

## MODULE 7: HARVEST MANAGEMENT



*Photo: Phil Bowden*

## Canola Technology Update for growers and advisors

### HARVEST MANAGEMENT

#### Aim

The aim of this module is to improve the understanding of canola plant growth and development, relating these processes to enhancing practical and profitable harvest management decisions.

#### Learning Outcomes

After completion of this module participants will be able to:

- Recognise key developmental stages of canola and how these may affect harvest outcomes.
- Quantify valid estimates of yield and oil accumulation during phases of seed development.
- Identify crop development stages to apply Best Management Practices (BMPs) to optimise economic returns.
- Identify key check points to minimise losses at different stages of harvest management operations.
- Compare practical and economic aspects of harvest management options.

#### About the Author

**Kathi Hertel** has been a District Agronomist with the NSW Department of Primary Industries since 1991. Kathi has worked at various locations in NSW, from Cobar and Nyngan in western NSW to Wellington and Dubbo on the slopes and plains. These locations have provided a strong foundation in adapting local farming systems in a variable climatic environment.

A major area of work over many years has involved the adaptation of crops (and pastures) through a focus on improved and more detailed understanding of plant phenology and physiology. Better understanding of these processes and linking them to agronomic management decisions and their production outcomes leads to making more informed, practical and economic crop management decisions.

Recent work has focused on addressing industry knowledge and understanding of windrowing and the perceptions that the impact of timing can have on crop performance. This has included extensive surveys across the canola cropping areas of NSW and northern Victoria, a benchmarking study, field demonstrations and experimental trials.

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## 1. LINKING PRACTICE WITH CROP PHYSIOLOGY

### 1.1 Canola growth and development

Summary
<p><b>Plant Growth and Development</b></p> <ul style="list-style-type: none"><li>• Controlled mainly by thermal time – accumulated day degrees.</li><li>• Flower bud initiation occurs after the production of a pre-determined number of leaves. This differs between varieties.</li><li>• The pods produced during the first 2 weeks of flowering contribute to the majority of yield.</li><li>• Seed development comprises of 3 phases.</li><li>• Pods are the main source of photosynthesis for seed fill following leaf senescence.</li><li>• Maximum seed weight and oil content has been reached when seed desiccation reaches 40% seed moisture.</li><li>• Seed colour is directly related to seed maturation.</li><li>• A seed begins to change colour from green to brown when the seed moisture content reaches between 50 and 55%.</li><li>• BMP is therefore to windrow when 40 – 60% of seed has changed colour to maximise yield and oil content.</li></ul>

Throughout the life cycle of the canola plant, growth and development are continuous; many of the growth and development stages overlap. There is a clear sequence of developmental phases that proceed from leaf to stem to pod to seed.

The duration of each phase is influenced by variety and a range of environmental conditions, particularly temperature (and moisture). Temperature effects are expressed through **thermal time**.

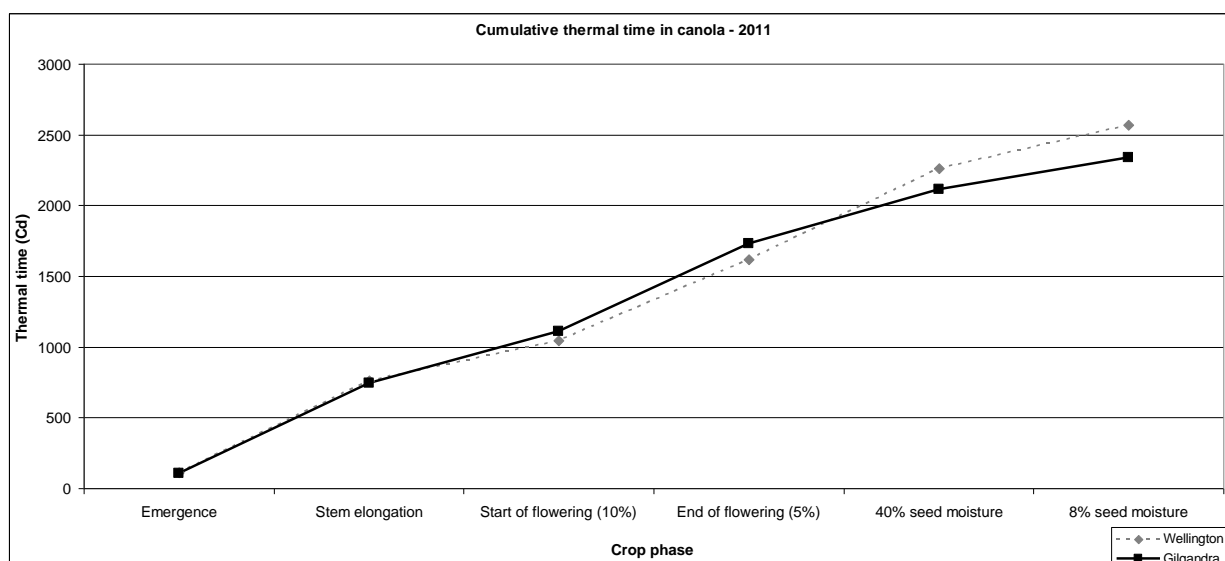
**Thermal time** is calculated, based on the average of measured maximum and minimum daily temperatures and expressed as **day degrees (°Cd)**.

For example, a daily temperature range of 10 to 24°C equals 17°Cd.

$$\begin{aligned}\text{Thermal time} &= \text{minimum temperature (°C)} + \text{maximum temperature (°C)} \div 2 \\ &= 10^{\circ}\text{C} + 24^{\circ}\text{C} \div 2 \\ &= 17^{\circ}\text{Cd}\end{aligned}$$

These daily temperatures are cumulative throughout the season. Each phase requires a specific threshold to be reached, before the next phase commences. This is why cold weather slows the rate of crop growth and can delay the timing of stem elongation and flowering.

Figure 1 shows the response to thermal time of the growth and development of two canola crops located at Wellington and Gilgandra sown in 2011 in central NSW. Despite temperature differences at the locations, similar temperature thresholds triggered the start of the next phase in each crop.



**Figure 1:** Comparative phase response to thermal time in canola crops at Wellington and Gilgandra NSW – 2011

Seasonal conditions at both sites were unusually favourable in 2011 with frequent rainfall events and mild temperatures. The conditions throughout the late winter and spring period were conducive to allowing crop development to progress unhindered.

Canola crops progress through key growth stages. Growth early in the season effects crop conditions later in the season, specifically potential yield and oil levels, and crop biomass to be handled at windrowing and harvest.

### 1.1.1 Key stages

#### 0.00 – Germination and emergence

Canola must be sown at the optimum sowing time for the location and variety, ideally at 2–3cm depth into moisture.

Where soil moisture is adequate, seed imbibition and emergence is largely regulated by soil temperature, with an optimum range between 15 and 20°C.

Soil temperatures below 10°C reduce germination and emergence. Canola should emerge within 4–14 days.

#### Key points

- The majority of canola yield comes from the early emerging plants.
- Patchy emergence can result in patchy crops, resulting in:
  - greater variability in crop maturity
  - difficulties to form uniform windrows

## 1.00 – Leaf growth & rosette formation

The first true leaf appears 4–8 days after emergence of the cotyledons (seed leaves) and leaves continue to appear every 7–10 days.

The first leaves form at the base of the rosette, with new younger leaves developing at the centre. Under good growing conditions, a plant produces between 10 and 15 leaves until it reaches the reproductive stage.

The production and growth of the earliest leaves govern the rate at which sunlight is intercepted. In turn, the rate at which plants grow is related to the amount of sunlight captured with photosynthesis producing assimilates (plant food) for shoot and root growth.

The larger the leaf area, the more dry matter the crop can produce and therefore the higher the potential yield. Canola plants commonly develop a leaf area index (LAI) of between 3 and 6. For example, an LAI of 3 is equivalent to 3m<sup>2</sup> of leaf surface area per m<sup>2</sup> of ground surface area.

### Key points

- Early crop growth and rapid ground cover is an indication of leaf area.
- Larger leaf area
  - greater potential crop biomass
  - higher potential yield & oil%

## 2.00 – Stem elongation

In canola, there is usually some overlap between the vegetative and reproductive stages.

Stem elongation begins after 8–9 leaves have formed, producing 15–20 internodes (space between nodes/branches) on the main stem. At each node, a leaf is attached to the stem.

During this vegetative stage, the reproductive stage begins with the appearance of flower buds on branches.

### Key points

- The formation of first branches occurs at or just before stem elongation.
- Each branch develops 1 to 4 leaves and a flower bud.
- Branching compensates for low population numbers.

Branches grow from the base of the upper leaves at around stem elongation. Each branch forms 1–4 leaves and a flower bud. Where poor crop establishment has occurred, branches contribute most of the compensatory growth and yield.

Stem elongation continues until the end of flowering. The duration of the stem elongation phase (from initiation to the end of flowering) is important to final yield.

## 3.00 – Flower bud development

Flower initiation begins on the main stem when leaf production ceases.

When this occurs is influenced by the presence of a minimum number of leaves, daily temperature and leaf production rate, vernalisation and response to day length.

Flower initiation occurs during early stem elongation when the flower buds are enclosed in the leaves, before emerging above the leaves as the stem elongates.

### Key point

- The formation of first flower buds occurs after the appearance of a minimum number of leaves. This is the main reason for the differences in flowering time between varieties.

The main reproductive structures including pollen develop during the green bud stage. Flower bud development is completed during the yellow bud stage (just before buds open as flowers).

#### 4.00 – Flowering

Canola florets are made up of a cluster of many flowers. The flowering period begins when the first floret opens at the base of the main stem, with flowers opening progressively up the main stem.

Flowering begins at the base of branches and similarly continues to the upper tip of the flower head. The first floret to flower forms the first pod at the base of the flower head.

The length of the flowering period is influenced by soil moisture and variety, and generally occurs over a 25–30 day period on each plant. Most of the pods at maturity are those that formed from flowers that opened during the first 2 weeks, mostly on the main stem and the first few branches that formed.

As flowering commences, there is a rapid increase in flower bearing branches. Plants begin to lose leaves, reducing the photosynthetic leaf area or effective LAI just after the start of flowering.

At this time, only the oldest seeds at the base of the plant have commenced the early stages of development. By full flowering, stems and pods are responsible for most of the plants photosynthesis, with leaves contributing to a lesser degree.

#### 5.00 – Pod development

Pod development begins immediately after flowering.

Pods initially grow rapidly in length, reaching near maximum length after around 3 weeks.

The extended flowering period of canola means that pods are at different stages of development at any point in time. This creates competition for assimilates, with earlier-formed pods having a competitive advantage over later-formed pods.

In the absence of leaves, pod wall photosynthesis is the main source of assimilates during this growth phase and may contribute 50 to 60% of final plant dry matter.

##### **Key points**

- Flowering begins at the base of the branch and continues upwards to the tip.
- Each flower can form a pod.
- When each flower opens, the maximum potential number of seeds in each pod has been determined.

##### **Key points**

- Around ¾ of pods at windrowing are formed from flowers that opened during the first 10–14 days of flowering.
- Pods are the main photosynthetic organ of the plant after flowering ends and as leaves senesce.
- Pods temporarily store carbohydrates which are re-distributed to developing seeds.



Photo: Kathi Hertel

**Image 1:** Pods ~ 32 days after flowering

## 6.00 – Seed development

Canola seed is comprised of the embryo (cotyledons), endosperm and seed coat. Seed development can be divided into early, mid and late cotyledon stages. The sequence of stages is indicated by days after flowering (DAF).

### *Early cotyledon stage (0–21 days DAF)*

Seed development begins whilst pods are still lengthening. Developing seeds are visible within a week after flowering. Seeds at this stage are made up of the seed coat, endosperm and embryo. Tiny (< 1mm) green seed embryos in the milky endosperm undergo rapid cell division in the first 2–3 weeks after flowering. The end of the embryo cell division phase coincides with pods reaching their full length.

Starch and sucrose (sugar) are the major carbohydrates produced by photosynthesis. During this stage, sucrose is evenly distributed between all seed components whilst starch is mainly found in the seed coat and liquid endosperm. Starch is only present during early development before the main stage of oil synthesis begins, and is depleted in the filling stage.

Chlorophyll is present within the embryo. Chlorophyll is essential for photosynthesis which produces energy for oil production within the seed. Around 60% of maximum chlorophyll content is present around 3 weeks after pollination with the most rapid accumulation occurring during the third week.

### *Mid cotyledon stage (21–35 days DAF)*

The transition of embryos from cell division to cell expansion indicates the mid cotyledon (or filling) stage. The seed coat reaches full size after 10–12 days and the quickly growing embryo consumes the liquid endosperm, and fills the seed's internal space. This results in a progressive increase in seed weight.

Oil and protein accumulation start and finish at the same time, but the rates of accumulation are different. Initially protein accumulates more rapidly than oil during the early stages of seed fill.

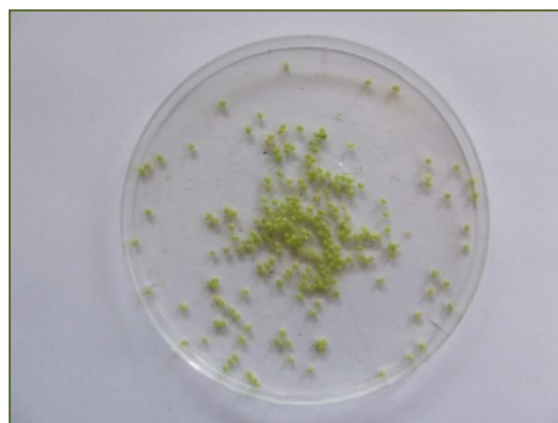


Photo: Kathi Hertel

**Image 2:** Seed formed ~ 32 days after flowering – 84.5% moisture content

The transition between mid and late cotyledons stage is marked by the commencement, around 5–6 weeks after flowering, of a rapid increase in the rate of oil synthesis.

During this stage, the senescence of remaining leaves is complete. Chlorophyll within the seed begins to degrade around 28 days after pollination. Pods are the main photosynthetic tissue to provide continuing supply of carbohydrates to developing seeds. Sucrose becomes the main carbohydrate used for seed growth and is produced mainly from photosynthesis occurring in the pods and to a smaller degree, seed embryo and stems. It is transported to the seeds for oil and protein synthesis.

Frosts or conditions of severe water stress during this period effectively slow the rate of chlorophyll degradation which may sometimes result in “green seed” at delivery. Chlorophyll is soluble in oil. Oil retains the green colour, its intensity being proportional to the concentration of chlorophyll in the seed.

#### ***Late cotyledon stage (35–60 days DAF)***

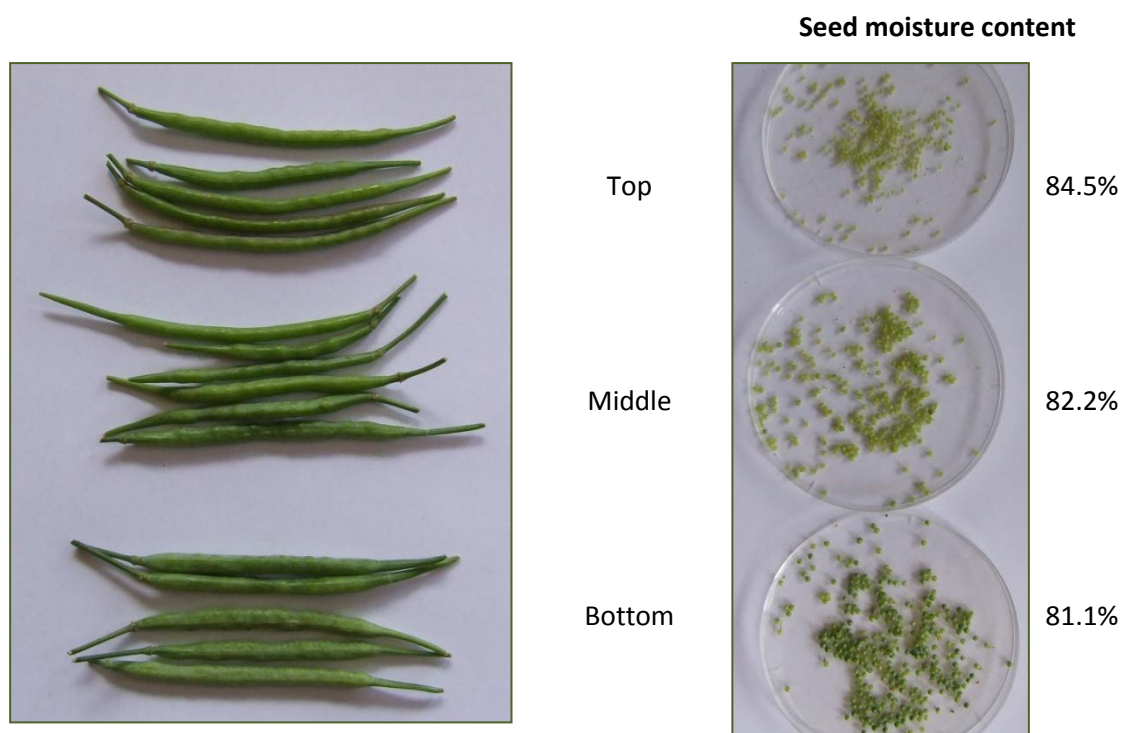
Seed fill continues during the late cotyledon stage extending over a 35–60 day period, accumulating seed weight, protein and oil.

The rapid phase of oil accumulation that began towards the end of the mid cotyledon stage continues for 1–3 weeks, before slowing as the seed dehydrates (loses moisture). Coinciding with the slowing down in oil synthesis, there is a rapid increase in the rate of protein synthesis.

Crop yield, indicated by gains in seed weight continues with peak accumulation rate occurring after 45 DAF before levelling off around 60 DAF. Maximum seed weight occurs when seed moisture content reaches about 40%.

The green seed begins to change colour to brown when the seed reaches 50–55% moisture content. Seed dehydration is progressive, with simultaneous changing colour of the seed coat, darkening from green to red/brown to black.

Chlorophyll within the embryo continues to degrade, ceasing when seed moisture content falls below 40%. The water content of the embryo plateaus then declines rapidly as the seed dehydrates.



**Image 3:** Pods and seeds from sections of main stem ~ 41 days after start of flowering. Note the darkening of the seed as moisture content declines. Bottom pods and seeds developed from the first flowers.

<b>Key points</b>
<ul style="list-style-type: none"> <li>Seed development can be divided into 3 phases. <ol style="list-style-type: none"> <li><b>Early cotyledon stage (0 – 21 DAF)</b> <ul style="list-style-type: none"> <li>– rapid cell division occurs, rapid seed chlorophyll accumulation</li> </ul> </li> <li><b>Mid cotyledon stage (21 – 35 DAF)</b> <ul style="list-style-type: none"> <li>– cell expansion (seed fill) stage commences, oil and protein accumulation begins, seed chlorophyll begins to degrade</li> </ul> </li> <li><b>Late cotyledon stage (35 – 60 DAF)</b> <ul style="list-style-type: none"> <li>– rapid increase in oil accumulation rate over 7 – 21 day period, seed weight peaks at around 45 DAF</li> </ul> </li> </ol> </li> <li>Overall patterns of oil and yield accumulation are similar, however when they begin and finish, and their duration differ.</li> <li>Oil and protein accumulation start and finish at the same time, but their accumulation rates vary.</li> <li>Pods are the main organ of photosynthesis during seed development.</li> </ul>

## Maturity

Physiological maturity occurs when the seed reaches the maximum seed dry matter accumulation. This is when maximum grain yield is achieved. In canola, this occurs at 35–40% moisture content. As moisture content falls below these critical levels, active seed metabolism ceases and the seed continues to dry down.

Seeds mature progressively up the main stem and from lower branches to the upper branches and ends of branches. Hence, seeds within pods located on the lower main stem are the most advanced and tend to be the most productive.

The duration of development of seeds located in the upper canopy is limited due to competition for plant assimilates. These are the least productive. Their low weight and small seed size result in poor harvest retention.

## Harvest

Harvest normally takes place 4–7 weeks after the end of flowering.

Seed moisture contents may decline in the order of 1–5% per day, depending on prevailing weather conditions.

Grain receival standards and storage require a maximum of 8% seed moisture.

### Key points

- Seed colour change signals the final stages of seed development.
- Seeds on the lower section of the main stem are the first to change colour.
- The beginning of changing colour from green happens when seed moisture content reaches between 50 and 55%.
- Maximum yield and oil accumulation has occurred when seed moisture falls to between 35 and 40% moisture content.

### Key points

- Timing of windrowing targets to maximise crop yield and oil.
- The rate of seed dehydration is influenced by local environmental circumstances. Rapid dry down occurs under hot dry conditions.
- Final crop performance is subject to harvest management. Losses can accumulate, occurring at various points between and during different operations.

## 1.2 Seed development: Implications for harvest management

The development of Best Management Practice (BMP) guidelines are the result of extensive research over many years. They require interpretation and adjustment to account for other outside influences like weather, machinery and economic changes that vary from season to season. The implementation of BMP's can change over time as practical accumulated experience and certain beliefs become more widespread. This can cause modifications to recommended BMP's with varying degrees of acceptance (disagreements) amongst industry participants. The result is often conflicting opinions and recommendations.

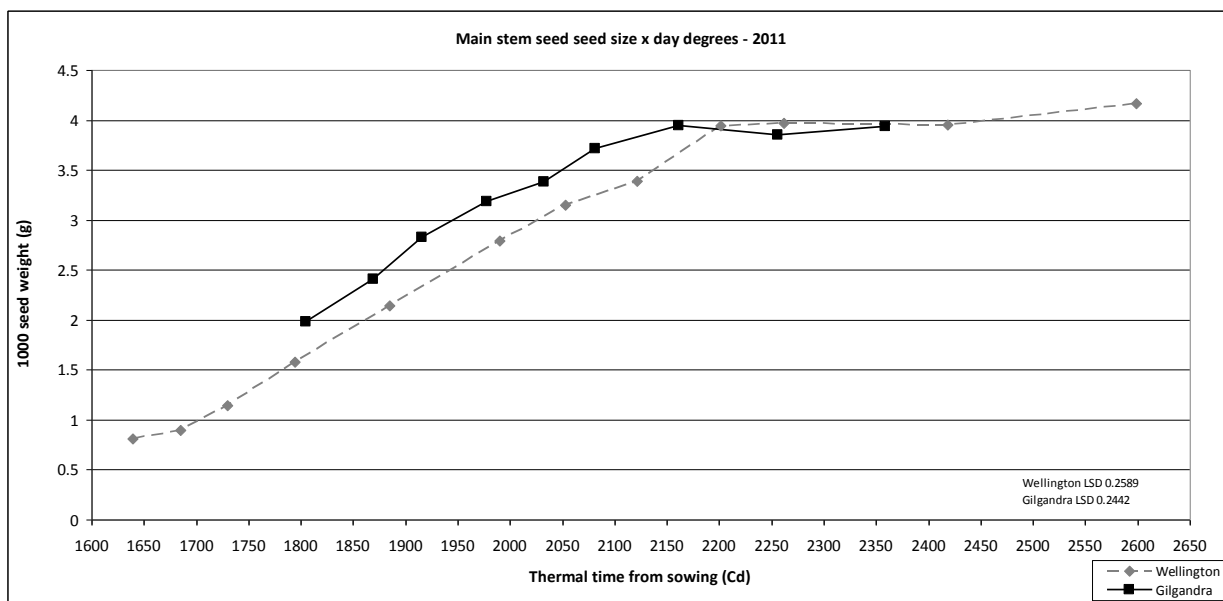
Variations in crop performance can be attributed to a range of reasons, not all of which are based on sound scientific evidence. Better knowledge and understanding how crop growth and development occurs and the relative impact of the consequences of seasonal conditions will assist in making more informed and therefore positive economic and practical crop management decisions including windrowing.

Selecting the optimum windrowing and harvest time requires an improved understanding of the visual signs in the paddock indicating at what stage of development a crop has reached and therefore how close it may be to optimum windrowing or harvest time.

### 1.2.1 When does seed size reach a maximum?

Seed size is an indication of physiological maturity or the accumulation of dry matter and therefore crop yield. Seed size is expressed as the weight (g) of 1000 seeds.

Figure 2 shows the progressive increase in the weight of main stem seeds at Gilgandra and Wellington in NSW in 2011.



**Figure 2:** Progress of canola seed size – Gilgandra and Wellington NSW – 2011

In the Wellington experiment, the early sampling times at 1 and 4 days after the end of the flowering initially showed no significant change in the weight of seeds on the main stem. A period of rapid increase in seed weight followed, lasting 23 days before levelling off. There was no significant difference in seed size at the final four (4) sampling times. The seed moisture content was 45% when maximum 1000 seed weight was reached.

A similar pattern was measured at Gilgandra with sampling commencing at a later phase of seed development – 5 days after the end of flowering (equal to 47 days after the **start** of flowering). Main stem seeds were already rapidly increasing in weight. There was no significant difference in seed size at the final three (3) sampling times. Maximum seed weight occurred when the moisture content of the seed was 39%.

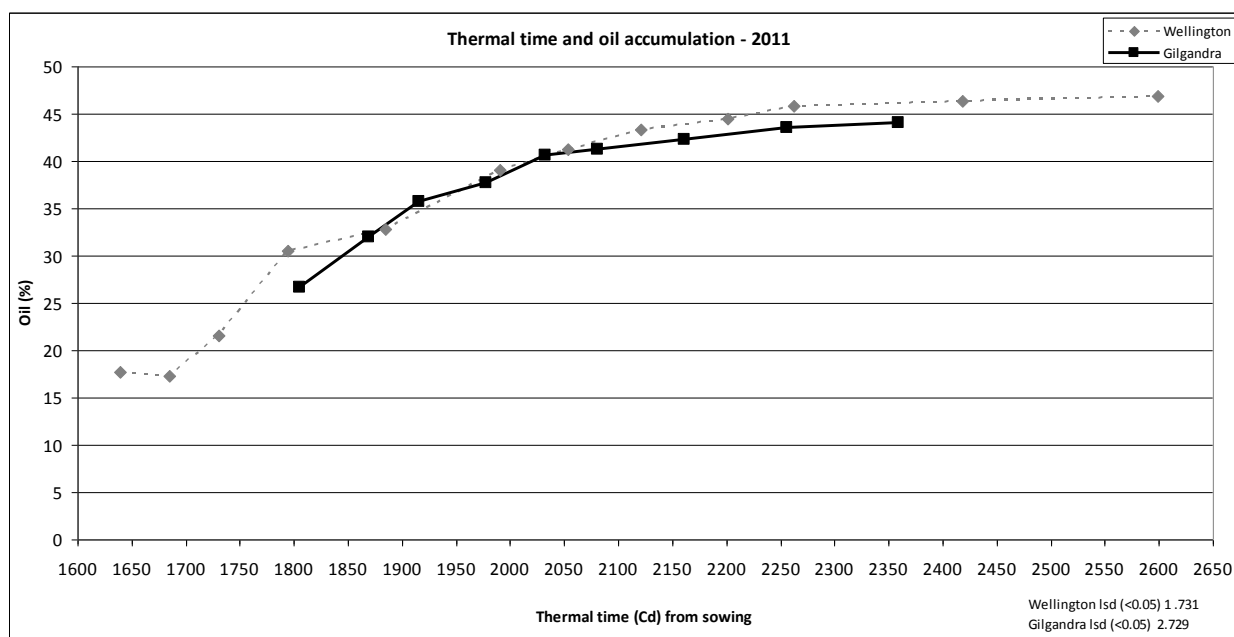
### 1.2.2 When does seed oil content reach a maximum?

Oil accumulation occurs independently of dry matter accumulation.

Changes in oil content as seed development progressed reflected similar patterns at both sites (Figure 3). The greatest rate of oil accumulation occurred over 14 day at Gilgandra and 21 day period at Wellington before levelling out.

The slowing of oil accumulation coincided with the early signs of colour change of seeds located on the main stem. There were no significant differences in oil content between the last few sampling times.

Frequent rainfall events throughout this period at both sites, combined with average daily temperatures of 13.7°C at Wellington and 15.2°C at Gilgandra were favourable environmental conditions for high oil levels to be realised. These unusually 'soft' environmental conditions allowed later developing seeds on higher branches to continue to develop for longer, contributing to small incremental increases in oil synthesis.



**Figure 3:** Influence of temperature on rate of oil accumulation at Wellington and Gilgandra NSW – 2011

### 1.2.3 What is seed colour change telling you?

Seed colour is an indication of the metabolic activity within the seed, indicating which phase of development has been reached. Changes in seed colour indicate the declining metabolic activity and progress to seed maturation.

Seed metabolic processes are strongly correlated with seed moisture content. Active seed metabolism is therefore indirectly affected by soil water availability and overall plant demand.

Colour change commences when seed moisture contents reach critical levels. Initially seeds appear almost translucent with a very light green colour before becoming a distinctly darker green as seed moisture content falls below 80%.

The first signs of seed colour change (non-green) appear on individual seeds when the moisture content reaches between 50 and 55%. These first signs are often seen as a light brown flecking on the outer seed coat. From then, descriptions of the progress of seed colour changes are variously described as “caramel”, red, brown, “rusty” before darkening further to deep red/burgundy/maroon or dark brown to finally black.

Differences in described colour reflect the continuing progression of the late phases of seed development. As the seed dries down, seed coat colour darkens.

At a single point in time, seeds from various positions within the crop canopy are at varying stages of maturity and therefore show a range of different colours. The process of seed maturation can halt in some seasons, for example due to high temperatures, severe moisture stress or frosts and so the timing of the adverse event or conditions will affect the visual

appearance of the seed. Variable coloured seed including green and lighter reddish/brown colours at harvest indicate premature cessation of the final seed maturation processes.

Table 1 shows an example of the average moisture content of all main stem, seeds that were measured at intervals as indicated by the percentage of seed colour change at Wellington NSW in 2011.

<b>Main stem average % seed colour change</b>	<b>Main stem average % seed moisture content</b>
1	53.1
10	48.4
20	46.8
30	45.8
40	44.9
50	44.1
60	43.3
70	42.5
80	41.4
90	39.8
99	35.2

**Table 1:** Seed colour change % and seed moisture content at Wellington NSW – 2011

Seeds are at a range of development stages depending on their position in the canopy at any point in time. The extended period of favourable growing conditions into late spring allowed less mature seeds in pods on the upper crop canopy that were still green or just beginning to change colour to reach their physiological potential, ie. more oil and heavier seed weight. The most advanced (mature) seeds on the main stem had reached physiological maturity first (therefore 100% seed colour change) up to 10 days earlier. This pattern of development means that at harvest there will be a certain amount of immature seed.

#### 1.2.4 How quickly does seed change colour?

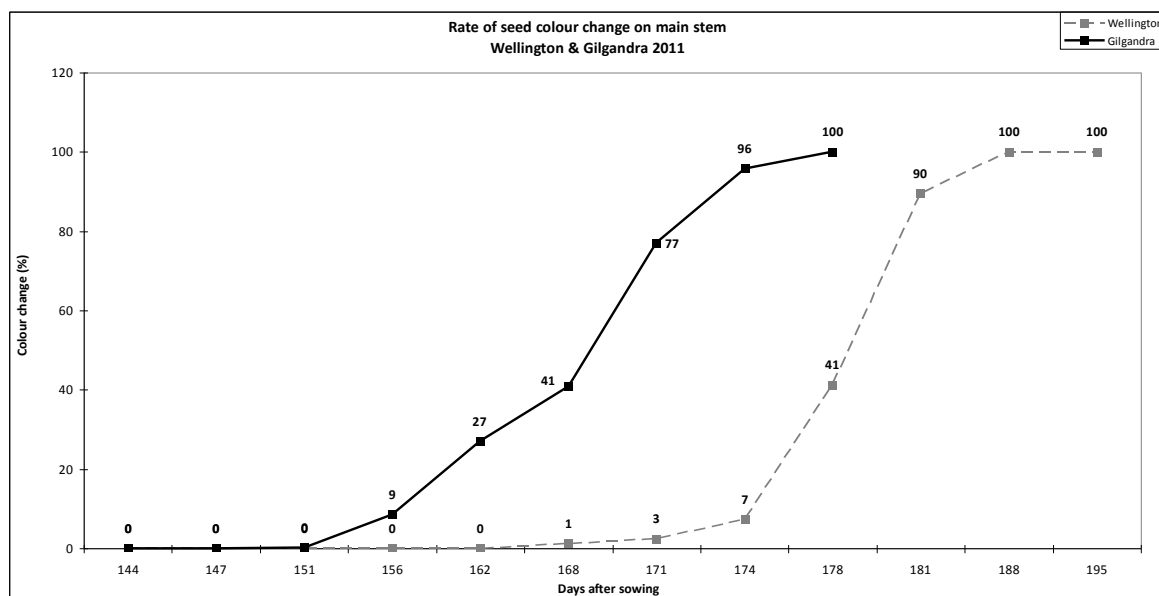
When canola crops are maturing during spring in Australia, the most common conditions are of increasing daily temperatures and decreasing available soil water. These two factors have the greatest impact on the how quickly the crop matures, as indicated by changes in seed colour.

For example, in 2011, under unusually 'soft' late spring conditions in central NSW, the period between the start (approximately 1%) of seed colour change to the range of 40–60% on the main stem was 13 days at Gilgandra and 9 days at Wellington.

Temperature is the dominant influence on the process of seed maturation and therefore changes in seed colour. The optimum temperature range for canola is between 13°C and 22°C. Plant growth and development processes cease above 30°C.

The time taken from approximately 1% to 100% seed colour change on the main stem was 23 and 18 days respectively at Gilgandra and Wellington in 2011 (Figure 4). Average daily temperatures during these periods ranged between 10°C and 23°C at Gilgandra and 14°C and 20°C at Wellington. At the same time, both sites received useful rainfall – 74mm over 5 days at Gilgandra and 13mm over 3 days at Wellington.

Anecdotally, reports of seed changing from just a few percent to close to 100% can occur within 2–3 days under conditions of high daily temperatures in mid to late spring. These changes can be further impacted by moisture stress.



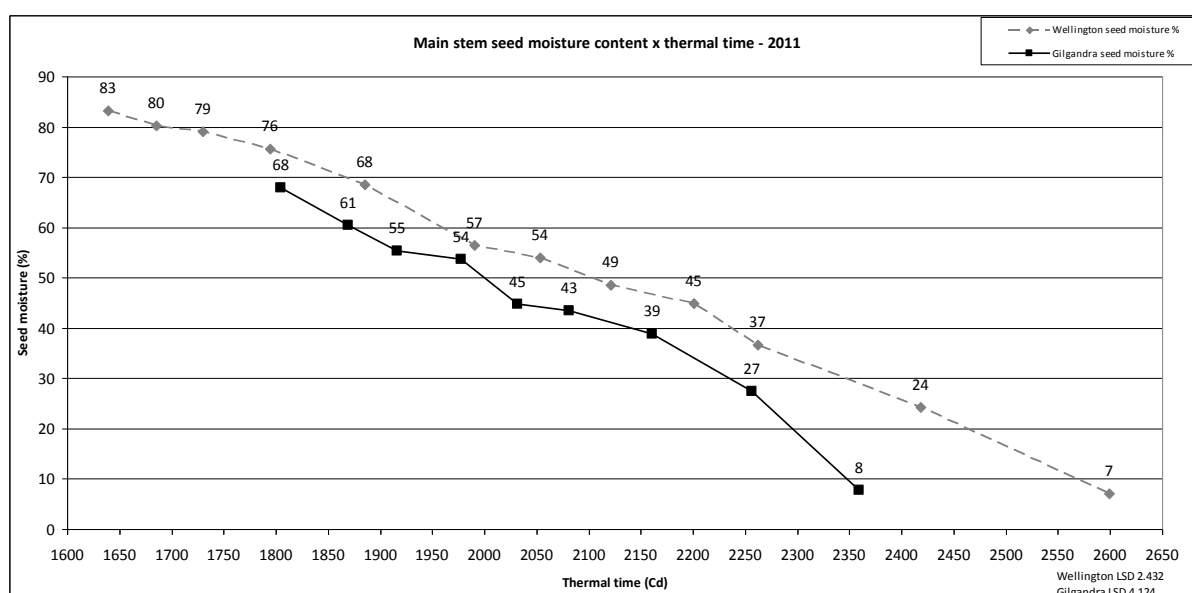
**Figure 4:** Rate of seed colour change on canola main stem at Gilgandra and Wellington NSW – 2011

### 1.2.5 How quickly does the seed moisture content decline?

Depending on environmental conditions, seed dehydration can occur between 1.5% and 5% per day, influenced by soil water availability and daily temperatures.

Figure 5 shows the average rate of decline of moisture content of main stem seeds at Gilgandra and Wellington in 2011 under abnormally cool and moist conditions. The average daily decline in seed moisture content was 3.8% at Gilgandra and 2.5% at Wellington.

Weather conditions during the last week, between the last 2 sampling times were ‘soft’ (temperatures in the low to mid 20’s and up to 13mm rainfall) compared to more typical Australian finishing conditions.



**Figure 5:** Rate of main stem seed dehydration at Gilgandra and Wellington NSW – 2011

## 1.2.6 Visual indicators in the paddock – How can you tell at what stage the crop is at?

### 1.2.6.1 Crop appearance

Differences in crop appearance are influenced by a combination of factors. Some of these include staggered germination at sowing time, crop density, changes in soil type and soil moisture, paddock aspect, variety and climatic conditions.











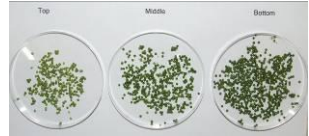
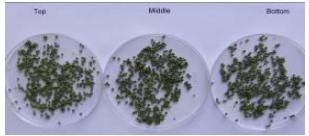
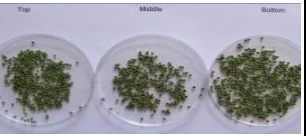
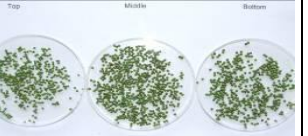
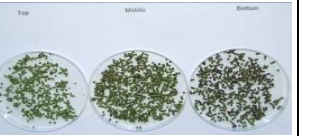
These issues interact to impact on individual plants within the overall crop population, with variability reflected in crop canopy appearance. Pod colour is not a reliable indicator of the stage of crop development, ie. seed maturity.

### 1.2.6.2 Seed appearance

Changes in seed colour reflect the progress of seed maturation. Colour change signals the final stages of seed development and therefore maximum yield and oil potential.









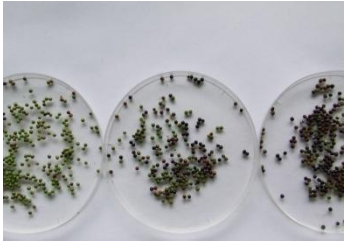
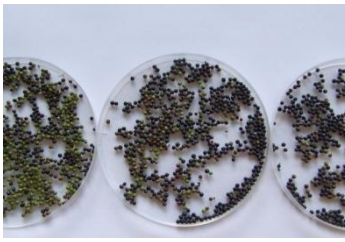
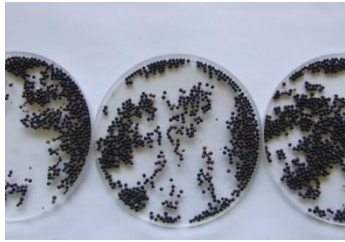
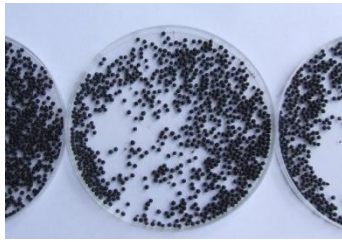
The following tables; Table 2, Table 3, Table 4 and Table 5 show the development of canola at Gilgandra and Wellington experimental sites in 2011. Images include the general appearance of the crop as well as representative samples of the pods and seeds taken from lower, middle and upper thirds of the main stem only from one replicate of the trial.

Seed moisture content and colour change percentages are from the pictured pods and seeds from a single replicate only.

<b>Crop view</b>					
<b>Main stem pods</b> Top Middle Bottom					
<b>Main stem seeds</b> L – top → middle → bottom – R					
<b>Date</b>	20 September	23 September	26 September	30 September	4 October
<b>Days after start of flowering</b>	47	50	53	57	61
<b>Days after end of flowering</b>	5	8	11	15	19
<b>Mean % seed moisture</b>	70	61	55	51	42
<b>Mean main stem % seed colour change</b>	0	0	0	3	18













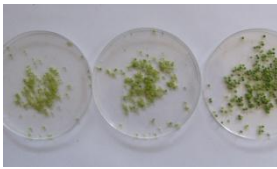
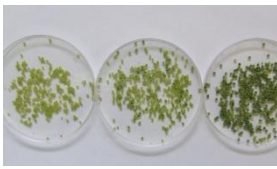
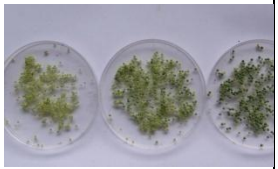
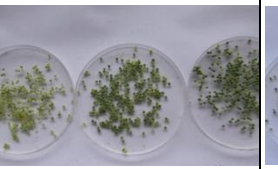
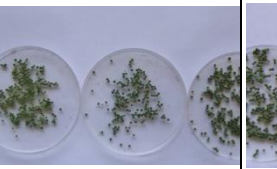
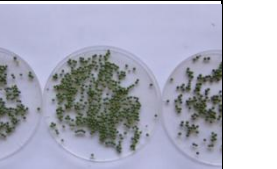
Photos: Kathi Hertel

**Table 2:** Pod and seed colour change in the Gilgandra windrowing trial – early stages of seed ripening – 2011

<b>Crop view</b>				
<b>Main stem pods</b> Top  Middle  Bottom				
<b>Main stem seeds</b> L – top → middle → bottom – R				
<b>Date</b>	7 October	12 October	17 October	22 October
<b>Days after start of flowering</b>	47	50	53	61
<b>Days after end of flowering</b>	22	27	32	37
<b>Average % seed moisture</b>	45	40	26	6
<b>Mean main stem % seed colour change</b>	48	77	98	100













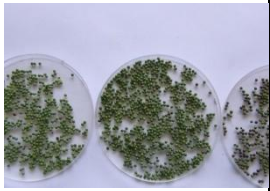
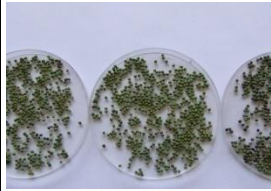
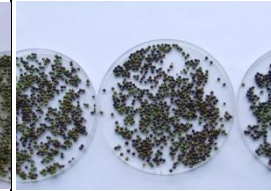
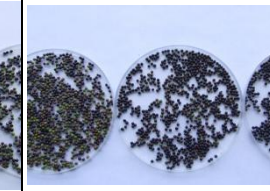
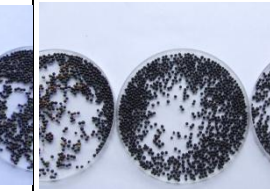
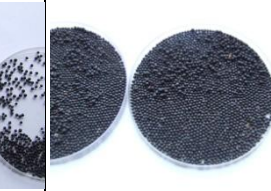
Photos: Kathi Hertel

Table 3: Pod and seed colour change in the Gilgandra windrowing trial – later stages of seed ripening – 2011

<b>Crop view</b>						
<b>Main stem pods</b> Top Middle Bottom						
<b>Main stem seeds</b> L-top → middle → bottom –R						
<b>Date</b>	24 September	27 September	1 October	6 October	12 October	18 October
<b>Days after start of flowering</b>	41	44	48	53	59	65
<b>Days after end of flowering</b>	1	4	8	13	19	25
<b>Mean % seed moisture</b>	82	80	81	75	65	56
<b>Mean main stem % seed colour change</b>	0	0	0	0	0	1

Photos: Kathi Hertel

**Table 4:** Pod and seed colour change in the Wellington windrowing trial – early stages of seed ripening – 2011

<b>Crop view</b>						
<b>Main stem pods</b> Top Middle Bottom						
<b>Main stem seeds</b> L-top → middle → bottom-R						
<b>Date</b>	21 October	24 October	28 October	31 October	7 November	14 November
<b>Days after start of flowering</b>	68	71	75	78	84	91
<b>Days after end of flowering</b>	28	31	35	38	45	52
<b>Mean seed moisture (%)</b>	52	49	45	40	27	7
<b>Mean main stem % seed colour change</b>	4	9	47	89	100	100

Photos: Kathi Hertel

**Table 5:** Pod and seed colour change in the Wellington windrowing trial – later stages of seed ripening – 2011

## 1.3 Shattering

Canola pods consist of 2 halves that are joined on the edges. Along these edges are cells located in the dehiscence (shatter) zone. At crop maturity, enzymes trigger changes in these cells, causing them to weaken. This causes the pod to break open (shatter), releasing the seeds.

Shattering losses are widely considered to be a significant risk in canola. Unlike mustard (*Brassica juncea*), canola (*Brassica napus*) has a lack of genetic variation for shatter resistance with two genes identified to control shatter resistance. A study conducted in 2010 tested the strength of pods for shatter resistance of 192 lines of canola representing commercial varieties and elite breeding lines. The energy required to split open the pod was measured. The measured differences were generally found to be insufficient to prevent harvest shattering. This work, in conjunction with mapping genes for shatter resistance continues.

Field studies investigating varietal shattering differences have reported widely variable results, but are considered to be inaccurate due to varying weather conditions at site locations and between seasons. Recorded observations tend to be opportunistic. Anecdotal evidence is frequently dominated with horror stories of large losses.

### 1.3.1 Crop stage/characteristics

The risk of shattering is affected by the crop moisture content and the amount of crop material. The mass and volume of the crop affects the potential stability of the windrow in the paddock against movement by wind as well as the internal humidity and therefore rate of dehydration within the windrow.

### 1.3.2 Current varietal differences

Australian research investigating the molecular genetics involved in shattering is ongoing. Varietal differences in shattering tolerance have revealed there was only limited genetic variation in canola. While there is progress with improved tolerance to shattering, it is still short of avoiding the need for windrowing and to allow direct heading with confidence.

### 1.3.3 Environmental conditions

- *Weather conditions*, for example daily temperatures, peak during the daylight hours. High temperatures and low humidity dries crops and material becomes more brittle.
- *Dew formation* occurs at night when there are clear skies (or few clouds) with no wind. Surface temperatures fall during the night and water vapour in the air condenses to form water droplets (dew). Crop material becomes less fragile to handling.
- *Wind speed and orientation* to prevailing winds, anchorage within standing stubble.

## 2. TIMING OF WINDROWING

### 2.1 Best Management Practice (BMP) – Optimum windrowing time

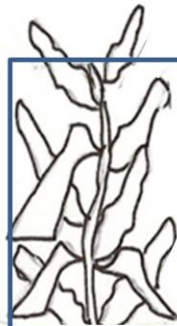
#### Optimum time to windrow

Assess pods collected from the **main stem**

**40–60%** of seeds have changed colour from green to red, brown or black

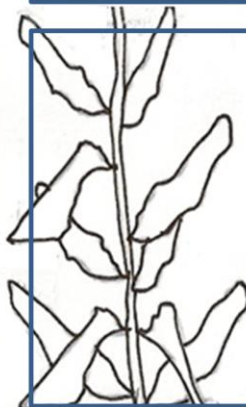
Seeds in the pods at the **top** of the main stem may be green but are firm when rolled between the thumb and forefinger.

### WINDROWING – OPTIMUM SEED DEVELOPMENT STAGES



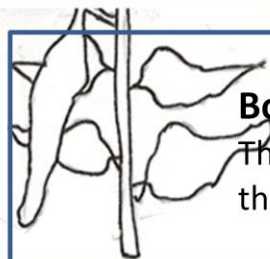
#### Upper Third:

Most of the seeds will be predominantly green in colour, firm and pliable when rolled between the forefinger and thumb. Seeds will be about 35-45% moisture.



#### Middle Third:

80% of the seed will be green to greenish red in colour, very firm and pliable. The remaining 20% may be reddish brown to light brown. Seeds will be about 25-40% moisture



#### Bottom Third:

These pods mature first and all the seed will be 20-35% moisture.

*Source: Adapted from Dovuro Agronomic Update*

**Figure 6:** Diagram of main stem with seed colour change

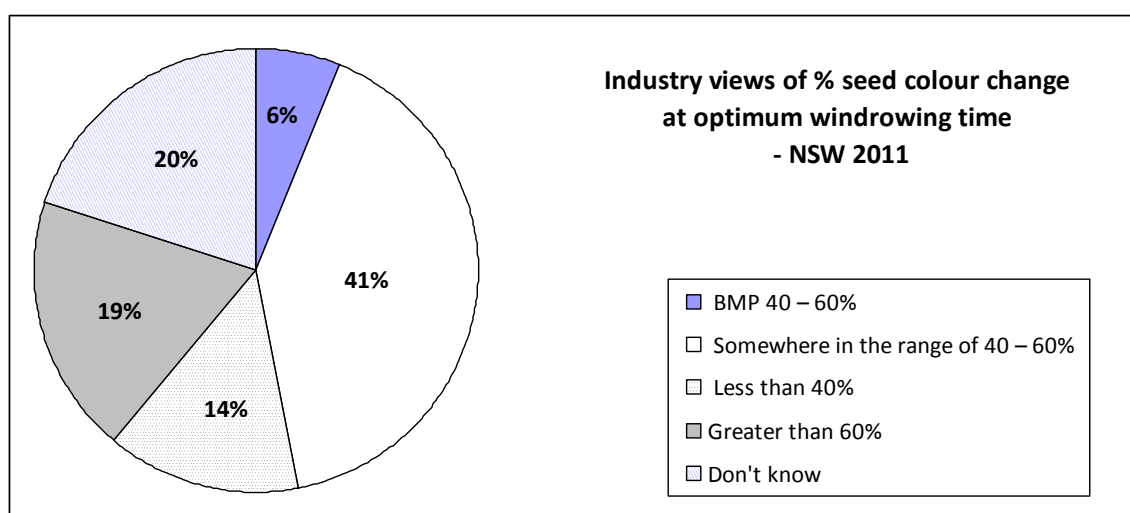
### 2.1.1 Industry recommendation versus current commercial practice

The following information is based largely on work carried out in mostly NSW (and northern Victoria) between 2009 and 2011, engaging with growers, agronomists and consultants and windrowing contractors.

Past research has established that the optimum time to windrow a crop is when 40–60% of the seed on the main stem of canola has changed colour. Guidelines have been developed as to when this occurs in different regional areas, approximately so many days or weeks after the end flowering.

The view within the canola industry as to the optimum time to windrow a crop varies considerably. Seed colour change was largely the determining feature; however the amount of colour change regarded to be the optimum ranged between 10% and 100%.

Figure 7 shows the proportion of answers to the question “**Nominate the optimum % seed colour change to windrow canola**”, surveyed at agronomy field days and a state wide (NSW) phone survey in 2011.



**Figure 7:** Survey responses on the optimum time to windrow canola, NSW – 2011

Answers to the question were mixed. Just 6% nominated the actual BMP of 40–60% seed colour change. Of the 6%, agronomists / consultants made up 3%, growers 1.5% and windrowing contractors 1.5%.

Forty one percent of respondents answered with ranges that somewhere touched on the BMP, eg. “30–40%”, “50%”, “60–80%”.

The question also revealed that 20% did not know what level of seed colour change was recommended for optimum windrowing time.

## 3. CANOLA HARVEST MANAGEMENT

Harvest management of canola can have a major impact on crop profitability. Technological developments in windrowing and harvest equipment have highlighted opportunities for greater economic efficiencies in broadacre farming operations.

Canola can be windrowed or direct headed and sometimes desiccated. The decision is based on knowledge and understanding of the crop and the balancing of costs, risks and practicalities.

### 3.1 Windrowing

Windrowing has been a widely adopted operation when growing canola in Australia.

#### 3.1.1 Advantages

- Hastens crop dry down → creates uniform seed maturity in uneven crops (topography, soil type variation, staggered crop establishment, long cool wet seasonal spring conditions)
- Reduce shattering losses
- Windrowing can continue 24 hours a day → cover large areas
- A windrowed crop is more protected, reducing the risk of damage from adverse weather conditions like storms, wind and hail
- Earlier harvest timing (7–10 days before other crops)
  - widens harvest period and reduces intense peak harvest activity
  - increased potential for double cropping
- Timeliness of harvest – greater flexibility in timing to pick up windrows (not as critical) and improved logistics with large acreages
- Weed escapes – may reduce viable seed production (herbicide resistant?), green weeds dry down → cleaner and drier harvest sample, ↓ risk of high moisture during storage
- Opportunity to spray weeds under crop canopy
- Integrated weed management strategy → taking off harvester spreaders when harvesting windrows allows the opportunity to burn header tailings.
- Protect against locust damage – green tissue absence

#### 3.1.2 Disadvantages

- Costs of operation
- Timely access to windrower
- Difficulties in some seasons with bulky crops
- Timing of windrowing
  - too early → reduced yield and oil, ↑ risk of green seed
  - too late → increased risk of shattering
- Heavy and/or lodged crops are difficult to lay an even smooth windrow → uneven drying and harvest problems
- Heavy crops may be difficult to feed into wider (40ft) windrowers
- Light ‘fluffy’ windrows may be at greater risk of losses from wind movement



*Photo: Kathi Hertel*

**Image 4:** Commercial crop at Wellington trial location – 2011

**Windrowed:**

3 November 2011

**Harvested:**

17 November (2 days later than planned due to harvester breakdown)

**Photo taken:**

7 November, 4 days after windrowing.

Note maturing wheat crop in the background.

### 3.1.3 Windrowing operations

#### 3.1.3.1 Types of windrower

There are 2 types of windrower – self propelled or power takeoff (PTO) driven. Self propelled (SP) windrowers include ‘tractors’ using adapted harvester fronts, and harvesters with draper fronts.

#### **Power Take-off (PTO) windrowers**

PTO windrowers were a popular choice for many years in Australia being cheaper than SP, practical – effectively towed with most tractors, and cost-effective for small crop areas.

PTO windrowers are limited in that they can only operate in crops that have been sown ‘round and round’ the paddock or paddocks have to be cut into blocks with minor losses associated with wheel “run down”.

PTO windrowers available in Australia include local manufacturers and imported equipment.

#### **Self propelled (SP) windrowers**

Unlike PTO windrowers, SP windrowers are able to windrow crops that have been sown in any direction, both ‘round and round’ and those sown ‘up and back’. Compared with PTO machines, they are more manoeuvrable with better visibility to monitor crop inflow. SP windrowers are suited to large operations and contractors.

With larger sized windrows, clearance under the frame of the windrower is important, to enable windrows to be adequately straddled. Most SP machines need larger wheels to increase clearance height.



*Photo: Felicity Pritchard*

**Image 5:** Self propelled windrower

Nylon sheeting under the windrower is useful for preventing canola catching on nooks and crannies.

Finger tine reels are effective under difficult crop conditions.

### ***Harvester draper fronts***

In some cases harvesters with draper fronts have performed a dual role, to windrow and later harvest canola. Fronts with twin belts are superior to single belts in allowing the canola to flow into the machine. Wide fronts and small openings in high volume crops have been problematic in high yielding situations.

#### **3.1.3.2 Windrowing the crop**

The intention when windrowing is for the crop material to feed into windrower without forming lumps or twisting and for the formed windrow to be laid out smoothly and uniformly in a tiered formation without protruding plants.

A well formed windrow is one with an even density. Irregular windrows dry down unevenly and cause problems at harvest, reducing harvest efficiencies.



*Photo: Felicity Pritchard*

**Image 6:** A well formed windrow

Crop characteristics can create challenges to achieve a well formed windrow. Canola is a bulky crop that tends to be 'fluffy' to handle. Problems with feeding into the front are common in heavy and/or lodged crops as well as very dry light crops. Tall heavy crops sometimes bunch underneath. Poorly laid windrows are prone to movement by wind and pod shattering within the windrow due to greater exposure to weather.

A windrow roller can assist in 'fluffy' windrow conditions.

Even feeding is assisted with moulded draper belts and reduces crop damage. Different machinery models options include single centre delivery or double windrow delivery. In the case of double windrow centres, adjustable decks create double windrows through merging crop material from end and centre deliveries. This can be an important option in years where crop potential is low and the low biomass of the crop can be doubled up to create a more stable windrow.

##### **3.1.3.2.1 Windrower settings**

Windrower setup will affect how well a windrow is formed.

*Reel setup* – the majority of windrowers are fitted with pick-up reels rather than batt reels. Reel speed should equal or slightly exceed the forward speed of the windrower. Reels should just clear the knife and draper frame.

*Operating speeds* – operating speeds are usually between 8 and 14 km/hr, influenced by crop and ground conditions. Ideally, aim to match ground speed with draper and reel speed. Experience has shown that the speed of draper belts has a lot to do with the formation of good windrows. Their speed needs to be changed for different crop situations. For example, sometimes in lighter crops the speed needs to be increased to push the pods of the crop together. By varying the speed of the drapers you can compact the windrows more evenly together to form a more stable and even windrow, keeping the pods up.

*Vertical cutting knife* – in crops > 2 t/ha a vertical cutting knife is essential. Ensure the knife is upright. A clean cut is difficult if knives are angled. Problems are made worse in crops that are leaning and if stems are quite green.

*Cutting height* – The height of cutting plays a role in anchoring the windrow, increasing its stability against wind. Heavier crops tend to be cut higher – 500 to 600mm; lighter crops – around 300mm. The height of stem under the windrow needs to ensure adequate air circulation through the windrow.

Cutting height can be a contentious and personal issue at times. Cutting height can be determined by the type of harvester to follow. Cutting as close to the lowest pods as possible where open front harvesters with crop lifters are used is favoured whereas cutting lower for pick-up fronts is more common. Experience has shown that cutting close to the bottom pod provides more of the windrow to be held off the ground, but still maintains stability under windy conditions.

At times there are strong opinions amongst industry participants regarding cutting height. A survey of 52 windrowed canola crops in 2009 in central western NSW found cutting heights ranged between 15 and 65cm.

Some individuals referred to the perceived value of cutting above the fork of first branch – the ‘fork’ assisting in holding together the laid windrow, to “stop slumping” whilst at the same time allowing adequate air circulation. Experience has shown that this also tends to stop the windrow being ‘pinned’. Cutting higher was usually to improve the ease of harvest, with less material for the harvester to thresh and sieve overloading when over-threshed or when dry and brittle.

Some growers prefer to cut crops shorter as it was seen as an advantage for ease of sowing the following winter crop. Other reasons for cutting low was to allow more “moisture” / “oil” / “goodness” / “nutrients” / “sap” to move from the cut stem into the seeds within pods.

#### 3.1.3.2.1.1 Picking up the windrows

Harvesters with draper fronts are considered to be most suitable for canola. The gentle action, taking the windrow in waves onto the rubber belt type pick-up with rubber or synthetic fingers helps to reduce shattering losses.

The aluminium pick-up is more suited to bunched windrows. Direct cut headers require crop lifter attachments for the width of the windrow to lift the windrow into the header. The rest of the cutter bar may be covered to prevent or reduce the amount of green second-cut stubble entering the harvester.

For ease of operation and minimising rougher handling of the crop material, windrows should be picked up in the same direction in which they were laid down.

## 3.2 Direct heading

Direct heading uses harvesters with either an open-front with an extended platform or with a belt-front attachment. The period where the crop is suitable to direct head is usually very short. Delays beyond these windows of opportunity can be costly. Crop losses may be high with the risk of shattering increasing daily and potentially made worse with exposure to adverse weather conditions.

### 3.2.1 Advantages

- Potential cost savings in not windrowing
- Practical one pass harvest for small areas for owner/operator
- Reduced risk of green seed
- A standing crop dries more quickly after light rainfall than a windrow
- Less Rutherglen bugs

### 3.2.2 Disadvantages

- No flexibility in harvest timing, must harvest when ready, interrupting harvest of other crops
- Slower crop dry down → several weeks delay to harvest → places canola crops at similar harvest dates with other winter crops → less flexibility in logistics
- Timing of unfavourable weather may delay harvest (eg. high moisture, boggy paddocks)
- Greater risk of shattering from high winds, hail or severe storms
- Uneven crops and variable maturity → poor harvest sample, shattering
- Harvest operations are often limited to early and late in the day
- Green weeds → harvest sample contamination, potential storage issues with greater moisture content

### 3.2.3 Improving consistency

Direct heading canola can have inconsistent results. Moisture content of grain tends to be more variable, particularly in paddocks with variable soil types and when seasonal conditions slow the drying down of crops.

Harvester speed is more critical when direct heading canola than other crops. Excessive speed, especially when the crop is dry can cause significant shattering at the knife and divider. Harvest speeds may need to be gradually reduced as the day approaches late mid morning / midday as pods dry and become more fragile. When the risks of shattering become too great, ceasing harvest until later in the day or the night is not uncommon.



*Photo: Frank McRae*

**Image 7:** Direct heading canola

Cool overcast days and nights tend to be the most suitable times to direct head canola. However in the case of very uneven crops, seed with higher moisture contents are difficult

to thresh. This too then creates problems with temporary storage, especially when seed has high oil contents in the interim period before delivery at 8% moisture.

On comb front machines, the fingers should be spaced wider and the spiral lifted up and back from the knife. On open front machines, the reel should be kept out of the crop or if used, be driven with a peripheral speed approximating ground speed so it does not hit the crop. Ground speed must be slow enough to prevent heavy shattering at the knife and divider. Best separation occurs when pods are slightly moist so consider harvesting at night or during cool cloudy days. A lower fan speed helps reduce losses from the back of the header.

### 3.3 Harvesting canola – General comments

- Start slow before settling on an operating speed. Speed will likely change with crop and weather conditions variations according to the time of day.
- Settings for canola are up to  $\frac{3}{4}$  of the settings of wheat.
- Ground speeds are generally reduced to 5 to 8 km /hr compared to cereals where ground speeds are more commonly in the range of 8 to 12 km /hr.
- The reel should be set high and as far back over the table as possible (to reduce shattering).
- Reel speed should be the same as the ground speed.
- Cylinder speed should be slow, about half that of wheat – 400–650 rpm. Cracked seed indicates excessive speed.
- Fan speeds generally between 400–650 rpm, adjust with seed weight and cleanness of sample.
- Use sieve (also known as riddles) settings, **not** wind to clean sample. Remember trash is measured by weight, not volume.
- Concave clearances – 5mm in the front and 3mm in the rear.
- Top sieve / chaffer set at  $\frac{1}{4}$  to  $\frac{3}{8}$ " for proper separation; Lower cleaning sieve set at  $\frac{1}{8}$  to  $\frac{1}{4}$ ".
- Set fingers straight up and down to minimise wrapping.
- The widespread adoption of hybrid canola varieties tends to produce larger bulkier crops which can create issues trying to get crops in the front of the harvester. The addition of rear cross augers behind the belt make a big difference, markedly improving the flow of heavy crops (eg. 3t/ha) or crops that are leaning into harvester.

Basic settings in modern harvesters are generally adequate and a good starting point, however fine tuning according to the conditions – indicated by running samples and time of day – should still generally be carried out. Some examples include:

- cutting fan speeds back with lower yielding crops to reduces losses,
- ensuring drum speeds are not too fast to avoid powdering stems in hot dry conditions with brittle crops, and
- making sure the concave is wider than that used when harvesting wheat. Grinding up stems can increase seed moisture.
- slow cylinder speed (about half that of wheat)

### 3.4 Desiccation

Crop desiccation is sometimes carried out as an alternative to windrowing to prepare an uneven crop for direct heading. It is usually applied by air. It has a similar effect to windrowing, drying down evenly all green vegetative growth, including weed escapes like thistles. The timing of desiccation is similar to that of windrowing and is based on when the crop is mature to avoid reducing grain yield and quality.

Desiccation rather than windrowing is preferred where heavy crops have lodged early. High yielding crops can pose difficulties in physically feeding the crop into the windrower. This creates significant problems in producing an even windrow and therefore leads to inefficiencies at harvest.

#### 3.4.1 Products registered for the desiccation of canola

The following table comprises extracts from the Reglone® label, the only currently registered product (as at April 2012).

Product	State	Rate	Critical comments
Reglone® (200 g/L diquat)	All states	1.5–3.0L/ha	<p>Spray when 70% of the pods are yellow and the seeds are brownish/bluish and pliable. Canola ripens unevenly and is prone to pod shatter and seed loss. Direct harvest 4 to 7 days after spraying.</p> <p><b>NOTE:</b> Use higher rate for dense or weedy crops. Wetting agent: Add Agral® at the rate of 200mL/100L or BS1000* at 160mL/100L of prepared spray unless otherwise specified.</p>

NOTE: Always read the label supplied with the product before each use. (Source: APVMA)

Table 6: Reglone® label details

### 3.5 Crop sealants

A number of commercially available products have been promoted to protect against shattering by sealing the pod. Usually applied by air, timing is critical with crop maturation. Interest in various crop sealants products has resulted replicated trials and demonstrations. The conclusions of these have been mixed. A summary of some published results is found in Appendix II (page 58).

Wheel tracks from ground-based sprayers at desiccation can be a problem at times. The feed into the harvester front is affected by having canola leaning or pushed over by the sprayer.

Overseas experience has indicated their use may hinder crop desiccation and delay harvest.

For example:

Canola Council of Canada notes “When seed is mature but before pods become dry and split, pod sealants will slow pod dry down and prevent the movement of moisture into and out of the pod, reducing shatter losses. Combine timing is crucial for minimizing shatter losses as the sealant efficacy diminishes with time and from repeated rains. Sealants slow crop dry down and harvest by 5 to 14 days.”

(Source: <http://canola-council.org/chapter11.aspx#ch11>)

Some products include Pod-Ceal™ and Desikote Max®. Registered label information is as follows:

#### **Pod-Ceal™**

Pod-Ceal™ is recommended to be applied to crops intended for windrowing or to be direct headed. "... when the majority of the pods have lost their intense green colour from dark green to light (Growth stage BBCH scale 81–83)" (Pod-Ceal™ brochure) \* NOTE: BBCH scale 81–83 → 10–30% of pods are ripe, seeds dark and hard.

#### **Desikote Max®**

Desikote Max® contains 55% terpene polymer. Label states its use to "control podshatter in podded crop and reduce transpiration in crops & grasses."

### **3.6 Pesticide residues**

Growers need to be extremely vigilant when spraying canola crops to ensure that only registered chemicals, timings and rates are used. Chemical registrations can vary from state to state so growers should check their state regulations.

The harvest withholding period (WHP) is identified on the registered label. It is the time period between pesticide application and harvest. For windrowed crops the harvest date is the windrow date as pesticide breakdown processes within the plant effectively cease once it is cut.

Grain samples are tested for chemical residues and residue levels above the Maximum Residue Limit (MRL) can severely impact export and domestic markets. Some markets (eg. Japan) have very low default MRLs so if a chemical is used and we do not have an MRL established in Australia, the Japanese use the very low default limit.

The National Residue Survey (NRS) was established by the Australian Government to ensure food products are "safe" for export and market access is not jeopardised. The oilseeds industry is a participant in this program.

### **3.7 Harvest losses**

Grain losses can occur at several stages, accumulating to substantial levels. Identifying potential points of crop loss and managing them can limit risks and possible costly losses.

#### **3.7.1 Pre-harvest**

Pod shattering can occur at various times throughout the late harvest period whether crops are windrowed or direct headed.

Pod shattering can occur during the windrowing operation, within the windrow and during harvest of the windrows or straight crop.

##### **3.7.1.1 During windrowing**

Excessive operational speeds can damage plants. Uneven crops with plants at an advanced stage of maturity will be more susceptible to shattering. Small branches can still fall to the ground when open front harvesters fitted with crop lifters are used.

### 3.7.1.2 Within the windrow

Shattering is a natural process in canola. Extended delays in picking up the windrow can leave plant material at very low moistures and brittle/fragile to disturbances (wind or pick-up). A succession of wetting and drying events can have the same effect.

## 3.7.2 At harvest

### 3.7.2.1 Harvest of windrow or standing crop

- Shattering can occur at the front of the harvester.
- Problems **feeding the crop material into the machine** after cutting can result in cut loose stalks on the ground rather than in the windrow or the harvester.
- An uneven feed into the harvester reduces losses with the harvester better able to operate at a consistent capacity.
- **Cutting.** Lodged crops can be difficult to be efficiently cut and fed into the machine resulting in uncut plants with seeds in pods remain in the paddock.
- **Machine set-up**
  - Windrowers with types of dividers that are unable to deal with separating heavy and tangled crops.
  - Harvester threshing system with unsuitable settings of the drum, concave and sieves can cause inefficiencies and seed losses.
  - Harvester leaks – check elevator doors, the elevators themselves, sieve settings and cross augers.
  - The combination of fan speed and sieve settings may need adjusting.
  - Rotor loss. Losses coming off the rotor usually show up on the monitor, however rotor speed is important as it may cause cracked or split canola. Split canola increases the losses over the sieves which will not show up on the monitors because of its very light weight.

All these losses are manageable and may be reduced by resetting the machine and changing the harvesting technique.

### 3.7.3 Reducing shattering losses when direct heading

- Ensure cutter bar is sharp.
- It is essential that the reel speed matches the ground speed.
- Run the reel as high and as far back as possible over the grain table.
- If batt reels are used, install reel bat shields to prevent branched stalks from catching on reel bat ends and wrapping around the reel.
- Remove row dividers. Dividing the row shatters pods where plants are pulled apart.
- Shattering is unavoidable where the inside end of the harvester divides the crop. On harvesters with wide header ends, modifying the rounded or peaked top of the divider will mean that seed that drops on the header end will all roll into the header, instead of half onto the ground. Using a wider harvester and slowing down some is better than driving faster with a narrow harvester.

- Harvesting in the cooler part of the day or at night can reduce shattering. Night time may be the only window of opportunity during spells of very hot weather.
- At times canola can be cut and threshed when it is too damp to harvest wheat. Canola seed within the damp pod is dry.

### 3.7.4 Quantifying harvest losses

An example of work investigating canola harvest losses was in NSW in 2002 in the **Best Bet Canola Project**.

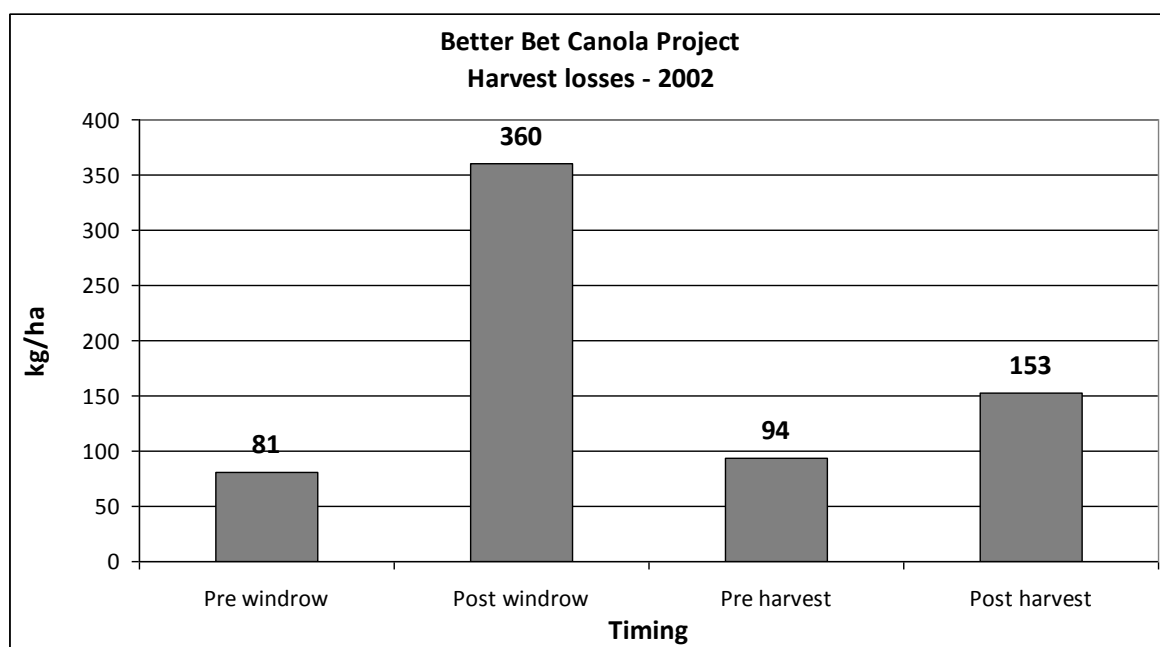
#### Harvest Losses – Peter Hamblin

Variety	Rainbow	Oscar	Grace	Beacon
Speed (km/hr)	~7.0	7.8	7.0	7.3
Timing (% seed colour change)	no	30	40–50	50
Settings			Fan 880 R 770 Concave 2.5	Drum 470 Fan 780
Seed losses (kg/ha)	80	360	94	153
% yield loss	4.4	18.9	4.3	9.0

Source: Peter Hamblin

**Table 7:** Trial conditions and harvest loss results – Best Bet Canola Project – 2002

#### Results



Source: Peter Hamblin

**Figure 8:** Harvest loss results – Best Bet Canola Project – 2002

Accurately measuring harvest losses is difficult due to the difficulties in seeing seed amongst trash, the varied distribution across machine operating widths and variations in seed size.

Several approaches have been used. One example is based on using a specified figure for seeds per kilogram and then calculating the losses based on seed counts in a square piece of weldmesh as a rough guide. Interpretation of this is required as losses usually concentrated in specific sections of trash.

No seeds per kg	Equiv. 1000 seed weight (g)	No. seeds in square													
		10	15	20	25	30	35	40	45	50	60	70	80	90	100
250,000	4.0	40	60	80	100	120	140	160	180	200	240	280	320	360	400
275,000	3.6	36	55	73	91	109	127	145	164	182	218	255	291	327	364
300,000	3.3	33	50	67	83	100	117	133	150	167	200	233	267	300	333
325,000	3.1	31	46	62	77	92	108	123	138	154	185	215	246	277	308
350,000	2.9	29	43	57	71	86	100	114	129	143	171	200	229	257	286

**Table 8:** Estimating harvest losses (kg/ha) based on seed size using a 10 x 10 cm squares (100cm<sup>2</sup>)

Another example is pictured below, using specified assumptions.

#### Assumptions

- Case 2388 harvester cleaning area width = 1.5 m
- Straw spreaders (spinners) are disabled ie seed is only directly behind the cleaning area
- Windrower cutting width = 9.1 m
- Weld mesh is 14.5 cm x 14.5 cm (5.7 inches x 5.7 inches)

#### Sample 1

2.10 g canola seed – 606 seeds



#### Sample 2

0.11 g canola seed – 28 seeds



#### Sample 3

0.42 g canola seed – 120 seeds



#### Sample 4

1.05 g canola seed – 298 seeds



Photos: Kathi Hertel

**Figure 9:** Varying quantities of harvest losses

The photos in Figure 9 represent possible seed losses found in the header trail. What would these pictures equate to when harvested with, for example a Case 2388 harvester? See Table 9.

	Windrower or harvester cutting width (m)				
	6.4	7.6	9.1	11	12.2
	Harvest losses (kg/ha)				
Sample 1	234	197	165	136	123
Sample 2	12	10	9	7	6
Sample 3	47	39	33	27	25
Sample 4	117	99	82	68	61

**Table 9:** Equivalent harvest losses at the rear of the harvester after picking up windrows or directly harvesting

		Windrower or harvester cutting width (m)				
		6.4	7.6	9.1	11	12.2
		Value of losses (\$/ha)				
	(\$/t)					
<b>Sample 1</b>	400	93.64	78.85	65.86	54.48	49.12
	500	117.05	98.57	82.32	68.10	61.40
	600	140.46	118.28	98.78	81.72	73.68
<b>Sample 2</b>	400	4.90	4.13	3.45	2.85	2.57
	500	6.13	5.16	4.31	3.57	3.22
	600	7.36	6.20	5.17	4.28	3.86
<b>Sample 3</b>	400	18.73	15.77	13.17	10.90	9.82
	500	23.41	19.71	16.46	13.62	12.28
	600	28.09	23.66	19.76	16.34	14.74
<b>Sample 4</b>	400	46.82	39.43	32.93	27.24	24.56
	500	58.52	49.28	41.16	34.05	30.70
	600	70.23	59.14	49.39	40.86	36.84

**Table 10:** Value of pictured harvest losses based on Figures in Table 9

\*Assuming 42% oil

### 3.7.5 Checking harvester set-up

A common practice is to disable straw spreaders on the harvester and do a trial run before undertaking the whole paddock. Measuring the width of the trash and comparing it to that of the windrow or harvester front width can give an idea of losses.

## 4. HARVEST ECONOMICS

Harvest operations are a major cost when growing canola. Improvements in operations can have significant effects on final economic outcomes. This has resulted in greater attention to possible cost savings, a common idea being to direct head rather than windrow canola.

With this, other considerations include the availability and cost of contract windrowing, if harvesting is owner/operator or reliant on contractors, the type of harvesters available, the area of crop to be harvested, the bulk/yield potential of crops to be harvested and the risk of bad weather occurring.

## 4.1 Maximising harvest efficiency

Harvesting canola can be a slower process than harvesting wheat. With harvesters costed on an hourly rate, the concept of harvest efficiency has become an important measure. “Harvest efficiency refers to the proportion of time spent harvesting relative to total time of running the header”.

[http://www.agric.wa.gov.au/objtwr/imported\\_assets/content/fcp/cer/bn\\_stubble\\_management.pdf](http://www.agric.wa.gov.au/objtwr/imported_assets/content/fcp/cer/bn_stubble_management.pdf)

Harvest efficiencies range from 25 to 80%, with an average 60% of the time actually spent harvesting. The remaining 40% of the time is spent either travelling back to field bins, waiting for trucks or empty field bins to arrive, or repairing the header and other harvesting equipment.

Whether a crop has been windrowed or is standing to be being directly harvested has a major bearing on the hours spent actively harvesting and the speed of harvest operations ie. ha/hr.

## 4.2 Windrowing

### 4.2.1 Crop value

Table 11 shows the relative values of seed based on different base prices.

Crop value (\$)										
t/ha	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
400	40	80	120	160	200	240	280	320	360	400
500	50	100	150	200	250	300	350	400	450	500
600	60	120	180	240	300	360	420	480	540	600

**Table 11:** Value of crop (assuming 42% oil)

ie.	t/ha	\$/kg
	400	0.40
	500	0.50
	600	0.60

***What difference do a few days earlier or later to the recommended optimum timing make to the gross value of the crop?***

The following example is based on a trial conducted at Wellington NSW in 2011. Favourable growing conditions, particularly during late winter right through until late spring were ideal for uninterrupted crop growth and development.

The trial was hand harvested and all seed collected to ensure there were no losses from in-crop shattering or mechanical action.

One of the aims of the trial was to quantify the differences in crop value at various stages during late crop development when windrowing often occurs. This included changes in the value of the crop when windrowing timing varied either earlier or later than the industry recommended BMP guideline of 40–60% seed colour change.

Table 12 shows the results from that trial, including changes in crop value at a number of base canola prices. Where analysed results showed no statistical significance, the median (middle) value was used. Colour change, seed moisture percentages and 1000 seed weight refer to seed on the main stem.

	7 days earlier	4 days earlier	Optimum date of windrowing	3 days later	10 days later
Date	21 October	24 October	28 October	31 October	7 November
Days after end flowering	28	31	35	38	45
% seed colour change	3	7	41	90	100
% seed moisture	54	49	45	37	24
1000 seed weight (g)	3.155	3.389	3.942	3.942	3.942
Yield (t/ha)	2.5	2.9	3.3	3.3	3.3
Oil (%)	41.3	43.4	44.5	44.5	44.5
<b>Value of crop (\$/ha)</b>					
\$400/t	989.5	1184.36	1369.5	1369.5	1369.5
Change in value (\$/ha)	-380	-185.14	0	0	0
%	-28	-14	0	0	0
\$500 /t	1236.88	1480.45	1711.88	1711.88	1711.88
Change in value (\$/ha)	-475	-231.43	0	0	0
%	-28	-14	0	0	0
\$600 /t	1484.25	1776.54	2054.25	2054.25	2054.25
Change in value (\$/ha)	-570	-277.71	0	0	0
%	-28	-14	0	0	0

**Table 12:** Summary of crop data and economic values at windrowing times – Wellington NSW – 2011

#### 4.2.2 Windrower operations

Efficiencies are also affected by the speed and width of the machine and therefore crop area covered per hour.

Speed (km/hr)	8	9	10	11	12	13	14
Width of windrower (m)	Area (ha) per hour						
6.4 (21 ft)	5.1	5.8	6.4	7.0	7.7	8.3	9.0
7.6 (25 ft)	6.1	6.8	7.6	8.4	9.1	9.9	10.6
9.1 (30 ft)	7.3	8.2	9.1	10.0	10.9	11.8	12.7
11 (36 ft)	8.8	9.9	11.0	12.1	13.2	14.3	15.4
12.2 (40 ft)	9.8	11.0	12.2	13.4	14.6	15.9	17.1

**Table 13:** THEORETICAL potential crop area / hour – Speed x width of windrower

#### 4.2.3 Rules of Thumb / Guidelines

The following guidelines are based on comments and opinions from a number of experienced windrowing contractors.

Speed of windrowing		
Crops	< 1.5 t/ha	14 km/hr
	1.5–2.5 t/ha	12 km/hr
	2.5–3.0 t/ha	10 km/hr
	3.0 <sup>+</sup> t/ha	8 km/hr

Speeds of operation will vary with types of fronts. Later model fronts with design modifications generally allow higher speeds than some older model fronts in the same crop and conditions.

#### 4.2.4 What does windrowing cost?

Speed (km/hr)	hrs /ha	ha/hr	Contract rate (\$/ha)	Cost (\$/hour)	Crop equivalent (kg/ha) *\$400 / t	Crop equivalent (kg/ha) *\$500 / t	Crop equivalent (kg/ha) *\$600 / t
<i>6.4m (21ft) windrower</i>							
8	0.20	5.12	30	153.6	75	60	50
10	0.16	6.4	30	192	75	60	50
11	0.14	7.04	30	211.2	75	60	50
12	0.13	7.68	30	230.4	75	60	50
14	0.11	8.96	30	268.8	75	60	50
<i>7.6m (25ft) windrower</i>							
8	0.16	6.08	30	182.4	75	60	50
10	0.13	7.6	30	228	75	60	50
11	0.12	8.36	30	250.8	75	60	50
12	0.11	9.12	30	273.6	75	60	50
14	0.09	10.64	30	319.2	75	60	50
<i>9.1m (30ft) windrower</i>							
8	0.14	7.28	30	218.4	75	60	50
10	0.11	9.1	30	273	75	60	50
11	0.10	10.01	30	300.3	75	60	50
12	0.09	10.92	30	327.6	75	60	50
14	0.08	12.74	30	382.2	75	60	50
<i>11m (36ft) windrower</i>							
8	0.11	8.80	30	264	75	60	50
10	0.09	11.00	30	330	75	60	50
11	0.08	12.10	30	363	75	60	50
12	0.08	13.20	30	396	75	60	50
14	0.06	15.40	30	462	75	60	50
<i>12.2m (40ft) windrower</i>							
8	0.10	9.76	30	292.8	75	60	50
10	0.08	12.20	30	366	75	60	50
11	0.07	13.42	30	402.6	75	60	50
12	0.07	14.64	30	439.2	75	60	50
14	0.06	17.08	30	512.4	75	60	50

**Table 14:** Windrowing costs compared with equivalent \$ value of crop expressed as crop yield (kg/ha)

\* assuming 42% oil

### 4.3 Direct heading

#### 4.3.1 Hours of operation

Hours of operation vary from season to season and the general environment. Hot dry summer conditions may only allow limited hours of operation, for example, operating between the hours of 8.00pm and 5.00am before stopping due to high crop moisture in the early morning hours. A delay before recommencing around 8.00am through until stopping again at 12 midday, equals 11 hours out of a 24 hour period.

Speed (km/hr)	4	6	8	9	10	11	12
Width of harvester (m)	Area (ha) per hour						
6.4 (21ft)	2.56	3.84	5.12	5.76	6.4	7.04	7.68
7.6 (25ft)	3.04	4.56	6.08	6.84	7.6	8.36	9.12
11 (36ft)	4.40	6.60	8.80	9.90	11.00	12.10	13.20
12.2 (40ft)	4.88	7.32	9.76	10.98	12.20	13.42	14.64

**Table 15:** THEORETICAL potential crop area / hour – Speed x width of harvester

### 4.3.2 What does direct heading cost?

Speed (km/hr)	hrs /ha	ha/hr	Contract rate (\$/hour)	Cost(\$/ha)	Crop equivalent (kg/ha) *\$400/t	Crop equivalent (kg/ha) *\$500/t	Crop equivalent (kg/ha) *\$600/t
<i>6.4m (21ft) harvester</i>							
4	0.39	2.56	400	156.25	391	313	260
6	0.26	3.84	400	104.17	260	208	174
8	0.20	5.12	400	78.13	195	156	130
9	0.17	5.76	400	69.44	174	139	116
10	0.16	6.4	400	62.50	156	125	104
11	0.14	7.04	400	56.82	142	114	95
12	0.13	7.68	400	52.08	130	104	87
<i>7.6m (25ft) harvester</i>							
4	0.33	3.04	400	131.58	329	263	219
6	0.22	4.56	400	87.72	219	175	146
8	0.16	6.08	400	65.79	164	132	110
9	0.15	6.84	400	58.48	146	117	97
10	0.13	7.6	400	52.63	132	105	88
11	0.12	8.36	400	47.85	120	96	80
12	0.11	9.12	400	43.86	110	88	73
<i>11m (36ft) harvester</i>							
4	0.23	4.40	575	130.68	327	261	218
6	0.15	6.60	575	87.12	218	174	145
8	0.11	8.80	575	65.34	163	131	109
9	0.10	9.90	575	58.08	145	116	97
10	0.09	11.00	575	52.27	131	105	87
11	0.08	12.10	575	47.52	119	95	79
12	0.08	13.20	575	43.56	109	87	73
<i>12.2m (40ft) harvester</i>							
4	0.20	4.88	575	117.83	295	236	196
6	0.14	7.32	575	78.55	196	157	131
8	0.10	9.76	575	58.91	147	118	98
9	0.09	10.98	575	52.37	131	105	87
10	0.08	12.20	575	47.13	118	94	79
11	0.07	13.42	575	42.85	107	86	71
12	0.07	14.64	575	39.28	98	79	65

**Table 16:** Direct heading costs of harvesters compared with equivalent \$ value of crop expressed as crop yield

\* assuming 42% oil

## Other considerations

Some other practical issues when deciding to windrowing and/or direct head canola include:

- weather forecasts eg. strong winds, storm events, high temperatures
- end of season growing conditions – moisture stressed crop and/or hot weather – shutting down crop prematurely → ↓ value of crop (\$/ha)?
- rain events – probability of untrafficable paddocks – soil types, local topography
- disease levels, eg. sclerotinia and blackleg – may increase shattering losses
- plant population – variable maturity, estimated crop yields (and therefore \$/ha value)
- Earlier stress periods, eg. moisture, frost, nutrition, pest pressure – timing and possible effects on crop performance (crop value (\$/ha))

These issues will combine with:

- Crop area to be harvested (canola and other crops)
- General logistics and the capacity of all harvest and associated operations (eg. trucks, field bins, storage, delivery, labour etc)
- Availability of contractors
- Owner equipment

## 4.4 Harvest management logistics

### 4.4.1 Direct heading vs windrowing

Harvest management is all about risk management. The longer it takes to harvest a crop, the greater the risks to potential economic outcomes with losses to both harvestable grain and grain quality.

The area of crop to be harvested, access to windrowers and to harvesters, including the number of harvesters will determine the duration of the harvest period. When forecasts of adverse weather conditions increases risks, harvesting the crop area as quickly as possible will reduce exposure to possible significant financial losses.

#### 4.4.1.1 Direct heading

When **direct heading** canola, there is no flexibility in timing. The crop is slower to dry down and must be harvested when it is ready, creating periods of intense harvest activity, particularly when coinciding with the harvesting of other crops. At times problems of variable seed moisture may further delay harvest. The hours of harvest operations may be limited to early and late in the day. The down time is often used to change header fronts and settings to go to other paddocks to harvest wheat and barley that is also ready to harvest.

When direct heading a crop, the hours of harvest operation can be limited by the prevailing weather conditions, particularly daytime temperatures and relative humidity, whereas a harvester can frequently pick up windrows around the clock.

When considering direct heading a crop, there is a limited time period in which to harvest the crop, with minimal flexibility. Do you have your own harvester ready to go or are contractors there when the crop is ready? The area of crop to be harvested is a key consideration. The hours of operation in a 24 hour period to direct head canola are limited.

The **area of crop** that can be direct headed is determined by:

1. the size (width) of the harvester,
2. harvest speed,
3. operation time – how many hours a day can the crop be safely harvested, and
4. the number of harvesters in operation.

Table 17 shows how these key factors interact.

Speed (km/hr)	hrs/ha	ha/hr	Contract rate (\$/hour)	Cost (\$/ha)	ha harvested /8 hrs	ha harvested /12 hrs	ha harvested /16 hrs	ha harvested /24 hrs	Harvest costs \$/8 hrs	Harvest costs \$/12 hrs	Harvest costs \$/16 hrs	Harvest costs \$/24 hrs
<i>6.4m (21ft) harvester</i>												
4	0.39	2.56	400	156.25	20.48	30.72	40.96	61.44	3200	4800	6400	9600
6	0.26	3.84	400	104.17	30.72	46.08	61.44	92.16	3200	4800	6400	9600
8	0.20	5.12	400	78.13	40.96	61.44	81.92	122.88	3200	4800	6400	9600
9	0.17	5.76	400	69.44	46.08	69.12	92.16	138.24	3200	4800	6400	9600
10	0.16	6.4	400	62.50	51.2	76.8	102.4	153.6	3200	4800	6400	9600
11	0.14	7.04	400	56.82	56.32	84.48	112.64	168.96	3200	4800	6400	9600
12	0.13	7.68	400	52.08	61.44	92.16	122.88	184.32	3200	4800	6400	9600
<i>7.6m (25ft) harvester</i>												
4	0.33	3.04	400	131.58	24.32	36.48	48.64	72.96	3200	4800	6400	9600
6	0.22	4.56	400	87.72	36.48	54.72	72.96	109.44	3200	4800	6400	9600
8	0.16	6.08	400	65.79	48.64	72.96	97.28	145.92	3200	4800	6400	9600
9	0.15	6.84	400	58.48	54.72	82.08	109.44	164.16	3200	4800	6400	9600
10	0.13	7.6	400	52.63	60.8	91.2	121.6	182.4	3200	4800	6400	9600
11	0.12	8.36	400	47.85	66.88	100.32	133.76	200.64	3200	4800	6400	9600
12	0.11	9.12	400	43.86	72.96	109.44	145.92	218.88	3200	4800	6400	9600
<i>11m (36ft) harvester</i>												
4	0.23	4.40	575	130.68	35.2	52.8	70.4	105.6	4600	6900	9200	13800
6	0.15	6.60	575	87.12	52.8	79.2	105.6	158.4	4600	6900	9200	13800
8	0.11	8.80	575	65.34	70.4	105.6	140.8	211.2	4600	6900	9200	13800
9	0.10	9.90	575	58.08	79.2	118.8	158.4	237.6	4600	6900	9200	13800
10	0.09	11.00	575	52.27	88	132	176	264	4600	6900	9200	13800
11	0.08	12.10	575	47.52	96.8	145.2	193.6	290.4	4600	6900	9200	13800
12	0.08	13.20	575	43.56	105.6	158.4	211.2	316.8	4600	6900	9200	13800
<i>12.2m (40ft) harvester</i>												
4	0.20	4.88	575	117.83	39.04	58.56	78.08	117.12	4600	6900	9200	13800
6	0.14	7.32	575	78.55	59	87.84	117	176	4600	6900	9200	13800
8	0.10	9.76	575	58.91	78.08	117.12	156.16	234.24	4600	6900	9200	13800
9	0.09	10.98	575	52.37	88	131.76	176	264	4600	6900	9200	13800
10	0.08	12.20	575	47.13	97.6	146.4	195.2	292.8	4600	6900	9200	13800
11	0.07	13.42	575	42.85	107	161.04	215	322	4600	6900	9200	13800
12	0.07	14.64	575	39.28	117.12	175.68	234.24	351.36	4600	6900	9200	13800

**Table 17:** Direct heading – THEORETICAL Hours of operation / day – Single (one) harvester

#### 4.4.1.2 Windrowing (Swathing)

When **windrowing**, the crop area, number of windrowers available and the limited window of opportunity to optimise crop outcomes need to be assessed. Overall harvest logistics are much improved when the crop has been windrowed, especially with large crops areas.

Speed (km/hr)	hrs /ha	ha/hr	Contract rate (\$/ha)	Cost (\$/hour)	Crop area (ha) /16 hrs	Crop area (ha) /20 hrs	Crop area (ha) /24 hrs	Windrowing cost \$/16 hrs	Windrowing cost \$/20 hrs	Windrowing cost \$/24 hrs
<i>6.4m (21ft) windrower</i>										
8	0.20	5.12	30	153.6	82	102	123	2458	3072	3686
10	0.16	6.4	30	192	102	128	154	3072	3840	4608
11	0.14	7.04	30	211.2	113	141	169	3379	4224	5069
12	0.13	7.68	30	230.4	123	154	184	3686	4608	5530
14	0.11	8.96	30	268.8	143	179	215	4301	5376	6451
<i>7.6m (25ft) windrower</i>										
8	0.16	6.08	30	182.4	97	122	146	2918	3648	4378
10	0.13	7.6	30	228	122	152	182	3648	4560	5472
11	0.12	8.36	30	250.8	134	167	201	4013	5016	6019
12	0.11	9.12	30	273.6	146	182	219	4378	5472	6566
14	0.09	10.64	30	319.2	170	213	255	5107	6384	7661
<i>9.1m (30ft) windrower</i>										
8	0.14	7.28	30	218.4	116	146	175	3494	4368	5242
10	0.11	9.1	30	273	146	182	218	4368	5460	6552
11	0.10	10.01	30	300.3	160	200	240	4805	6006	7207
12	0.09	10.92	30	327.6	175	218	262	5242	6552	7862
14	0.08	12.74	30	382.2	204	255	306	6115	7644	9173
<i>11m (36ft) windrower</i>										
8	0.11	8.80	30	264	141	176	211	4224	5280	6336
10	0.09	11.00	30	330	176	220	264	5280	6600	7920
11	0.08	12.10	30	363	194	242	290	5808	7260	8712
12	0.08	13.20	30	396	211	264	317	6336	7920	9504
14	0.06	15.40	30	462	246	308	370	7392	9240	11088
<i>12.2m (40ft) windrower</i>										
8	0.10	9.76	30	292.8	156	195	234	4685	5856	7027
10	0.08	12.20	30	366	195	244	293	5856	7320	8784
11	0.07	13.42	30	402.6	215	268	322	6442	8052	9662
12	0.07	14.64	30	439.2	234	293	351	7027	8784	10541
14	0.06	17.08	30	512.4	273	342	410	8198	10248	12298

**Table 18:** THEORETICAL windrowed crop area – single (one) windrower

#### 4.4.1.3 Harvesting windrows

Compared with a standing canola crop there is much greater flexibility in the timing to pick up windrows and with much less risk of losses. If picking up a canola crop that has been windrowed, it is generally ready 7 – 10 days before the harvest maturity of other crop types. The canola harvest can be completed before starting on wheat and barley.

Picking up a windrowed crop generally can occur 20, even 24 hours a day in some seasons. This has a major impact on harvest efficiency with harvesters able to continue operating most hours of the day.

The **area of windrowed crop** that is harvested is determined mainly by:

1. the size (width) of the harvester,
2. bulk of the windrow
3. harvest speed (influenced by windrow bulk and uniformity), and
4. number of headers in operation

Table 19 shows how these key factors interact.

Speed (km/hr)	hrs/ha	ha/hr	Contract rate (\$/hour)	Cost (\$/ha)	ha harvested /20 hrs	ha harvested /24 hrs	Harvest costs \$/20 hrs	Harvest costs \$/24 hrs
<i>6.4m (21ft) harvester</i>								
4	0.39	2.56	400	156.25	51.2	61.4	8000	9600
6	0.26	3.84	400	104.17	76.8	92.2	8000	9600
8	0.20	5.12	400	78.13	102.4	122.9	8000	9600
9	0.17	5.76	400	69.44	115.2	138.2	8000	9600
10	0.16	6.4	400	62.50	128.0	153.6	8000	9600
11	0.14	7.04	400	56.82	140.8	169.0	8000	9600
12	0.13	7.68	400	52.08	153.6	184.3	8000	9600
<i>7.6m (25ft) harvester</i>								
4	0.33	3.04	400	131.58	60.8	73.0	8000	9600
6	0.22	4.56	400	87.72	91.2	109.4	8000	9600
8	0.16	6.08	400	65.79	121.6	145.9	8000	9600
9	0.15	6.84	400	58.48	136.8	164.2	8000	9600
10	0.13	7.6	400	52.63	152.0	182.4	8000	9600
11	0.12	8.36	400	47.85	167.2	200.6	8000	9600
12	0.11	9.12	400	43.86	182.4	218.9	8000	9600
<i>11m (36ft) harvester</i>								
4	0.23	4.40	575	130.68	88.0	105.6	11500	13800
6	0.15	6.60	575	87.12	132.0	158.4	11500	13800
8	0.11	8.80	575	65.34	176.0	211.2	11500	13800
9	0.10	9.90	575	58.08	198.0	237.6	11500	13800
10	0.09	11.00	575	52.27	220.0	264.0	11500	13800
11	0.08	12.10	575	47.52	242.0	290.4	11500	13800
12	0.08	13.20	575	43.56	264.0	316.8	11500	13800
<i>12.2m (40ft) harvester</i>								
4	0.20	4.88	575	117.83	97.6	117.1	11500	13800
6	0.14	7.32	575	78.55	146.4	175.7	11500	13800
8	0.10	9.76	575	58.91	195.2	234.2	11500	13800
9	0.09	10.98	575	52.37	219.6	263.5	11500	13800
10	0.08	12.20	575	47.13	244.0	292.8	11500	13800
11	0.07	13.42	575	42.85	268.4	322.1	11500	13800
12	0.07	14.64	575	39.28	292.8	351.4	11500	13800

**Table 19:** Harvesting windrows – THEORETICAL Hours of operation / day – Single (one) harvester

The decision as to how to manage the canola harvest also needs to consider the value of the crop. The following tables (Table 20 to Table 24) show the value of the crop based on yield.

Yield 1.0 t/ha	hrs/ha	ha/hr	\$400 / t				\$500 / t				\$600 / t			
			Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)
6.4m (21ft) harvester														
4	0.39	2.56	8192	12288	16384	24576	10240	15360	20480	30720	12288	18432	24576	36864
6	0.26	3.84	12288	18432	24576	36864	15360	23040	30720	46080	18432	27648	36864	55296
8	0.20	5.12	16384	24576	32768	49152	20480	30720	40960	61440	24576	36864	49152	73728
9	0.17	5.76	18432	27648	36864	55296	23040	34560	46080	69120	27648	41472	55296	82944
10	0.16	6.4	20480	30720	40960	61440	25600	38400	51200	76800	30720	46080	61440	92160
11	0.14	7.04	22528	33792	45056	67584	28160	42240	56320	84480	33792	50688	67584	101376
12	0.13	7.68	24576	36864	49152	73728	30720	46080	61440	92160	36864	55296	73728	110592
7.6m (25ft) harvester														
4	0.33	3.04	9728	14592	19456	29184	12160	18240	24320	36480	14592	21888	29184	43776
6	0.22	4.56	14592	21888	29184	43776	18240	27360	36480	54720	21888	32832	43776	65664
8	0.16	6.08	19456	29184	38912	58368	24320	36480	48640	72960	29184	43776	58368	87552
9	0.15	6.84	21888	32832	43776	65664	27360	41040	54720	82080	32832	49248	65664	98496
10	0.13	7.6	24320	36480	48640	72960	30400	45600	60800	91200	36480	54720	72960	109440
11	0.12	8.36	26752	40128	53504	80256	33440	50160	66880	100320	40128	60192	80256	120384
12	0.11	9.12	29184	43776	58368	87552	36480	54720	72960	109440	43776	65664	87552	131328
11m (36ft) harvester														
4	0.23	4.40	14080	21120	28160	42240	17600	26400	35200	52800	21120	31680	42240	63360
6	0.15	6.60	21120	31680	42240	63360	26400	39600	52800	79200	31680	47520	63360	95040
8	0.11	8.80	28160	42240	56320	84480	35200	52800	70400	105600	42240	63360	84480	126720
9	0.10	9.90	31680	47520	63360	95040	39600	59400	79200	118800	47520	71280	95040	142560
10	0.09	11.00	35200	52800	70400	105600	44000	66000	88000	132000	52800	79200	105600	158400
11	0.08	12.10	38720	58080	77440	116160	48400	72600	96800	145200	58080	87120	116160	174240
12	0.08	13.20	42240	63360	84480	126720	52800	79200	105600	158400	63360	95040	126720	190080
12.2m (40ft) harvester														
4	0.20	4.88	15616	23424	31232	46848	19520	29280	39040	58560	23424	35136	46848	70272
6	0.14	7.32	23424	35136	46848	70272	29280	43920	58560	87840	35136	52704	70272	105408
8	0.10	9.76	31232	46848	62464	93696	39040	58560	78080	117120	46848	70272	93696	140544
9	0.09	10.98	35136	52704	70272	105408	43920	65880	87840	131760	52704	79056	105408	158112
10	0.08	12.20	39040	58560	78080	117120	48800	73200	97600	146400	58560	87840	117120	175680
11	0.07	13.42	42944	64416	85888	128832	53680	80520	107360	161040	64416	96624	128832	193248
12	0.07	14.64	46848	70272	93696	140544	58560	87840	117120	175680	70272	105408	140544	210816

Table 20: Value of crop based on yield of 1.0 t/ha (42% oil)

Yield 1.5 t/ha	hrs/ha	ha/hr	\$400 / t				\$500 / t				\$600 / t			
			Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)
6.4m (21ft) harvester														
4	0.39	2.56	12288	18432	24576	36864	15360	23040	30720	46080	18432	27648	36864	55296
6	0.26	3.84	18432	27648	36864	55296	23040	34560	46080	69120	27648	41472	55296	82944
8	0.20	5.12	24576	36864	49152	73728	30720	46080	61440	92160	36864	55296	73728	110592
9	0.17	5.76	27648	41472	55296	82944	34560	51840	69120	103680	41472	62208	82944	124416
10	0.16	6.4	30720	46080	61440	92160	38400	57600	76800	115200	46080	69120	92160	138240
11	0.14	7.04	33792	50688	67584	101376	42240	63360	84480	126720	50688	76032	101376	152064
12	0.13	7.68	36864	55296	73728	110592	46080	69120	92160	138240	55296	82944	110592	165888
7.6m (25ft) harvester														
4	0.33	3.04	14592	21888	29184	43776	18240	27360	36480	54720	21888	32832	43776	65664
6	0.22	4.56	21888	32832	43776	65664	27360	41040	54720	82080	32832	49248	65664	98496
8	0.16	6.08	29184	43776	58368	87552	36480	54720	72960	109440	43776	65664	87552	131328
9	0.15	6.84	32832	49248	65664	98496	41040	61560	82080	123120	49248	73872	98496	147744
10	0.13	7.6	36480	54720	72960	109440	45600	68400	91200	136800	54720	82080	109440	164160
11	0.12	8.36	40128	60192	80256	120384	50160	75240	100320	150480	60192	90288	120384	180576
12	0.11	9.12	43776	65664	87552	131328	54720	82080	109440	164160	65664	98496	131328	196992
11m (36ft) harvester														
4	0.23	4.40	21120	31680	42240	63360	26400	39600	52800	79200	31680	47520	63360	95040
6	0.15	6.60	31680	47520	63360	95040	39600	59400	79200	118800	47520	71280	95040	142560
8	0.11	8.80	42240	63360	84480	126720	52800	79200	105600	158400	63360	95040	126720	190080
9	0.10	9.90	47520	71280	95040	142560	59400	89100	118800	178200	71280	106920	142560	213840
10	0.09	11.00	52800	79200	105600	158400	66000	99000	132000	198000	79200	118800	158400	237600
11	0.08	12.10	58080	87120	116160	174240	72600	108900	145200	217800	87120	130680	174240	261360
12	0.08	13.20	63360	95040	126720	190080	79200	118800	158400	237600	95040	142560	190080	285120
12.2m (40ft) harvester														
4	0.20	4.88	23424	35136	46848	70272	29280	43920	58560	87840	35136	52704	70272	105408
6	0.14	7.32	35136	52704	70272	105408	43920	65880	87840	131760	52704	79056	105408	158112
8	0.10	9.76	46848	70272	93696	140544	58560	87840	117120	175680	70272	105408	140544	210816
9	0.09	10.98	52704	79056	105408	158112	65880	98820	131760	197640	79056	118584	158112	237168
10	0.08	12.20	58560	87840	117120	175680	73200	109800	146400	219600	87840	131760	175680	263520
11	0.07	13.42	64416	96624	128832	193248	80520	120780	161040	241560	96624	144936	193248	289872
12	0.07	14.64	70272	105408	140544	210816	87840	131760	175680	263520	105408	158112	210816	316224

Table 21: Value of crop based on yield of 1.5 t/ha (42% oil)

Yield 2.0 t/ha	hrs/ha	ha/hr	\$400 / t				\$500 / t				\$600 / t			
			Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)
6.4m (21ft) harvester														
4	0.39	2.56	16384	24576	32768	49152	20480	30720	40960	61440	24576	36864	49152	73728
6	0.26	3.84	24576	36864	49152	73728	30720	46080	61440	92160	36864	55296	73728	110592
8	0.20	5.12	32768	49152	65536	98304	40960	61440	81920	122880	49152	73728	98304	147456
9	0.17	5.76	36864	55296	73728	110592	46080	69120	92160	138240	55296	82944	110592	165888
10	0.16	6.4	40960	61440	81920	122880	51200	76800	102400	153600	61440	92160	122880	184320
11	0.14	7.04	45056	67584	90112	135168	56320	84480	112640	168960	67584	101376	135168	202752
12	0.13	7.68	49152	73728	98304	147456	61440	92160	122880	184320	73728	110592	147456	221184
7.6m (25ft) harvester														
4	0.33	3.04	19456	29184	38912	58368	24320	36480	48640	72960	29184	43776	58368	87552
6	0.22	4.56	29184	43776	58368	87552	36480	54720	72960	109440	43776	65664	87552	131328
8	0.16	6.08	38912	58368	77824	116736	48640	72960	97280	145920	58368	87552	116736	175104
9	0.15	6.84	43776	65664	87552	131328	54720	82080	109440	164160	65664	98496	131328	196992
10	0.13	7.6	48640	72960	97280	145920	60800	91200	121600	182400	72960	109440	145920	218880
11	0.12	8.36	53504	80256	107008	160512	66880	100320	133760	200640	80256	120384	160512	240768
12	0.11	9.12	58368	87552	116736	175104	72960	109440	145920	218880	87552	131328	175104	262656
11m (36ft) harvester														
4	0.23	4.40	28160	42240	56320	84480	35200	52800	70400	105600	42240	63360	84480	126720
6	0.15	6.60	42240	63360	84480	126720	52800	79200	105600	158400	63360	95040	126720	190080
8	0.11	8.80	56320	84480	112640	168960	70400	105600	140800	211200	84480	126720	168960	253440
9	0.10	9.90	63360	95040	126720	190080	79200	118800	158400	237600	95040	142560	190080	285120
10	0.09	11.00	70400	105600	140800	211200	88000	132000	176000	264000	105600	158400	211200	316800
11	0.08	12.10	77440	116160	154880	232320	96800	145200	193600	290400	116160	174240	232320	348480
12	0.08	13.20	84480	126720	168960	253440	105600	158400	211200	316800	126720	190080	253440	380160
12.2m (40ft) harvester														
4	0.20	4.88	31232	46848	62464	93696	39040	58560	78080	117120	46848	70272	93696	140544
6	0.14	7.32	46848	70272	93696	140544	58560	87840	117120	175680	70272	105408	140544	210816
8	0.10	9.76	62464	93696	124928	187392	78080	117120	156160	234240	93696	140544	187392	281088
9	0.09	10.98	70272	105408	140544	210816	87840	131760	175680	263520	105408	158112	210816	316224
10	0.08	12.20	78080	117120	156160	234240	97600	146400	195200	292800	117120	175680	234240	351360
11	0.07	13.42	85888	128832	171776	257664	107360	161040	214720	322080	128832	193248	257664	386496
12	0.07	14.64	93696	140544	187392	281088	117120	175680	234240	351360	140544	210816	281088	421632

Table 22: Value of crop based on yield of 2.0 t/ha (42% oil)

Yield 2.5 t/ha	hrs/ha	ha/hr	\$400 / t				\$500 / t				\$600 / t			
			Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)
6.4m (21ft) harvester														
4	0.39	2.56	20480	30720	40960	61440	25600	38400	51200	76800	30720	46080	61440	92160
6	0.26	3.84	30720	46080	61440	92160	38400	57600	76800	115200	46080	69120	92160	138240
8	0.20	5.12	40960	61440	81920	122880	51200	76800	102400	153600	61440	92160	122880	184320
9	0.17	5.76	46080	69120	92160	138240	57600	86400	115200	172800	69120	103680	138240	207360
10	0.16	6.4	51200	76800	102400	153600	64000	96000	128000	192000	76800	115200	153600	230400
11	0.14	7.04	56320	84480	112640	168960	70400	105600	140800	211200	84480	126720	168960	253440
12	0.13	7.68	61440	92160	122880	184320	76800	115200	153600	230400	92160	138240	184320	276480
7.6m (25ft) harvester														
4	0.33	3.04	24320	36480	48640	72960	30400	45600	60800	91200	36480	54720	72960	109440
6	0.22	4.56	36480	54720	72960	109440	45600	68400	91200	136800	54720	82080	109440	164160
8	0.16	6.08	48640	72960	97280	145920	60800	91200	121600	182400	72960	109440	145920	218880
9	0.15	6.84	54720	82080	109440	164160	68400	102600	136800	205200	82080	123120	164160	246240
10	0.13	7.6	60800	91200	121600	182400	76000	114000	152000	228000	91200	136800	182400	273600
11	0.12	8.36	66880	100320	133760	200640	83600	125400	167200	250800	100320	150480	200640	300960
12	0.11	9.12	72960	109440	145920	218880	91200	136800	182400	273600	109440	164160	218880	328320
11m (36ft) harvester														
4	0.23	4.40	35200	52800	70400	105600	44000	66000	88000	132000	52800	79200	105600	158400
6	0.15	6.60	52800	79200	105600	158400	66000	99000	132000	198000	79200	118800	158400	237600
8	0.11	8.80	70400	105600	140800	211200	88000	132000	176000	264000	105600	158400	211200	316800
9	0.10	9.90	79200	118800	158400	237600	99000	148500	198000	297000	118800	178200	237600	356400
10	0.09	11.00	88000	132000	176000	264000	110000	165000	220000	330000	132000	198000	264000	396000
11	0.08	12.10	96800	145200	193600	290400	121000	181500	242000	363000	145200	217800	290400	435600
12	0.08	13.20	105600	158400	211200	316800	132000	198000	264000	396000	158400	237600	316800	475200
12.2m (40ft) harvester														
4	0.20	4.88	39040	58560	78080	117120	48800	73200	97600	146400	58560	87840	117120	175680
6	0.14	7.32	58560	87840	117120	175680	73200	109800	146400	219600	87840	131760	175680	263520
8	0.10	9.76	78080	117120	156160	234240	97600	146400	195200	292800	117120	175680	234240	351360
9	0.09	10.98	87840	131760	175680	263520	109800	164700	219600	329400	131760	197640	263520	395280
10	0.08	12.20	97600	146400	195200	292800	122000	183000	244000	366000	146400	219600	292800	439200
11	0.07	13.42	107360	161040	214720	322080	134200	201300	268400	402600	161040	241560	322080	483120
12	0.07	14.64	117120	175680	234240	351360	146400	219600	292800	439200	175680	263520	351360	527040

Table 23: Value of crop based on yield of 2.5 t/ha (42% oil)

Yield 3.0 t/ha	hrs/ha	ha/hr	\$400 / t				\$500 / t				\$600 / t			
			Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)	Harvested crop value (\$/ 8 hrs)	Harvested crop value (\$/ 12 hrs)	Harvested crop value (\$/ 16 hrs)	Harvested crop value (\$/ 24 hrs)
6.4m (21ft) harvester														
4	0.39	2.56	24576	36864	49152	73728	30720	46080	61440	92160	36864	55296	73728	110592
6	0.26	3.84	36864	55296	73728	110592	46080	69120	92160	138240	55296	82944	110592	165888
8	0.20	5.12	49152	73728	98304	147456	61440	92160	122880	184320	73728	110592	147456	221184
9	0.17	5.76	55296	82944	110592	165888	69120	103680	138240	207360	82944	124416	165888	248832
10	0.16	6.4	61440	92160	122880	184320	76800	115200	153600	230400	92160	138240	184320	276480
11	0.14	7.04	67584	101376	135168	202752	84480	126720	168960	253440	101376	152064	202752	304128
12	0.13	7.68	73728	110592	147456	221184	92160	138240	184320	276480	110592	165888	221184	331776
7.6m (25ft) harvester														
4	0.33	3.04	29184	43776	58368	87552	36480	54720	72960	109440	43776	65664	87552	131328
6	0.22	4.56	43776	65664	87552	131328	54720	82080	109440	164160	65664	98496	131328	196992
8	0.16	6.08	58368	87552	116736	175104	72960	109440	145920	218880	87552	131328	175104	262656
9	0.15	6.84	65664	98496	131328	196992	82080	123120	164160	246240	98496	147744	196992	295488
10	0.13	7.6	72960	109440	145920	218880	91200	136800	182400	273600	109440	164160	218880	328320
11	0.12	8.36	80256	120384	160512	240768	100320	150480	200640	300960	120384	180576	240768	361152
12	0.11	9.12	87552	131328	175104	262656	109440	164160	218880	328320	131328	196992	262656	393984
11m (36ft) harvester														
4	0.23	4.40	42240	63360	84480	126720	52800	79200	105600	158400	63360	95040	126720	190080
6	0.15	6.60	63360	95040	126720	190080	79200	118800	158400	237600	95040	142560	190080	285120
8	0.11	8.80	84480	126720	168960	253440	105600	158400	211200	316800	126720	190080	253440	380160
9	0.10	9.90	95040	142560	190080	285120	118800	178200	237600	356400	142560	213840	285120	427680
10	0.09	11.00	105600	158400	211200	316800	132000	198000	264000	396000	158400	237600	316800	475200
11	0.08	12.10	116160	174240	232320	348480	145200	217800	290400	435600	174240	261360	348480	522720
12	0.08	13.20	126720	190080	253440	380160	158400	237600	316800	475200	190080	285120	380160	570240
12.2m (40ft) harvester														
4	0.20	4.88	46848	70272	93696	140544	58560	87840	117120	175680	70272	105408	140544	210816
6	0.14	7.32	70272	105408	140544	210816	87840	131760	175680	263520	105408	158112	210816	316224
8	0.10	9.76	93696	140544	187392	281088	117120	175680	234240	351360	140544	210816	281088	421632
9	0.09	10.98	105408	158112	210816	316224	131760	197640	263520	395280	158112	237168	316224	474336
10	0.08	12.20	117120	175680	234240	351360	146400	219600	292800	439200	175680	263520	351360	527040
11	0.07	13.42	128832	193248	257664	386496	161040	241560	322080	483120	193248	289872	386496	579744
12	0.07	14.64	140544	210816	281088	421632	175680	263520	351360	527040	210816	316224	421632	632448

Table 24: Value of crop based on yield of 3.0 t/ha (42% oil)

The value of the crop per hectare can vary considerably with harvest management operations. Timing of direct heading operations and the timing of the windrowing operation can have a significant effect on the value of the crop to be harvested.

#### 4.4.2 How else does windrowing and direct heading compare?

Using the following assumptions:

- Crop – 2.5 t/ha, 42% oil, assuming no shattering losses (*for simplicity*)
- Crop valued at \$500/t, 42% oil
- Windrower – 11 m (36 ft) width operating at 8 km/hr @ \$30/ha
- Harvesting windrows – Harvester – 11 m (36 ft) width operating at 8 km/hr @ \$575/hr
- Direct heading – Harvester – 11 m (36 ft) width operating at 9 km/hr @ \$575/hr
- Assuming no stoppages / breakdowns, even well laid windrows, even standing crop with lodging etc.
- Figures are based on a single windrowing machine or harvester

	Crop area 200 ha	Crop area 500 ha	Crop area 1000 ha	Crop area 1500 ha
<b>Windrowing</b>				
hrs / ha	0.11	0.11	0.11	0.11
ha / hr	8.8	8.80	8.80	8.80
Cost \$/ hr	273	273	273	273
Cost \$/ha	30	30	30	30
Average hours of operation / day	20	20	20	20
Total cost / day (\$)	5460	5460	5460	5460
Time taken to complete windrowing (hrs)	22.7	56.8	113.6	170.5
Time taken to complete windrowing (days)	0.9	2.8	5.7	8.5
Total cost of windrowing (\$)	6000	15 000	30 000	45 000
Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	60	60	60	60
Value of crop \$/ha	1250	1250	1250	1250
Gross value of crop area (\$)	250 000	625 000	1 250 000	1 875 000
Cost of windrowing / gross crop value (%)	2.4	2.4	2.4	2.4
<b>Harvesting windrows</b>				
hrs / ha	0.11	0.11	0.11	0.11
ha / hr	8.80	8.80	8.80	8.80
Cost \$/ hr	575	575	575	575
Cost \$/ha	65.34	65.34	65.34	65.34
Average hours of operation / day	20	20	20	20
Total cost / day (\$)	11 500	11 500	11 500	11 500
Area harvested / day (ha)	176	176	176	176
Time taken to complete harvest of windrows (hrs)	22.7	56.8	113.6	170.5
Time taken harvest windrows (days)	0.9	2.8	5.7	8.5
Total cost of harvesting windrows (\$)	13 068	32 670	65 340	98 010
Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	131	131	131	131
Value of crop \$/ha	1250	1250	1250	1250
Gross value of crop area (\$)	250 000	625 000	1 250 000	1 875 000
Cost of harvesting windrows / gross crop value (%)	5.2	5.2	5.2	5.2

	Crop area 200 ha	Crop area 500 ha	Crop area 1000 ha	Crop area 1500 ha
<b>Direct heading</b>				
hrs / ha	0.10	0.10	0.10	0.10
ha / hr	9.90	9.90	9.90	9.90
Cost \$/ hr	575	575	575	575
Cost \$/ha	58.08	58.08	58.08	58.08
Average hours of operation / day	12	12	12	12
Total cost / day (\$)	6900	6900	6900	6900
Area direct headed / day (ha)	118.8	118.8	118.8	118.8
Time taken to direct head crop (hrs)	20.2	50.5	101	151.5
Time taken direct head crop (days)	1.7	4.2	8.4	12.6
Total cost of direct heading (\$)	11 616	29 038	58 075	87 113
Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	116	116	116	116
Value of crop \$/ha	1250	1250	1250	1250
Gross value of crop area (\$)	250 000	625 000	1 250 000	1 875 000
Cost of direct heading / gross crop value (%)	4.6	4.6	4.6	4.6

**Table 25:** Economic comparison of direct heading and windrowing

### Your situation

The following table allows you to enter your own figures to estimate some of how the economics of harvest management operations compare.

Look up the tables for your windrower and/or harvester.

To assist in which table or figure to use in calculations, each part is identified (see first column) and the calculation or appropriate Table is indicated in the far-right column. An example is shown in column 3.

You can nominate:

- Crop area (ha)
- width of windrower / harvester
- Speed of operation
- Hours of operation
- Crop yield (t/ha)
- Oil content (see Appendix I, page 55) for bonification values
- Crop value

		Example Crop area 500 ha	Your crop <input type="text"/> ha	Your crop <input type="text"/> ha	Your crop <input type="text"/> ha	Reference / calculation
<b>ID</b>						
	<b>Windrowing</b>					
WA	hrs / ha	0.11				Table 18 pg 44
WB	ha / hr	8.80				Table 18 pg 44
WC	Cost \$/ hr	273				WB x WD
WD	Cost \$/ha	30				<i>Insert your figure</i>
WE	Average hours of operation / day	20				<i>Insert your figure</i>
WF	Total cost / day (\$)	5280				WC x WE
WG	Time taken to complete windrowing (hrs)	56.8				Area (ha) / WB
WH	Time taken to complete windrowing ( <b>days</b> )	2.8				WG / WE
WI	Total cost of windrowing (\$)	15 000				WD x area (ha)
WJ	Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	60				Table 14 pg 40
WK	Value of crop \$/ha	1250				<i>Insert your figure</i>
WL	Gross value of crop area (\$)	625 000				WK x area (ha)
WM	Cost of windrowing / gross crop value (%)	2.4				WI/WL x 100
	<b>Harvesting windrows</b>					
HWA	hrs / ha	0.11				Table 19 pg 45
HWB	ha / hr	8.80				Table 19 pg 45
HWC	Cost \$/ hr	575				<i>Insert your figure</i>
HWD	Cost \$/ha	65.34				HWC / HWB
HWE	Average hours of operation / day	20				<i>Insert your figure</i>
HWF	Total cost / day (\$)	11 500				HWC x HWE
HWG	Area harvested / day (ha)	176				HWB x HWE
HWH	Time taken to complete harvest of windrows (hrs)	56.8				Area (ha) / HWB
HWI	Time taken harvest windrows (days)	2.8				HWH / HWE
HWJ	Total cost of harvesting windrows (\$)	32 670				HWD x area (ha)
HWK	Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	131				Table 16 pg 41
HWL	Value of crop \$/ha	1250				<i>Insert your figure</i>
HWM	Gross value of crop area (\$)	625 000				HWL x area (ha)
HWN	Cost of harvesting windrows / gross crop value (%)	5.2				HWJ / HWM x 100
	<b>Direct heading</b>					
DHA	hrs / ha	0.10				Table 17 pg 43
DHB	ha / hr	9.90				Table 17 pg 43
DHC	Cost \$/ hr	575				<i>Insert your figure</i>
DHD	Cost \$/ha	58.08				DWC / DWB
DHE	Average hours of operation / day	12				<i>Insert your figure</i>
DHF	Total cost / day (\$)	6900				DHC x DHE
DHG	Area direct headed / day (ha)	118.8				DHB x DHE
DHH	Time taken to direct head crop (hrs)	50.5				Area (ha) / DHB
DHI	Time taken direct head crop (days)	4.2				DHH / DHE
DHJ	Total cost of direct heading (\$)	29 038				DHD x area (ha)
DHK	Crop equivalent (kg/ha) @ \$500/t to cover cost of operation	116				Table 16 pg 41
DHL	Value of crop \$/ha	1250				<i>Insert your figure</i>
DHM	Gross value of crop area (\$)	625 000				DHL x area (ha)
DHN	Cost of direct heading / gross crop value (%)	4.6				DHJ / DHM x 100

**Table 26: YOUR Calculations – Economic comparison of direct heading and windrowing**

## 4.5 Desiccation

Desiccation is sometimes used in conjunction with direct heading to even up a crop with variable maturity.

Product	\$ / L	Application rate (L/ha)	Cost of product (\$/ha)	*Aerial application costs (\$/ha)	Total cost (\$/ha)
Reglone®	24.25	1.5	36.38	14	50.38
		2.0	48.50	14	62.50
		3.0	72.75	14	86.75

**Table 27:** Example of budget costs of desiccation

\* (GST ex) based on 30 L/ha spray volume and 360 ha. Cost will vary with crop proximity, spray volume and crop area.

## 4.6 Crop sealants

Crop sealants have been used as means of reducing the risk of shattering in crops to be direct headed. Investigations as to their effectiveness and economic value have been approached through demonstrations (sometimes referred to as trials) and replicated experiments. The results of some of these are shown in Appendix II (page 58).

Product	\$ / L	Application rate (L/ha)	Cost of product (\$/ha)	*Aerial application costs (\$/ha)	Total cost (\$/ha)
Pod-Ceal™	28	1.0–1.2	28	14	42
Desikote Max®	31.50	0.4	12.6	14	26.60

**Table 28:** Example of budget costs of sealant products

\* (GST ex) based on 30 L/ha spray volume and 360 ha. Cost will vary with crop proximity, spray volume and crop area.

## Appendix I: Oil bonification

Canola prices are quoted at quoted at the base oil content of 42% (and 0% admixture). Farmers are paid on the basis of the bonification scheme which calculates a 1.5% bonus or deduction for every percentage point above or below 42%.

The following tables show the impact of the oil content on the premium or deduction applied at different base grain prices.

**Table 1:** Silo price \$400/t

<b>Oil (%)</b>	<b>30</b>	<b>30.1</b>	<b>30.2</b>	<b>30.3</b>	<b>30.4</b>	<b>30.5</b>	<b>30.6</b>	<b>30.7</b>	<b>30.8</b>	<b>30.9</b>
Bonification (\$)	-72.00	-71.40	-70.80	-70.20	-69.60	-69.00	-68.40	-67.80	-67.20	-66.60
<b>Oil (%)</b>	<b>31</b>	<b>31.1</b>	<b>31.2</b>	<b>31.3</b>	<b>31.4</b>	<b>31.5</b>	<b>31.6</b>	<b>31.7</b>	<b>31.8</b>	<b>31.9</b>
Bonification (\$)	-66.00	-65.40	-64.80	-64.20	-63.60	-63.00	-62.40	-61.80	-61.20	-60.60
<b>Oil (%)</b>	<b>32</b>	<b>32.1</b>	<b>32.2</b>	<b>32.3</b>	<b>32.4</b>	<b>32.5</b>	<b>32.6</b>	<b>32.7</b>	<b>32.8</b>	<b>32.9</b>
Bonification (\$)	-60.00	-59.40	-58.80	-58.20	-57.60	-57.00	-56.40	-55.80	-55.20	-54.60
<b>Oil (%)</b>	<b>33</b>	<b>33.1</b>	<b>33.2</b>	<b>33.3</b>	<b>33.4</b>	<b>33.5</b>	<b>33.6</b>	<b>33.7</b>	<b>33.8</b>	<b>33.9</b>
Bonification (\$)	0	-53.40	-52.80	-52.20	-51.60	-51.00	-50.40	-49.80	-49.20	-48.60
<b>Oil (%)</b>	<b>34</b>	<b>34.1</b>	<b>34.2</b>	<b>34.3</b>	<b>34.4</b>	<b>34.5</b>	<b>34.6</b>	<b>34.7</b>	<b>34.8</b>	<b>34.9</b>
Bonification (\$)	-48.00	-47.40	-46.80	-46.20	-45.60	-45.00	-44.40	-43.80	-43.20	-42.60
<b>Oil (%)</b>	<b>35</b>	<b>35.1</b>	<b>35.2</b>	<b>35.3</b>	<b>35.4</b>	<b>35.5</b>	<b>35.6</b>	<b>35.7</b>	<b>35.8</b>	<b>35.9</b>
Bonification (\$)	-42	-41.4	-40.8	-40.2	-39.6	-39	-38.4	-37.8	-37.2	-36.6
<b>Oil (%)</b>	<b>36</b>	<b>36.1</b>	<b>36.2</b>	<b>36.3</b>	<b>36.4</b>	<b>36.5</b>	<b>36.6</b>	<b>36.7</b>	<b>36.8</b>	<b>36.9</b>
Bonification (\$)	-36.00	-35.40	-34.80	-34.20	-33.60	-33.00	-32.40	-31.80	-31.20	-30.60
<b>Oil (%)</b>	<b>37</b>	<b>37.1</b>	<b>37.2</b>	<b>37.3</b>	<b>37.4</b>	<b>37.5</b>	<b>37.6</b>	<b>37.7</b>	<b>37.8</b>	<b>37.9</b>
Bonification (\$)	-30.00	-29.40	-28.80	-28.20	-27.60	-27.00	-26.40	-25.80	-25.20	-24.60
<b>Oil (%)</b>	<b>38</b>	<b>38.1</b>	<b>38.2</b>	<b>38.3</b>	<b>38.4</b>	<b>38.5</b>	<b>38.6</b>	<b>38.7</b>	<b>38.8</b>	<b>38.9</b>
Bonification (\$)	-24.00	-23.40	-22.80	-22.20	-21.60	-21.00	-20.40	-19.80	-19.20	-18.60
<b>Oil (%)</b>	<b>39</b>	<b>39.1</b>	<b>39.2</b>	<b>39.3</b>	<b>39.4</b>	<b>39.5</b>	<b>39.6</b>	<b>39.7</b>	<b>39.8</b>	<b>39.9</b>
Bonification (\$)	-18.00	-17.40	-16.80	-16.20	-15.60	-15.00	-14.40	-13.80	-13.20	-12.60
<b>Oil (%)</b>	<b>40</b>	<b>40.1</b>	<b>40.2</b>	<b>40.3</b>	<b>40.4</b>	<b>40.5</b>	<b>40.6</b>	<b>40.7</b>	<b>40.8</b>	<b>40.9</b>
Bonification (\$)	-12.00	-11.40	-10.80	-10.20	-9.60	-9.00	-8.40	-7.80	-7.20	-6.60
<b>Oil (%)</b>	<b>41</b>	<b>41.1</b>	<b>41.2</b>	<b>41.3</b>	<b>41.4</b>	<b>41.5</b>	<b>41.6</b>	<b>41.7</b>	<b>41.8</b>	<b>41.9</b>
Bonification (\$)	-6.00	-5.40	-4.80	-4.20	-3.60	-3.00	-2.40	-1.80	-1.20	-0.60
<b>Oil (%)</b>	<b>42</b>	<b>42.1</b>	<b>42.2</b>	<b>42.3</b>	<b>42.4</b>	<b>42.5</b>	<b>42.6</b>	<b>42.7</b>	<b>42.8</b>	<b>42.9</b>
Bonification (\$)	0	0.60	1.20	1.80	2.40	3.00	3.60	4.20	4.80	5.40
<b>Oil (%)</b>	<b>43</b>	<b>43.1</b>	<b>43.2</b>	<b>43.3</b>	<b>43.4</b>	<b>43.5</b>	<b>43.6</b>	<b>43.7</b>	<b>43.8</b>	<b>43.9</b>
Bonification (\$)	6.00	6.60	7.20	7.80	8.40	9.00	9.60	10.20	10.80	11.40
<b>Oil (%)</b>	<b>44</b>	<b>44.1</b>	<b>44.2</b>	<b>44.3</b>	<b>44.4</b>	<b>44.5</b>	<b>44.6</b>	<b>44.7</b>	<b>44.8</b>	<b>44.9</b>
Bonification (\$)	12.00	12.60	13.20	13.80	14.40	15.00	15.60	16.20	16.80	17.40
<b>Oil (%)</b>	<b>45</b>	<b>45.1</b>	<b>45.2</b>	<b>45.3</b>	<b>45.4</b>	<b>45.5</b>	<b>45.6</b>	<b>45.7</b>	<b>45.8</b>	<b>45.9</b>
Bonification (\$)	18	18.6	19.2	19.8	20.4	21	21.6	22.2	22.8	23.4
<b>Oil (%)</b>	<b>46</b>	<b>46.1</b>	<b>46.2</b>	<b>46.3</b>	<b>46.4</b>	<b>46.5</b>	<b>46.6</b>	<b>46.7</b>	<b>46.8</b>	<b>46.9</b>
Bonification (\$)	24.00	24.60	25.20	25.80	26.40	27.00	27.60	28.20	28.80	29.40
<b>Oil (%)</b>	<b>47</b>	<b>47.1</b>	<b>47.2</b>	<b>47.3</b>	<b>47.4</b>	<b>47.5</b>	<b>47.6</b>	<b>47.7</b>	<b>47.8</b>	<b>47.9</b>
Bonification (\$)	30.00	30.60	31.20	31.80	32.40	33.00	33.60	34.20	34.80	35.40
<b>Oil (%)</b>	<b>48</b>	<b>48.1</b>	<b>48.2</b>	<b>48.3</b>	<b>48.4</b>	<b>48.5</b>	<b>48.6</b>	<b>48.7</b>	<b>48.8</b>	<b>48.9</b>
Bonification (\$)	36.00	36.60	37.20	37.80	38.40	39.00	39.60	40.20	40.80	41.40
<b>Oil (%)</b>	<b>49</b>	<b>49.1</b>	<b>49.2</b>	<b>49.3</b>	<b>49.4</b>	<b>49.5</b>	<b>49.6</b>	<b>49.7</b>	<b>49.8</b>	<b>49.9</b>
Bonification (\$)	42.00	42.60	43.20	43.80	44.40	45.00	45.60	46.20	46.80	47.40

**Table 2:** Silo price \$500/t

<b>Oil (%)</b>	<b>30</b>	<b>30.1</b>	<b>30.2</b>	<b>30.3</b>	<b>30.4</b>	<b>30.5</b>	<b>30.6</b>	<b>30.7</b>	<b>30.8</b>	<b>30.9</b>
Bonification (\$)	-90.00	-89.25	-88.50	-87.75	-87.00	-86.25	-85.50	-84.75	-84.00	-83.25
<b>Oil (%)</b>	<b>31</b>	<b>31.1</b>	<b>31.2</b>	<b>31.3</b>	<b>31.4</b>	<b>31.5</b>	<b>31.6</b>	<b>31.7</b>	<b>31.8</b>	<b>31.9</b>
Bonification (\$)	-82.50	-81.75	-81.00	-80.25	-79.50	-78.75	-78.00	-77.25	-76.50	-75.75
<b>Oil (%)</b>	<b>32</b>	<b>32.1</b>	<b>32.2</b>	<b>32.3</b>	<b>32.4</b>	<b>32.5</b>	<b>32.6</b>	<b>32.7</b>	<b>32.8</b>	<b>32.9</b>
Bonification (\$)	-75.00	-74.25	-73.50	-72.75	-72.00	-71.25	-70.50	-69.75	-69.00	-68.25
<b>Oil (%)</b>	<b>33</b>	<b>33.1</b>	<b>33.2</b>	<b>33.3</b>	<b>33.4</b>	<b>33.5</b>	<b>33.6</b>	<b>33.7</b>	<b>33.8</b>	<b>33.9</b>
Bonification (\$)	-67.50	-66.75	-66.00	-65.25	-64.50	-63.75	-63.00	-62.25	-61.50	-60.75
<b>Oil (%)</b>	<b>34</b>	<b>34.1</b>	<b>34.2</b>	<b>34.3</b>	<b>34.4</b>	<b>34.5</b>	<b>34.6</b>	<b>34.7</b>	<b>34.8</b>	<b>34.9</b>
Bonification (\$)	-60.00	-59.25	-58.50	-57.75	-57.00	-56.25	-55.50	-54.75	-54.00	-53.25
<b>Oil (%)</b>	<b>35</b>	<b>35.1</b>	<b>35.2</b>	<b>35.3</b>	<b>35.4</b>	<b>35.5</b>	<b>35.6</b>	<b>35.7</b>	<b>35.8</b>	<b>35.9</b>
Bonification (\$)	-52.5	-51.75	-51	-50.25	-49.5	-48.75	-48	-47.25	-46.5	-45.75
<b>Oil (%)</b>	<b>36</b>	<b>36.1</b>	<b>36.2</b>	<b>36.3</b>	<b>36.4</b>	<b>36.5</b>	<b>36.6</b>	<b>36.7</b>	<b>36.8</b>	<b>36.9</b>
Bonification (\$)	-45.00	-44.25	-43.50	-42.75	-42.00	-41.25	-40.50	-39.75	-39.00	-38.25
<b>Oil (%)</b>	<b>37</b>	<b>37.1</b>	<b>37.2</b>	<b>37.3</b>	<b>37.4</b>	<b>37.5</b>	<b>37.6</b>	<b>37.7</b>	<b>37.8</b>	<b>37.9</b>
Bonification (\$)	-37.50	-36.75	-36.00	-35.25	-34.50	-33.75	-33.00	-32.25	-31.50	-30.75
<b>Oil (%)</b>	<b>38</b>	<b>38.1</b>	<b>38.2</b>	<b>38.3</b>	<b>38.4</b>	<b>38.5</b>	<b>38.6</b>	<b>38.7</b>	<b>38.8</b>	<b>38.9</b>
Bonification (\$)	-30.00	-29.25	-28.50	-27.75	-27.00	-26.25	-25.50	-24.75	-24.00	-23.25
<b>Oil (%)</b>	<b>39</b>	<b>39.1</b>	<b>39.2</b>	<b>39.3</b>	<b>39.4</b>	<b>39.5</b>	<b>39.6</b>	<b>39.7</b>	<b>39.8</b>	<b>39.9</b>
Bonification (\$)	-22.50	-21.75	-21.00	-20.25	-19.50	-18.75	-18.00	-17.25	-16.50	-15.75
<b>Oil (%)</b>	<b>40</b>	<b>40.1</b>	<b>40.2</b>	<b>40.3</b>	<b>40.4</b>	<b>40.5</b>	<b>40.6</b>	<b>40.7</b>	<b>40.8</b>	<b>40.9</b>
Bonification (\$)	-15.00	-14.25	-13.50	-12.75	-12.00	-11.25	-10.50	-9.75	-9.00	-8.25
<b>Oil (%)</b>	<b>41</b>	<b>41.1</b>	<b>41.2</b>	<b>41.3</b>	<b>41.4</b>	<b>41.5</b>	<b>41.6</b>	<b>41.7</b>	<b>41.8</b>	<b>41.9</b>
Bonification (\$)	-7.50	-6.75	-6.00	-5.25	-4.50	-3.75	-3.00	-2.25	-1.50	-0.75
<b>Oil (%)</b>	<b>42</b>	<b>42.1</b>	<b>42.2</b>	<b>42.3</b>	<b>42.4</b>	<b>42.5</b>	<b>42.6</b>	<b>42.7</b>	<b>42.8</b>	<b>42.9</b>
Bonification (\$)	0.00	0.75	1.50	2.25	3.00	3.75	4.50	5.25	6.00	6.75
<b>Oil (%)</b>	<b>43</b>	<b>43.1</b>	<b>43.2</b>	<b>43.3</b>	<b>43.4</b>	<b>43.5</b>	<b>43.6</b>	<b>43.7</b>	<b>43.8</b>	<b>43.9</b>
Bonification (\$)	7.50	8.25	9.00	9.75	10.50	11.25	12.00	12.75	13.50	14.25
<b>Oil (%)</b>	<b>44</b>	<b>44.1</b>	<b>44.2</b>	<b>44.3</b>	<b>44.4</b>	<b>44.5</b>	<b>44.6</b>	<b>44.7</b>	<b>44.8</b>	<b>44.9</b>
Bonification (\$)	15.00	15.75	16.50	17.25	18.00	18.75	19.50	20.25	21.00	21.75
<b>Oil (%)</b>	<b>45</b>	<b>45.1</b>	<b>45.2</b>	<b>45.3</b>	<b>45.4</b>	<b>45.5</b>	<b>45.6</b>	<b>45.7</b>	<b>45.8</b>	<b>45.9</b>
Bonification (\$)	22.5	23.25	24	24.75	25.5	26.25	27	27.75	28.5	29.25
<b>Oil (%)</b>	<b>46</b>	<b>46.1</b>	<b>46.2</b>	<b>46.3</b>	<b>46.4</b>	<b>46.5</b>	<b>46.6</b>	<b>46.7</b>	<b>46.8</b>	<b>46.9</b>
Bonification (\$)	30.00	30.75	31.50	32.25	33.00	33.75	34.50	35.25	36.00	36.75
<b>Oil (%)</b>	<b>47</b>	<b>47.1</b>	<b>47.2</b>	<b>47.3</b>	<b>47.4</b>	<b>47.5</b>	<b>47.6</b>	<b>47.7</b>	<b>47.8</b>	<b>47.9</b>
Bonification (\$)	37.50	38.25	39.00	39.75	40.50	41.25	42.00	42.75	43.50	44.25
<b>Oil (%)</b>	<b>48</b>	<b>48.1</b>	<b>48.2</b>	<b>48.3</b>	<b>48.4</b>	<b>48.5</b>	<b>48.6</b>	<b>48.7</b>	<b>48.8</b>	<b>48.9</b>
Bonification (\$)	45.00	45.75	46.50	47.25	48.00	48.75	49.50	50.25	51.00	51.75
<b>Oil (%)</b>	<b>49</b>	<b>49.1</b>	<b>49.2</b>	<b>49.3</b>	<b>49.4</b>	<b>49.5</b>	<b>49.6</b>	<b>49.7</b>	<b>49.8</b>	<b>49.9</b>
Bonification (\$)	52.50	53.25	54.00	54.75	55.50	56.25	57.00	57.75	58.50	59.25

**Table 3:** Silo price \$600/t

<b>Oil (%)</b>	<b>30</b>	<b>30.1</b>	<b>30.2</b>	<b>30.3</b>	<b>30.4</b>	<b>30.5</b>	<b>30.6</b>	<b>30.7</b>	<b>30.8</b>	<b>30.9</b>
Bonification (\$)	-108.00	-107.10	-106.20	-105.30	-104.40	-103.50	-102.60	-101.70	-100.80	-99.90
<b>Oil (%)</b>	<b>31</b>	<b>31.1</b>	<b>31.2</b>	<b>31.3</b>	<b>31.4</b>	<b>31.5</b>	<b>31.6</b>	<b>31.7</b>	<b>31.8</b>	<b>31.9</b>
Bonification (\$)	-99.00	-98.10	-97.20	-96.30	-95.40	-94.50	-93.60	-92.70	-91.80	-90.90
<b>Oil (%)</b>	<b>32</b>	<b>32.1</b>	<b>32.2</b>	<b>32.3</b>	<b>32.4</b>	<b>32.5</b>	<b>32.6</b>	<b>32.7</b>	<b>32.8</b>	<b>32.9</b>
Bonification (\$)	-90.00	-89.10	-88.20	-87.30	-86.40	-85.50	-84.60	-83.70	-82.80	-81.90
<b>Oil (%)</b>	<b>33</b>	<b>33.1</b>	<b>33.2</b>	<b>33.3</b>	<b>33.4</b>	<b>33.5</b>	<b>33.6</b>	<b>33.7</b>	<b>33.8</b>	<b>33.9</b>
Bonification (\$)	-81.00	-80.10	-79.20	-78.30	-77.40	-76.50	-75.60	-74.70	-73.80	-72.90
<b>Oil (%)</b>	<b>34</b>	<b>34.1</b>	<b>34.2</b>	<b>34.3</b>	<b>34.4</b>	<b>34.5</b>	<b>34.6</b>	<b>34.7</b>	<b>34.8</b>	<b>34.9</b>
Bonification (\$)	-72.00	-71.10	-70.20	-69.30	-68.40	-67.50	-66.60	-65.70	-64.80	-63.90
<b>Oil (%)</b>	<b>35</b>	<b>35.1</b>	<b>35.2</b>	<b>35.3</b>	<b>35.4</b>	<b>35.5</b>	<b>35.6</b>	<b>35.7</b>	<b>35.8</b>	<b>35.9</b>
Bonification (\$)	-63	-62.1	-61.2	-60.3	-59.4	-58.5	-57.6	-56.7	-55.8	-54.9
<b>Oil (%)</b>	<b>36</b>	<b>36.1</b>	<b>36.2</b>	<b>36.3</b>	<b>36.4</b>	<b>36.5</b>	<b>36.6</b>	<b>36.7</b>	<b>36.8</b>	<b>36.9</b>
Bonification (\$)	-54.00	-53.10	-52.20	-51.30	-50.40	-49.50	-48.60	-47.70	-46.80	-45.90
<b>Oil (%)</b>	<b>37</b>	<b>37.1</b>	<b>37.2</b>	<b>37.3</b>	<b>37.4</b>	<b>37.5</b>	<b>37.6</b>	<b>37.7</b>	<b>37.8</b>	<b>37.9</b>
Bonification (\$)	-45.00	-44.10	-43.20	-42.30	-41.40	-40.50	-39.60	-38.70	-37.80	-36.90
<b>Oil (%)</b>	<b>38</b>	<b>38.1</b>	<b>38.2</b>	<b>38.3</b>	<b>38.4</b>	<b>38.5</b>	<b>38.6</b>	<b>38.7</b>	<b>38.8</b>	<b>38.9</b>
Bonification (\$)	-36.00	-35.10	-34.20	-33.30	-32.40	-31.50	-30.60	-29.70	-28.80	-27.90
<b>Oil (%)</b>	<b>39</b>	<b>39.1</b>	<b>39.2</b>	<b>39.3</b>	<b>39.4</b>	<b>39.5</b>	<b>39.6</b>	<b>39.7</b>	<b>39.8</b>	<b>39.9</b>
Bonification (\$)	-27.00	-26.10	-25.20	-24.30	-23.40	-22.50	-21.60	-20.70	-19.80	-18.90
<b>Oil (%)</b>	<b>40</b>	<b>40.1</b>	<b>40.2</b>	<b>40.3</b>	<b>40.4</b>	<b>40.5</b>	<b>40.6</b>	<b>40.7</b>	<b>40.8</b>	<b>40.9</b>
Bonification (\$)	-18.00	-17.10	-16.20	-15.30	-14.40	-13.50	-12.60	-11.70	-10.80	-9.90
<b>Oil (%)</b>	<b>41</b>	<b>41.1</b>	<b>41.2</b>	<b>41.3</b>	<b>41.4</b>	<b>41.5</b>	<b>41.6</b>	<b>41.7</b>	<b>41.8</b>	<b>41.9</b>
Bonification (\$)	-9.00	-8.10	-7.20	-6.30	-5.40	-4.50	-3.60	-2.70	-1.80	-0.90
<b>Oil (%)</b>	<b>42</b>	<b>42.1</b>	<b>42.2</b>	<b>42.3</b>	<b>42.4</b>	<b>42.5</b>	<b>42.6</b>	<b>42.7</b>	<b>42.8</b>	<b>42.9</b>
Bonification (\$)	0.00	0.90	1.80	2.70	3.60	4.50	5.40	6.30	7.20	8.10
<b>Oil (%)</b>	<b>43</b>	<b>43.1</b>	<b>43.2</b>	<b>43.3</b>	<b>43.4</b>	<b>43.5</b>	<b>43.6</b>	<b>43.7</b>	<b>43.8</b>	<b>43.9</b>
Bonification (\$)	9.00	9.90	10.80	11.70	12.60	13.50	14.40	15.30	16.20	17.10
<b>Oil (%)</b>	<b>44</b>	<b>44.1</b>	<b>44.2</b>	<b>44.3</b>	<b>44.4</b>	<b>44.5</b>	<b>44.6</b>	<b>44.7</b>	<b>44.8</b>	<b>44.9</b>
Bonification (\$)	18.00	18.90	19.80	20.70	21.60	22.50	23.40	24.30	25.20	26.10
<b>Oil (%)</b>	<b>45</b>	<b>45.1</b>	<b>45.2</b>	<b>45.3</b>	<b>45.4</b>	<b>45.5</b>	<b>45.6</b>	<b>45.7</b>	<b>45.8</b>	<b>45.9</b>
Bonification (\$)	27	27.9	28.8	29.7	30.6	31.5	32.4	33.3	34.2	35.1
<b>Oil (%)</b>	<b>46</b>	<b>46.1</b>	<b>46.2</b>	<b>46.3</b>	<b>46.4</b>	<b>46.5</b>	<b>46.6</b>	<b>46.7</b>	<b>46.8</b>	<b>46.9</b>
Bonification (\$)	36.00	36.90	37.80	38.70	39.60	40.50	41.40	42.30	43.20	44.10
<b>Oil (%)</b>	<b>47</b>	<b>47.1</b>	<b>47.2</b>	<b>47.3</b>	<b>47.4</b>	<b>47.5</b>	<b>47.6</b>	<b>47.7</b>	<b>47.8</b>	<b>47.9</b>
Bonification (\$)	45.00	45.90	46.80	47.70	48.60	49.50	50.40	51.30	52.20	53.10
<b>Oil (%)</b>	<b>48</b>	<b>48.1</b>	<b>48.2</b>	<b>48.3</b>	<b>48.4</b>	<b>48.5</b>	<b>48.6</b>	<b>48.7</b>	<b>48.8</b>	<b>48.9</b>
Bonification (\$)	54.00	54.90	55.80	56.70	57.60	58.50	59.40	60.30	61.20	62.10
<b>Oil (%)</b>	<b>49</b>	<b>49.1</b>	<b>49.2</b>	<b>49.3</b>	<b>49.4</b>	<b>49.5</b>	<b>49.6</b>	<b>49.7</b>	<b>49.8</b>	<b>49.9</b>
Bonification (\$)	63.00	63.90	64.80	65.70	66.60	67.50	68.40	69.30	70.20	71.10

## Appendix II: Description and Results of Trials and Demonstrations

Trial	Experimental design& site details	What is being assessed	Application / treatment details	Results	Statistical analysis	Conclusions/comments	Source
Carmarthen Farm Dowerin WA  2000	Randomised block design with three replicates.  The individual plots were 2.4 m wide x 15 m long.	Effects of time of swathing and desiccant application on the seed yield and oil content of canola.	<u>Treatments:</u> 1. Swathing 2. 1.5 L/ha Roundup® 3. 1.5 L/ha Reglone® 4. Untreated control  <u>Timings:</u> 10% , 38%, 56%, 94% seed colour change	<p>The optimum time for applying Reglone® is at 50–70% seed colour change.</p> <p>There was no optimum time of applying Reglone® to achieve a maximum yield, though application at all timings increased yield above all treatments except Reglone® applied at 56% seed colour change.</p> <p>The most profitable treatment combination was Reglone® applied at 56% seed colour change with a gross margin of \$6.52 per hectare.</p> <p>Reglone® recorded the highest oil content and significantly higher yield than all other treatments. Swathing and applying Reglone® outside the optimum time of 60–70% and 50–70% respectively reduced seed yield and oil content.</p> <p>Applying Roundup® at all timings gave yields above the trial average, Roundup® had no optimum time of application.</p>	<p>There was significant difference in yield when swathed at 56% seed colour change – 0.68 t/ha compared with Reglone (0.91 t/ha) and Roundup treatments (0.80 t/ha). Untreated (direct headed) = 0.79 t/ha.</p> <p>At 56% seed colour changes there was no significant difference in oil content between any treatment.</p>	<p>Swathing and applying Reglone® outside the optimum time of 60–70% and 50–70% respectively reduced seed yield and oil content.</p> <p>Applying Roundup® at all timings gave yields above the trial average, Roundup® had no optimum time of application.</p>	<p>Thomas C &amp; Martin L (2000) “Effects of time of swathing and desiccant application on the seed yield and oil content of canola” Crop Updates  <a href="http://www.agric.wa.gov.au/PC90914.html?s=0">http://www.agric.wa.gov.au/PC90914.html?s=0</a></p>

## Appendix II: Description and Results of Trials and Demonstrations

Trial	Experimental design & site details	What is being assessed	Application / treatment details	Results	Statistical analysis	Conclusions/comments	Source
Pod-Ceal® Redbank SA 2007  Conducted by Agri-Search Services	No available design details.  Treatments: 1. Untreated control – Windrowed 2. Untreated control – Direct headed 3. 0.7 L/ha Pod-Ceal® – Direct head 4. 1.2 L/ha Pod-Ceal® – Direct headed	Compare untreated windrow and direct headed canola with two rates of Pod-Ceal® and direct heading.	No crop details available for timing of treatments or harvest.  Pod-Ceal® applied 18 October 2007 (when majority of pods had changed colour from dark green to light green.)  Water rate: 150 L/ha  Windrowed: 1 November 2007  Harvest: 1 December (37 days after Pod-Ceal® application)	No evidence of statistical analysis is provided.  Canola yield of direct headed treatments with 0.7 and 1.4 L/ha Pod-Ceal® was approximately 0.91 and 0.88 t/ha compared with 0.78 t/ha in the windrowed treatment and 0.85 t/ha in the direct headed treatment.	No statistical details of analysis provided.	Significance & reliability of results is unknown.  No details of seed colour change were provided and therefore stage of crop maturity.	<a href="http://www.podceal.com.au/research.html">http://www.podceal.com.au/research.html</a>
Pod-Ceal® Lyndhurst NSW 2007  Conducted by Agri-Search Services	No available design details.  Treatments: 1. Untreated control – Windrowed 2. 0.7 L/ha Pod-Ceal® – Direct head 3. 1.2 L/ha Pod-Ceal® – Direct headed	Compare untreated windrow and direct headed canola with two rates of Pod-Ceal® and direct heading.	No crop details available for timing of treatments or harvest.  Pod-Ceal® applied 6 November 2007 (when 60% of pods had changed colour from dark green to light green.)  Water rate: 143 L/ha  Windrowed: 13 November 2007  Harvest: 18 December (42 days after Pod-Ceal® application)	No evidence of statistical analysis is provided.  Canola yield of direct headed treatments with 0.7 and 1.4 L/ha Pod-Ceal® was approximately 0.19 and 1.19 t/ha compared with 0.6 t/ha in the windrowed treatment.	No statistical details of analysis provided.	Significance & reliability of results is unknown.  No details of seed colour change were provided and therefore stage of crop maturity.	<a href="http://www.podceal.com.au/research.html">http://www.podceal.com.au/research.html</a>

## Appendix II: Description and Results of Trials and Demonstrations

Trial	Experimental design & site details	What is being assessed	Application / treatment details	Results	Statistical analysis	Conclusions/comments	Source
Pod-Ceal® York WA 2007  Conducted by Agri-Search Services	No available design details.  Treatments: 1. Untreated control – Windrowed 2. 0.7 L/ha Pod-Ceal® – Direct headed 3. 1.2 L/ha Pod-Ceal® – Direct headed	Compare canola yields after untreated windrowed canola with two rates of direct headed canola treated with Pod-Ceal®.	No crop details (eg. seed colour change, seed moisture %) was provided for timing of treatments or harvest.  Pod-Ceal® applied 20 November 2007 (when 60% of pods had changed colour)  Water rate: 150 L/ha  Windrowed: 26 October 2007  Harvest: 23 November (36 days after Pod-Ceal® application)	No evidence of statistical analysis is provided.  Canola yield of direct headed treatments with 0.7 and 1.4 L/ha Pod-Ceal® was approximately 1.3 and 1.5 t/ha compared with 1.0 t/ha in the windrowed treatment.	No details of statistical analysis provided.	Significance & reliability of results is unknown.  No details of seed colour change were provided and therefore stage of crop maturity.	<a href="http://www.podceal.com.au/research.html">http://www.podceal.com.au/research.html</a>
Pod-Ceal® Coonalpyn SA 2008	Paddock of canola divided into 2 sections, one treated with pod-Ceal, the other untreated.  Aerial application of 0.7 L/ha Pod-Ceal + direct headed – 10.25 ha  Untreated – windrowed – 30 ha	Comparing yield of canola – aerial application of direct headed + 0.7 L/ha Pod-Ceal at 25 & 50 L/ha water vs untreated windrowed canola.	No crop details (eg. seed colour change, seed moisture %) was provided for timing of treatments or harvest.  Water rates: 25 & 50 L/ha  Harvest: windrowed area was harvested 4 weeks before direct headed canola	0.7 L/ha Pod-Ceal® treatment increased yield by 18% over the untreated windrowed canola.	Nil. Demonstration only.	Significance & reliability of results is unknown.  No details of stage of crop maturity at windrowing were provided.	<a href="http://www.podceal.com.au/research.html">http://www.podceal.com.au/research.html</a>
Timing of windrowing “Larry’s Plains” Geurie NSW 2009	Large scale commercial crop area.  Treatments were randomised.  Results were obtained from commercial harvester at the time of harvest.	Compare timings of windrowing on canola yield.	Treatments: 1. 10% seed colour change 2. 50% seed colour change 3. 70% seed colour change	No significant difference between yields when windrowed at 50 and 70% seed colour change. Yield = 1.6 t/ha. 10% seed colour change - Yield = 1.3 t/ha No significant difference with any treatment on oil content.	<b>Yield</b> CV = 4.23%, LSD 5% = 0.28 t/ha	Windrowing at 10% seed colour change significantly reduced yield compared with 50% and 70%.  There was no yield difference when windrowing at 50% and 70% colour change.  There were no effects on oil content with any treatment.	Grain Orana Alliance

## Appendix II: Description and Results of Trials and Demonstrations

Trial	Experimental design & site details	What is being assessed	Application / treatment details	Results	Statistical analysis	Conclusions/comments	Source
Timing of windrowing "Netherway" Coonamble NSW 2009	Large scale commercial crop area. Treatments were not randomised. 3 replicates  Results were obtained with commercial harvester.	Compare timings of windrowing (10, 50 and 70% seed colour change), Pod-Ceal®, 2.5 L/ha Reglone® and direct heading on canola yield and economics.	Treatments: 1. 10% seed colour change 2. 50% seed colour change 3. 70% seed colour change 4. Pod-Ceal® 5. Reglone® 6. Direct harvest	No significant difference in yield or oil content between Direct heading, Pod-Ceal® or Reglone® treatments.  <i>Timing of windrowing Yields</i> 10% colour change – 1.48 t/ha 50% colour change – 1.7 t/ha 70% colour change – 1.9 t/ha	<i>Timing of windrowing Yields</i> CV = 4.84%, LSD 5% = 0.16 t/ha  <b>Oil content</b> Not significant	Windrowing at 10% and 50% seed colour change significantly reduced yield compared with 70%.  There were no effects on oil content with timing of windrowing.  There were no significant differences in yield or oil between direct heading, Pod-Ceal® or Reglone® treatments.	Grain Orana Alliance
Windrowing and direct headed canola treated with crop sealing products. Milbrulong NSW 2010	Replicated experiment	<b>Aim:</b> To trial the efficacy of crop sealing products on canola.	Treatments: 1. Direct head 2. Direct head + 1.0 L/ha PodCeal (Agspec) 3. Direct head + 1.0 L/ha Desikote Max® (Nufarm) 4. Direct head + 1.0 L/ha PodCeal + 1.6 L/ha Roundup® 5. Direct head + 1.0 L/ha PodCeal + 1.6 L/ha Desikote Max® (Nufarm) 6. Windrowed	<b>Yield</b> There was <b>no significant difference</b> in yield between any treatment.  <b>Oil %</b> <b>T1:</b> 45.4% <b>T2:</b> 45.3% <i>ab</i> <b>T3:</b> 44.8% <i>b</i> <b>T4:</b> 45.2% <i>ab</i> <b>T5:</b> 45.1% <i>ab</i> <b>T6:</b> 45.4% <i>a</i>	CV = 11.08%,  <b>Yield</b> LSD 5% = 0.392 t/ha  <b>Oil</b> LSD 5% = 0.526%	The trial harvest was delayed by 10 days due to rainfall; harvest took place 20 days after windrowing.  <b>Yield</b> - It was expected that the direct head only treatment would show adverse effects from the delayed harvest but this was not proven.  The <b>oil</b> content of the direct head only and the windrowed treatments were significantly higher than the direct head + Desikote Max® treatment.	FarmLink 2010 Research Report pp 33

## Appendix II: Description and Results of Trials and Demonstrations

Trial	Experimental design & site details	What is being assessed	Application / treatment details	Results	Statistical analysis	Conclusions/comments	Source
Windrowing and direct headed canola treated with crop sealing products. Junee NSW 2010	Demonstration	Measurements were taken for windrowed shattering loss.  Direct headed areas were measured for shattering loss, yield, harvest speed, grain quality and post harvest seed germination.	Podceal® was applied to measured areas of the crop by air.		Not applicable	The direct head with Podceal® treatment was 212kg/ha greater than direct heading without Podceal® and 180kg/ha greater than the average of the windrowed treatments. Shattering losses were influenced by moisture level and temperature at the time of harvest. The direct head without Podceal® treatment was harvested at 7.30pm which raised the moisture level by 1% above that of the direct head with Podceal® treatment. Total shattering losses per hectare were 3.78kg/ha for nil Podceal® and 9.1kg/ha for plus Podceal®. This equates to a direct harvest shattering loss between 0.13% and 0.3% of total yield.	FarmLink 2010 Research Report pp 34 – 36
Windrowing and direct headed canola treated with crop sealing products. Downside NSW 2010		Measurements were taken for windrowed shattering loss. Direct headed areas were measured for shattering loss, yield, harvest speed, grain quality and post harvest seed germination.	Podceal® was applied to measured areas of the crop by air.		Not applicable	<b>Observations</b> <ul style="list-style-type: none"> <li>• Harvest speed was decreased with direct heading treatments by an average of 0.45 ha/hr.</li> <li>• Direct heading worked well with belt fronts, the assistance of a cross auger is beneficial.</li> <li>• Growers risk losses due to shattering in canola if direct heading is delayed.</li> <li>• Shattering losses were impacted by disease levels in 2010.</li> </ul>	FarmLink 2010 Research Report pp 36 - 37

## Appendix III: Key Contacts & Organisations

- **Australian Oilseeds Federation**

PO Box H236  
AUSTRALIA SQUARE NSW 1215  
P: 02 8007 7553  
F: 02 8007 7549  
W: [www.australianoilseeds.com](http://www.australianoilseeds.com)

### State Government Departments

- **Department of Primary Industries**

Locked Bag 21  
ORANGE NSW 2800  
P: 02 – 6391 3100  
W: [www.dpi.nsw.gov.au](http://www.dpi.nsw.gov.au)

- **South Australian Research & Development Institute (SARDI)**

GPO Box 397  
ADELAIDE SA 5001  
P: 08 9368 333  
F: 08 9474 2405  
E: [sardi@sa.gov.au](mailto:sardi@sa.gov.au)  
W: [www.sardi.sa.gov.au](http://www.sardi.sa.gov.au)

- **Department of Agriculture & Food**

Locked Bag 4  
BENTLEY DELIVERY CENTRE WA 6983  
P: 08 9368 3333  
F: 08 9474 2405  
E: [enquiries@agric.wa.gov.au](mailto:enquiries@agric.wa.gov.au)  
W: [www.agric.wa.gov.au](http://www.agric.wa.gov.au)

- **Department of Agriculture Fisheries & Forestry**

GPO Box 46  
BRISBANE QLD 4001  
P: 13 25 23  
W: [www.daff.qld.gov.au](http://www.daff.qld.gov.au)

## Canola Breeding Companies

- **Canola Breeders**

P: 1300 667 371

F: 1300 737 662

W: [www.cbwa.net.au](http://www.cbwa.net.au)

*Western Australian Office*

Locked Bag 888

COMO WA 6952

P: 08 9367 8555

*Eastern Australian Office*

PO Box 1176

MOONEE PONDS VIC 3039

P: 03 9326 2622

F: 03 9326 1184

E: [customer.service@cbwa.net.au](mailto:customer.service@cbwa.net.au)

- **Pacific Seeds**

268 Anzac Avenue

(PO Box 337)

TOOWOOMBA QLD 4350

P: 07 4690 2666

F: 07 4630 1063

E: [info@pacseeds.com.au](mailto:info@pacseeds.com.au)

W: [www.pacseeds.com.au](http://www.pacseeds.com.au)

- **Pioneer Hi-Bred Australia Pty Ltd**

Cnr Industrial Ave & Orford Crt

TOOWOOMBA QLD 4350

PO Box 900

P: 07 4637 3600

E: [Pioneer.Australia@pioneer.com](mailto:Pioneer.Australia@pioneer.com)

W: [www.australia.pioneer.com](http://www.australia.pioneer.com)

- **NuSeed**

PO Box 103

LAVERTON VIC 3028

P: 03 9282 1184

F: 03 9282 1099

W: [www.nuseed.com.au](http://www.nuseed.com.au)

## Marketing organisations

- **Cargill Australia Ltd**  
GPO Box 58  
MELBOURNE VIC 3001  
P: 03 9268 7200  
F: 03 9682 2677  
W: [www.cargill.com.au](http://www.cargill.com.au)
- **Grain Corp**  
Level 26  
175 Liverpool Street  
SYDNEY NSW 2000  
  
PO Box A268  
SYDNEY SOUTH NSW 1235  
T: 02 9325 9100  
F: 02 9325 9180  
E: [enquiries@graincorp.com.au](mailto:enquiries@graincorp.com.au)

## Other organisations

- **Grain Growers Limited**  
PO Box 7  
NORTH RYDE NSW 1670  
P: 02 9888 9600  
F: 02 9888 5821  
W: [www.graingrowers.com.au](http://www.graingrowers.com.au)
- **The Australian Grain Harvesters Association Inc**  
PO Box 21,  
CAMBOOYA QLD 4358  
W: [www.agha.org.au](http://www.agha.org.au)
- **Australian Agricultural Contractors Association Inc**  
PO Box 1883  
BAKERY HILL VIC 3354  
P: 0418 503 974  
E: [info@agcontracting.org.au](mailto:info@agcontracting.org.au)  
W: [www.agcontracting.org.au](http://www.agcontracting.org.au)