When above average rainfall in low rainfall environment happens - is there enough N to capture it?

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Above-average rainfall can rapidly lift cereal and canola yield potential on Central and Upper Eyre Peninsula. The challenge is that crop N demand can increase just as the remaining opportunities to incorporate extra fertiliser become fewer, less certain and harder to service across large areas.

Central and Upper EP growers are used to managing nitrogen around downside risk. In many seasons, water sets the yield ceiling and excessive N can add cost, drive unnecessary early biomass and increase the risk of haying-off if spring rainfall fails.

But a wetter year changes the question. Yield potential can move well beyond the level used to set the original N budget, particularly in wheat, barley and canola. At the same time, the lower-rainfall environment does not suddenly acquire the reliable in-season rainfall or simple fertiliser logistics of a higher-rainfall district.

That makes the current point in the season useful for two reasons. Growers can ask whether the N decisions made this year have kept pace with the season, and they can use what this year has revealed about each paddock to plan the next crop. The important caution is that next year will probably be different. The lesson from a wet year is not to fertilise every future crop for a wet year; it is to build enough flexibility into the system to capture one when it occurs.

In lower-rainfall farming systems the key question is not simply how much N a good crop needs, but how much of that demand can realistically be supplied after sowing.

How quickly can N demand change?

A useful way to review the season is to start with the N leaving the paddock in grain. Grain N removal is not the same as total crop N demand - substantial N remains in straw, roots and residues - but it is a simple way to understand how quickly a good season can change the N balance of a rotation.

Crop	Typical grain protein	Approx. grain N removed	Example
Wheat	10.5%	18 kg N/t grain	4 t/ha removes ~72 kg N/ha
Barley	10%	16 kg N/t grain	4 t/ha removes ~64 kg N/ha
Canola	20%	32 kg N/t grain	2 t/ha removes ~64 kg N/ha
Lentil	24%	39 kg N/t grain	1.5 t/ha removes ~59 kg N/ha

For wheat, the calculation can be made from the actual protein result: grain N removal (kg N/ha) is approximately yield (t/ha) x grain protein (%) x 1.75. So 3 t/ha of wheat at 10.5% protein removes about 55 kg N/ha in grain; 5 t/ha at the same protein removes about 92 kg N/ha.

These figures come from the GRDC Nitrogen Reference Manual. They are removal figures, not fertiliser recommendations. For example, the same manual estimates total above-ground crop N at about 26 kg N/t of wheat at 10.5% protein and about 58 kg N/t of canola at 20% protein. The crop must obtain that N from starting mineral N, mineralisation and fertiliser, and fertiliser recovery is never 100%.

Why a wet year can outrun the original N budget

Consider a wheat crop initially managed for 2.5 t/ha that develops the water supply to produce 4 t/ha. At 10.5% protein, the extra 1.5 t/ha represents about another 27 kg N/ha exported in grain and roughly 39 kg N/ha of additional above-ground crop N demand. For canola, an increase from 1.2 to 2.0 t/ha represents around another 46 kg N/ha of above-ground crop N demand.

This is why an N program that looked adequate at sowing can become restrictive in an above-average season without having been a poor decision at the time. The seasonal opportunity has changed.

In higher-rainfall districts, growers can often respond by splitting more N into the crop. The GRDC canola guide, for example, supports holding some N back so rates can be adjusted as yield potential becomes clearer, with topdressing preferably completed before stem elongation for maximum yield response. The same principle applies to wheat, but late applications increasingly influence grain protein rather than yield, and a dry finish can prevent late N being taken up at all.

Why 'play the season' is harder on Central and Upper EP

The agronomic logic of waiting is sound: delay some expenditure until rainfall and yield potential are clearer. But the lower-rainfall environment places practical limits on how far that strategy can be pushed.

First, the number of rainfall events capable of moving surface-applied urea into the root zone can be small. Later applications are therefore exposed to a different type of risk than early applications: rather than having N present in a dry year when the crop cannot use it, growers can finish with N stranded in a dry surface layer when a good crop actually needs it.

Second, many Central and Upper EP soils are sandy, alkaline or highly calcareous. Ammonia volatilisation after surface urea is highly dependent on soil, moisture and rainfall after application. Recent GRDC work emphasises that in-crop N is most reliable where rainfall can synchronise mineral N supply with crop demand; where in-crop rainfall is less reliable, later surface applications become increasingly risky.

Third, the rainfall opportunity has to be serviced. A useful forecast may require thousands of hectares to be spread within a few days. Fertiliser must be available, freighted from port or storage, loaded and applied while contractors and growers across the district are responding to the same event. A strategy that relies on a large late topdress therefore carries a logistics risk as well as a rainfall risk.

Where does background N fertility fit?

This is where the two broad farming-system strategies used across Central and Upper EP become relevant. Many farms retain medic or other legume pasture on soils where pasture remains a strong fit, while using more crop-intensive rotations based around pulses, canola, wheat and barley on reliable cropping land. Neither pathway is inherently superior; they simply carry and replace N differently.

A productive medic phase builds N biologically before the following cereal needs it. N is spread across roots, residues, microbial biomass, soil organic matter and mineral N, so part of the benefit can persist beyond the immediate pasture year. GRDC low-rainfall pasture work found substantial subsequent cereal yield and protein benefits, and modelling estimated that legume phases could add roughly 14-70 kg N/ha per year to the system N bank depending on their intensity.

A more continuous cropping system can also maintain high N fertility, but the replacement task becomes more deliberate. Pulses fix atmospheric N, yet harvested grain removes a large amount of N: around 39 kg N for every tonne of lentils using the standard GRDC value. Canola and consecutive cereals then continue to export N. The important accounting question is therefore not simply whether a pulse was grown, but whether total fertiliser plus net legume N is keeping pace with removal across the whole rotation.

Older South Australian work reinforces the importance of soil type. At Karoonda, estimated N-supply potential in a Decile 5 year varied from about 20-30 kg N/ha on dune and midslope positions to 33-58 kg N/ha in swales. Wider SA work also found nearly a ten-fold range in mineralisable N potential between soils. Organic carbon mattered, but so did total N, C:N ratio, pH, bulk density and water-holding characteristics.

A continuous-cropping system does not have to be N-poor. It does, however, need a deliberate plan to replace N removed by grain and to avoid relying on one uncertain topdressing opportunity to rescue a high-potential year.

Strategies to keep continuous cropping responsive in a good year

1. Know the starting position. Use pre-sowing mineral N and plant-available water tests on representative soil zones. Rotation history alone is increasingly unreliable where crop intensity, pulse yield and fertiliser history vary.

2. Keep a simple multi-year N account. Use grain removal as the starting point. Wheat at 10.5% protein removes ~18 kg N/t, barley ~16, canola ~32 and lentils ~39. Add fertiliser inputs and a realistic estimate of net legume contribution. The aim is not a perfect balance sheet; it is to identify persistent N mining before it becomes obvious in crop performance.

3. Carry more N where the soil and crop opportunity justify it. Productive swales, heavier soils and successfully ameliorated zones may justify a higher starting N position than low-PAWC sands or constrained calcareous rises. The objective is flexibility, not a large nitrate bank across every hectare.

4. Decide before sowing how much of the program can genuinely be tactical. If a farm has few reliable post-sowing incorporation events, long freight distances or limited spreading capacity, it is risky to budget a large share of expected crop demand on the assumption that it can always be applied later. Pre-position a larger proportion of likely demand on reliable zones while retaining some capacity to respond.

5. Set an in-season trigger before the rain forecast arrives. Use PAW, rainfall to date, crop stage, biomass/N status and revised yield potential to decide which crops and zones deserve priority. Also have product supply, storage and spreading arrangements considered beforehand. This turns a forecast event into a decision rather than a scramble.

6. Recognise the closing yield window. For canola, N topdressing is most effective before stem elongation. In wheat, useful yield responses can still occur later under favourable finishes, but responses become less reliable and later N increasingly shifts protein rather than yield. If incorporation rainfall is unlikely, chasing a large yield response very late may simply strand fertiliser.

7. Use the season as an experiment. Retain low-N and extra-N strips, or compare zones with different starting N. Crop colour, biomass and later grain protein can help identify whether the crop was genuinely N limited, while post-harvest soil N can show whether unused N remains for the next crop.

What should we learn from 2026 before planning 2027? A wet or above-average season is useful because it stress-tests the N strategy. At this point in the year, growers can ask three questions.

Did this year's crops have enough N when potential increased? Look for persistent paling, differences between paddocks or soil zones, responses to topdressing, and ultimately yield and grain protein. Low cereal protein at a good yield is often a useful retrospective signal that N supply was stretched.

How much N is this season likely to export? Use expected or harvested grain yield and protein to calculate removal. A high-yielding lentil, canola or cereal year can remove much more N than an average season and may materially change the starting position for the next crop.

What part of the problem was agronomic and what part was logistical? If a profitable N response was identified but product, freight, spreading capacity or incorporation rainfall prevented the application, that is important information for next year's plan.

The trap would be to conclude from a wet 2026 that 2027 should simply receive more N. A dry 2027 would punish that approach. A better response is to use this year to improve the starting information and the flexibility of the system: identify which soils can safely carry more N, restore any obvious multi-year N deficits, maintain productive pasture where it fits the land class, protect pulse fixation, and make sure the farm has a realistic plan for tactical fertiliser if the next season again exceeds expectations.

What can we say now?

Above-average rainfall changes more than yield potential. It changes the amount of N a crop can profitably use and exposes whether the farming system can deliver that N at the time and place it is needed.

On Central and Upper EP, the response cannot rely solely on ever-larger in-season applications. Rainfall for incorporation is less reliable, soils vary greatly in their ability to store and supply N, and logistics can prevent a theoretically sound application from being made in time.

Pasture-supported and crop-intensive systems can both provide the necessary N fertility. The practical aim is to maintain enough N capital across the rotation - biological, organic, mineral and fertiliser N - that a good season does not have to be rescued late, while avoiding excessive upfront N that increases cost and dry-season risk.

The lesson from a high-rainfall year is therefore not to predict that the next one will be the same. It is to enter the next season knowing what N was removed, what remains in the soil, which zones can carry additional fertility, and how much of the next crop's N requirement can genuinely be left to an in-season decision.

Quick reference: calculating grain N removal

Wheat: N removed (kg/ha) ≈ yield (t/ha) x grain protein (%) x 1.75. At 10.5% protein this is about 18 kg N/t. For simple rotation accounting use approximately 16 kg N/t for barley at 10% protein, 32 kg N/t for canola at 20% protein and 39 kg N/t for lentils at 24% protein. Actual grain N concentration varies, so laboratory grain N/protein is preferable where available. These values estimate N exported in grain only; they are not fertiliser-rate recommendations.

Selected evidence base

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