

# Stubble Management Guidelines



## Break crop options

### Key facts

- » Break crops offer a range of benefits in low-rainfall stubble-retained farming systems.
- » Local trial results revealed that incorporating break crops provided a more profitable outcome over four years than a cropping program of continuous wheat.
- » Incorporating break crops into a cropping program provides multiple benefits including weed control, disease breaks and increased soil nitrogen levels.
- » Growers need to select break crops according to individual paddock needs, seasonal outlook and farm-system compatibility.



Results from a four-year GRDC project have highlighted the multiple benefits of strategically-selected and managed break crops. Photo: UNFS Crop Sequencing Trial Site 2011, Michael Wurst, Rural Solutions

**Break crops offer** a range of potential benefits in the low-rainfall stubble-retained cropping systems of the South Australia's Upper North. While growers across the Upper North have increasingly adopted continuous or more intensive cereal rotations, driven by the low-risk, high-return potential of these systems, challenges such as herbicide-resistant grass weeds, plummeting soil fertility and increasing soil-borne diseases levels are encouraging growers to consider the role of break crops.

Benefits from incorporating a break crop option into a long-term wheat-on-wheat cropping program include:

- access to alternative weed control options (including different herbicide groups, grazing and fodder production)
- an opportunity to reduce cereal root and crown disease levels in cropping paddocks
- increasing soil nitrogen levels through legume crops and pastures
- risk management across a more diverse crop portfolio.

While the risks of incorporating break crops include crop failure during dry seasons, comparatively lower returns on a single-year basis, and soil erosion through rapid stubble breakdown or overgrazing, strategic break crop selection and management can yield significant and longer-term financial and whole-system benefits.

### Understanding current practices

As part of the GRDC-funded *Water Use Efficiency Project*, during 2012 growers across the Upper North were surveyed to better understand their current approach and attitudes towards break crops.

## Project information

This break crop management guideline has been developed for the Upper North Farming Systems Group (UNFS) as part of the Maintaining Profitable Farming Systems with Retained Stubble Initiative, funded by the Grains Research and Development Corporation (GRDC UNF00002).

The Stubble Initiative involves farming systems groups in Victoria, South Australia and southern and central New South Wales, collaborating with research organisations and agribusiness, to address challenges associated with stubble retention.

The GRDC, on behalf of growers and the Australian Government, is investing \$17.5 million in the initiative that has been instigated by the GRDC Southern Regional Panel and the four Regional Cropping Solutions Networks that support the panel.

Respondents indicated their main objectives for including break crops were: to control grass weeds, increase nitrogen supply to subsequent crops, manage cereal root diseases and provide feed for livestock.

On average respondents were sowing only five per cent of their total farm area to break crops in any one year. Of this area, 56 per cent was sown to pasture.

The main break crops growers across the Upper North were choosing to incorporate into their systems were: medic pastures followed by vetch, field peas, lupins and canola. Seventy five per cent of growers were using 'double breaks' (two years of break crop) in at least a part of their farming system to control weeds and disease and to manage risk.

## Assessing the benefits

A major GRDC-funded project — the *Profitable Crop Sequencing in the Low Rainfall Areas of South Eastern Australia* — has assessed the profitability of many different break options at five low-rainfall sites across south-eastern Australia from 2011 to 2015.

Trials were carried out at Condobolin, New South Wales with Central West Farming Systems; Chinkapook, Victoria, with Birchip Cropping Group; Mildura, Victoria, with Mallee Sustainable Farming; Appila, SA with Upper North Farming Systems and Minnipa, SA, with the Eyre Peninsula Agricultural Research Foundation.

The trial paddock at Appila has a long history of intensive cereal production, however root disease levels remained relatively low as assessed by Predicta™B.

Across all trial sites results revealed that incorporating break crops provided a more profitable outcome over four years than continuous wheat.

At each site, approximately 15 different break options were used for a one or two-year break during 2011. From 2012, wheat was sown on the one-year break sites, and in 2013 and 2014 wheat was sown on all sites.

A control plot of continuous wheat was planted at each site to allow researchers to make direct comparisons.

## Results from Appila

In the first year (2011) at the Appila site, break crops (peas, lentils and canola) were severely damaged by frost and were unviable to harvest; cutting for hay or grazing were the best options. Peas cut as hay provided a high gross margin, but for other break crop options (lentils and canola), the cost of hay cutting, baling and freight would have erased all or most of the profit.

In the second year (2012) the break crops varied widely in their performance, with canola sown following fallow performing well above average and most pulse crops (peas, lentils and vetch) suffering frost damage leading to below-average yields.

Barley sown on wheat during 2012 performed well yielding almost double that of wheat on wheat. Barley has consistently yielded 10–15 per cent more than wheat in National Variety Trials at low-rainfall sites when sown under the same conditions as wheat.



Earlier-finishing lupin varieties, such as Mandelup cv, enable effective ryegrass control during the break crop phase.



New vetch varieties are improving the potential for vetch to be a profitable break crop option in the Upper North.

Photos: Ruth Sommerville, UNFS

## Drawing useful conclusions

The *Low Rainfall Crop Sequencing Project* has been invaluable in evaluating the economic performance of wheat after a range of different break options. Across all four years of the trial, wheat yields at the Appila site were average to above average in all crop sequences.

Break crops increased wheat yields across a wide range of environments by:

- 0.5t/ha following oats
- 0.8t/ha following canola
- 1.0t/ha following grain legumes (ranging from 0.7 – 1.6t/ha).

The 'break crop benefit' often extended to the second wheat crop (but rarely the third, except under dry conditions). As such, it is worth considering the economics of break crops over the whole crop sequence — not just the one year. Some two-year breaks had high returns over the four years (see Table 1), particularly where the break crop options had a positive gross margin in any given year.

On the other hand, where break options produced large negative gross margins it is difficult for the following wheat crops to make sufficient additional returns to cover these losses.

**TABLE 1. Yield and gross margin benefits of a range of break options in the Upper North for 2013 and 2014**

Crop sequence	Wheat yield* (t/ha)		Average annual gross margin (\$/ha)^
	Year 1 (2013)	Year 2 (2014)	
Control — continuous wheat	0	0	209
Long (one-year) chemical fallow followed by canola	0.87	0.65	320
Oats/vetch/medic hay followed by oats/vetch/medic grazed	0.71	0.68	317
Oaten hay	0.53	0.31	308
Pea hay followed by canola#	0.78	0.71	303
Feed barley	0.4	0.12	285
Long chemical fallow followed by lentils#	0.73	0.53	273
Long chemical fallow (one year)	0.95	0.69	267
Canola/vetch hay followed by field peas#	0.8	0.19	253
Summer crop followed by vetch brown manure	0.65	0.59	243
Two years sown pasture	0.59 to 0.97##	0.1 to 0.68###	173–248
Field peas# followed by canola#	0.78	0.71	212
Two years chemical fallow	1.32	0.13	202
Pulse crop#	0.25	0.34	195
Grassy volunteer single-year pasture	0.31	0.1	186
Single year grass/legume pasture	0.1 – 0.5	0.1 – 0.22	184 – \$187
Canola# followed by field peas#	0.79	0.16	142

\*Wheat yield shown indicates yield achieved over and above the yield for wheat-on-wheat (control — continuous wheat).

# severe frost damage in the first year with minor damage in the second year

##sown medic pasture

### sown oats/vetch/medic pasture;

^ average annual gross margin over the four years of the trial

**Note:** Gross margin assumptions were as follows: pasture grazing (\$54/DSE with 30 per cent pasture utilisation), hay (all hay operations at contract rates; cereal hay cut leaving 1t/ha stubble; pea and vetch hay cut leaving 1.7t/ha stubble), summer weeds controlled to conserve soil moisture and nitrogen, adequate nitrogen fertiliser applied to achieve maximum yields and chemical fallow (two summer and two winter herbicide applications).

Long chemical fallow followed by canola gave the highest average annual gross margin with canola producing well-above average grain yields as a result of the stored soil moisture and mineralised nitrogen from the fallow.

Yields for oaten/vetch/medic hay, oaten hay and pea hay were above average during 2011 and rotations including a hay break produced high average annual gross margins.

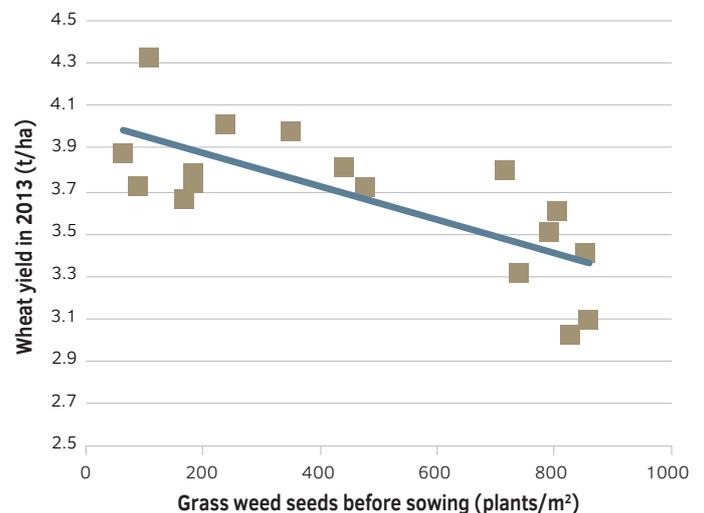
It is worth noting average hay yields were generally well below the results for 2011 alone.

### Weed control boosts wheat yields

A major driver of increased wheat yields was the improved grass weed control offered by including break crops.

Figure 1 indicates that as pressure from grass weeds increased (as estimated by the number of weed seeds in the topsoil before sowing during 2013), wheat yields declined, despite the use of trifluralin at sowing in all treatments and the strategic use of Intervix® herbicide mid-season in all treatments where Grenade CL wheat had been sown.

**Figure 1. Effect of grass weed pressure (measured as grass weed seeds per m<sup>2</sup>) on wheat production in 2013 at Appila**



Two-year breaks were required to reduce grass-weed seedbanks substantially compared with the continuous wheat control (see Figure 2).

Most of the break options with pastures (ungrazed) had little impact on grass weed pressure.

In the continuous wheat plots annual ryegrass seed numbers continued to increase and a range of chemical strategies was used to manage weeds. Delayed weed control and sowing (one week) during 2013 in treatments with high grass weed numbers had limited success in reducing ryegrass numbers.

## Additional benefits

Building on the reduced weed competition was the impact of treatments on stored soil moisture. During November 2011 the chemical fallow treatment had 40mm more stored soil moisture and oaten hay 20mm more than those of wheat. All other break options had similar soil moisture levels to wheat.

Although canola is considered a high-risk option in low-rainfall areas, by ensuring adequate stored soil moisture at sowing (fallow or hay in the previous season) this risk can be reduced, increasing profitability while providing a disease and weed break for following cereal crops. Canola is likely to be an attractive break option for Upper North growers, particularly for paddocks with high levels of root disease (e.g. crown rot) or problem weeds, which normally require a two-year break or alternative management options.

Despite the two-year break (fallow or hay followed by canola) these options can still be highly profitable when considered within a 4–5year rotation.

All productive legume options during 2011 increased soil mineral nitrogen levels by up to 50kg N/ha, similar to that of the fallow treatment.



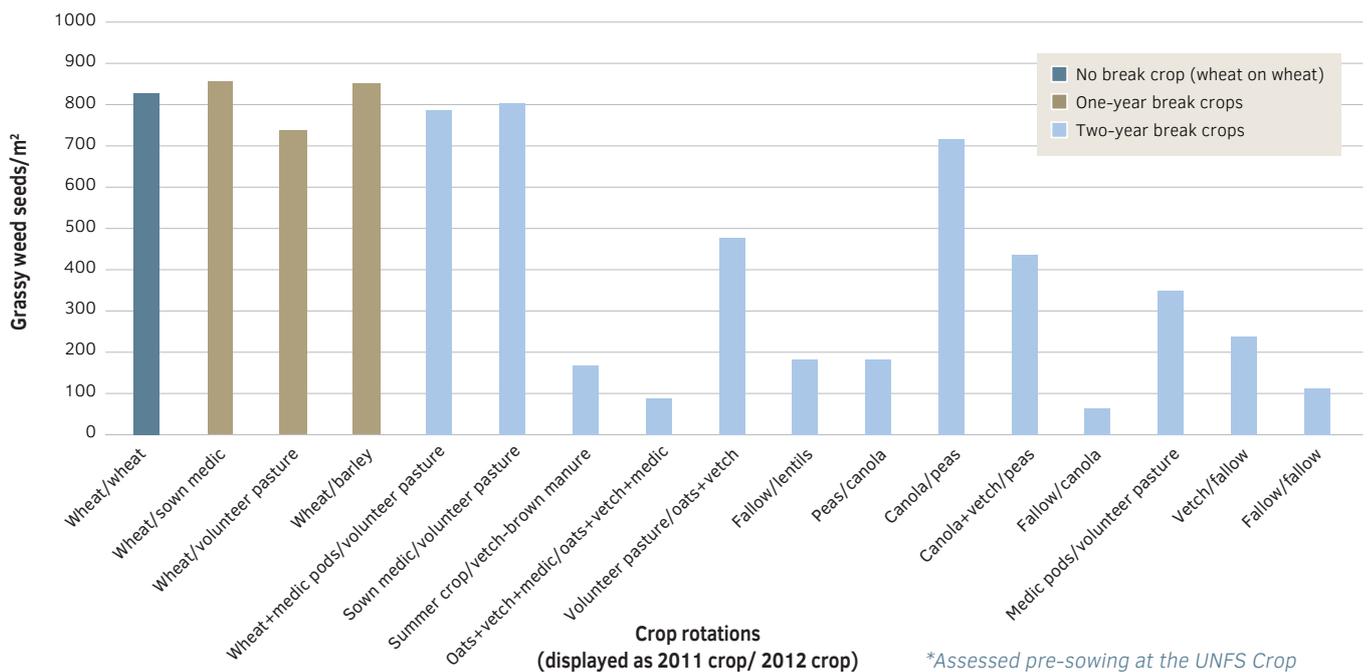
## Key lessons from crop-sequencing trials

A summary of the findings from all sites involved with the *Profitable Crop Sequencing in the Low Rainfall Areas of South Eastern Australia* project is as follows:

- » Wheat yields after a two-year break were higher than from wheat crops following a one-year break, which in turn were higher than continuous wheat.
- » Break crop benefits of 0.5–1.25t/ha (wheat) were achieved following a two-year non-cereal break phase compared with continuous wheat.
- » The benefits in subsequent wheat production continued into the second and third-year cereal crops following the break.
- » Many of the most profitable crop sequences over the four-year period started with a two-year break phase.
- » The benefit of a two-year break had little to do with the break options chosen for those two breaks, providing excellent grass-weed control could be achieved in both.
- » The benefit of a one-year break may only last one season if grass weeds are a significant factor.
- » Soil nitrogen levels were elevated even up to two years after a legume crop or pasture was included as a break crop option.
- » Crop sequences (excluding fallow) had small and variable effects on plant-available soil water.

Sown medic pastures had poor returns in the year of establishment, compared with small positive returns for volunteer pasture, however the subsequent pastures and wheat crops following the sown medic had significantly higher returns making these break options more profitable.

Figure 2. Grassy weed seed numbers resulting from different break crop options\*



\*Assessed pre-sowing at the UNFS Crop Sequencing Trial at Appila in 2013 after a one or two-year break. Dark blue shows a wheat-on-wheat rotation, Brown bars indicate a one-year break and light blue bars are a two-year break.



## Keys to success

To maximise the potential benefits and minimise risk, growers need to identify the key need on a paddock-by-paddock basis — choose a break crop that will best serve the challenge faced by any given paddock

For example, where grassy weeds are a key factor impacting wheat yields, canola can have a significant effect on the weed seedbank for multiple years. Grass selective herbicides can be used and canola also competes strongly with any escape weeds.

On the other hand, vetch cannot compete with grass weeds early in the season and any escapes have the potential to set a lot of seed.

Where nutrients are a limiting factor for wheat yields, canola is unlikely to be as beneficial an alternative when compared with a legume, which fixes nitrogen from the atmosphere and can build soil reserves.

It also is important to consider the options available after a crop has been sown. Seasonal conditions are always a risk. Choosing a crop that can be cut for hay, grazed or harvested for grain can reduce the risk level. For example, field peas can be taken through for grain if seasonal conditions allow, but also can be cut for hay if the season is cut short.



## Consider erosion risk when selecting break crop options

Some break crop options need to be carefully managed to protect soil resources following harvest in low-rainfall areas. Legume crops, including field peas and vetch, pose the highest risk of soil erosion over summer. Stubble residues are low and quick to break down, particularly when grazed, leaving low levels of soil cover during the critical late summer–autumn period.

Grazing of field peas and vetch stubbles needs to be managed carefully to avoid severe wind erosion, particularly on lighter soils. It is often best to avoid grazing or only graze lightly late in the season.

Refer to *UNFS Stubble Guidelines on 'Managing Stubble'* and *'Monitoring Stubble'* for further detail.

Legume-dominant pastures provide effective soil cover and anchorage, however also need to be managed carefully to avoid overgrazing, particularly around watering points.

Most other break crops provide adequate soil cover during most years, providing grazing is well managed during late summer and autumn.

LEFT: Gonyah peas inter-row sown in barley stubble, Melrose. Photo: Andrew Walter.

BELOW: Canola provides the option to gain a foothold over grass weeds during the break crop phase and can reduce the weed seedbank for a number of years. Photo: // // // //



# Break crops offer multiple whole-system benefits

## Bentley and Matt Foulis, Willowie and Wilmington

The Foulis family has used a range of break crops in their farming system for many years, including: oaten hay, canola, vetch and field peas. In any given season they aim to have roughly 30 per cent of the farm planted to break crops.

According to Bentley and Matt Foulis, break crops benefit their overall farm profitability in several ways including: offering seasonal risk management, reducing levels of soil-borne and stubble-borne disease, supporting effective weed control and improving soil nutrition (nitrogen through legumes).

About half of the Foulis' cropping area is at Willowie (average annual rainfall of 308mm) with the other half at Wilmington (average annual rainfall of 420mm). Rainfall at each location plays a major role in break crop selection. The Foulis select a crop such as canola, for example, generally only for the medium rainfall area at Wilmington. They manage risk by cutting failed canola crops for hay or grazing them, being mindful of high plant nitrate levels.

Bentley and Matt grow oaten hay at both locations and often use this break crop as a non-herbicide grass weed control option. Oaten hay is often followed by a second break crop, such as canola or field peas (depending on location).

The father and son team feels a two-year break from wheat is critical where ryegrass numbers are high.

Break crops offer several risk management advantages for Bentley and Matt, including: a spread of commodity prices (diversification), disease control and increased soil moisture and nutrient availability for the following crop.

Crown rot is a continuing problem on the Foulis' property, particularly during seasons with a dry spring, something that is increasingly common in the area. Growing non-cereal break crops, such as canola, field peas and vetch is a key disease-management tool.

Bentley and Matt admit there is significant variation in the profitability of various break crops from season to season. For example, with an extremely wet start and dry finish during 2014, combined with high commodity prices, export oaten hay had the highest gross margin (even higher than wheat). On the other hand, during 2013 canola and barley had equal highest gross margin. Generally, field peas and vetch are rarely more profitable than a cereal crop in any given season, although the residual nitrogen and stored soil moisture for the following year's cereal crop can improve overall paddock profitability.

Bentley and Matt agree it is important to focus on the long-term combination of benefits than returns from any one break crop in any given year.

## Further information

<https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/The-value-of-break-crops-in-low-rainfall-farming-systems-and-which-ones-perform-the-best>

## Acknowledgements

Developed in collaboration with R/// Barr, SARDI through the following funding:

////////

## References

- » Barr R (2015) *Break crops deliver profit in low rainfall regions*, GRDC Media release <http://www.grdc.com.au/Media-Centre/Media-News/South/2015/06/Break-crops-deliver-profit-in-low-rainfall-regions>
- » Peoples M, Hunt J, Craig S (2015) Profitable crop sequences in focus GRDC Project Code CSP000146
- » Kirkegaard J (2015) *Grain legumes can deliver an extra 1t/ha yield to wheat crops*, GRDC Supplement Issue 115 March–April 2015.

## Disclaimer

Any recommendations, suggestions or opinions contained in this publication do not necessarily represent the policy or views of the Upper North Farming Systems Group (UNFS) or the Grains Research and Development Corporation (GRDC).

No person should act on the basis of the contents of this publication without first obtaining specific, independent professional advice. The UNFS, GRDC and contributors to these guidelines may identify products by proprietary or trade names to help readers identify particular types of products. We do not endorse or recommend the products of any manufacturer referred to.

Other products may perform as well as or better than those specifically referred to. The UNFS and GRDC will not be liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on the information in this publication.

