Comparing different crop and pasture sequences

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Key messages

- Break crops can help increase the returns from future wheat crops.
- Break crops are profitable when the expected increase in return from future wheat crops exceeds the opportunity cost of growing a break crop instead of a wheat crop.
- An economic simulation study for a sand over gravel at Kojonup demonstrates how a loss making pasture can generate future profits through higher wheat yields.
- The higher wheat yields occurred because of the control of soil borne disease and weeds.
- Pastures must be managed well, or they will be costly.
- Break crops help maximise profits in better years.

Aims

Crop rotation is one of the oldest practices in agriculture. Almost everyone "knows" crops should be rotated, or at least grown in sequence and seasons vary. For a crop to reach yield potential, it must be free of weeds and disease. The key objective of a break crop, like a legume or oilseed, is to help restore the paddock to a weed and disease free state for the following crop to maximise crop yield and the value of the break could be dependent on the season.

Ideally, farmers want to grow a profitable break crop, and increase returns above and beyond what could be achieved with a continuous cereal crop sequence. If a break crop makes a profit in its own right that is equivalent to the dominant cereal crop then break crops can be grown regularly to keep weeds and diseases at low levels. In many instances, canola can be grown profitably in rotation with wheat.

If wheat yields, or the yields of the dominant crop, have declined to a level that is uneconomic, then a break crop must be grown because there are no productive options left for that paddock and without some intervention it will remain unprofitable.

However, outside of these scenarios, the risks and rewards of growing a break crop are more complex. There is usually an opportunity cost (the difference in the immediate profit between the break crop and main crop) of growing a break crop. The profit of subsequent cereal crops must increase sufficiently to at least cover this opportunity cost of growing the break crop. Weeds and diseases must be controlled during the break crop, otherwise there will be no benefit to growing it. The aim of this study is to explore what impact break crops and pastures have on future profit, where seasons vary.

Method

Here, we use an economic model to quantify the costs and benefits of including a break crop in the rotation at Kojonup on a sand over gravel soil. The changes in weed population and disease are simulated. Disease generally increases in wetter years, and if present can cause more damage to the cereal crop in higher yielding seasons. The yield for the respective crops and pastures are generated using the APSIM crop model, which underpins yield prophet.

The economic simulation compares three rotations: 1. Three successive wheat crops, 2. a legume dominant pasture where weed management was a high priority followed by two wheat crops, or 3. a canola crop where weeds were managed, but not as well as they could have been in a pasture followed by two wheat crops. Each crop sequence was run for one cycle of three years.

Each simulation was repeated 5000 times using different combination of seasons to explore the average effect crop rotation has on profit, and the effect crop rotation has on profit in different seasons. Therefore, one scenario may choose the years 1960, 1961 and 1954. The next simulation may choose the years 1957, 1981 and 1998. Each combination will produce different potential wheat yields, with different nitrogen requirements. If disease is present, the impact of that disease will also vary with season.

Results

In the continuous wheat system, designed to simulate wheat yields on a poor sand over gravel in the Kojonup region, cereal yields are almost 0.5 t/ha lower than wheat yields grown following a break crop (Figure 1) as the crop has high levels of disease and weeds, relative to the crops grown following a break (Figure 2). Disease levels in the wheat crop are suppressed by both the pasture and canola breaks. The pasture also reduced the weed pressure (Figure 2). Since it was a legume, this ensured the wheat crop was sown into a weed free, disease free and nutrient rich environment that minimised fertiliser N costs.

Overall, profits for each crop change through time. For the canola-wheat-wheat sequence, large profits were produced every year (Figure 3). However, weeds increased in that system, and eventually they needed to be managed. The profits from the continuous wheat sequence declined with each successive wheat crop, as the disease and weed levels increased. In contrast, the pasture system deliver the most 'peaky' profits, where a loss occurred under the pasture, but there was a large increase in the profit of the subsequent wheat crops due to the control of weed and disease pressures and the increase in soil fertility (Figure 3). Over three years the pasture wheat sequence was more profitable than the continuous wheat sequence (Figure 3) and demonstrates how a break from cropping can overcome an apparent missed opportunity to grow a cereal crop.

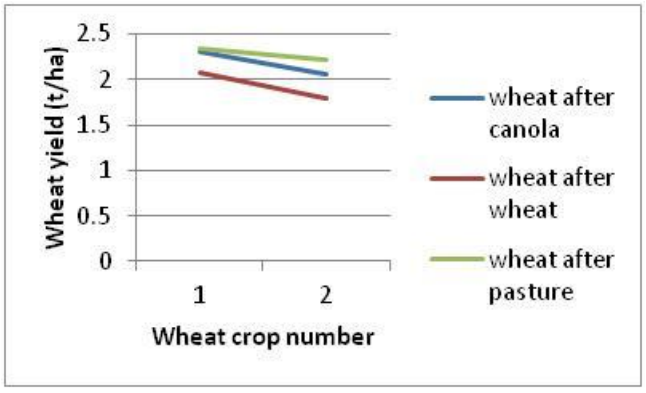

Figure 1 Wheat yield for wheat crops grown after wheat, a canola break crop or a pasture managed to reduce weeds and maximise nitrogen inputs.

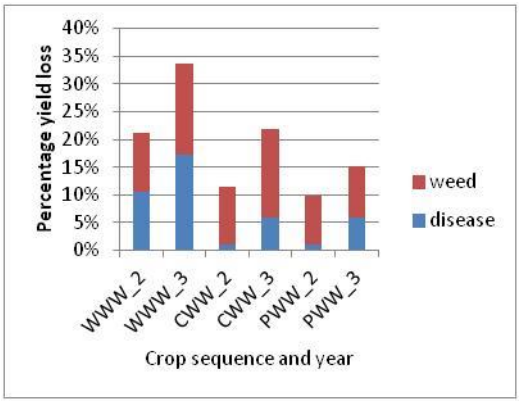

Figure 2 Percentage yield loss of the wheat crop due to weeds and disease pressure for wheat grown after wheat (WWW) , a canola break crop (CWW) or a pasture (PWW) for the second and third year of the crop sequence. The number indicates the year (2 or 3) of the crop sequence.

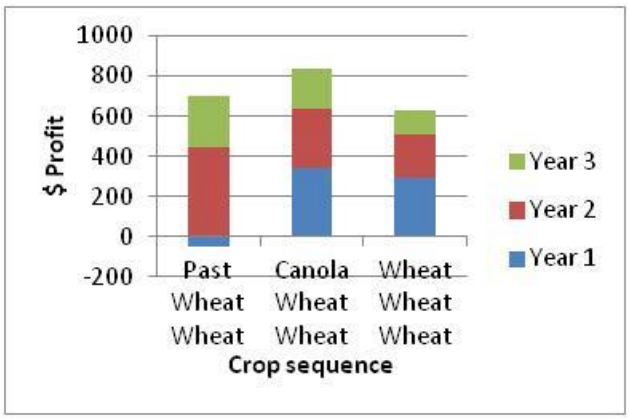

Figure 3 Profits generated in each year of three different crop sequences. The size of the bar indicates the amount of profit generated for that year.

How often do crop sequences generate a viable economic return?

Average break crop effects, presented in figures 1 to 3 provide some insight into the system, but hide the impact that seasonal variability can have on overall profit, or the likelihood a particular crop sequence will generate a given return, in this instance, $200 /ha. In the Wheat-Wheat-Wheat system, much of the profit is generated in the first year, and 55% of seasons generated a return higher than the $200/ha target. This declined to just 36% of seasons for the second crop and 9% for the third wheat crop, as weed and disease problems combined to reduce crop yields and substantially reduce profits in good seasons. They also reduce yields in poor seasons, but the overall effect is low (Figure 4, 5, 6). In contrast the Canola-Wheat-Wheat sequence frequently generated sound profits in the first year with profits exceeding $200 / ha in 66% of seasons. The wheat crop following canola generated profits exceeding $200 / ha in 57% of seasons, because disease had been suppressed by the canola. In the third year of the sequence, the wheat crop still produced profits that exceed $200/ha in 45% of seasons. These wheat crops had an increased probability of reaching close to their yield potential because diseases were managed and canola is capable of generated high returns (Figure 4, 5, 6).

Finally the pasture-wheat-wheat crop sequence, was generally not that profitable in the first year of the rotation. This pasture was managed for weeds, and we assumed it

provided less grazing opportunities than might otherwise be the case. Therefore, only 11% of seasons produced a return great than $200/ha. This year of pasture should be viewed as a 'set-up' phase in the crop sequence. Thereafter, the well managed legume pasture that fixed nitrogen, reduced disease and enabled the farmer to employ a wide range of weed management options to reduce the weed seed bank provided the perfect platform to grow a wheat crop. That wheat crop produced a profit that exceeded $200/ha in 66% of seasons. Furthermore, it produced more than $400/ha profit in 43% of years because of the combined influence of nitrogen fertiliser savings and capacity to produce a yield near potential with few weeds and diseases. Profits were often acceptable in the third wheat crop, where 48% of crops generated a return of $200/ha. These were substantially lower than the previous wheat crop because the nitrogen savings had been used by the preceding crop. Nevertheless, disease and weed levels were low enough to ensure the second wheat crop could frequently generate an acceptable profit (Figure 4, 5, 6).

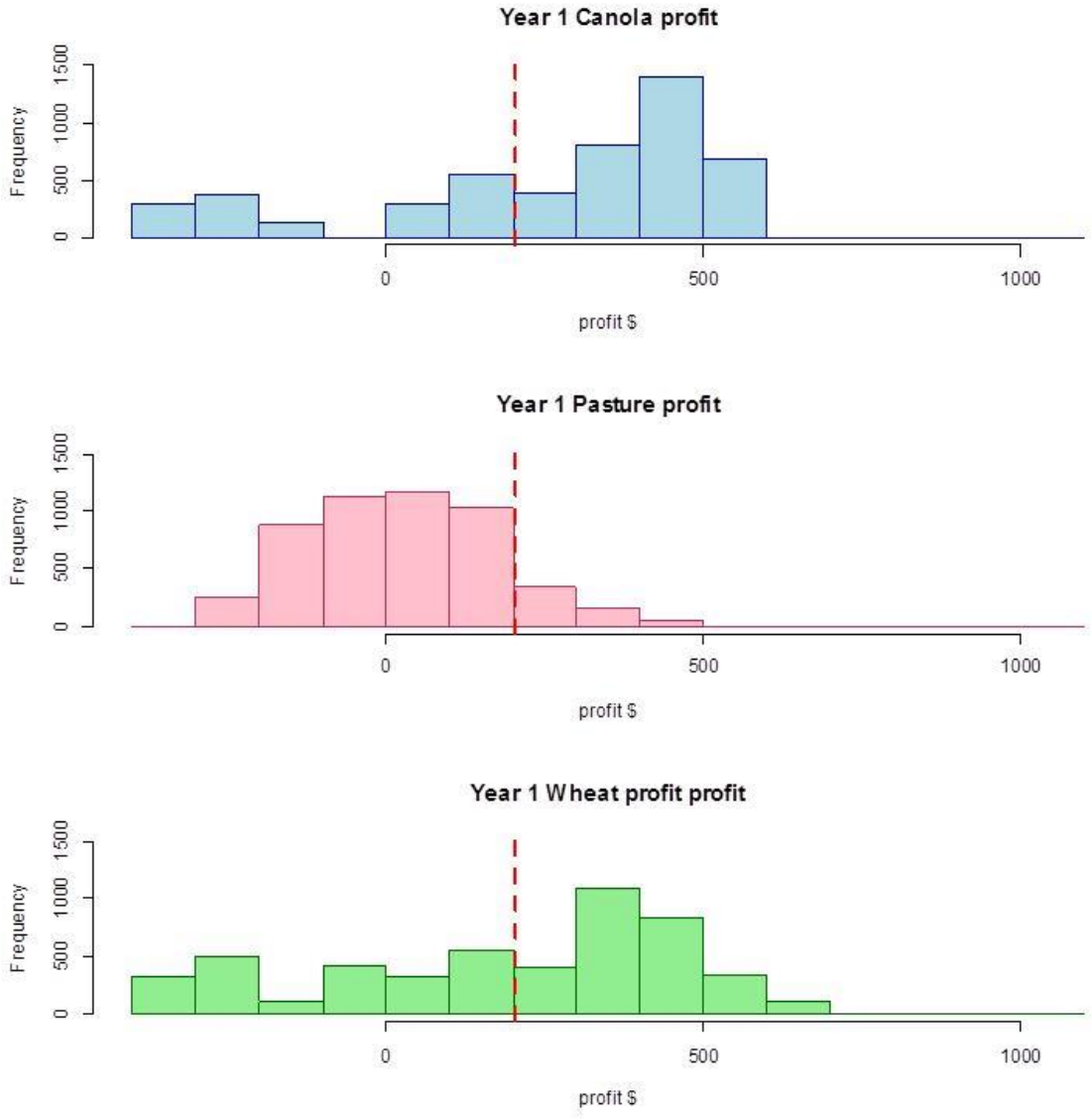

Figure 4 A histogram of profits generated in year 1 of a 3 year crop sequence for Canola Wheat Wheat, Pasture Wheat Wheat and Wheat, Wheat, Wheat. The dashed line is represents $200/ha and the more bars to the right of this line demonstrate that crops are more likely to achieve at least this margin of profit.

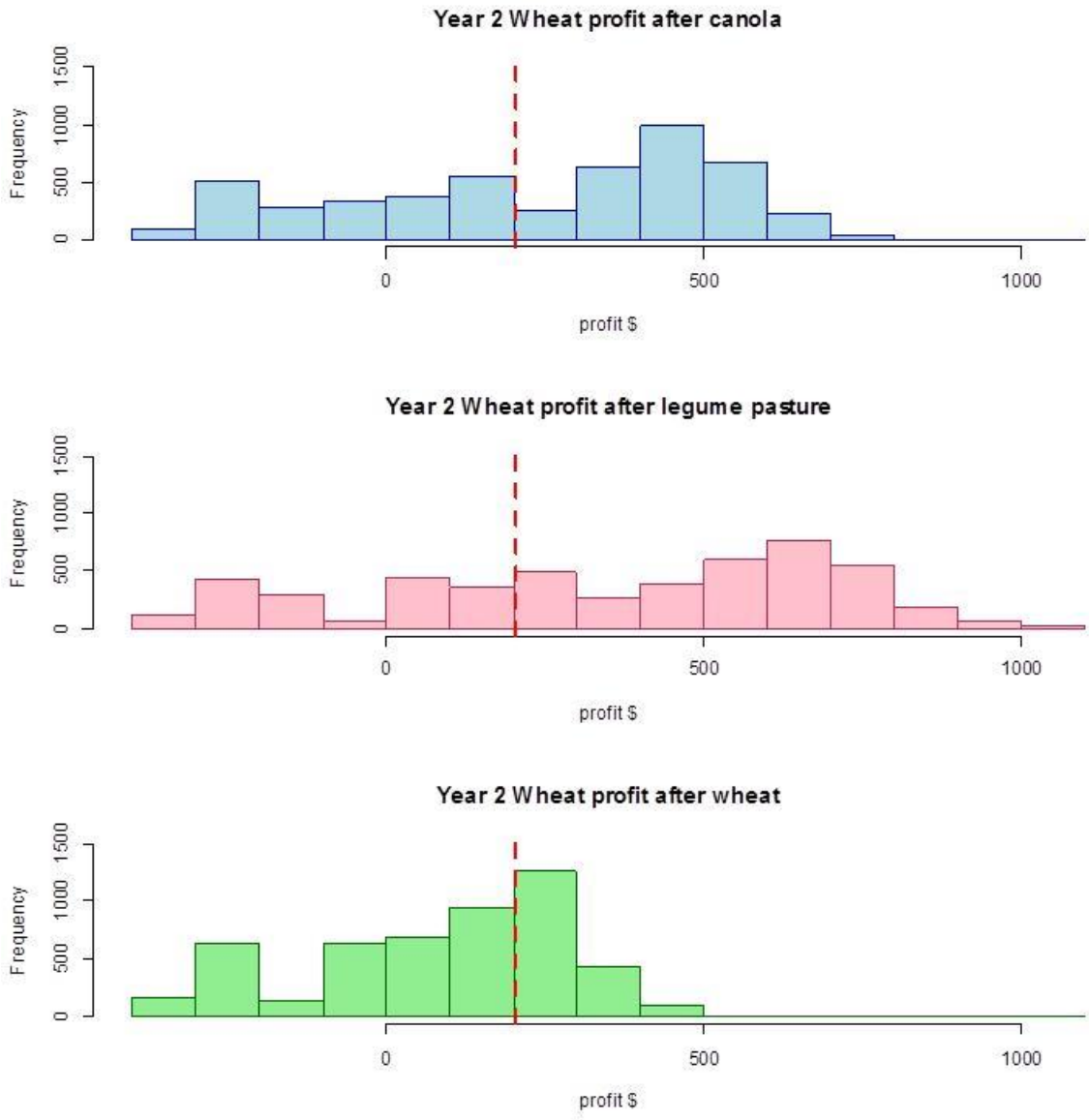

Figure 5 A histogram of profits generated in year 2 of a 3 year crop sequence for Canola Wheat Wheat, Pasture Wheat Wheat and Wheat, Wheat, Wheat. All crops are wheat. The dashed line is represents $200/ha and the more bars to the right of this line demonstrate that crops are more likely to achieve at least this margin of profit.

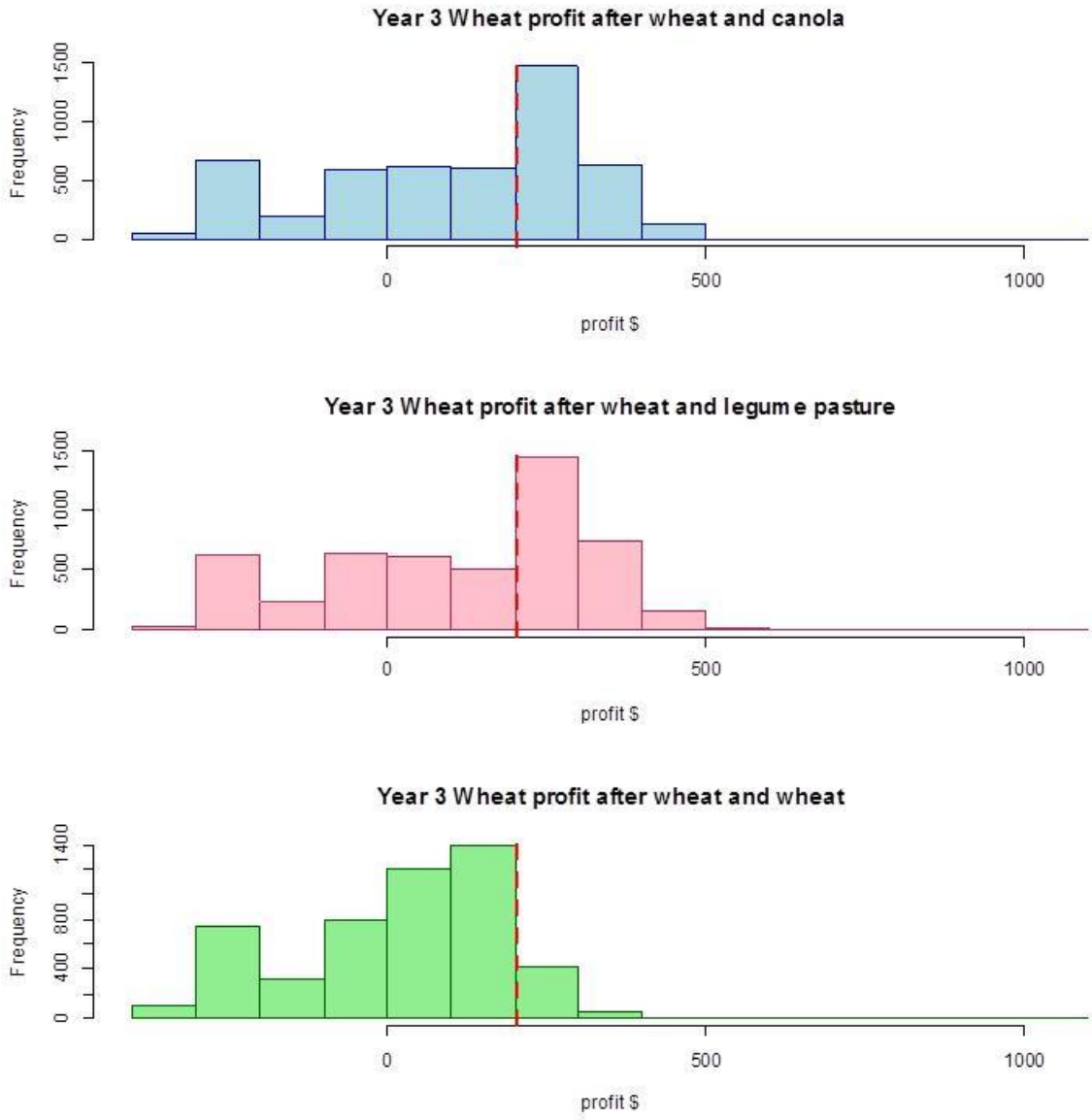

Figure 6 A histogram of profits generated in year 3 of a 3 year crop sequence for Canola Wheat Wheat, Pasture Wheat Wheat and Wheat, Wheat, Wheat. All crops are wheat. The dashed line is represents $200/ha and the more bars to the right of this line demonstrate that crops are more likely to achieve at least this margin of profit.

Conclusion

Crop sequences take on many forms and often increase profits in future wheat crops. Importantly they appear to be most beneficial in good years, where problems like disease create large yield differences between crops following a break and crops following a cereal. Thus break crops can help maximise the upside in favourable seasons. However, it is vital that pasture breaks are well managed to ensure you generate a nitrogen benefit and reduce the risk of diseases and weeds in subsequent cereal crops. Finally, the economics of growing a break crop need to be evaluated

across a number of years and demonstrate that a loss can generate substantial future profits.

Key words

Crop Rotation, Crop Sequencing, Break Crops, Seasonal Variability

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