the benefit of break crops
in stubble retained systems in Central West NSW

Project code CWF00018

KEY MESSAGES

- Break crops provide a strategy to break pest, weed and disease cycles in farming systems.
- The economics of break crops need to be carefully examined by individual businesses. The same crop or sequence will not suit every enterprise.
- Lucerne based pastures are an important break crop for cereals across the CWFS region. Critical issues appear to be establishment, weed management at the end of the lucerne phase and amount of stored soil water for the following crop.
- The most profitable rotation determined from long term trials at Merriwagga has been two cereals following a break crop of either peas or canola.

A break crop is any crop that can provide diversity to a cropping rotation. This diversity often addresses issues such as diseases, weeds and nutrient deficiencies. In a stubble retained system it is often found that the stubble is providing an ideal environment for diseases and weeds.

A break crop is a unique opportunity to provide a targeted strategy towards pests, weeds and diseases. An example of this would be using a broad leaf crop in a specific paddock to broaden the range of herbicides that can be used on the grass weeds in that paddock.

The ongoing inclusion of break crops in a sequential cropping rotation is termed as crop sequencing and quite often includes a series of broad leaf crops followed by a series of cereal crops.

Crop sequencing has been shown to provide ongoing benefits with regard to the control of weeds and diseases, improvements in soil structure, increased soil moisture carry over into the next season and increased nitrogen production and availability.

Within the CWFS region of Central West NSW, break crops are generally winter species. This is due to the consideration that summer rainfall is often irregular, day time temperatures often reach beyond 40 degrees and the potential of crop failure is high.
Additionally rainfall accumulated in a summer fallow can contribute up to 50–60 per cent of winter cereal’s moisture needs in Central West NSW.

Winter break crops include canola/Monola®, field peas, vetch, lupins, chick peas and to a lesser extent faba beans.

As a general observation over the CWFS region, vetch is seen to be more common in the southern areas; field peas and lupins in the central areas and chick peas in the northern areas. Canola is seen to be common across all the regions. However the choice of break crop can and will vary over time and between seasons due to a multitude of economic and market factors.

Impacts on weeds

Break crops and herbicide resistance:

A population of weeds is classified as being herbicide resistant when the herbicide that once controlled the weed under consideration no longer works. By using a break crop it is possible to provide as many as five integrated weed options.

1. Modes of action: When a herbicide is designed to kill a specific weed, the herbicide is selected based on its mode of action. To explain further, a ‘mode of action’ is simply the way a chemical interrupts a plant’s growth process. An example of this may be a chemical that attacks the roots of the plant, which limits the weed’s potential to compete with the crop. By using a break crop an opportunity is created to change the mode of action of the chemistry used within the crop, which means that we can rotate between chemicals and potentially achieve a higher level of weed control.

2. Crop topping: Crop topping and desiccation, although similar, provide separate outcomes within a break crop. Desiccation prepares the crop for harvest, and crop topping aims to stop weed seed set within a crop.

   It must be noted that crop topping is not suitable for all pulses. Suitable crops for crop topping are narrow leaf lupins, lentils, field peas and faba beans. This method of weed control is considered to be useful for reducing annual ryegrass and wild radish seed numbers. Crop topping is best applied at crop maturity when the weed seeds are at the soft milky dough stage. This control strategy should be a component of an integrated weed management plan and not be used in isolation.

   It should be noted that when pulse crops are desiccated there is a further benefit in relation to nitrogen fixation.

3. Hay cutting: The use of pulses for hay provides a number of options for weed control. The hay cuts should coincide with the weed’s seed development stage. A common practice is to cut in time to halt the development of weed seed sets as well as to follow up with an additional spray, usually glyphosate, to capture any new emerging weed seedlings.

4 and 5. Green and brown manuring:

   Both practices serve as a useful tool when it comes to addressing weed and disease burdens.

   Green manuring is when the crop and weeds are killed by cultivation before reaching maturity.

   Brown manuring is defined by growing a crop with the goal of applying a knock down herbicide to prevent weed seed set and provide ground cover through summer.

Soil health

Break crops have the potential to improve soil health in a variety of ways. For example, canola breaks various disease cycles for cereal crops and vetch can increase N as well as providing a dense population of organic material in the soil via its large root mass.

The manuring of break crops has been shown to increase the soil’s drainage potential, water retention and microbiology. In hard setting or compacted soils, crops such as tillage radish or safflower can be used as ‘biological ploughs’ with their strong tap roots opening the compacted soil and leaving channels as the roots decay.

Disease control

Cereal rotations within stubble retained systems increases the risk of soil borne root diseases and associated stubble diseases, such as yellow leaf spot and crownrot.

By incorporating a break crop into the rotation, such as canola, it has been shown to reduce disease inoculum levels significantly.

Break crops (pulses or legumes) provide cereal disease control via a number of methods— they do not host many cereal diseases, provide a variety of weed control options that break both the disease residue and green bridges; and the carry over nitrogen from pulse break crops provides improved cereal plant health and vigour.

Break crops such as canola and faba beans provide an ideal environment for cereal stubble decomposition.

However a break crop will only be effective in controlling successive cereal crop diseases if weed hosts are controlled and cereal disease inoculum (plant residue) is broken down and destroyed.

Role of pastures as a break crop

Pastures are an essential component of most sustainable mixed livestock and cropping systems in Central West NSW. Well managed pastures can reduce nitrogen fertiliser input and increase grain yields in following crops. A legume based pasture phase is necessary to help maintain soil organic carbon and nitrogen levels. Improved pastures are a valuable source of livestock fodder.

Permanent legume based pastures, with tactical graze/spell management and legume based pasture phases in rotation with crops, can directly contribute to the soil by way of more organic matter, soil nitrogen, beneficial soil organisms, better soil structure, water infiltration and water holding capacity. This reduces the rate of soil degradation; can reverse the decline in the productiveness of soils and improve the long term viability of the farm business.

Semi-winter dormant lucerne (5 to 7 on dormancy scale) is the most popular legume pasture grown in Central Western NSW. They are often sown with a companion medic or clover species to provide winter active legumes.
Results and discussion:
Economic comparisons:
Over the 15 years some clear trends have been identified. It should be noted that the costs are at contractor rates to provide a comparison of the real costs associated with each farming system.
- No-till farming methods have either maintained or increased yield under continuous cropping rotations. Although this was not the case when a fallow was included in the rotation, in this instance cultivation tended to increase yields.
- When looking at growing crops in no-till systems, the no till farming techniques have been on average 15 per cent cheaper than when cultivation is used.
- The most profitable rotation has appeared to be two cereals following a break crop of either peas or canola under no-till systems. Even though the continuous wheat appeared to be close behind, there is a greater agronomic risk involved when accounting for weed, moisture and disease pressures.

Nutrition:
The nutritional variation between no-till and cultivation treatments was not statistically different. However a consistent difference between the different rotations was observed. Overall the rotations with fallows or peas proved to have significantly higher levels of soil nitrogen.

Another interesting point to make was the steady increase of Colwell phosphorous. This may be due to the fact that during the drought years, more P was added to the system than the crops were removing.

Weeds:
Overall the no-till rotations have hosted fewer weeds than the cultivated rotations. This is thought to be as a result of better herbicide efficacy in no-till systems with the use of pre-emergent herbicides and also the increased weed persistence through seed burial in cultivated systems.

As expected, the rotations with fallow periods tended to be the cleanest. The rotations with field peas often hosted higher levels of fumitory.

Use of cover crops in establishment of pastures
There has been much research on whether a cover crop is beneficial to establishment of pasture. In most cases the cover crop is viewed as cash return for the cost of sowing the pasture, but in lower rainfall areas like Central West NSW the economics of this and the practicalities of sowing should be explored on a seasonal basis.

Richard Hayes (NSW DPI) presented at the 2015 GRDC Grains Research Update at Parkes on cover crops for undersown pastures in CWFS districts. His conclusions are that a cover crop in all but the wettest of seasons is detrimental to the establishment of undersown pastures and could well be a false economy when future grazing and nitrogen fixation is considered.

Watch Richard Hayes (NSW DPI) speak on the pros and cons of cover crops in pasture establishment in central western NSW, at the GRDC Grains Research Update at Parkes on 28 July 2015 or follow link below:
https://www.youtube.com/watch?v=U89NQw42e8E
The continuous wheat rotations were at the stage where ryegrass had begun to outcompete the crop by 2007, eight years into the trial. Pre-emergent herbicide strategies have now reduced ryegrass levels to a level where they are not so different from the other rotations.

View the full Merriwagga tillage and rotation trial 2014/15 or follow link below:


**Case study 1:**

**Field peas**

**Grower:** Geoff McCallum, NorthParkes mine Enterprises: Cereal, legumes, canola.

**Soil and pH:** Clay and red soils.

**Property size:** 4000 ha.

**Overview:**

North Parkes mine is located approximately 80 km north west of Parkes, Central West NSW. Surrounding the mine is a commercial cropping operation which is managed by Geoff McCallum, who has over thirty years of farm management experience in both the medium and low rainfall zones of NSW and Victoria.

Geoff plants approximately a quarter of the cropping area to legumes, a quarter to canola and the rest cereal, usually a quarter wheat and a quarter barley.

Fifteen years ago Geoff introduced conservation farming methods to the farm; with all crops now inter-row sown into retained stubble via a tine air seeder on 30 cm row spacing, using 2 cm GPS guidance. Keeping an eye out for new ideas that could benefit their cropping activities, three years ago Geoff decided to implement the outcomes of GRDC research which identified the benefits of brown manuring the grain legume field peas within a pea-canola-cereal-cereal rotation.

In this rotation field peas provide a fallow period following the brown manuring.

Brown manuring field peas for a fallow period has been shown to increase soil moisture and soil carbon; provide significant nitrogen into a system and also has the ability to assist in addressing herbicide resistance via a complete kill of all weeds during the manuring process. Geoff likes the field peas compared to other break crops as they provide the option to use a greater array of herbicides during the manuring process and they consume less moisture and nutrients leaving more for the following crop in the rotation. This assists in reducing the next season’s nitrogen budget, and provides the ability for the next crop to survive and produce during a dry season due to the available soil moisture. However, the issue of removing one year’s income from a cropping rotation is a serious consideration and investigation into the different options available to provide cash income from the pea crop is being conducted.

Morgan peas are the predominant variety grown due to their upright behaviour and production of biomass in either dry or wet years. They handle well in an auger; set pods well and produce a large biomass.

In 2013 the variety “Hayman” was trialled. This variety has the ability to grow more dry matter than the Morgan. However, they are a later variety and may require earlier sowing, good rainfall or irrigation to ensure a good pod fill.

In any given year, within the legume crop approximately one fifth of that area is retained for seed production for use either the following season or for sale.

Due to the distance from the point of sale and the glut of peas at the time of harvest, Geoff believes that a better option is to store the seed and sell when prices are at a premium, or retain for future usage in the event of a seed crop failure.

**Sowing:**

At the start of the cropping rotation, peas are sown into the previous year’s cereal stubble with no fertilizer and at a sowing rate of 80 - 100 kg per ha; well above the recommended 35 kg per ha.

This is done to achieve the highest pea biomass early in the season; to ensure a good germination rate and limit weed growth via shading and competition for nutrients.

At the time of sowing pea inoculant is sown with the seed and applied at 1.5 times above the recommended levels. This is done to ensure no margin for error; ensuring high rates of root nodulation and providing the maximum opportunity for optimum nitrogen fixation.

Sowing the next rotation crop of canola into the thick mat of the previous year’s pea stubble has required some creative thinking, as well as additions to the sowing equipment. The residual mat of pea biomass must be dry when sowing into it.

This was identified on a previous occasion when the combination of wet pea residue combined with the wet clay soils found on the mine site required the seeder to ‘lift and loop’ up to 8 times per run – impacting upon evenness of sowing and the cost effectiveness of the sowing operation.

To get through the pea mat, coulter points have had to be installed on the tine seeder and serious consideration has been given to the timing of the brown manuring. When brown manured on the point of flowering, the pea stems are un-lignified and break up relatively easily when dry. If brown manuring post-flowering and at pod set, the stems are lignified and do not break as easily when dry.

Although brown manuring at a later stage can produce higher amounts of biomass and nitrogen, it has been found to be of limited value if you cannot plant into it the following season. Consequently, the brown manuring is targeted to occur at flowering.
Weed control:
After 17 years of conservation farming, herbicide resistance has been encountered at the mine site. The brown manuring process has been introduced to assist in addressing this issue.

Brown manuring provides a high knockdown rate of all weed species at their infant stage, when they are most susceptible to a herbicide application.

The timing of brown manuring has been trialled using three different stages of the pea’s life cycle. This trial demonstrated that at the mine they are better to spray on the point of flowering to gain the moisture effects for the fallow, achieve a high level of weed control and reduce the lignification of the pea mass.

In 2013 brown manuring was required on two occasions as approximately one weed per square metre survived, which was considered to be due to the peas impacting upon herbicide coverage. Although this increased expenditure, it was considered worthwhile to achieve full weed control.

The field pea-canola components of the rotation further provides two broadleaf break crops in succession, which enables the ability to control populations of grassy weeds and diseases prior to the cereal rotations.

Nitrogen:
Geoff has some concerns that the peas are not fixing as much N into the soil as expected. The soils are not acidic and rhizobium nodulation is advanced and healthy. He is considering using faba beans (to trial whether or not they will fix more N) and would like to see more research by grower and research groups into this.

Disease:
The cropping rotation of pea-canola-cereal-cereal allows for the correct period of time between crops to break the cycle of disease between the rotation components. Prior to the introduction of the pea and canola rotations, crown rot was an issue within cereal crops. However, the introduction of two years of broadleaf break crops has seemingly reduced the carry-over of crown rot between the cereal rotations; one of the main reasons Geoff started using peas as a break crop.

Peas are susceptible to a variety of diseases and there is some concern about the possibility of disease carry-over between pea crops (facilitated by a number of dry years) and reducing the ability of pea crop residue to break down, but as yet no issues have been experienced.

Some on-farm ‘time of sowing’ pea trials have occurred with ‘early sowing’ showing an increase in the risk of black spot; and late sowing providing limited N as well as a reduced pea biomass. Consequently for the mine site the best time for sowing has been identified as ‘early’ (mid-May). This strategy has reduced the risk of disease and has the added benefit of providing optimum rates of nitrogen fixation.

Stubble height of the previous crop is believed to be an issue that requires consideration when sowing peas into retained stubble. At the juvenile stage, a pea is susceptible to damage via abrasion which will increase the chance of infection. Consequently a stubble height of approximately 150 mm is considered to be the optimum height.

At the mine, stubble height is achieved via the general rule that stubble post-harvest should be the same as the row spacing, which is 30 cm, and this approach has not caused any disease issues to date. However, as 80 per cent of the pea crop is grown to become brown manure, disease is not a major concern.

Further on-farm investigation into peas at North Parkes Mine is occurring with green manuring to be trialed and the outcomes of the Hayman pea trial to be fully investigated. But for now, the brown manuring process and the Morgan peas have proven their worth and are considered to be a valuable component of the cropping rotation.

Harvest:
A harvest of 1.5-3 t per ha of pea seed is considered to be a good outcome; however if a hard dry spring with temperatures greater than 25 degrees is experienced, yields have been found to be ‘ordinary’.

Peas grown at North Parkes Mine have been harvested three ways, via direct heading, desiccation then direct heading and windrowing.

Windrowing is the preferred method of harvest followed by desiccation then direct heading. Consequently, desiccation followed by direct heading is the main method used. If timed properly, windrowing and desiccation of the field peas allows for their harvest prior to the windrowing of canola; which fits in well with Geoff’s harvesting program and ensures that the peas are harvested at their optimum time.

Harvesting of peas via direct heading has its own individual challenges; the Morgan variety displays upright growth behaviour. However, due to the large biomass produced, once seed is set they tend to lay down which means that the header has to harvest at a low height and slow speed which costs additional contractor’s time and risks damage to the header.

Due to the damage that has occurred in the past, an older header dedicated to the pea harvest is used by the contractor.

If the pea crop is rained upon, the mat of pea biomass develops the consistency of ‘chewing tobacco’ which blocks the header – consequently harvest must occur when the crop is dry.

Soil health, farm profitability and sustainability:
Overall, Geoff feels the soil structure and overall health has improved since using direct drill. Organic material is more visible and soil carbon in the 0-10 cm range has not decreased in fifteen years.

The soil is noticeably softer and crusting is no longer an issue.

The use of peas as a break crop has not only contributed to that improvement, but has helped to maintain profitability within his stubble retained system through more efficient weed and disease control and maintenance of soil nitrogen.

Listen to a podcast of Geoff’s case study or follow link below:

Case study 2:
Oats and lucerne
Grower: McDonald Brothers, Condobolin NSW
Enterprises: Cropping and sheep (Merinos and White Suffolks)
Soil and pH: Red loam, with pH of 4.5 to 5.5

Overview:
The McDonalds farm approximately 3000 ha of wheat and around 1000 ha of oats. They run a crop rotation that generally comprises of four to five years of cereals, followed by a four to five year pasture phase of lucerne and medic.

They also run 6000 merino ewes with half joined to White Suffolks.

Canola or Monola® is sown as an opportunity crop if the market is strong and soil moisture is adequate.

Yarran oats is sown as break crop in their cropping program for a variety of reasons; as a cover crop to establish lucerne and medic pastures, a cash crop, sheep fodder, to increase ground cover and to break disease cycles.

Thanks largely to a new oat milling business in Condobolin sourcing export markets for oats and oats by-products, oats is now a more profitable option (in 2013, $250/t was realised).

The McDonalds not only sow oats at the end of a cropping cycle as a cover crop for legumes, but also pre-fallow if a pasture has become compacted by a reduction in ground cover.

Pre-fallow 2013
Sowing:
In early March 2013, oats were direct drilled into a four year old lucerne and medic paddock that had become hard with thinning pasture plant populations. Oats were used as an opportunity crop, and in preparation for the coming wheat cycle by improving ground cover and increasing water infiltration.

No pre-spraying was undertaken. The oats were sown at 30 kg/ha with 25 kg/ha of monoammonium phosphate (MAP) using knife points and press wheels.

Because feed was plentiful and the crop was performing well under good conditions, the McDonalds decided not to graze the paddock or to spray it out for brown manure as would normally be the practice, but decided to allow the crop to mature to harvest.

Weed control:
No weed control was used in the opportunity crop as it was originally planned to brown manure the crop for fallow.

This resulted in a large increase in the population of barley grass to an extent the paddock was unable to be included in the wheat program for 2014.

The paddock was grazed post-harvest through until August 2014, then spray fallowed in preparation for a wheat crop in 2015.

Disease:
The initial use of oats in the existing lucerne pasture provides a good break to wheat and grass borne diseases, but a high population of barley grass encouraged by the tillage and fertilizer application created opportunity for pathogens such as rhizoctonia root rot, take-all and cereal cyst nematodes in the following wheat crop.

The decision to grow the crop to maturity, however, resulted in a good return on investment for a low input opportunity crop, provided stubble grazing for sheep until fallowing, and improved ground cover and moisture retention for the 2015 wheat crop.

Harvest:
The opportunity crop of Yarran yielded 1.85 t/ha of feed quality oats and was marketed through a local miller for $250/t.

Soil health, profitability and sustainability: Although the pre-sown oat crop uses some nutrients before the main cropping phase, once brown manured it gives the advantage of softening the soil and creating a superior seed bed, gives better control of weeds and is a disease break from existing grasses in the pasture phase.

It is not usual for a brown manure pre-cropping phase oat crop to become an opportunity cash crop except in exceptionally good seasons.

Pasture establishment 2014
Sowing:
In 2014 at the end of a cropping cycle, the McDonalds sowed 800 ha of Yarran oats at 10 kg/ha as a low density cover crop for lucerne and medics.

The oats were sown late March to early April and as a cash crop to offset the cost of establishing the pasture. MAP fertiliser was applied at 60 kg/ha mainly for the under-sown pastures. Lucerne was sown at a rate of 1.3 kg/ha, rose clover at 0.25 kg/ha and barrel medic at 1 kg/ha.

Since 2014 the McDonalds have increased the lucerne sowing rate to 2 kg/ha.

Weed Control:
In 2014 the McDonalds experienced a quite serious wild poppy problem. It affected most paddocks and the reason is not clear, but the under-sown crop was not sprayed as the pastures had not germinated to an extent to make spraying a viable economic option and the oats was to be retained on farm for their lamb feedlot.

Nitrogen:
The use of legume based pastures between cropping phases has long been a valuable tool for not only fixing N, but for the mixed farmer providing useful pastures. The oat cover crop itself obviously fixes no N but can be beneficial as a ‘shelter’ crop for emerging pasture seedlings (if not sown at too high a rate), and as a cash crop to offset the cost of pasture establishment.

Disease:
There were no disease issues with the oats; the McDonalds rarely have any disease issues (smut or bunt) with oats.

As the paddock will be going back into a four or five year pasture phase any carry-over of cereal root or stubble borne diseases are negated somewhat by the oats phase, unless the pastures are infested by wild oats or disease harboring grasses in the subsequent pasture phase.

Harvest:
The cover crop of oats performed quite well, yielding approximately 2t/ha after a dry finish. It was retained on farm for use in their lamb feedlot. The pastures had very poor germination and Graham is now considering re-sowing the pasture in a year or two.
Case study 3:
Peas and lupins
Grower: Derrick Davis, Lake Cargelligo, NSW
Enterprises: Wheat, lupins and field peas.
Soil and pH: Red loam/clay with a pH of 7.
Property size: 10,000 ha.

Overview:
The Davis’ annually grow approximately 6000 hectares of wheat, 2000 hectares of lupins and field peas and leave 1000 hectares long fallow.

They like to use Sturt field peas in their rotations as they can be sown earlier and provide rapid growth to provide thick biomass for brown manure, spraying in July/August while retaining about 20% for grain.

In the past, green manured crops were ploughed using offsets, but they have modified their system and are now brown manuring.

They tend to grow lupins more for grain as it tends to be higher yielding than peas and are simpler to bring to harvest.

Sowing:
Sowing of peas begins in April. The sowing rate depends on whether or not they are to be retained for seed or brown manured.

Pea biomass is generally not a problem as it is sprayed early enough before jointing becomes an issue. If being sown for purely brown manuring, i.e. not for seed retention, the peas are sown at a rate of 50-55 kg/ha with fertiliser (MAP) at a rate of 20 kg/ha.

Lupins are also sown in April at a rate of 65 kg/ha with a fertilizer (MAP) rate of 40 kg/ha. All seed is inoculated pre-sowing.

Weed Control:
One of the two main reasons the Davis’ use peas and lupins for break crops is weed control.

After continuous cropping for many years they had noticed an increase in the population of wild oats, ryegrass and barley grass, and since using these break crops control of these weed populations has improved greatly.

Nitrogen:
Costs of applying urea are greatly reduced with enough N in the soil after a pea or lupins break crop for two subsequent cereal crops, ensuring high levels of protein.

Disease:
The Davis’ experience very little disease in their cereals since growing pulse break crops with crown rot and take-all virtually non-existent.

Harvest:
The Davis’ have no issues with stubble management at harvest, as they have found inter-row sowing with a disc seeder eliminates any stubble issues, whether with break crops or cereal stubble.

Soil health, profitability and sustainability:
The major negative aspect of growing peas, and to lesser extent lupins, as break crops for the Davis’ is the cost of the operation.

Although it would be cheaper to just leave the paddocks out of operation and still gain weed control, the obvious benefits to soil health in microbial activity and the higher yields with higher protein (both approximately 20 per cent higher) not only compensate for the costs but leave the country in better condition into the future.

There is also more certainty in growing a higher yielding crop the following year regardless of the season. The decisions are certainly based on long term planning.

Listen to a podcast of Derrick’s case study or follow link below:

Case study 4:

**Vetch**
**Grower:** Michael Fitzner, Rankins Springs, NSW
**Enterprises:** Cropping with a controlled traffic system.
**Soil and pH:** Red sandy loam with a pH of 5.2
**Property size:** 2800 ha.

**Overview:**
Michael's family has been farming in the Rankins Springs district since the 1960's. They originally ran a mixed farm enterprise with cropping and sheep.

Their cropping program once involved committing a third of the cropping country to crop, a third to fallow and a third to pasture, but since the millennium drought their farming system has changed to full cropping with retained stubble and no livestock.

Michael uses a disc seeder on a 12 metre controlled farming system, growing vetch, peas and lupins as break crops in his crop rotation; but his main focus is vetch for use as brown manure, hay and seed.

Initially vetch was grown to provide fodder for sheep but has evolved into an important strategy within his cropping program.

**Sowing:**
The vetch seed is slurry inoculated before sowing through an agri-vac as it is put into the grouper.

**Weed Control:**
Although weed control is not a one year fix, Michael says the use of brown manuring plays a strong role in controlling weed populations simply by not letting weeds grow to maturity during the brown manuring phase.

**Disease:**
Yellow leaf spot is still an issue because of retained stubble, even with break crops.
Michael has found that applying urea to his cereal crops when a yellow leaf spot situation occurs seems to work as well as fungicides.

**Soil Health, profitability and sustainability:**
Michael's philosophy is that growing season rainfall is not always as the average would suggest, so stored moisture is king.

He believes what he is really farming is moisture first, then crops.

By brown manuring the vetch Michael is denied income from lost seed sales. However the increase in soil nitrogen and moisture retention offer more benefits in the longer term, particularly increased protein levels in future cereal crops.

Since moving to a stubble retained system with legume break crops, Michael has noticed an improvement in soil health, with a noticeable increase in moisture retention, soil microbial and worm activity. Part of this, he feels, is due to the large root system of the vetch. In areas where there are still compaction issues Michael now sows safflower with the vetch as a companion for extra root penetration, or bio-cultivation.

Listen to a podcast of Michael’s case study or follow link below:


**Link:**

Trials included in the above paper show a yield increase of 40-50 per cent yield benefit for wheat growing after grain legumes and about 20 per cent for wheat after canola.

The advantage of legumes is that they provide residual N, as well as a disease break, while canola is presumed to provide a disease break with no N-benefit (Table 2).

**Further links:**
- Link to article and papers by CSIRO on break crops http://www.publish.csiro.au/cp/cp14252

Figure 1: Changes in wheat yield each decade from the 1860’s to the present. Up to 1960 the graph and explanations are from Donald and after that from Angus.

**Conclusion and updates**

**Key points:**
- Break crops have become a best practice in continual cropping programs.
- Along with superphosphate, new varieties and better fallow management, the use of break crops (Figure 1) are a key driver in increasing crop yields in Australian farming systems. (from a paper by J.F. Angus, J.A. Kirkegaard and M.B. Peoples - CSIRO Plant Industry, Canberra.)

**Link:**
http://cwfs.org.au/
Summary:
Lower rainfall areas of Central West NSW have less choice in broadleaf crops suitable for a break crop compared to higher rainfall areas, so consideration must be given to the economics of the system. Oats, barley and canola continue to be key break crops for the lower rainfall CWFS areas. Field peas, vetch, faba beans and lupins are more common in eastern, higher rainfall areas of the CWFS region.

Table 2: Wheat yields after legume and pulse break crops.

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<th>Reference</th>
<th>Experiments</th>
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<td>1.61</td>
<td>53 45</td>
</tr>
<tr>
<td>Felton et al. (23)</td>
<td>Nth NSW, 9 site-yrs</td>
<td>1.57</td>
<td>54</td>
</tr>
<tr>
<td>Asseng et al. (24)</td>
<td>East Beverley, 1 yr</td>
<td>1.6</td>
<td>131 31 50 38</td>
</tr>
<tr>
<td>Dalal et al. (25)</td>
<td>Warra, 8 yrs</td>
<td>2.11</td>
<td>39</td>
</tr>
<tr>
<td>Angus, unpub.</td>
<td>Junee, 1 yr</td>
<td>3.7</td>
<td>68 65 58 51 32</td>
</tr>
<tr>
<td>Angus et al. (26)</td>
<td>Sthn Aust, 26 site-yrs</td>
<td>3.29</td>
<td>42 19</td>
</tr>
<tr>
<td>Weighted means</td>
<td></td>
<td>1.98</td>
<td>46 42 53 19</td>
</tr>
</tbody>
</table>

References:

Acknowledgements:
Richard Hayes (NSW DPI), Barry Haskins (Ag Grow Agronomy and Research), Geoff McCallum, Graham McDonald, Derrick Davis and Michael Pfitzner.

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This guideline has been developed by Central West Farming Systems Inc. (CWFS) as part of the Maintaining Profitable Farming Systems with Retained Stubble initiative, funded by the Grains Research and Development Corporation (GRDC). The initiative involves farming systems groups in Victoria, South Australia, southern and central New South Wales and Tasmania collaborating to validate current research at a local level and address issues for growers that impact the profitability of cropping systems with stubble; including pests, diseases, weeds, nutrition and the physical aspects of sowing and establishing crops in heavy residues.

During 2012 discussions with local producers resulted in CWFS identifying 13 subjects that impact on the management decisions for producers in Central West NSW.

Since then CWFS has undertaken a range of research, development and extension (RD&E) activities focusing on these subjects. These publications are an attempt to capture those activities and provide regionally specific guidelines for producers aiming to retain stubble in Central West NSW.

A primary part of this work has been to correlate existing resources and research from several organisations and CWFS thanks these respective organisations for their work. CWFS and the GRDC also thank the experts who technically reviewed these guidelines.