Reducing chemical use in broadacre crops

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The use of chemicals in broadacre cropping has been a major concern to the agricultural industry. Not only are there issues with development of resistance in weeds and pests, but also environmental damage, toxicity harming wildlife and humans, with an inflation of pest and disease control costs in the grain industry.

Biological control: *Phasmarhabditis hermaphrodita*
- Numerous crops are damaged by pests and yield is reduced. For example, the grey field slug (*Deroceras reticulatum*) in canola (Ester & Wilson 2005).
- A parasitic nematode, *Phasmarhabditis hermaphrodita*, has been proven to act as a suitable alternative to chemicals (Wynne, Morris & Rae 2016):
  - Causes death in slugs after invasion (Wynne, Morris & Rae 2016)
  - Manipulates host behaviour, resulting in high mortality (Morris et al. 2018)

While experiments on canola are limited, the in-field experiments on other crops have demonstrated *Phasmarhabditis hermaphrodita* to be a possible protection method against slugs.

Biopesticides: *Bacillus thuringiensis* and Chitinases
- Derived from biological sources, biopesticides can be used as a prevention/treatment for pests/weeds/diseases.
- *Bacillus thuringiensis*:
  - A soil-borne bacteria used extensively as a selective insecticide against the Cotton Bollworm (*Helicoverpa armigera*) (Joshi 2006)
  - It can be applied as a spray or genetically incorporated into the crop (*Bt* cotton) (Joshi 2006).
- Chitinases:
  - Can be sourced from microbes or viruses.
  - Capable of digesting the chitin present in fungi providing selective treatment to infected plants (Singh 2013).
  - Have no negative effects on the wider environment (Berini 2018, pg. 818).
  - Effectiveness is based on the host and is therefore variable. Further research is required.

Genetically Modified Crops as part of Integrated Pest Management (IPM)
- Genetically modified (GM) crops aim to build immunity in crops (Huang, 2003).
- Use of GM crops in integrated pest management schemes have been shown to reduce chemical use (Huang, 2003).
- GM crops face heavy criticism and are legally banned in some countries (Hobbs and Plunkett, 2000).
- To increase use, education is recommended:
  - Show the in-field benefits to farmers in developing countries (Mbabazi, 2016).
  - Use universities and government institution education programs to teach the general public (Mbabazi, 2016).

General IPM control
- Overuse of insecticides has lead to: resistance of 600 species world wide and toxicity impacting humans and the environment (Maino et al., 2017).
- Pest management costs AUD $77/hectare annually, representing 19.5% of the crop’s value (Wright et al., 2018).
- Integrated pest management (IPM) involves the use of beneficial insects/arachnids, cultural and chemicals (EPA, 2017).
- Benefits include decreased costs (and increased profits) and protection of human welfare.
- This is an underutilised method despite its great possibilities demonstrated by its success within horticulture (Gül et al., 2017). Small alterations are required to increase its suitability to broadacre cropping.

Conclusion/Recommendations
The overall recommendation for this sustainability challenge is via stakeholders (advisors and agronomists) to convince farmers to adopt the non-chemical IPM methods in Australian broadacre farming. This knowledge could be delivered by conducting University supported conferences, with specialists, researchers, advisors, agronomists or farmers to speak about IPM and their suggestions on improving crop health and yield. Regional field days can also demonstrate how these IPM methods can potentially be an effective and successful alternative control against broadacre crop pests.