Break crop selection for Eyre Peninsula low rainfall farming systems

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Location
Minnipa Agricultural Centre, paddock S10
Rainfall
Av. Annual: 324 mm
Av. GSR: 241 mm
2019 Total: 254 mm
2019 GSR: 234 mm
Soil type
Clay loam
Plot size
2 m x 10 m x 3 reps
Trial design
Experimental: Split plot

Key messages

- **Field pea had higher biomass and grain yield production than other break crop species at Minnipa, although @RISK analysis suggests field pea is only profitable as a grain crop in 41% of years.**
- **@RISK analysis model outcomes indicate chickpea, vetch hay and lentil are lower risk break crop species, and are profitable in more than 50% of years.**
- **Field pea and vetch have multiple alternative end-use options in dry seasonal conditions that can be utilised to recover crop input costs and salvage a financial return.**

Why do the trial?

Farming systems in the low rainfall zone of southern Australia are dominated by cereal production. There is increasing concern about grass weed and soil-borne disease pressure, diminishing soil fertility (particularly nitrogen), and water use efficiency, as a result of continuously cropping cereals. Break crops have a key role to play in addressing these issues, as well as diversifying crop production and economic risk, and maintaining long-term sustainability of the system. However, there remains a lack of information available to growers about choosing the break crop best suited to their situation, as break crop development to date has largely occurred in medium and high rainfall zones. The aim of this research is to identify the best break crop options for different climate, soil type and biotic stress situations within major cropping regions of the southern low rainfall zone.

How was it done?

A break crop species-by-variety trial was conducted at Minnipa Agricultural Centre in 2017, 2018 and 2019 to compare varieties of six break crop species. This trial was part of a wider program, with similar trials undertaken at four key locations across the southern low rainfall zone. The trials include three to six varieties (to represent major potential options for the low rainfall zone) of canola, lupin, field pea, vetch, lentil, chickpea and faba bean. Lupin was not included at Minnipa after consultation with local advisors, as it is not suited to the environment. Varietal options included herbicide-tolerant varieties and those with potential for different end-uses. Measurements taken include site soil characteristics, soil moisture, grain yield, biomass yield and gross margin. Plot arrangement was in a split plot randomised design with three replicates, with random assignment of break crop species to the whole plot and variety to the sub plot. The use of this design ensures each break crop species receives appropriate management.

The trial was sown at Minnipa using an experimental plot seeder with 27 cm row spacing. Biomass measurements were taken at late flowering to early podding growth stage to identify potential use as a hay, forage or manure crop. Gross margin was calculated using the PIRSA Rural Solutions 'Farm Gross Margin and Enterprise Planning Guide' and a five-year average grain price for each season. A multi-environment trial analysis using a factor analytic model (Smith, Cullis, & Thompson, 2001), with adjustment for design factors and spatial variation, was conducted for biomass and grain yields. Models were fitted in ASReml-R (Butler, Cullis, Gilmour, & Gogel, 2009), in the statistical software platform R.

A model developed by Rural Directions Pty Ltd using @RISK, an add-on to Microsoft Excel, was used to assess risk and net profit associated with including different break crop options in a three-year break-wheat-wheat rotation. Percentile 10, 50 and 90 yields and prices were used in the model (Table 2), together with low-input variable costs for each crop, and the model was used to analyse 5000 seasonal outcomes. Estimated yield benefits and penalties associated with the following crop, and estimated fixed costs (depreciation, finance cost and overhead costs) were included in the model.

Table 1. Break crop species by variety trial fertiliser rate, sowing dates and harvest dates at Minnipa, 2017-2019.

	2017	2018	2019
Sowing date	Canola: 31 May Vetch, field pea: 2 June Chickpea, faba bean, lentil: 30 June	21 June	Pulses: 15 May Canola: 24 May
Fertiliser	Pulses: 75 kg/ha MAP Canola: 75 kg/ha DAP	Pulses: 100 kg/ha MAP Canola: 100 kg/ha DAP	Pulses: 100 kg/ha MAP Canola: 100 kg/ha DAP
Harvest date	21 November	16 November	Field pea: 1 November Canola: 7 November Lentil: 13 November Faba bean, vetch, chickpea: 25 November

Table 2. Grain price and yield percentiles used in the @RISK model analysis.

	Price ($/t) percentiles			Yield (t/ha) percentiles		
	P10	P50	P90	P10	P50	P90
Wheat	180	230	280	0.4	1.3	2.8
Canola	450	490	530	0.2	0.5	1.2
Lentil	415	660	1000	0.2	0.6	1.3
Chickpea	620	1000	1400	0.2	0.6	1.3
Field pea	200	320	485	0.2	0.8	1.7
Faba bean	240	323	461	0.2	0.6	1.3
Lupin	180	320	500	0.2	0.7	1.6
Vetch hay	180	240	300	0.7	2.4	5.3

What happened?

Seasonal conditions

In 2017, well above average rainfall was recorded for January and February, providing some stored subsoil moisture prior to sowing. However, dry conditions in March and April dried out the top soil, and continued dry conditions into May and June resulted in poor canola establishment. Rainfall totalling above 80 mm throughout July and August, along with increasing temperatures in August, aided rapid crop growth. Scattered showers in October were generally too late to be beneficial to crop yields, with warmer temperatures and low soil moisture leading to rapid crop senescence.

Close to average rainfall conditions were experienced in 2018 (Figure 1). However, dry conditions from January to June led to soil profiles containing little to no stored soil moisture. Well-above average rainfall was recorded in August, and warmer sunny days led to rapid crop growth. Heavy frost events were experienced in September, with the worst affected crops in the district being cut for hay. Showers during early October were not enough to benefit crop yields.

Below average annual rainfall was recorded in 2019 (Figure 1). Soil profiles were dry prior to sowing, with less than 20 mm of rain leading up to May. Adequate rainfall during May and June fell in time for sowing to be completed. Growing season rainfall was just above average, with heavy rainfall in late winter and early spring aiding crop growth.

Biomass production

Field pea and vetch are both versatile break crop species that can be grown for grain, hay, silage, grazing, or green or brown manure. The versatility of field pea and vetch allows a financial return to be salvaged if crops are drought or frost affected. Biomass production of field pea (1.2-3.2 t/ha) and vetch (1.05-2.06 t/ha) was higher than other break crop species at Minnipa (Figure 2). Field pea variety performance was inconsistent, with no one variety out-performing all other varieties in all three seasons. Conventional type field pea are often preferred when grown for alternative end-uses to grain, due to their higher biomass potential. However, conventional type field pea have not offered consistent improved biomass production over semi-leafless types. Additionally, conventional type field pea have poor lodging resistance, therefore semi-leafless varieties may be a more suitable option, regardless of intended end-use.

Vetch biomass production was similar across varieties at Minnipa, while across all low rainfall environments in the project, Volga had higher biomass production than Rasina and Timok. Early maturing canola variety Nuseed Diamond had consistent high biomass production compared to other canola varieties. Desi chickpea PBA Striker had higher biomass yield than Genesis090 and PBA Monarch at Minnipa in all three seasons (Figure 2).

PBA Striker also showed improved early vigour and ground cover over kabuli PBA Monarch, visually and statistically from normalised difference vegetation index measurements.

Faba bean biomass production was similar across varieties in 2017 and 2018. In 2019, PBA Samira and PBA Marne produced 21% and 22% more biomass than PBA Bendoc, respectively (Figure 2). Lentil biomass production was similar across varieties at Minnipa. Of the herbicide tolerant lentil varieties, PBA Hallmark XT consistently had higher biomass production than PBA Hurricane XT. For conventional varieties, biomass production was similar, with a slight increase in biomass from PBA Jumbo2 at Minnipa (Figure 2).

Grain yield

Grain yield of field pea (0.18-1.40 t/ha) was higher than all other break crop species at Minnipa in 2017-2019 (Figure 3), showing they have consistent and reliable production in this region. As with biomass production, field pea variety performance was inconsistent and no single variety out-yielded other field pea varieties across all three seasons. Vetch variety grain yield performance was also variable at Minnipa. Early maturing Volga was often the highest yielding vetch variety across low rainfall environments in the wider program. PBA Hallmark XT was the highest yielding lentil variety in 2018, while PBA Jumbo2 was the highest yielding in 2019 (Figure 3). Faba bean grain yield was similar across varieties, with a 0.2 t/ha drop in grain yield of PBA Samira in 2019, compared to PBA Marne and PBA Bendoc (Figure 3). PBA Striker desi chickpea and Genesis090 kabuli chickpea varieties were higher yielding than the large seeded kabuli PBA Monarch. Hybrid Nuseed Diamond canola was at least 12% higher yielding than other canola varieties across all seasons at Minnipa.

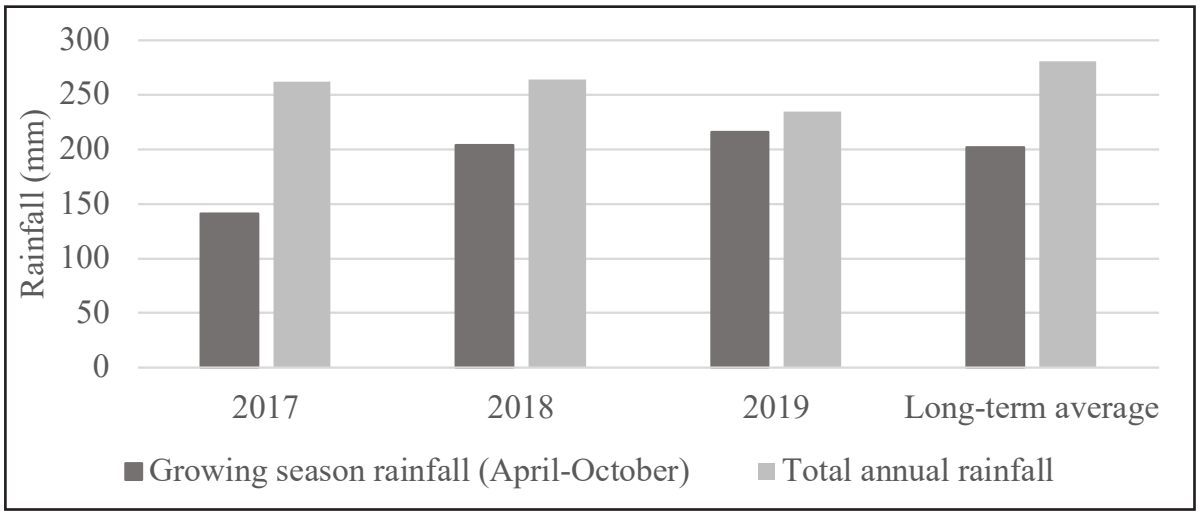

Figure 1. Growing season rainfall and total annual rainfall (mm) for 2017-2019, compared to the long-term average rainfall, recorded at Minnipa Agricultural Centre.

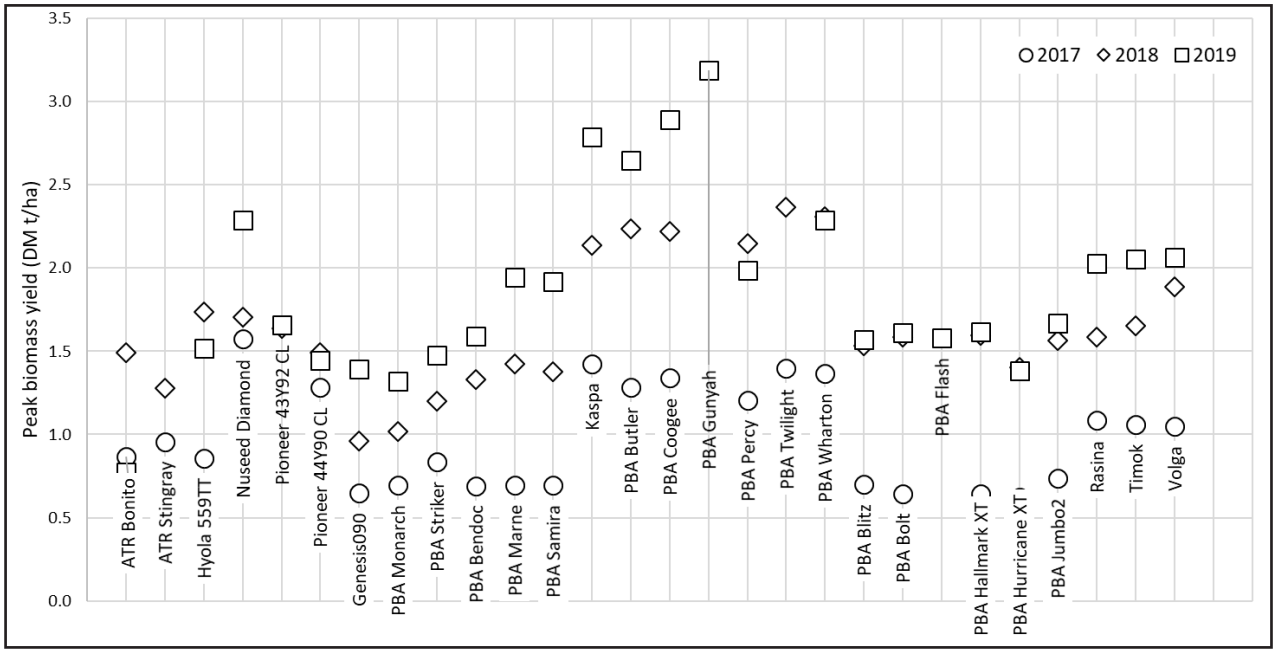

Figure 2. Peak biomass yield performance (DM t/ha) of break crop varieties at Minnipa over three seasons (2017-2019). Varieties of the same crop species are grouped together along the x-axis. Standard error is 0.17-0.23.

Gross margin and @RISK analysis

The @RISK analysis of 5000 seasonal outcomes provided a percentage of years that each break crop would be profitable, and the net profit for each rotation sequence (Table 3). Average net profit per hectare per year over a three year rotation for chickpea and lentil was $181.86 and $72.71, respectively, compared to $4.40 for field pea. Rotation sequences including field pea were profitable in 40.7% of years, and including lentil were profitable in 51.6% of years. Sequences that included chickpea were profitable in 55.5% of years. However, it is important to keep in mind that this analysis was based on a low input system with the application of only one fungicide spray, and chickpea would not be as profitable in a season with high disease risk or infection of ascochyta blight. The analysis indicated that canola and faba bean were the least profitable and higher risk break crop options, profitable in 34.3% and 38.7% of years, respectively.

What does this mean?

The decision to grow a break crop is generally done with a whole systems approach, as break crops can be utilised to address the issues and constraints that arise from continuously cropping cereals. The choice of break crop is made depending on the reason for growing a break crop, crop end-use, financial risk, paddock selection and soil type. Field pea production is more stable than other break crop species across the low rainfall environment. However, field pea is least suited to frost prone areas, and is a risk for grain production where spring frost events occur frequently. Field pea has multiple alternative end-uses to grain, and with high biomass potential can be utilised as a hay, forage, silage or manure crop when frost or drought affected, to salvage a financial return.

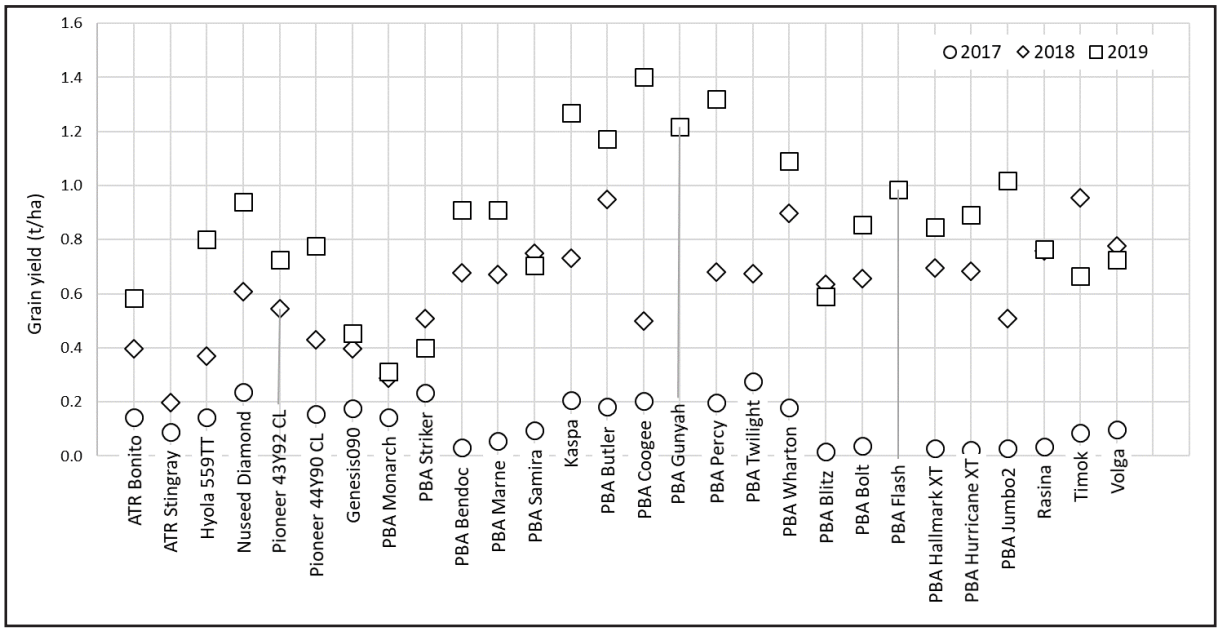

Figure 3. Grain yield (t/ha) of break crop varieties at Minnipa over three seasons (2017-2019). Varieties of the same crop species are grouped together along the x-axis. Standard error is 0.03-0.11.

Table 3. @RISK analysis of break crop options in a 3-year rotation with wheat, with rotation sequence ranked from lowest risk and most profitable, to highest risk and least profitable. Lupin were not grown at Minnipa, but were included in break crop trials as part of the wider program.

Rotation sequence	Average gross margin $/ha	Average net profit $/ha	% of years break crop is profitable	Rank
Chickpea-wheat-wheat	281.86	181.86	55.5	1
Vetch hay-wheat-wheat	178.03	78.03	56.6	2
Lentil-wheat-wheat	172.71	72.71	51.6	3
Lupin-wheat-wheat	124.28	24.28	44.3	4
Field pea-wheat-wheat	104.40	4.40	40.7	5
Faba bean-wheat-wheat	89.68	-10.32	38.7	6
Canola-wheat-wheat	55.81	-44.19	34.3	7

Vetch is also a versatile crop, having multiple potential end-uses, and is a good fit in a mixed farming system. Vetch hay can be profitable in 56.6% of years. Canola, lentil and faba bean can provide herbicide tolerant crop options where in-crop weeds or herbicide residues are an issue. Canola also has a good fit where cereal root diseases are limiting production (Kirkegaard, Christen, Krupinsky, & Layzell, 2008). However, canola requires adequate soil moisture at sowing for successful germination, in particular on heavier soil types, and may be an opportunistic crop in some environments.

Lentil can be profitable in 51.6% of years. However, lentil is more sensitive to soil constraints than other break crop species and plant height is often low, leading to poor harvestability. Faba bean would be suitable where a break crop is needed in a frost prone area, as faba bean tolerates reproductive frost events better than other pulse crop species. Chickpea can be profitable across the southern low rainfall zone in 55.5% of years. Although chickpea grain yields were low at Minnipa (0.14-0.51 t/ha), chickpea has shown better adaptability and stability in the upper Victorian Mallee.

Each break crop species has its own unique fit in the farming system, and all available agronomic, local, and paddock information needs to be taken into consideration when selecting a break crop to fit into each individual farming system. Each break crop species has a number of varieties with a range of agronomic characteristics to select from that are suitable for production in the low rainfall environment. Although top performing varieties have been identified for some break crop species, the final selection will depend on the individual farming system, in particular where soil type, herbicide residues and/or broadleaf weeds are a constraint to production.

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Useful Resources

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