# The effect of agronomic management on gross margins from crop sequences in the high rainfall zone of south western Victoria

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## Abstract
Alternating cereal crops with canola and pulses has been shown to mitigate disease and weed pressures, with pulse crops potentially providing an additional source of nitrogen (N). However, there is a lack of information regarding the financial effect of agronomic management on crop sequence profitability. Two separate crop competitions were conducted at Inverleigh and Lake Bolac in the high rainfall zone of south western Victoria from 2011 to 2013. At each site plots were established for competing teams to grow and manage their respective sequence of pulse, canola and wheat crops. Teams consisted of either, farmers, advisers, researchers or academics, competing to achieve the highest yearly and three year rotational gross margin. The choice of pulse and crop variety, sowing, in-crop management and grain marketing were at the discretion of each team. Both crop competitions showed large variations in returns, despite all teams growing identical sequences of crops on the same soil types and receiving the same amounts of rainfall. Teams that produced high yielding crops whilst minimising their costs of production achieved higher margins, with the winning teams generating an extra $1379/ha and $1724/ha over the course of the competition compared with the worst performing teams at the Inverleigh and Lake Bolac sites, respectively. Effective weed control; conservative N fertiliser application to canola and wheat; timely fungicide applications to the pulse and wheat crops; and the selection of long seasoned wheat varieties that capitalised on favourable late growing season conditions in 2013 were influential strategies for increasing gross margins.

## Key words
Pulse, canola, wheat, break crop, crop sequence, gross margin.

## Introduction
Yields from continuous cereal cropping often decline from a build-up of soil or stubble borne diseases, or diminishing soil N supply (Kirkegaard et al. 2008). Rotating cereals with canola and pulses (break crops) can disrupt disease cycles, with pulse crops providing N fixed from the atmosphere (Peoples et al. 2001), and potentially supplying a cheaper source of N to following crops. N derived from pulse crops have the potential to reduce the cost of production, with N fertiliser representing a significant variable cost for most commercial grain growers (McClelland and Norton 2014). Furthermore, different herbicides are used to control weeds in break crops compared with cereals, and less frequent use of herbicides with the same mode of action can slow the development of herbicide resistant weed populations.

While the benefits of including break crops in crop sequences are well documented, there is often a lack of information regarding the financial implications of agronomic management on the viability of crop sequences that include pulse crops. Gross margins help evaluate the financial effect of agronomic decision making across similar enterprises, however, they do not account for all fixed and overhead costs (eg depreciation, interest payments, rates, or permanent labour) and are a guide to profitability (PIRSA 2014). In this paper we compare yield, variable and some fixed costs and net income from teams competing to achieve the highest gross margin from two separate crop competitions conducted in south western Victoria. Thus identifying the key agronomic management strategies, that can enhance financial returns from crop sequences in the high rainfall zone.

## Methods
Two crop competition sites were established at Inverleigh (143$^{o}$9’E, 38$^{o}$09’S) and Lake Bolac (142$^{o}$8’E, 37$^{o}$72’S) in south west Victoria, commencing in 2011 and finishing in 2013. At each site, eight 2 x 12 m

plots were allocated to each competing team to grow and manage their respective sequences of crops over the three year period. Each team consisted of either farmers, advisers, researchers or academics, competing against one another to achieve the highest yearly and three year rotational gross margin. The choice of pulse and crop variety, sowing and in-crop management and grain marketing were at the discretion of each team. However, a pulse had to be grown in 2011, and all teams chose to grow canola in 2012, followed by a compulsory wheat crop in 2013. Any team that did not compete for the full three years of the sequence or had failed wheat crops in 2013 have not been included in the results.

Nominated captains from each team directed management for each crop in the sequence through the Southern Farming Systems Trial Coordinator, who was then responsible for implementing the management on behalf of each team. The Trial Coordinator recorded the date, rate and cost for every management input imposed by each team. Grain yield for each crop was measured by mechanically harvesting each plot, and a grain sub-sample retained for quality assessment. Gross margins were calculated by multiplying grain yield by price determined by grain quality and corresponding grain segregation, less variable and some fixed costs (Table 1).

**Table 1. Variable and some fixed costs ($/ha) for each team at Inverleigh and Lake Bolac, from 2011 to 2013, in south west Victoria.**

| | Inverleigh | | | | | | Lake Bolac | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Team | A | B | C | D | E | F | G | H | I | J | K | L | M |
| **2011** | | | | | | | | | | | | | |
| Seed[1] | 174 | 269 | 228 | 106 | 151 | 167 | 244 | 108 | 282 | 295 | 68 | 103 | 155 |
| Fertiliser[2] | 100 | 0 | 67 | 59 | 65 | 54 | 65 | 136 | 64 | 104 | 67 | 50 | 58 |
| Herbicide[3] | 57 | 27 | 108 | 41 | 39 | 36 | 45 | 19 | 35 | 36 | 28 | 28 | 23 |
| Insecticide | 0 | 0 | 0 | 3 | 0 | 4 | 2 | 0 | 0 | 0 | 0 | 0 | 32 |
| Fungicide | 20 | 0 | 11 | 0 | 0 | 0 | 42 | 0 | 50 | 26 | 0 | 0 | 0 |
| Fixed[4] | 175 | 80 | 155 | 165 | 160 | 165 | 175 | 105 | 175 | 165 | 155 | 145 | 103 |
| Total | 526 | 376 | 569 | 374 | 415 | 426 | 573 | 368 | 606 | 626 | 318 | 326 | 371 |
| **2012** | | | | | | | | | | | | | |
| Seed[1] | 64 | 59 | 71 | 71 | 71 | 71 | 71 | 51 | 51 | 71 | 39 | 34 | 94 |
| Fertiliser[2] | 181 | 125 | 132 | 197 | 165 | 161 | 136 | 279 | 146 | 183 | 128 | 778 | 239 |
| Herbicide[3] | 50 | 44 | 64 | 60 | 22 | 40 | 28 | 69 | 47 | 48 | 36 | 28 | 19 |
| Insecticide | 0 | 1 | 2 | 32 | 25 | 31 | 41 | 41 | 41 | 41 | 41 | 82 | 41 |
| Fungicide | 8 | 16 | 8 | 8 | 10 | 7 | 0 | 0 | 8 | 8 | 8 | 0 | 32 |
| Fixed[4] | 169 | 207 | 179 | 191 | 181 | 171 | 167 | 189 | 167 | 189 | 167 | 601 | 209 |
| Total | 472 | 452 | 456 | 559 | 474 | 481 | 443 | 629 | 460 | 540 | 419 | 1523[5] | 634 |
| **2013** | | | | | | | | | | | | | |
| Seed[1] | 81 | 86 | 72 | 90 | 90 | 77 | 90 | 81 | 81 | 81 | 81 | 86 | 81 |
| Fertiliser[2] | 116 | 258 | 135 | 124 | 149 | 156 | 113 | 99 | 123 | 142 | 123 | 156 | 153 |
| Herbicide[3] | 61 | 19 | 27 | 21 | 75 | 47 | 62 | 86 | 82 | 49 | 52 | 54 | 44 |
| Insecticide | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Fungicide | 0 | 22 | 7 | 14 | 16 | 2 | 0 | 0 | 6 | 13 | 19 | 32 | 19 |
| Fixed[4] | 147 | 169 | 157 | 147 | 169 | 169 | 137 | 147 | 157 | 181 | 147 | 179 | 137 |
| Total | 405 | 554 | 398 | 396 | 499 | 451 | 402 | 413 | 449 | 466 | 422 | 507 | 434 |

[1]Includes seed dressings and inoculants, [2]Includes seedbed and in-season fertiliser applications, [3]Includes pre and post emergence herbicides and adjuvants, [4]Includes sowing, fertilising, spraying and harvesting operations, [5] Includes subsoil manure treatment.

## Results and Discussion

Team D and J achieved the highest 3 year rotational gross margins at the respective Inverleigh and Lake Bolac sites, achieved largely from high returns during the pulse crop in the sequence (Table 2). Teams that decided to brown manure or achieved low yielding or failed pulse crops largely resulting from poor weed control in year 1, experienced lower rotational gross margins. Generally higher yielding crops translated into higher gross margins, with the exception of Team L who chose to subsoil manure before planting the second crop in the sequence, a costly operation that negatively affected income.

Effective weed control and timely fungicide treatments in the first crop (2011) at both sites strongly influenced pulse yield and gross margin. At Inverleigh, pulse yields were higher where post emergence herbicides were applied to control wild radish. Weed control at Lake Bolac was entirely dependent on incorporating pre-emergent herbicide at sowing; teams opting to spray later were unable to control annual ryegrass populations that were resistant to some in-crop herbicide treatments, resulting in unplanned brown manure and silage crops.

**Table 2. Yearly grain yield (GY) and yearly and rotational (3 years) total cost (TC) and gross margin (GM) for each team at Inverleigh and Lake Bolac from 2011 to 2013, in south west Victoria.**

| Team | 2011 Pulse | | | | 2012 Canola | | | | 2013 Wheat | | | | 3 Year | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Crop | GY t/ha | TC $/ha | GM $/ha | Variety | GY t/ha | TC $/ha | GM $/ha | Variety | GY t/ha | TC $/ha | GM $/ha | TC $/ha | GM $/ha |
| | | | | | | | *Inverleigh* | | | | | | | |
| A | Faba Bean | 2.77 | 526 | 277 | Hyola 555TT | 3.05 | 472 | 1295 | Bolac | 7.06 | 405 | 1403 | 1403 | 2975 |
| B | Faba Bean | 0.00[A] | 376 | -376 | Hyola 971CL | 3.44 | 452 | 1460 | Elmore CL+ | 5.64 | 554 | 1124 | 1382 | 2208 |
| C | Faba Bean | 4.11 | 569 | 653 | Hyola 575CL | 3.10 | 456 | 1308 | Phantom | 5.7 | 398 | 1038 | 1423 | 2999 |
| D | Lupin | 3.46 | 374 | 543 | Hyola 575CL | 2.83 | 559 | 1003 | Revenue | 7.38 | 396 | 1853 | 1329 | 3399 |
| E | Field Pea | 2.28 | 415 | 332 | Hyola 555TT | 2.47 | 474 | 914 | Beaufort | 5.37 | 499 | 774 | 1388 | 2020 |
| F | Field Pea | 2.26 | 426 | 191 | Hyola 575CL | 2.88 | 481 | 1105 | Phantom | 5.97 | 451 | 1120 | 1358 | 2416 |
| | | | | | | | *Lake Bolac* | | | | | | | |
| G | Faba Bean | 2.06 | 573 | 24 | Hyola 505RR | 2.45 | 443 | 960 | Scout | 6.30 | 402 | 1338 | 1418 | 2322 |
| H | Faba Bean | 0.00[B] | 368 | -368 | Thumper TT | 2.39 | 629 | 628 | Beaufort | 3.70 | 413 | 462 | 1410 | 722 |
| I | Faba Bean | 3.08 | 606 | 287 | Crusher TT | 2.37 | 460 | 821 | Phantom | 5.06 | 449 | 884 | 1515 | 1992 |
| J | Faba Bean | 4.05 | 626 | 562 | Hyola 555TT | 2.36 | 540 | 767 | Phantom | 5.64 | 466 | 1117 | 1632 | 2446 |
| K | Lupin | 1.59 | 318 | 103 | Garnet | 2.50 | 419 | 1050 | Revenue | 6.18 | 422 | 1220 | 1159 | 2373 |
| L | Field Pea | 1.45 | 326 | -154 | Cougar RR | 3.51 | 1523[D] | 228 | Revenue | 7.17 | 507 | 1247 | 2356 | 1321 |
| M | Field Pea | 0.00[B] | 371 | 0[C] | Taurus | 2.07 | 634 | 652[E] | Phantom | 5.96 | 434 | 1141 | 1439 | 1793 |

[A]planned brown manure, [B]failed crop due to inadequate weed control, [C]includes income from silage cut, [D]subsoil manured treatment, [E]includes income from grazing over summer.

Financial returns from canola and wheat at both sites were largely driven by robust herbicide programs that minimised weed pressures, along with conservative N fertiliser applications and longer seasoned variety selection. Weed control strongly influenced crop performance and returns, with wild radish control at Inverleigh crucial in the 2012 canola crops and herbicide resistant annual ryegrass at Lake Bolac affecting wheat yields in 2013. Ineffective weed control was observed in Team E at Inverleigh, who applied Atrazine post emergent but did not follow up with a second application later in the season, resulting in unsatisfactory wild radish control and a 20% reduction in canola yield. At Lake Bolac in 2013 there were three failed wheat crops (data not shown) due to poor weed control; crops were overrun by annual ryegrass with weed biomass exceeding 6 t DM/ha. Generally teams applied conservative rates of N fertiliser, most underestimating demand especially in the 2013 wheat crop, when grain protein levels were well below 11.5%. Several team captains expressed concern that the pre-sowing deep soil testing over-estimated plant available N levels, although at Inverleigh Team B outlaid an extra $100/ha on N fertiliser in the wheat crop compared with any other team, with no measurable yield or quality advantage at a loss of income. The choice of the long seasoned and historically high yielding wheat variety Revenue, increased returns at both sites in a season receiving above average spring rainfall. Forward grain marketing didn't play a significant part in the outcome of the competition in the first or second year. In 2013 some Inverleigh teams lost inconsequential amounts from theirgross margin due to poorly timed forward sales. Team L at Lake Bolac oversold their final wheat yield, losing $165 from their 2013 wheat gross margin.

The cost per tonne of grain produced ($/t) was a highly significant ($P$<0.001) indicator of financial returns from each crop in the sequence (Figure 1). Cost structures across all teams were similar (Table 1) with the exception of Team L, whose investment into subsoil manure was not offset by subsequent yields and returns from canola and wheat (Table 2). Subsoil manure is likely to provide longer term yield responses (Sale *et al*. 2012) and a three year study insufficient time to assess the economic merits of this strategy; furthermore other trials have found the Lake Bolac soil less responsive to manuring perhaps from low subsoil clay contents. Nonetheless, the additional cost incurred by Team L's decision to subsoil manure, meant that the cost per tonne of grain produced was a better predictor of gross margin than simply grain yield.

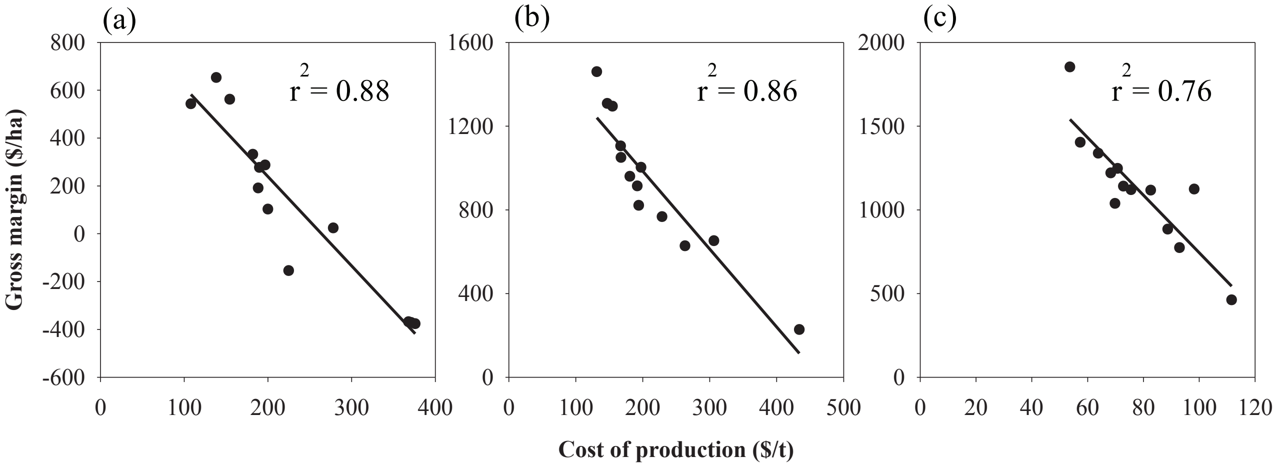


**Figure 1. Relationship between the cost per tonne of grain produced and gross margin in the pulse (a), canola (b) and wheat (c) crops, at Inverleigh and Lake Bolac in south west Victoria.**

## Conclusion

Crop competitions showed large variations in returns, despite all teams growing identical sequences of crops on the same soil types and receiving the same amounts of rainfall at the respective Inverleigh and Lake Bolac sites. The teams achieving the highest financial returns were those that produced high yielding crops whilst minimising their costs of production, reducing weed pressures through effective herbicide programs, combined with conservative in-crop N fertiliser applications and choice of longer seasoned wheat variety suited to above average spring rainfall received in 2013.


## Acknowledgements

We thank the GRDC for funding and field staff from Southern Farming Systems.


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