IMPROVED DROUGHT RESILIENCE THROUGH OPTIMAL MANAGEMENT OF SOILS AND AVAILABLE WATER

KEY MESSAGES

- **Deep nitrogen analysis and farmer observations show that the use of a legume in a rotation provided more nitrogen than a pure cereal history for the subsequent canola crop**
- **The application of nitrogen based on deep soil nitrogen (DSN) testing, and the use of nitrogen budgeting by the farmer, resulted in more uniform nitrogen levels across the whole paddock and availability for crops**
- **Comprehensive soil testing for variety and crop types is increasingly important for future farm resilience**
- **Soil water measurements taken prior to sowing canola showed higher plant available water under wheat stubble compared to faba bean stubble, likely the result of greater ground cover provided by the wheat stubble over summer**
- **Early sowing crops can provide opportunities for grazing and diversification of the farming system**
- **Early sowing a portion of the cropping program can bring more crops into the ideal sowing window and reduce the risk of seasonal effects, such as frost.**

BACKGROUND

The *Improved drought resilience through optimal management of soils and available water* project consists of 12 demonstration sites across a region that includes north east Victoria and central and southern New South Wales.

The project aims to improve the management of natural capital through increased water use efficiency, soil organic carbon, and nitrogen (N) utilisation, which, in-turn, is crucial to environmental and economic resilience in drought.

In delivering this project, Riverine Plains has collaborated with three other farming systems groups including Central West Farming Systems, Farmlink, and Southern Growers, as well as Charles Sturt University (CSU).

The 12 sites focus on demonstrating three management strategies (diversity, early sowing and N-banking) that have been previously shown in small-plot GRDC field trials in NSW to increase profitability and productivity. The GRDC field trials are being led by John Kirkegaard, CSIRO.

PROJECT PROGRESS

Riverine Plains hosted three of the 12 demonstration sites established as part of this project during 2022 and 2023.

Data collected from the demonstration sites, as well as audio and video content featuring the host farmers, is being developed into project case studies which will be used to extend the findings of both the GRDC small plots trials, and the demonstration sites. The extension and promotion of the case studies through the Victoria and southern NSW Drought Resilience Adoption and Innovation Hubs, as well as through Riverine Plains' network of farmers, aims to encourage wider adoption of the management practices being trialed in the project.

Table 1 Riverine Plains focus paddock 1 site details, Howlong, 2023

Sowing Date	16 May 2023
Crop	Eagle Truflex Canola
Fertiliser	Starter and in-season
Row spacing	16.5 cm
Average GSR rainfall	347 mm
2023 GSR rainfall	292 mm

RIVERINE PLAINS FOCUS PADDOCK 1: DIVERSE ROTATIONS

AIM

To demonstrate how diverse legume rotations can potentially provide a range of system benefits.

METHOD

A demonstration site located at Howlong, NSW, consisted of a paddock half sown to faba beans and half sown to wheat in 2022. Extensive waterlogging in 2022 reduced the yields of faba beans (0.98t/ha) and wheat (2.5t/ha). Canola was sown across the whole paddock on the 16 May 2023. Deep nitrogen and soil water tests were taken prior to cropping to determine the quantity of nitrogen available for the canola, based on the previous year's crop. Sulphur, soil pH and sodicity were also measured. The paddock was irrigated with approximately 50mm in September 2023.

RESULTS AND DISCUSSION

Soil tests were taken prior to sowing the canola, with results showing that the 2022 faba bean residue contributed 78 kg N/ha more nitrogen than the wheat residue (Table 1).

Based on soil tests and in-crop observations, 58 kg/ha nitrogen and 14 kg/ha sulphur were applied to the paddock on 25 May 2023. Subsequently, the farmer applied an additional 58 kg/ha nitrogen and 14 kg/ha sulphur to the wheat stubble portion of the paddock on 10 July, to balance the nitrogen level across the paddock. A 72m wide nitrogen-rich test strip of 58 kg N/ha was applied to the faba bean portion of the paddock to understand if there were any key differences in yield.

Soil moisture tests showed that the wheat residue stored 51.3 mm more plant available water (PAW) than the faba bean residue (Table 2), which was consistent with soil moisture tests taken previously (reported in *Research for the Riverine Plains, 2023*.

Table 2 Nitrogen and plant available water (PAW) status under faba bean and wheat stubble at Howlong, 2023.

PROPERTIES	DEPTH (CM)	FABA BEAN STUBBLE	WHEAT STUBBLE	FABA BEAN STUBBLE	WHEAT STUBBLE
Sample date		4 April 2023		20 July 2023	
Nitrogen (kg N/ha)	0-90	249	171	174	187
PAW (mm)	0-90	107	158	N/A	N/A

OBSERVATIONS AND COMMENTS

Plant establishment counts showed that canola plant populations (not presented) were less than desirable due to a heavy stubble load and wet conditions during early growth.

The paddock was harvested on 19 November, and unfortunately yield maps were not collected due to a technical issue. The paddock yielded an average of 2.4 t/ha, with the dryland area outside of the pivot yielding approximately 3.5 t/ha, while the irrigated area was estimated to have yielded less than 2.5 t/ha.

Anecdotally, the farmer saved $95.70 /ha, due to a saving of 58 kg/ha in nitrogen application (based on urea at $700/t and application cost of $7.50/ha). This was a direct result of the inclusion of legumes in the previous paddock rotation.

Through this project, the importance of sulphur for canola nutrition has been highlighted. Sulphur availability is often lower after wet, high yielding seasons and soil tests identified that an application of gypsum would also benefit the system by addressing the sodicity seen in elevated levels in the 10-20cm layer. Soil water measurements taken prior to sowing canola showed that the wheat stubble stored 50mm more water than the faba bean stubble, which is a likely result of the increased ground cover provided by the wheat stubble over the summer.

RIVERINE PLAINS FOCUS PADDOCKS 2 AND 3: EARLY SOWING

AIM

To understand the benefits of early sowing wheat in a farming system, in addition to the known benefits of dual-purpose cropping.

Table 3 Riverine Plains focus paddock 2 and 3 site details, Mulwala, 2023

	North Mulwala		West Mulwala		
	IRRIGATED + GRAZED	**DRYLAND**	**IRRIGATED**	**DRYLAND**	
Sowing Date	15 April	3 May	7 April	7 April	1 May
Crop	Illabo wheat @ 100kg/ha	Planet Barley @ 80kg/ha	Illabo wheat @ 90kg/ha	Illabo wheat @ 90kg/ha	Scepter wheat @ 70kg/ha
Fertiliser	MAP 80kg/ha + urea 250kg/ha	MAP 80kg/ha + urea 150kg/ha	MAP 90kg/ha + urea 250kg/ha		
Row Spacing	19 cm		30cm		
Average growing season (Apr-Oct) rainfall 311 mm					
2023 growing season (Apr-Oct) rainfall 304 mm					

METHOD

Two farmers, located at north and west Mulwala, hosted early sowing demonstrations as part of this project. Both farmers sowed Illabo wheat for the 2023 season and both regularly employ early sowing as a management practice in their overall operation.

Data from focus paddock 2 (North Mulwala) is excluded from this report, as the West Mulwala site produced data which was more comparable across its three paddocks.

WEST MULWALA

The West Mulwala site compared a flood-irrigated paddock with a dryland paddock. The irrigated paddock was sown to Illabo wheat in early April, whereas the dryland paddock was divided in two, with 50 percent sown to Illabo wheat in early April and 50 percent sown to Scepter wheat within the standard sowing window (early May). Pre-season soil samples were taken to understand starting nitrogen and soil moisture levels (Table 3).

To gain an understanding of crop establishment in each treatment, plant emergence counts were taken early in the season. Biomass cuts were also taken prior to harvest for each early sown paddock and sent to NSW Department of Primary Industries (NSW DPI), Wagga Wagga, for harvest index, yield and seed protein estimate calculations. Post-harvest soil tests for total nitrogen and soil water content were taken in January 2023, to allow comparison with pre-sowing results.

RESULTS

Plant counts taken at emergence show a significant difference between the dryland and irrigated paddocks, with emergence in the irrigated early sown paddock significantly higher than the dryland early paddock (data not shown). There was not a notable difference between emergence in the early sowing and standard sowing treatments.

A comparison of pre-sowing and post-harvest soil test nitrogen and plant available water results are shown in Table 4. Biomass cuts taken at harvest and yield estimates based on these cuts are also shown in Table 5.

Table 4 Soil properties at the West Mulwala early sowing focus paddocks, 2023

PROPERTIES	DEPTH (CM)	IRRIGATED ILLABO (EARLY SOWING)		DRYLAND ILLABO (EARLY SOWING)		DRYLAND SCEPTER (STANDARD SOWING)	
		Pre-sowing	Post-harvest	Pre-sowing	Post-harvest	Pre-sowing	Post-harvest
Nitrogen kg N/ha	0-90	174.1	45.1	129.9	28	129.9	37.8
Soil moisture (PAW mm)	0-90	18.6	0	34.5	3.5	34.5	0

Table 5. Harvest data at the West Mulwala early sowing focus paddocks, 2023

	IRRIGATED ILLABO (EARLY SOWING)	DRYLAND ILLABO (EARLY SOWING)	SDRYLAND SCEPTER (STANDARD SOWING)
Total dry matter (DM t/ha)	18.7	19.3	N/A
Harvest index	0.4	0.4	N/A
Actual grain yield (t/ha)	8.0	7.6	6.4

OBSERVATIONS AND COMMENTS

The early sown crops were shown to use more nitrogen compared to the standard sown crop. This can be attributed to the higher yield of the early sown Illabo, compared to the Scepter sown in the standard sowing window. Additionally, Illabo is a long season wheat which likely produced more biomass over the course of the growing season than the mid-season sown Scepter, and therefore required more nutrition for growth.

The comparison of dryland Illabo and Scepter showed that Illabo had a greater water use efficiency than Scepter, probably due to its higher yield (grown using the same available moisture), based on measures of plant available water taken after harvest.

Both the irrigated and dryland early sown Illabo crops showed a higher yield than the dryland standard-season sown Scepter. The irrigated early sown Illabo had a yield of around 0.4 t/ha more than the dryland early sown Illabo, which in turn yielded around 1.1t/ha more than the dryland Scepter. This demonstrates the benefits of early sowing for improved crop yields, even when dual-purpose long season wheat crops aren't grazed.

Yield maps were obtained post-harvest for each of the three paddocks detailed in this article. These maps highlight the yield variability within each paddock, with Figure 1 showing the dryland paddock, with Scepter on the left side (west) and Illabo on the right (east). The greener areas of the Illabo represent the overall yield increase between each half of the paddock. Figure 2 shows the irrigated paddock of Illabo, with even higher yields.

Figure 1 Yield map of dryland wheat (Scepter and Illabo)

Figure 2 Yield map of irrigated wheat (Illabo)

These two focus paddocks have been able to highlight key benefits of including early sown crops in a farming system. Early sowing is a practice that introduces diversity into the system, with opportunities for grazing as well as harvesting for grain yield. Longer season crops can also provide added benefits to the soil, including increased protection from erosion, as well as greater opportunities for microbial activity and the building of soil carbon because of the increased amount of time living roots are present in the soil. Starting the sowing program earlier also ensures more crops are sown at the optimal time, and avoids crops falling out of this window, which can make them more prone to seasonal risks at key growth stages, such as frost.

CONCLUSION

This project will end in September 2024, when the 12 case studies will be published in a range of formats including audio, video and printed case studies.

It is hoped that at the end of the project, farmers will have an improved understanding of the strategies available to help manage future climate extremes and drought, by seeing the benefits of using pulses, nitrogen banking and early sowing strategies. This will ultimately increase gross margins for the farm enterprise and help farmers be more resilient.

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