# Strategic winter fallow reduces financial and agronomic risk for Western Australian wheatbelt farmers

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**Aim**

To compare the economic and agronomic response between the paddock rotations of wheat on wheat, wheat on late pasture topping and wheat on chemical fallow. This investigation aims to identify winter fallowing as a low-risk rotational strategy for low rainfall cropping systems in the North and Eastern Wheatbelt region of Western Australia.

**Background**

Continuous cropping has become prevalent on many farms in the North and Eastern Western Australian (WA) wheatbelt. The decline in sheep numbers and lack of diversity within cropping programs has highlighted a need to find new weed control strategies. Variability in seasonal rainfall in these regions has also lead to an increasing reliance on stored soil moisture. Strategic winter fallowing may reduce agronomic risk by storing soil moisture for the following year's crop production, decreasing weed seed banks and reducing disease pressure. Introducing a fallow component in crop rotations should reduce yield variability by increasing yield in these lower rainfall years. This may reduce the financial risk by offsetting projected yield losses in poor years and potentially increase long-term yields. These reasons are attracting WA farmers to take a fresh look at winter fallowing.

**Key points**

- Think of a fallow as a risk reducing investment for your property.
- Soil testing after chemical fallow is essential to determine the starting point of available nutrients in the soil.
- Good agronomic practices that maximise plant health and growth will allow crops to use water more effectively, improving yield potential.
- Weed free fallows mean increased moisture conservation leading to potentially higher yielding crops for the following year and more profitable rotations.
- The use of a residual herbicide to help suppress weeds over summer will be beneficial.
- If this trial was to be repeated, results will vary given different seasons and different soil types.

**Trial Details**

| | |
|---|---|
| **Property** | Wenballa Farm, east of Dalwallinu |
| **Plot size & replication** | 18.2m x 110m x 3 replications |
| **Soil type** | Heavy red clay |
| **Soil pH ($CaCl_2$)** | 5.4 – 7.4 (0 – 90cm) |
| **Paddock rotation** | 6$^{th}$ continuous wheat |
| **Variety** | 2011 Wyalkatchem, 2012 Wyalkatchem |
| **Seeding date** | 2011 – 31/5/11; 2012 –13/6/12 |
| **Seeding rate** | 2011 – 50 kg/ha; 2012 – 50 kg/ha |
| **Fertiliser** | 2011 – 44 kg/ha DAP at seeding & 45 kg/ha urea post emergent<br>2012 – 50 kg/ha DAP at seeding & 50 kg/ha urea post emergent |
| **Growing season rainfall** | 2011 – 361mm; 2012 – 132mm |
| **Herbicides** | Wheat 2011<br>31/5/11: 1.5 L/ha Trifluralin, 1.5 L/ha Glyphosate at seeding;<br>13/7/11: 750 mL/ha Jaguar, 500 mL/ha LVE MCPA post emergent<br>Wheat 2012<br>13/6/12: 2 L/ha Trifluralin, 1.5 L/ha Glyphosate, 250 g/ha Diuron<br>17/7/12: 500 mL/ha Jaguar + 300 mL/ha LVE MCPA + 140mL/ha Zinc<br>Chemical fallow 2011<br>8/7/11: 2.5 L/ha Glyphosate, 0.5% LI700 |

| | |
|---|---|
| | 23/8/11 – 3 L/ha Glyphosate, 500 mL/ha Ester 680, 50 g/ha Logran B-Power, 80mL/ha Triclopyr, 0.5% LI700<br>Late pasture topping (LPT) 2011<br>1/9/11: 1.3 L/ha Glyphosate, 600 mL/ha Ester 680, 0.5% LI700<br>12/10/11: 1.5 L/ha Glyphosate, 0.5% LI700 |

## Method

In 2011, three broad scale paddock rotations were replicated;

- wheat
- late pasture topping (LPT) (unimproved pasture)
- chemical fallow

These three rotations were followed by wheat in 2012. The continuous wheat rotation was treated as farmer standard practice. The trial was sown with knife point press wheels and chemicals were applied with a Beverley Hydraboom. Refer to the trial details (above) for rates and timings of the chemicals applied.

## Results

Nitrate nitrogen, phosphorus, potassium and sulphur were in good supply at the start of 2011 (Table 1). The soil type was heavy red clay, and although acidity was not a soil constraint (Table 1); there was a physical hard pan throughout the site. However, observations from the soil pit demonstrated plant roots from the wheat on chemical fallow plot penetrated the compacted layer and were 40cm further down the soil profile than the continuous wheat plot.

**Table 1**: 2011 soil test results.

| | **0 - 10cm** | **10 - 30cm** | **30 - 60cm** | **60 - 90cm** |
|---|---|---|---|---|
| **pH (CaCl2)** | 5.4 | 6.5 | 7.6 | 7.4 |
| **Nitrate N (mg/kg)** | 23 | 2 | 3 | 4 |
| **P (mg/kg)** | 50 | 16 | 25 | 34 |
| **K (mg/kg)** | 337 | 243 | 243 | 253 |
| **S (mg/kg)** | 70 | 26 | 47 | 57 |
| **Organic Carbon %** | 0.95 | 0.64 | 0.54 | 0.59 |

Plant tissue tests conducted in August 2012 found that the plant weights from the wheat on chemical fallow plots were 151% greater than the plant weights from the continuous wheat plots (Figure 1). Based on these plant weights and the total nitrogen percentage (Table 2); the nitrogen uptake is 2.5 times greater in the wheat on chemical fallow plots than the continuous wheat treatments. This can be attributed to the nitrogen diluting through the plants because of the higher plant weights from the wheat on chemical fallow plots (Figure 1).

**Table 2**: 2012 plant tissue test results.

| | **Wheat on wheat** | **Wheat on LPT** | **Wheat on chemical fallow** |
|---|---|---|---|
| **N Total % PTA** | 5.71 | 5.84 | 5.43 |
| **Nitrate N mg/kg PTA** | 1328 | 1718 | 1924 |
| **K % PTA** | 4.19 | 5.25 | 6.03 |
| **S % PTA** | 0.38 | 0.42 | 0.42 |
| **P % PTA** | 0.46 | 0.58 | 0.48 |

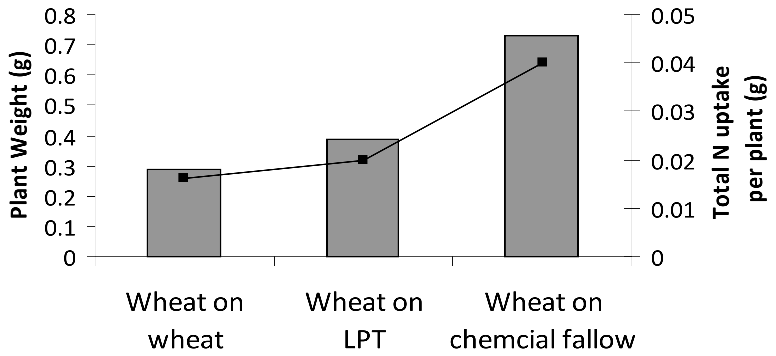


**Figure 1:** 2012 average wheat plant weights and total nitrogen uptake per plant from each treatment. Nitrogen uptake = plant weight x total nitrogen percentage.

In 2012, the wheat on chemical fallow rotation had the lowest weed burden in comparison to the other rotations. Barley grass numbers in the continuous wheat plots were significantly higher than the other treatments and although they were patchy, wild oat numbers were also greater in the continuous wheat rotation. There was also a significant difference between each weed species in the wheat on LPT and wheat on chemical fallow plots (Figure 2).

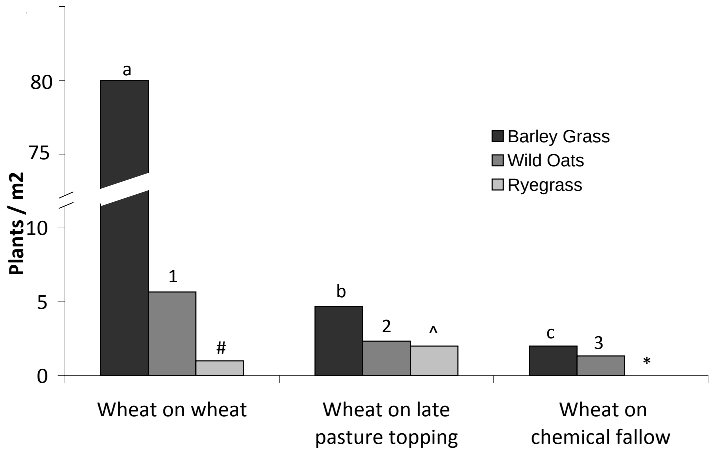


**Figure 2:** 2012 average plant densities of barley grass, wild oats and ryegrass. (NB: scale on the y axis).

The water use efficiency (WUE) of the wheat on chemical fallow plot was twice as efficient as the continuous wheat plots (Table 3). There was an 800 kg/ha yield increase in the wheat on chemical fallow treatment compared to the continuous wheat rotation in the 2012 season (Figure 3). The difference in grain quality (Table 4) influenced the overall gross margins as the wheat on chemical fallow gave significantly improved grain quality over the continuous wheat rotation which resulted in achieving separate payment grades. The 2011/12 gross margin of the wheat on chemical fallow rotation gained $50/ha over the continuous wheat rotation and $116/ha more than the wheat on LPT rotation (Figure 3). Gross margin results are based on the assumption that there are no sheep in the farming system. Refer to Appendix 1 for full gross margin analysis.

**Table 3**: WUE = Yield (kg) ÷ GSR (kg/mm). GSR = April to October. No account for evaporation or summer rainfall.

| | Wheat on wheat | Wheat on LPT | Wheat on chemical fallow |
|---|---|---|---|
| **2011** | 4 kg/ha/mm | - | - |
| **2012** | 6 kg/ha/mm | 9 kg/ha/mm | 12 kg/ha/mm |

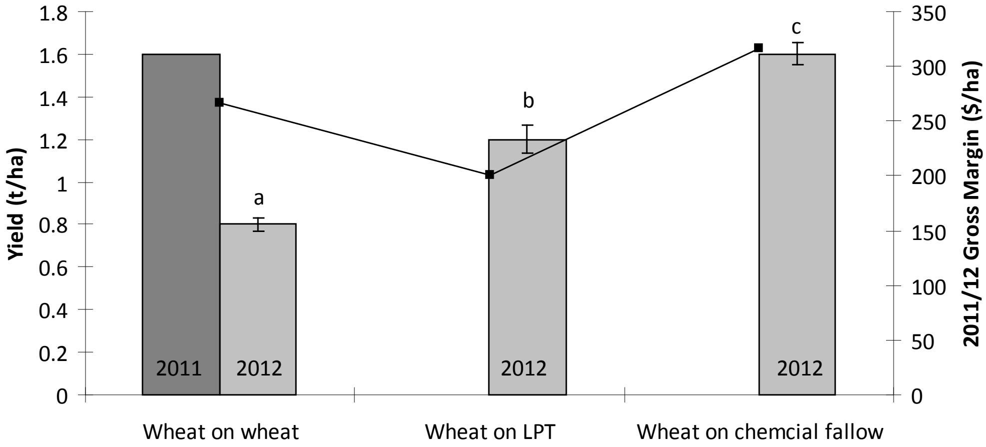


**Figure 3:** 2011/12 yield and gross margins of the three treatments

**Table 4:** 2012 grain grades, price and quality results.

| | Hectolitre weight (g/hL) | Protein (%) | Screenings (%) | Grade (grain price $) |
|---|---|---|---|---|
| **Wheat on wheat** | 80.3 (a) | 13.5 (b) | 5.3 (b) | AGP ($310) |
| **Wheat on LPT** | 79.6 (b) | 13.6 (b) | 4.9 (b) | APW ($340) |
| **Wheat on chemical fallow** | 81.0 (c) | 14.4 (a) | 3.1 (a) | APW ($340) |

## Discussion

Modelling suggests winter fallowing can obtain up to a 2 t/ha benefit in the following year's cereal crop production (*Oliver, 2012*). Research conducted by CSIRO suggests that the Dalwallinu farming region may only receive yield benefits from fallowing 3 in 10 years on a sandy loam soil type (*Oliver, 2012*). Modelling also suggests that the yield benefit from a fallow will decrease if there is high summer rainfall and/or an average season in the year following a fallow (*Oliver, 2012*). Stored soil water may be the main driver of fallowing, but improvements in weed and disease control, mineralisation of nutrients, time of sowing and strategic paddock selection can further influence yield responses and spread financial risk.

Continuous cropping rotations lack diversity in weed control. These long-term rotations have had an over-reliance on herbicides for weed control and resistance to selective herbicides has now become widespread throughout these wheatbelt regions. Post-emergent ryegrass control is no longer a viable option in many areas, and has resulted in the build-up of ryegrass populations in cropping programs. Wild oats are extremely competitive with the crop and are also developing resistance to selective chemicals. Barley grass chemical control options are limited, expensive, and offer only suppression. The continuous wheat scenario was based on the individual farmer's standard practice (FSP) in 2011 and 2012 and as such, post-emergent chemical control for barley grass and wild oats was not applied. Given the large barley grass weed burden, a post-emergent spray would have been recommended as it impacted yield over the two years. High weed burdens not only contribute to direct yield loss in one season but will be an added expense to control in following seasons. The FSP influenced the overall gross margin assumptions in this particular study, as the additional cost of weed control usually would have been included in the continuous wheat rotation. Barley grass does not persist in the soil and possesses little or no dormancy *(Peltzer, 2001)* and ryegrass seeds have a relatively low dormancy and usually only persist in the soil for up to 2-3 years under minimal tillage systems *(Peltzer & Matson, 2002).* Therefore, these two weed species are easier to target and achieve fast results to overcome large seed banks in a short amount of time. A well-managed chemical fallow, unlike a late spray topped pasture, allows multiple populations of weeds to germinate in the one season and thus reduce the weed seed bank at a faster rate.

Soil mineralisation during a winter fallow rotation can reduce the reliance on nitrogen fertiliser in the following wheat crop. Soil tests from 2011 indicated the trial site had nitrate nitrogen at depth, however, due to the physical hard pan; previous continuous wheat crops have not been able to access it. In 2012, the wheat roots in the 2011 chemical fallow plots explored further down the soil profile and had access to these nutrients later in the season. Further root exploration in the chemical fallow plots may have directly influenced yield due to access to stored soil moisture at depth, but it also influenced the further additions to grain protein *(Moodie, 2012).* Ideally, additional soil samples from each plot at the start of 2012 should have been taken to give an indication of potential differences in nutrition levels. This may have influenced gross margin assumptions, as changes to fertiliser inputs between treatments may have been recommended. Although nitrogen was not a limiting factor in this trial, the wheat in the chemical fallow plots was more efficient in N utilisation, as not only did these plots yield more, but converted N into higher protein, coupled with lower screenings. Late pasture topping strategies can reduce the weed numbers in the following cereal crop; however, the weeds that have germinated over the winter can use valuable moisture and nutrients throughout the season *(Wicks & Smika, 1973)*. A chemical fallow conserves the mineralised nutrients and stored moisture which are then utilised by the following crop.

Fungal and nematode root diseases in wheat alone, costs WA growers $84 million each year *(Anon, 2011).* There is an increased risk of cereal root and leaf disease in continuous cropping rotations. The degree to which disease influences yield is not only related to inoculum levels, but seasonal conditions and variety tolerance will also influence the extent to which the disease is expressed and directly impacts yield. The 2012 seasonal conditions were not conducive to significant levels of foliar disease and there were no obvious signs of root disease throughout the trial. However, chemical fallow and LPT rotations both reduce the risk of leaf disease for following cereal crops but unlike a chemical fallow, a grassy pasture also acts as a host for cereal root diseases and nematodes. A chemical fallow provides a true break from cereal root and leaf diseases.

Strategic winter fallowing provides the opportunity for earlier crop establishment in the following season. Farmers can take advantage of stored soil moisture and lower weed pressure on these fallowed paddocks, and have the confidence to sow into these paddocks first in the following season. For winter crops, earlier planting improves the conversion of water into biomass and grain because it allows the crop to mature in more favourable conditions in early spring *(Anon, 2009)*. This opportunity is of particular importance in seasons with a late opening break, where non-selective weed control is often compromised and the priority to wait for knockdown opportunities is over-ridden by the necessity to complete cropping programs by a certain calendar date. Furthermore, this strategy allows farmers to continue sowing wheat crops consecutively after a fallow but maintain a better long-term return, due to the enhanced weed control in the fallow year. It was concluded that the WUE of the wheat on chemical fallow rotation was twice as efficient as the continuous wheat rotation, even though the rotations were subjected to the same sowing date. The soil in the wheat on chemical fallow plots had a greater ability to capture and store water and the following wheat crop had access to water stored in the soil and rainfall during the season. Therefore, it had a greater ability to convert water into biomass and ultimately had a higher harvest index. The improved efficacy of water use from chemical fallow was demonstrated in this particular trial, regardless of the fact that the effect of early establishment on yield was not investigated.

Strategic fallow in itself means strategically selecting paddocks for fallow rotations. Soil type, ground cover and identifying sub-soil constraints are some of the considerations required for strategically selecting fallow paddocks. There was a physical hard pan throughout the trial site. This could have been a limiting factor for root exploration, potentially reducing the utilisation of soil moisture further down the profile and therefore decreasing yield responses from the previous fallow rotation. However, this study has shown that the roots from the wheat on chemical fallow treatments were further down the soil profile than the roots from the continuous wheat treatments. This may be due to the soil in the wheat on chemical fallow plot retaining moisture from 2011 and over the summer, resulting in the soil profile being softer and root penetration being easier. Other sub-soil constraints such as low pH or high aluminium levels may also limit root exploration, preventing the following crop from utilising the retained sub-soil moisture. Adequate ground cover is also a requirement when selecting paddocks for fallow, to minimise wind and water erosion risk. Farmers should strategically cut stubble’s high when harvesting paddocks the year prior to a fallow rotation. Soil types prone to wind erosion should be avoided for fallow selection. Medium to heavy soil types are less prone to erosion and have larger water-holding capacities. This is critical for fallow selection, as the retention of stored water it a vital component to receiving yield responses the following year.

The chemical fallow return on investment (ROI) will vary between seasons and individual businesses. Values have not been placed on overheads in this trial as they will be different for each farm, nor has a value been factored in regarding the weed reduction and its potential longer term benefits or potential savings on disease management. During a chemical fallow phase there is only the one season's fertiliser and operational costs, one season's wear and tear on a more harvestable crop, and only one seeding and harvesting operation instead of two. Thus, the ROI is greater because there is a return of two crops but at one year's expense. When funds are limited and growers need to be risk averse, chemical fallow is a strategy with many benefits. Although this study only investigated fallow over two seasons, and those seasons could not have been more extreme, WA Northern and Eastern wheatbelt farmers increasingly have to deal with extreme variability, and consequently have to become more adept at managing risk. With sheep no longer present in many farming operations in these areas, strategically selecting paddocks for fallow within a farm rotation reduces financial and agronomic risks.

**Acknowledgements**
Darren Chitty and Meagan Pearce, Landmark Agronomists
The Mills Family.

**Paper reviewed by:** Meagan Pearce, Landmark and Grant Thompson, Crop Circle Consulting/Landmark.

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**Appendix 1**

| | Year | Inputs | $/ha |
|---|---|---|---|
| **Wheat on wheat** | | | |
| Income | 2011 | 1.6 t/ha at $230/t (AGP) | 368 |
| | 2012 | 0.8 t/ha at $310/t (AGP) | 248 |
| | | *Total Income* | *616* |
| Expenses | 2011 | Airseeder | 30 |
| | | Boomspray x 2 | 10 |
| | | Harvest | 35 |
| | | 50 kg/ha Wyalkatchem | 10 |
| | | 44 kg/ha DAP | 34 |
| | | 40 kg/ha Urea | 25 |
| | | Knockdown | 13 |
| | | Jaguar + LVE | 16 |
| | 2012 | Airseeder | 30 |
| | | Boomspray x 2 | 10 |
| | | Harvest | 35 |
| | | 50kg/ha Wyalkatchem | 10 |
| | | 50kg/ha DAP | 30 |
| | | 50kg/ha Urea | 31 |
| | | Knockdown | 21 |
| | | Jaguar + LVE + Zinc | 10 |
| | | *Total Expenses* | *350* |
| **Wheat on wheat 11/12 gross margin $/ha** | | | **266** |

| | | | |
|---|---|---|---|
| **Wheat on LPT 11/12 Gross Margin $/ha** | | | |
| Income | 2011 | | 0 |
| | 2012 | 1.2 t/ha at $340/t (APW) | 408 |
| | | *Total Income* | *408* |
| Expenses | 2011 | Boomspray x 2 | 10 |
| | | Spraytopping | 21 |
| | 2012 | Airseeder | 30 |
| | | Boomspray x 2 | 10 |
| | | Harvest | 35 |
| | | 50 kg/ha Wyalkatchem | 10 |
| | | 50 kg/ha DAP | 30 |
| | | 50 kg/ha Urea | 31 |
| | | Knockdown | 21 |
| | | Jaguar + LVE + Zinc | 10 |
| | | *Total Expenses* | *208* |
| **Wheat on LPT 11/12 gross margin $/ha** | | | **200** |

| | | | |
|---|---|---|---|
| **Wheat on chemical fallow** | | | |
| Income | 2011 | | 0 |
| | 2012 | 1.6 t/ha at $340/t (APW) | 544 |
| | | *Total Income* | *544* |
| Expenses | 2011 | Boomspray x 2 | 10 |
| | | Knockdowns | 41 |
| | 2012 | Airseeder | 30 |
| | | Boomspray x 2 | 10 |
| | | Harvest | 35 |
| | | 50 kg/ha Wyalkatchem | 10 |
| | | 50 kg/ha DAP | 30 |
| | | 50 kg/ha Urea | 31 |
| | | Knockdown | 21 |
| | | Jaguar + LVE + Zinc | 10 |
| | | *Total Expenses* | *228* |
| **Wheat on chemical fallow 11/12 gross margin $/ha** | | | **316** |

*All input and commodity prices used to calculate the results were current when each operation occurred. Results may vary slightly.