed that **at all sites** there were systems achieving **$200-$300/ha above the baseline (canola-wheat-wheat) system**. At two sites, there were systems that were **$700/ha above the baseline.**
- **Diversity.** Grain legume crops, and diverse sequences including legumes, outperformed the baseline canola-wheat sequences **at all sites** during the dry seasons, and at two out of four sites in the wetter 2020 season. This resulted from both the profitability of the legumes, and the significant legacy of either increased soil water (20-60 mm) in dry years, and/or soil N (50-100 kg/ha) on subsequent crops in wetter years. In some cases, the legacies of extra water left at harvest had diminished at the sowing of subsequent crops due to reduced soil cover after the legumes, but this was dependent upon the pattern of summer fallow rainfall. Of the non-grazed systems, the most consistently profitable diverse system was timely-sown, high-value legume (chickpea or lentil)-canola-wheat with a conservative (Decile 2) N strategy. The N benefits of legumes have proven especially valuable as N fertiliser prices have doubled recently.
- **Early sowing (and grazing).** Early-sown grazed crops (wheat and canola) have been highly profitable in all seasons. They were two to three times more profitable than non-grazed equivalents in the dry years even without grain harvests, and highly profitable in wetter years. Legacies of dry soils reduced grazing biomass and grain yield in the second dry year. Grazed wheat and canola crops were especially responsive to higher N (both fertiliser and legumes) due to increased forage and grain yield. In all cases, the early-sown ungrazed systems were less profitable than the baseline, partly due to the limited varietal choice for this practice. Grazed crops will only represent a small portion of the farm but have significant impacts on farm level profit if they can be grazed effectively.
- **N strategies.** The more robust N strategy (Decile 7) provided increased biomass for grazing crops or hay cuts, but had either no effect or negative effects on grain yield and profit in the dry 2018-19 years. However, the unused N in dry seasons carried over to improve biomass and yield in subsequent years, especially in the wet 2020 year, where residual N from legumes and fertiliser significantly increased the yield. The wetter years since 2020 have reinforced the benefits of maintaining a higher N strategy to underpin the high yield potentials in repeated wet years.

Conclusions

The results of these system experiments to date show that both sequence and N strategies have significant effects on crop productivity, profitability and risk in individual years, and these effects can differ depending on individual seasonal conditions. However, the significant legacy effects of crop sequence (crop intensity and legume inclusion) and N strategy across seasons mean that the profitability of the systems over three – four years can play out differently to responses observed in a single season. The project is just finishing its 5th year with a further planned year to complete two-3-year phases in 2023. Outcomes will be presented at the upcoming GRDC Updates in Wagga, Corowa, Dubbo and others in February 2023, and FarmLink will continue to report the outcomes in an ongoing series throughout 2023. Further work is planned to explore this in more detail.

More information

Extracting more profit from Farming Systems

www.farmlink.com.au/ifs

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