Reference Manual for Brassicas and Alternative Forages
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### BRASSICA USER GUIDE
1. Introduction

1.1 PGG SEEDS - A Profile

Forage crops are a valuable tool for meeting the changing feed and energy requirements of a livestock operation throughout the year. Feed supply and stock performance can be manipulated through the use of different brassica and herb species. PGG Seeds recognises the integral role of brassicas, investing in breeding and research, and is proud to supply products, through our Australian distribution network, specifically bred for semi-arid and temperate farming systems. Please refer to the back cover for your regional distributor of PGG Seeds products.

Investment in breeding

PGG Seeds is an Australasian identify that breeds and markets proprietary forage varieties throughout Australia and New Zealand. The breeding facility is based in New Zealand, with extensive offsite evaluation programmes in Victoria, New South Wales and southern Queensland. Twenty-five years after the initiation of a brassica breeding programme, Australian farmers now have access to brassica products with beneficial advances in agronomic performance, pest and disease tolerance, better productivity and reliable animal performance.

1.2 The breeding process

Understanding the breeding process is useful when considering the purchasing of a new product. All PGG Seeds products have progressed through each step, including extensive offsite evaluation in different environments and farming systems. Farmers can buy PGG Seeds products with confidence knowing they come from a highly developed breeding programme and are backed by strong technical support to retailers and farmers alike.

Dr Alan Stewart, Plant Breeder, has focused his successful breeding programme on producing new brassica cultivars with improved tolerance to temperate pests and diseases.

1.3 Why use certified seed?

Buying certified seed is an investment. It ensures that the bag of seed is what you think it is and are paying for. The certification programme includes:

- An industry-accredited testing regime.
- Effective and efficient tracking systems for seed purity and germination from the seed growers’ paddock to the market.
- Availability of the seed analysis certification for your inspection.

Wherever possible use certified seed, as it is true to type and meets strict standards including purity and germination. Every time certified seed is purchased you are making an investment in quality.

1.4 Why keep forage brassicas in your rotation?

An ideal disease break following cereal crops

Some brassicas release 'glucosinolates' into the soil and this fumigation action can assist in controlling root diseases such as crown rot, common root rot, take-all and root nematodes. After a brassica crop rotation, the impact of cereal foliar diseases is reduced on subsequent cereal crops - often up to a 30% improvement in grain yield.

A method of paddock clean-up prior to re-establishment of pasture or lucerne

A forage brassica allows opportunities for chemical control of grass weeds, a break in root diseases, mechanical soil working and fertiliser application and incorporation. It may also give the opportunity to conserve good soil moisture reserves, depending upon when the break crop is grown.

Flexibility of where to slot them in a rotation

- Either winter or spring/summer crops, between cereal rotations or as part of a pasture renewal programme.
- Adapt to the seasonal conditions - use as spring-sown if no autumn break sowing was possible. A short-term, late summer-autumn crop in early break situations.
- Reduce paddock down-time if autumn canola sowing was impossible by a spring sowing of forage brassicas.
- Forage brassicas require similar preparation, establishment, and agronomic considerations as canola.

A grazing crop offers alternatives in the years where high stock prices are more attractive than canola returns.

Brassicas as a biofumigant

Many brassica species are known to have biofumigant properties. Their chemical make-up allows the suppression or control of a range of insects, nematodes and fungi. Early studies at Wollongbar Agricultural Institute indicated that brassicas may specifically reduce the fungal disease of kikuyu, commonly known as Kikuyu Yellows, Vemucavias flavocirtm, (Slack & Fullkerson, 2002).
1. Introduction

1.5 Why consider brassicas?
Brassica crops can offer a superior feed supply (both in terms of quantity and quality) in many situations. They provide an excellent source of energy and protein for grazing stock.

The following table highlights the value of the Brassica-Herb system, which is outlined on page 16.

Table 1. Energy measurements of some PGG Seeds’ brassicas and herbs (26/9/2005).

<table>
<thead>
<tr>
<th>Brassica/Herb</th>
<th>ME Content (MJME/kgDM)</th>
<th>Crude Protein (%)</th>
<th>Digestibility (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grouse Chicory</td>
<td>11.63</td>
<td>30.8</td>
<td>80.18</td>
</tr>
<tr>
<td>Gran Forage Brassica</td>
<td>10.96</td>
<td>28.0</td>
<td>76.25</td>
</tr>
<tr>
<td>Tonic Plantain</td>
<td>11.97</td>
<td>32.1</td>
<td>82.18</td>
</tr>
<tr>
<td>Hunter Forage Brassica</td>
<td>11.21</td>
<td>27.3</td>
<td>77.72</td>
</tr>
</tbody>
</table>

Using a brassica crop should be considered in any situation where pasture quantity or quality is limiting the potential production of your livestock. The most common situations are as follows:

- **Young stock finishing in early summer** - feed for post weaning period, where feed demands increase at a time when vegetative pasture growth rates are falling.

- **Mid-late summer feed for all stock classes** - at a time when pastures are of low quality and low moisture levels are impacting on pasture growth.

- **Summer “safe” feed** - a parasite/pathogen free grazing environment.

- **Autumn feed** - to support an increasing stocking rate resulting from the removal of paddocks in rotation for pasture renewal and filling the feed gap when kikuyu becomes dormant and before grazing of annual ryegrass.

- **Winter feed** - maintenance feed for stock when pasture growth is limited, allows building of pasture cover reserves by holding stock on small areas, allows pastures across the farm to build up for valuable, high quality, early spring feed, and to avoid widespread pasture damage in very wet conditions through pugging.

- **Winter stock finishing** - large quantities of quality feed suitable for finishing. For example, cattle and winter lamb contracts.

- **Break crop for renovation programme of sub-standard pastures** - if managed, will provide a significant dry matter contribution, minimal time out of production, useful system for assisting in weed and disease clean up pre pasture establishment, and a good opportunity for improving the soil fertility status.
## MULTIPLE GRAZING BRASSICAS

<table>
<thead>
<tr>
<th>Brassica</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WINFRED</strong></td>
<td>Forage Brassica&lt;br&gt;Early maturing (10 - 12 weeks), multiple grazing, summer, autumn and winter feed, for all stock types.</td>
</tr>
<tr>
<td><strong>ACE</strong></td>
<td>Forage Brassica&lt;br&gt;Improved alternative to non-certified Rangi rape with 90-100 days to maturity. Higher yielding than Rangi rape.</td>
</tr>
<tr>
<td><strong>HUNTER</strong></td>
<td>Forage Brassica&lt;br&gt;Fast growing (6-8 weeks to first graze), multiple grazing, for stock finishing in fertile, summer most areas.</td>
</tr>
<tr>
<td><strong>GRAZA</strong></td>
<td>Forage Brassica&lt;br&gt;Graza is a uniquely smooth-leaved, low crowned and late-flowering forage brassica. It requires minimal ripening (50 days or 6-8 weeks).</td>
</tr>
</tbody>
</table>

## SINGLE GRAZE BRASSICA OPTIONS

<table>
<thead>
<tr>
<th>Brassica</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rival</strong></td>
<td>Turnip&lt;br&gt;Early maturing (12-14 weeks), tankard bulb, short term, one graze, summer crop.</td>
</tr>
<tr>
<td><strong>NEW YORK</strong></td>
<td>Turnip&lt;br&gt;White fleshed, purple skinned, full leaved, 16+ weeks to maturity, bred for improved virus and disease resistance and yield potential over York Globe.</td>
</tr>
<tr>
<td><strong>Sovereign</strong></td>
<td>Swede&lt;br&gt;Medium tall kale, high yield potential, high leaf: stem ratio, excellent utilisation rates for valuable winter feed, limited use in most areas.</td>
</tr>
<tr>
<td><strong>Dominion</strong></td>
<td>Swede&lt;br&gt;Yellow fleshed, main crop swede, valuable keeping potential, favourable culinary taste, stock maintenance through winter, limited use in most areas.</td>
</tr>
</tbody>
</table>

## COMPANION SPECIES WITH BRASSICAS

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tonic</strong></td>
<td>Mineral rich perennial herb, fast establishing, strong year round production, grow with multiple grazing brassicas and pastures to boost overall production and diet quality.</td>
</tr>
<tr>
<td><strong>Choice Chicory</strong></td>
<td>A longer-rotation cultivar, bred to provide high dry matter production, improved cool-season growth and recovery after grazing. Preferred chicory variety to use in mixes with perennial grasses.</td>
</tr>
<tr>
<td><strong>Grass Chicory</strong></td>
<td>Cool season active, summer productive, high quality component in permanent pastures or specialist short term crop pastures.</td>
</tr>
<tr>
<td><strong>Colenso Sensation</strong></td>
<td>Fine stemmed, dense tillering, early-mid flowering, and good tolerance to heat and drought. Good cool season production, grazing type.</td>
</tr>
<tr>
<td><strong>Red Clover</strong></td>
<td>Upright growing and high yielding. High levels of natural reseeding, bred for persistence and reduced levels of formononetin.</td>
</tr>
</tbody>
</table>
2.2 Brassica species overview

**Forage Brassicas (aka Hybrid Brassicas, Leafy Turnips) - Hunter**

This crop is an intra-specific hybrid developed by crossing turnips with related Asian leaf vegetables of the same species. The resulting quick growing, leafy turnip, with minimal bulb development, is best suited to multiple grazing summer and autumn feed requirements.

Hybrid brassicas are the fastest maturing of the forage brassicas, with first grazings possible at 6-8 weeks. They may be sown from mid spring to late summer, at a sowing rate of 4-5 kg/ha, with the potential for 2-4 grazings. Low sowing rates and/or poor establishment may result in greater expression of bulb development. Under high soil fertility they will out-yield bulb turnips, with a feed value similar or slightly better than bulb turnips. They are cold resistant and will provide feed well into winter. Plants usually show good resistance to most clubroot races, but they are susceptible to drought and aphids, so should be used for summer production only in summer moist/irrigated areas.

The most outstanding feature of hybrid brassicas is the excellent regrowth after grazing, a result of the low growing points which are protected during all but the heaviest grazings. Strip grazing and back fencing with an electric fence will maximise regrowth potential. Early grazing is advised at the 6-8 week period, to gain maximum advantage before feed quality declines. They can be prone to early bolting (premature flowering through summer before winter vernalisation) from a spring sowing. Following best practice grazing guidelines will minimise any stock health issues.

**Bulb Turnips - Australian Purple Top, New York, Rival**

The well established role of turnips is reflected by the extensive range of cultivars available; from the yellow fleshed (hard) through to the white fleshed (soft), to the modern stubble/summer turnips, all with differing maturities, leaf: bulb ratios and feeding times.

Turnips can be sown from spring through to late summer for summer, autumn or winter feed (depending upon the cultivar). Sowing rates vary depending on sowing method and turnip type. Rates range from 0.5-1.0 kg/ha when sown for bulb production, and should be as high as 2 kg/ha if the aim is high leaf production. Tetraploid cultivars require higher sowing rates. Other practices include mixing turnips with rape or grass, especially short rotation grasses. Older main crop types tolerate low soil fertility (often used for breaking in virgin ground). The new, high yielding cultivars, and the tetraploids, require higher soil fertility levels. Clubroot, dry rot, aphids and viral diseases are the most common problems.

Turnips can be utilised for both their leaf and bulb production. Turnips have a minimal ripening requirement. Stock may take time to adjust to grazing bulbs. Turnips are best grazed at maturity to maximise dry matter production. Regrowth is possible from a light grazing if the bulbs are not damaged.
2. Brassicas

Forage Rape - Winfred, Ace
Traditionally rape has been used as a summer crop for providing a bulk of quick feed for grazing stock. However, cultivars with good frost resistance and better regrowth potential have extended feeding times from early summer to late winter. Rape is the most versatile of the brassicas, being suitable for a wide range of soil fertility and environmental conditions, stock classes and sowing times.

Rape may be sown from early spring to late summer, and used 12-16 weeks later (depending upon the cultivar and environment). The usual sowing rate is 3-4 kg/ha, or in mixtures with pasture species at 0.5-1.0 kg/ha.

Sowing with Tonic plantain will increase the regrowth potential of the crop and provide a more balanced diet. Rape can be grown at lower soil fertility than most other brassicas, and responds well to irrigation. It is not often grown in clubroot infected areas, but resistant cultivars are available.

Strip grazing with an electric fence is recommended to control diet and minimise wastage. Careful stock management including gradual stock introduction and grazing when the crop is mature (often indicated by a purplish colouration of the leaf margins) will help to prevent rape scald, scour and nitrate poisoning. Refer to section on animal health, page 31.

Swedes - Dominion
Swede crops are a traditional winter feed in cool wet climates, and hence, have limited potential in Australia. Swedes have the advantage over turnips of carrying a larger bulb, greater yield, and better dry matter quality over winter.

Swedes are usually sown in late spring/early summer in areas with cold winters and moist summers. Sowing rates vary from 0.5 kg/ha -1.0 kg/ha. They can be sown with kale to improve leaf yield. Time to maturity varies with swede varieties, the range typically being from 24-30 weeks. Pests and diseases (such as clubroot, dry rot, aphids and bulb chipping) can adversely affect swede yield and keeping quality. Swedes are commonly grazed from early to late winter.

Forage Brassica - Graza
Graza forage brassica is uniquely smooth-leaved, low-crowned and late-flowering. It originates from a complex series of crosses and selections carried out over 17 years for smooth leaves, an ability to recover from multiple grazing and for late-flowering habit. Graza's palatability, yield and quality under grazing companies favourably with the widely-used leaf turnips. A big advantage over leaf turnip crops is Graza's persistence giving more grazing cycles. Graza can be utilised as a pure stand or in mixes with brassicas or pasture herbs in grazing systems.

Kale - Sovereign
Kale is a tall, bulky brassica grown mainly for winter feed for cattle. It is slower to mature than the traditional or multiple grazing brassicas, and more suited to cool, summer moist climates. Kale has very limited use in most areas of Australia, with the exception of Tasmania and southern Victoria and the high altitude areas of New South Wales.

Kale maturity times range from 18-24 weeks. Sowing rates range from 3-5 kg/ha in 20cm drill rows to 2 kg/ha when mixed with swedes. Giant types are best suited to cattle, and medium stem types for both cattle and sheep. Late flowering types are a better option for late winter-early spring feed.
2. Brassicas

2.3 Companion species overview

Chicory - Grouse, Choice
Chicory is well known as a high quality, active forage, with documented research showing excellent liveweight gains in cattle, lambs and deer. Chicory is best suited to fertile, free draining soils in summer moist areas. Chicory can be sown at 5 kg/ha with legumes, and at 1-2 kg/ha in a standard pasture mix or with a multiple grazing brassica. Chicory is not a legume and Nitrogen applications are essential to maximise production. Broadleaf herbicides cannot be used on chicory, so pre-emergent weed control is important.

Chicory has one of the highest digestibility figures of the forage plants, which accounts for the high liveweight gains and general good health of stock on chicory pastures. Overgrazing can be a problem in pasture mixes, especially with sheep. Chicory, like plantain, has a high mineral content. It is best suited to rotational grazing or cutting for silage. Control of seedheads over spring-summer is important for maintaining feed quality and stand life. Plants can suffer from the rot disease Sclerotinia, which may be more prevalent in wet soil conditions. Excessive moisture in the hollow flower stem increases the risk of plant loss.

Plantain - Tonic
Plantain is a mineral rich, perennial, grazing herb. It is becoming an increasingly valuable pasture component for supply of minerals and dry matter production, particularly in drier regions and less fertile conditions. Plantain is a fast establishing species, and will be productive and persistent over a wide range of soils and climatic conditions. This includes less fertile soils and especially dryland regions. Plantain can be sown with a multiple grazing brassica at 2-3 kg/ha, with a permanent pasture mix at 2-4 kg/ha, and up to 10 kg/ha as a specialist crop with legumes. Plantain suffers from few pests and diseases. Pre-emergent weed control is important as plantain is susceptible to broadleaf herbicides after emergence. It is not recommended to sow plantain if a brassica crop is being used as a tool for weed clean-up.

Plantain is highly palatable and preferentially grazed. Plantain suits a grazing management similar to ryegrass, with potential yields similar to that of perennial ryegrass. Ideally a 20-25 day rotation will maintain seedhead palatability through late spring and summer. Plantain is not known to cause milk taint.

Scientific evidence (Moorhead et al. 2002) suggests plantain is effective at transferring minerals to its plant tissue and hence to the grazing animal. Plantain forage has a higher calcium, sodium and copper status than ryegrass. Furthermore, plantain has a measurable effect on the grazing animal (Figure 8, page 21). Literature reviewed by Stewart (1996) has identified biologically active compounds in plantain that have beneficial medicinal properties.

Red clover - Colenso, Sensation
Red clover, like chicory, is an essential forage component for high performance stock systems. High palatability, a tap root that supports summer production and a high degree of acceptance by all stock, makes it excellent for use in a wide range of pasture situations.

Red clover usually persists for 2-4 years with lax or long summer grazing rotations. In perennial pastures it is often included, at 4-6 kg/ha with white clover and herbs, or at 4-6 kg/ha with short rotation ryegrasses or supplementary feed paddocks. Red clover can also be established with other legumes and herbs (without grass) as a short term, high quality summer forage for young stock finishing, with a sowing rate of 6-8 kg/ha in this situation. This is one of the possible options for a clover-herb multiple grazing brassica crop. Sowing red clover with a multiple grazing brassica will allow the successful establishment of the clover in the first instance, and an increasing dietary contribution over time. Red clover cultivars vary in their growth habit, with erect types being more suited to hay but less persistent under grazing.

Red clover cultivars can be divided into early and late flowering types. Early types not only flower earlier but commence spring growth earlier, and are generally more cost-season active. This may be useful in production systems that require early legume content. Late flowering types tend to be more winter dormant. Colenso and Sensation were selected for lower oestrogen levels.
2. Brassicas

2.4 Forage brassica decision tool

**Hunter** forage brassica, *Brassica campestris* spp *rapa* is a hybrid cross between a turnip and a rape, producing one of the fastest maturing brassicas, with a look most like a leafy, non-bulb producing turnip.

**Winfred** forage brassica, *Brassica napus*, is a cross between a turnip and a kale.

These different genetic make-ups have conferred very different characteristics. The following diagram (Figure 1) summarises these characteristics and how they relate to their suitability for different farming systems. The photos portray the differences in grazing management requirements.

The major difference between **Hunter** and **Winfred** is the speed to first grazing; **Hunter** is four to six weeks earlier than **Winfred**.

Another big difference between **Hunter** and **Winfred** is in the intensity that it can be grazed. The harder **Hunter** is grazed the less likely it is to persist for a second or third regrowth (Photo 1). **Winfred** can be grazed to very low residuals without significant plant loss (Photo 2), providing more opportunities for multiple grazing over longer periods of time.

For more information on the grazing management of **Hunter** and **Winfred** see pages 10 and 12.
2. Brassicas

2.5 Forage brassica cultivars

**WINFRED FORAGE BRASSICA**

- Early maturing, 10-12 weeks
- High leaf: stem ratio for excellent utilisation rates
- Regrowth potential for 3-4 grazings
- Retains leaf and stem quality in frost and cold conditions
- Fast and strong survival/recovery from grazing with excellent subsequent yields
- Tolerant of dry conditions
- Ideal for summer, autumn and winter feed

Winfred forage brassica was identified, by its Netherlands breeders, as a line that survived an unusually cold winter. The name is derived from the reference to winter (Win) and a close approximation to the German word froid (Fred), meaning cold. The ability to withstand -15°C frosts and retain green leaf makes Winfred a reliable forage brassica for winter feed.

Winfred forage brassica is a cross between a turnip and kale, generally termed a rape. Traditionally rape has been used as a summer lamb finishing crop and ewe flushing feed. However Winfred, which has good frost tolerance and strong regrowth potential, may extend grazing times from early summer to late winter. Winfred is the most versatile of brassicas, being suitable for a wide range of soil fertility and environmental conditions, stock classes and sowing times. Due to the potential of an earlier first grazing, Winfred has the ability to be grazed up to three times through summer and early autumn, at which time it is regularly shut up and carried into winter as a winter feed.

The direct drilling of annual ryegrass into this regrowth in early-mid autumn is an option. This differs from many existing rapes which often have longer ripening requirements and are grazed later providing less opportunity for multiple regrowth periods.

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield (depending on number of grazings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR. Late August to September</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>2-4</td>
<td>10-12 t/ha</td>
</tr>
<tr>
<td>HR. Mid-October to early November</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>3-4</td>
<td>10-12 t/ha</td>
</tr>
<tr>
<td>February to March</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-2</td>
<td>5-8 t/ha</td>
</tr>
<tr>
<td>April to May*</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>2-4</td>
<td>10-12 t/ha</td>
</tr>
</tbody>
</table>

HR: High rainfall or long spring
LR: Low rainfall or short spring

*Plants will vernalise and require good grazing pressure in early spring. Be aware of potential animal health issues if grazing vernalising plants. To minimise vernalisation, plants need to be grazed heavily in early spring. Vernalisation is the breaking of reproductive dormancy by plant exposure to a period of cold conditions. See page 23.
2. Brassicas

Maximising returns from Winfred

Winfred has been widely adopted as a summer finishing forage in summer-dry environments. Traditionally these crops have either been continuously grazed from early summer into the autumn, or grazed in blocks of 3-6 weeks with a short recovery period (1-3 weeks) in between. Experiments at Ceres Research Centre have focused on identifying the appropriate grazing management of Winfred to maximise animal productivity. The effect of daily allowance on liveweight gain per head and per hectare on mid-height crops in a rotationally grazed system was established (Figure 2) with a view to determining optimum grazing parameters. At low allowances (1.0 kg DM/hd/day), liveweight gain per hectare was not maximised because despite high stocking rates (92 lambs/ha), lambs grew slowly. Slow growth (60 g/day) was a consequence of restricted intake. At generous allowances (3.5 kgDM/hd/day), per hectare production was not maximised because despite lambs growing rapidly (320 g/day), stocking rates were low (38 lambs/ha). At allowances of around 2.5 kgDM/hd/day liveweight gain per hectare was maximised (14 kg LWG/ha/day).

Increasing grazing intensity and consequently leaving lower post-grazing residuals had a minor effect on the survival of Winfred plants, but a much larger effect on Hunter plants (Figure 3). Heavy grazing removed up to 70% of Hunter plants but only 20% of Winfred plants. Plant survival is an important component of regrowth yield. Maximising productivity per hectare comes from optimising grazing parameters. To achieve maximum liveweight gain per hectare, lamb producers grazing mid-height crops (75 cm) should look for stock to eat essentially all leaf laminae, all petiole, and up to one third of the stem.

Figure 2. Effect of daily allowance of Winfred on liveweight gain

Figure 3. The effect of daily allowance (kg DM/lamb/day) on plant survival

Results mentioned may vary in taller crops.
This type of brassica is an intra-specific hybrid developed by crossing turnips with related Asian leaf vegetables of the same species. The resulting quick-growing, leafy turnip, with minimal bulb development, is best suited to multiple grazings for summer and early-autumn feed requirements. Hunter is a fast maturing forage brassica with the first grazing possible at 6-8 weeks. Hunter is an excellent quality forage capable of providing extremely high liveweight gain on growing animals. Hunter was bred for tolerance to turnip mosaic virus and cauliflower mosaic virus. This, combined with selecting for vigorous regrowth, has provided a variety with fast recovery from grazing and excellent ability to yield in the second, third and sometimes fourth regrowth cycle. Plants usually show good resistance to most club root races, but they are susceptible to drought and aphids, and are best suited to heavier soil conditions with periodic summer moisture or irrigation.

In 2005, PGG Seeds, in conjunction with QDPI, evaluated autumn-sown temperate forage options for winter and spring. The results were:

Table 3: 2005 Annual Demonstration Plots - QDPI Mutdapilly (Sown 21 April 2005).

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>kg DM/day</th>
<th>Total DM produced</th>
<th>Total number of production days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunter forage brassica</td>
<td>131</td>
<td>20,456</td>
<td>156</td>
</tr>
<tr>
<td>Graze forage brassica</td>
<td>115</td>
<td>17,947</td>
<td>156</td>
</tr>
<tr>
<td>Haifa white clover</td>
<td>59</td>
<td>14,785</td>
<td>252</td>
</tr>
<tr>
<td>Sequel lucerne</td>
<td>90</td>
<td>25,622</td>
<td>284</td>
</tr>
<tr>
<td>Prairie grass + chicory</td>
<td>83</td>
<td>19,999</td>
<td>284</td>
</tr>
<tr>
<td>Grouse chicory</td>
<td>81</td>
<td>22,915</td>
<td>284</td>
</tr>
<tr>
<td>Commander chicory</td>
<td>78</td>
<td>22,227</td>
<td>284</td>
</tr>
<tr>
<td>Puna chicory</td>
<td>72</td>
<td>20,358</td>
<td>284</td>
</tr>
<tr>
<td>Prairie grass + Tonic plantain*</td>
<td>71</td>
<td>15,300</td>
<td>284</td>
</tr>
<tr>
<td>Tonic plantain*</td>
<td>63</td>
<td>17,893</td>
<td>284</td>
</tr>
</tbody>
</table>

* These species grow more like pasture plants that can be utilised in winter feed crops but offer more potential for longer-term production than specific short-term volume.

Table 3 is an example of late-sown Hunter forage brassica in the sub-tropical environment of North east Queensland and highlights the vigour of Hunter from an autumn sowing in mid winter environments.

Table 4. Sowing dates and grazing times for Hunter forage brassica.

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield (depending on number of grazings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR: Mid October to November</td>
<td>4</td>
<td>6-8 weeks</td>
<td>3-4</td>
<td>10-12 t/ha</td>
</tr>
<tr>
<td>February possible</td>
<td>4</td>
<td>8-10 weeks</td>
<td>2-3</td>
<td>10-12 t/ha</td>
</tr>
<tr>
<td>March to April</td>
<td>4</td>
<td>8-10 weeks</td>
<td>2-3</td>
<td>10-12 t/ha</td>
</tr>
<tr>
<td>LR: September</td>
<td>4</td>
<td>8 weeks</td>
<td>2</td>
<td>6-8 t/ha</td>
</tr>
</tbody>
</table>
Maximising returns from Hunter

Leafy turnips like Hunter have become a common feed source for finishing lambs. It is common to set-stock lambs on the crop and draft them off as they reach target weights. An experiment at Ceres Research Centre suggests it is unlikely this grazing management makes the most efficient use of the Hunter crop.

The experiment investigated the effect of daily allowance on the production of liveweight per hectare in a rotationally-grazed Hunter finishing system, with the view of determining optimum grazing parameters.

At allowances of 1 kgDM/hd/day or less, where grazing residual was low, the crop produced little regrowth, lamb growth rates were poor (25–75 g/day) and production per hectare was not maximised (2–5 kgLWG/ha/day).

At generous allowances (3.5 kgDM/hd/day) where grazing residual was high (3000 kgDM/ha) and where lamb growth rates were high (300 g/day), per hectare production was still not maximised (7 kgLWG/ha/day) because of low stocking rates. In this experiment, per hectare productivity was maximised (12 kgLWG/ha/day) at an allowance of 2.0–2.5 kgDM/hd/day where lambs grew at 300 g/day.

The key message from this work was that in rotationally grazed Hunter systems shifted on a weekly basis, maximum per hectare production was achieved on a daily allowance of 2.0–2.5 kgDM/hd/day).

Quick guide to Hunter grazing management

Residuals too low - stock eating too much of crop
- High stocking rates (approximately 100 lambs/ha) low animal growth
- Liveweight gain/ha: 25–75 g/day
- Low UWG/ha > 2.5 kg/ha/day
- Eating 80% of forage on offer

Residuals to maximise liveweight gain/ha
- Optimal stocking rates (approximately 100 lambs/ha) and animals growing fast (300 g/day)
- Maximum UWG/ha > 12.4 kg/ha/day
- Eating 65% of forage on offer

Residuals too high - not eating enough of crop
- Low stocking rates (approximately 25 lambs/ha) and animals growing fast (300 g/day)
- Moderate UWG/ha > 7.2 kg/ha
- Eating 95% of forage on offer

Footnote:
Appropriate stocking rates will vary depending on pre-grazing mass and speed of growth.

2. Brassicas

Figure 4.
Effect of daily allowance on Hunter forage brassica production/ha

![Graph showing the effect of daily allowance on Hunter forage brassica production/ha.](image)
2. Brassicas

2.6 Other brassica cultivars

- Australian Purple Top is the latest brassica to come from the PGG Seeds Ceres breeding programme. It is a Victorian selection from the reliable English-bred Mammoth Purple Top turnip.
- As its name suggests, Australian Purple Top is a purple top/white base, bulb-type turnip used traditionally in hard, drier regions. The key advances in selecting Australian Purple Top turnip was for improved drought and Diamondback Moth tolerance.

*Table 5. Sowing dates and grazing times for Australian Purple Top turnip*

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>January to March, September to November</td>
<td>1-2</td>
<td>12-14 weeks</td>
<td>1</td>
<td>6-8 t/ha</td>
</tr>
</tbody>
</table>

- New York is a white-fleshed, purple-skinned, oval-bulb turnip.
- New York is distinguished by having a full leaf and a greater leaf-to-bulb ratio than York Globe. The extra leaf-holding has come about from improved tolerance to Turnip Mosaic Virus.

*Table 6. Sowing dates and grazing times for New York turnip*

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>January to March</td>
<td>1-2</td>
<td>16-20 weeks</td>
<td>1</td>
<td>6-8 t/ha</td>
</tr>
</tbody>
</table>

- Rival is an early-maturing summer turnip with a tankard-shaped bulb, bred for high leaf production. Rival is ideally used as part of a pasture renovation programme within dairy farms that have a period of dry or a loss of pasture quality through January and February. Rival turnips provide increased volumes of high ME and high protein.

*Table 7. Sowing dates and grazing times for Rival turnip*

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>September to January</td>
<td>1-2</td>
<td>12-14 weeks</td>
<td>1</td>
<td>Up to 10 t/ha</td>
</tr>
</tbody>
</table>
Ace was commercially released in Spring 2005, and feedback has been positive. It is the certified alternative for those farmers who have a place for Rangi rape-types in their summer feed systems.

Table 8. Sowing dates and grazing times for Ace forage rape

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield (depending on number of grazings)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-October to early November</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-3</td>
<td>5-8 t/ha</td>
</tr>
<tr>
<td>February to March</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-2</td>
<td>5-8 t/ha</td>
</tr>
</tbody>
</table>

Dominion swede is a traditional high-yielding, yellow-fleshed main crop swede. Dominion has a good record of performance and provides a good example of a traditional first crop, yellow-flesh swede with favourable culinary comments.

Table 10. Sowing dates and grazing times for Dominion swede

<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate Alone (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Potential Grazings</th>
<th>Potential Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late November to early December</td>
<td>1 kg drilled or 1.5 kg broadcast</td>
<td>24-30 weeks</td>
<td>1 (Possibly the tops in Feb/Mar)</td>
<td>10-14 t/ha</td>
</tr>
</tbody>
</table>
3. Companion Species with Brassicas

3.1 Herbs and clovers with forage brassicas

The increasing popularity of the pasture herbs, plantain and chicory, is a result of the real benefits they provide to animal well being and farm production. Establishing herbs and clovers with a multiple grazing brassica, e.g. Winfred, can improve the regrowth potential of the crop in repeat grazing situations, or be a useful method of establishing these companion species for future pasture sow downs.

The addition of Tonic plantain to a multiple grazing brassica can have the following benefits:

- Provides variety in the diet, with a greater mineral availability than a brassica crop alone.
- Increase total crop production (see Figure 5).
- Increase regrowth yields in subsequent grazings (see Figure 6).
- Be productive and persistent in dry periods, with rapid recovery when soil moisture improves.
- Provide continued growth under cold conditions.
- May reduce animal health issues that can arise on a sole brassica diet.
- Provide an established herb base for the direct drilling of grass and clover species into the run out brassica crop.

In a typical pasture renovation, when herbs and clovers are established with grass, they may be disadvantaged in terms of establishment rate and the following grazing management of the sward. Adding red clover and/or plantain and chicory with a multiple grazing brassica is a valuable establishment tool, when used in conjunction with subsequent direct drilling of grass species.

A yield trial evaluated the value of adding Tonic plantain to a Winfred crop. Two mixes were Winfred at 2 kg/ha and a Winfred/Tonic mix at 2 and 3 kg/ha respectively. Trial sown in October 1999, average rainfall of 620mm. This trial demonstrated a 1.8 tonne advantage by adding Tonic compared to just having Winfred on its own.

Figure 5. Yield trial evaluating the addition of Tonic plantain to Winfred forage brassica.

Yield advantages in the 2nd, 3rd and 4th grazings.

The potential benefits of combining herbs and clovers with a brassica crop are:

- The brassicas can act as a cover crop to these slower establishing species.
- The red clover and herbs will provide a small but high quality contribution to the diet.
- Herbs will act as a mineral supplement.
- An extended range of options at the end of the brassica life.
- Subsequent pastures will have a strong legume and herb content relative to a traditionally-established pasture.
To gain the most benefit from this system you must be committed to following the steps in the progression of the crop. Establishing the herbs for a 2-3 year period allows them to exhibit their full potential and achieve a return on the cost of establishment.

Autumn grass establishment provides greater winter bulk and reduces the opportunity for weed species to take hold in a herb dominant crop. Even if the herb component looks strong in the autumn it is not recommended to opt out of grass oversowing.

Pick the seasonal production system that suits your feed demand.

The flexibility of Brassica-Herb forage systems allows different feed options to be created depending upon:
- Whether the crop is going to be used as a clean-up tool for weeds, etc.
- Timings of the feed requirement of the farm.
- The season that sowing is to occur in.
- Preferred method of sowing.

3. Companion Species with Brassicas

### Brassica-Herb system options

<table>
<thead>
<tr>
<th>Option</th>
<th>Spring</th>
<th>Summer</th>
<th>Autumn</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>2</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>3</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>4</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>5</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>6</td>
<td>WINFRED + TONIC</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED + TONIC</td>
<td>April-May</td>
</tr>
<tr>
<td>7</td>
<td>WINFRED + herbs + clovers</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED + herbs + clovers</td>
<td>April-May</td>
</tr>
<tr>
<td>8</td>
<td>WINFRED + herbs + clovers</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED + herbs + clovers</td>
<td>April-May</td>
</tr>
<tr>
<td>9</td>
<td>WINFRED only</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED only</td>
<td>April-May</td>
</tr>
<tr>
<td>10</td>
<td>WINFRED + herbs + clovers</td>
<td>November-December</td>
<td>January-February</td>
<td>Grass + herbs + clovers</td>
<td>WINFRED + herbs + clovers</td>
<td>April-May</td>
</tr>
</tbody>
</table>

Key:
- **WINFRED** dominant crop
- **WINFRED** transitional crop
- **WINFRED** non-brassica pasture

To seed new species into existing crop:
- Decision on continuation of crop

### 3.2 Suggested brassica and herb mixes

#### Forage brassica and herb mix

To maximise regrowth:
- **Winfred** forage brassica: 3kg
- **Tonic** plantain: 2kg
- **Grouse** chicory: 2kg
- **Colenso** red clover (optional): 4kg
- **Trophy** or **Tribute** white clover (optional): 2kg

#### Leaf turnip & herb mix

For early start:
- **Hunter** forage brassica: 4kg
- **Tonic** plantain: 2kg
- **Grouse** chicory: 2kg
- **Colenso** red clover (optional): 4kg
- **Trophy** or **Tribute** white clover (optional): 2kg

#### Bulb turnip & herb mix

For a stand-over feed mix:
- **Australian Purple Top** turnip: 1kg
- **Tonic** plantain: 2kg
- **Grouse** chicory: 2kg
- **Colenso** red clover (optional): 4kg
- **Trophy** or **Tribute** white clover (optional): 2kg

It is recommended that the seed is treated to provide protection during the establishment period.
3. Companion Species with Brassicas

3.3 Chicory forage system

Features of chicory
- High forage quality
- High summer growth
- Improved animal performance
- Preferentially grazed
- Good grazing tolerance
- Used to reduce water recharge and soil salinity
- Elevated mineral content (Zn, Cu, Mg, Ca, K, S)
- Reduced faecal egg count in lambs

Grouse chicory was bred at the Ceres Research Centre to provide a short-rotation, upright, uniformly leaved chicory, with a longer seasonal growth pattern from early-spring to late-autumn and winter.

Grouse has rapid establishment and erect growth, making it the ideal chicory to use in brassica-herb blends and with short-term ryegrass varieties. As it responds strongly in the cooler months to moisture, Grouse is ideal in areas where winter/spring moisture/irrigation occurs.

Dairy cow grazing
Cows can produce up to 90% more milk when fed on chicory relative to perennial ryegrass (Figure 6). Dairy cow milk production responses from chicory are similar to those from turnips, improving milk solids production when supplementing pasture over the summer and/or autumn periods (Waugh et al. 1998).

Figure 6. Summer milk production from cows grazing four pasture types, Terang, Victoria. Tharamaj et al. 2005.
3. Companion Species with Brassicas

3.4 Companion species with brassicas

Establishment
- Chicory is more sensitive than ryegrass to sowing depth and soil temperature.
- Sow into warm soils (10°C +) at 10mm in depth.
- Ensure low amounts of competition from other plants in the first three months.
- Weeds should be thoroughly eliminated before sowing because post-establishment herbicides for chicory are limited.
- Only use herbicides registered for use on chicory.
- Soil fertility should be the same as for ryegrass/clover pastures (medium to high).
- Nitrogen fertiliser improves establishment of chicory, especially when temperatures allow for active growth.

Management
- Chicory is most productive and persistent when it is rotationally grazed.
- Avoid re-grazing until 3-4 leaves/plant have fully re-grown (in spring and autumn, this will mean a 25 to 35 day rotation).
- When self-stocked on chicory/grass mixed pastures, animals will preferentially graze the chicory plants, reducing chicory production, competitiveness with grass, and persistence.

Mid-Spring
- Chicory plants will develop a reproductive stem.
- Grazing off close to the ground while the stem is small (<10 cm) and soft.
- A second grazing just two weeks later will reduce stem regrowth for the rest of the season.
- This management will require a high stocking rate, e.g., a sheep farm may require ewes with older lambs at foot to be moved onto the chicory.
- Mowing of mature stems may reduce plant survival due to rainwater accumulating in the hollow stem.
- Because chicory is selectively grazed in a chicory/grass mixed pasture, stem growth doesn’t require much control.
- Specialist stands of chicory without grass will tend to get winter annual grasses (e.g., winter grass, barley grass) after 1–2 seasons. These can be controlled with grass-selective herbicides to improve spring production and persistence.
- Over-drilling with grasses will increase ground cover in winter and reduce winter grass weed invasion, but care must be taken to avoid grazing when soils are wet.

Fertiliser
- Chicory is very responsive to large amounts of fertiliser.
- Clover in the sward will not provide enough fixation for maximum chicory growth, so nitrogen is required.
- Farms with specialist chicory pastures under irrigation should apply nitrogen (e.g., 60 kg/ha of urea after every grazing).
- For lower-input systems, 2 to 4 applications of 80 kg/ha of urea over spring and early-summer will be adequate for moderate carrying capacities.
- Phosphorus, sulphur and potassium should be applied at maintenance rates that reflect the higher stocking rates (e.g., 200% of farm average).

Herbicides
- Tasmania only - Broadstrike is registered for use on forage grasses, clovers and chicory.

Farm systems for specialist chicory stands

Dairy farm
- The recommended system is to establish seven paddocks (e.g., 6 ha per 100 cows) close to the dairy.
- Move the cows onto a paddock that is being back-laced (e.g., 0.25 ha per 100 cows/day) for an hour after morning milking.
- Allow them to walk onto their day paddock when finished.
- Chicory is effectively a perennial substitute for summer tumps, and boosts animal nutrition when it is lacking from pasture.

For lamb-finishing
- To maximise animal growth rates, the chicory stand should be divided into at least 6 paddocks, with animals shifted every few days during good growing conditions.
- Lambs should stay on the chicory pasture until they are sold as they can lose appetite and weight when moved onto grass pasture.
3. Companion Species with Brassicas

3.5 Plantain forage system

- Strong cool season growth
- Upright growth habit
- Excellent recovery from grazing or after periods of moisture stress
- Reliable establishment on varied soils types and climatic conditions

Dry matter production and quality

Adding Tonic to a perennial ryegrass can increase overall production. Relative to ryegrass, Tonic provides consistent dry matter production in all seasons. This extra production is generally due to more growth into summer and faster recovery in autumn. This extra feed fills an important gap during the transition period between summer grasses and temperate species.

Figure 7. Dry matter production trial results Wollongbar Research Station, north Coast NSW.

The quality of Tonic plantain is equal to other temperate species and better than Kikuyu-based pastures. This quality, combined with extra autumn dry matter production (Figure 7) makes this a valuable species during the transition period, when other high quality temperate species are re-establishing.
3. Companion Species with Brassicas

Lactation Case Study
Plantain has been evaluated as a forage for use during ewe lactation. Twin-bearing ewes were set stocked on Tonic or perennial ryegrass pastures from early August to late November.

Despite producing similar amounts of dry matter per hectare, the Tonic plantain treatments carried a lower stocking rate suggesting individual ewes and lambs consumed more per head. Lamb growth rates were higher by 80 g/day on Tonic treatments resulting in a 7.2 kg difference in mean weaning weight. In addition, lambs and ewes grazing Tonic plantain were heavier and in better body condition.

Table 12. Lactation case study results

<table>
<thead>
<tr>
<th></th>
<th>Perennial Ryegrass</th>
<th>Tonic Plantain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average pasture mass (kg DM/ha)</td>
<td>11.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Pasture growth (kg DM/ha/day)</td>
<td>7.1</td>
<td>7.2</td>
</tr>
<tr>
<td>Stocking rate (ewes/ha)</td>
<td>15.6</td>
<td>10.5</td>
</tr>
<tr>
<td>Lamb liveweight gain (g/day)</td>
<td>296</td>
<td>376</td>
</tr>
<tr>
<td>Weaning weight (kg)</td>
<td>33.9</td>
<td>41.1</td>
</tr>
<tr>
<td>Ewe liveweight (kg)</td>
<td>70.6</td>
<td>86.1</td>
</tr>
<tr>
<td>Ewe condition score (1 being poor; 5 being good)</td>
<td>2.6</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Trial findings
This case study indicates that Tonic plantain may provide significant benefits to lamb production systems through increases in weaning weight and ewe body condition at weaning, which has resulted from improved lactation nutrition.

Lamb finishing systems
A three year grazing trial was established aimed at determining the impact of including Tonic plantain with perennial ryegrass on production systems.

Table 13. Liver nutrient analysis.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Liver Copper µmol/kg FW</th>
<th>Liver Selenium nmol/kg FW</th>
<th>Liver B12 nmol/kg FW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonic plantain</td>
<td>2250</td>
<td>671</td>
<td>620</td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td>716</td>
<td>380</td>
<td>571</td>
</tr>
<tr>
<td>Significance</td>
<td>P&lt;0.01</td>
<td>P&lt;0.01</td>
<td>NS</td>
</tr>
</tbody>
</table>


Trial findings
Analysis of liver biopsies after 90 days on Tonic plantain found a significantly higher level of copper and selenium in the lambs grazing Tonic compared to lambs grazing ryegrass.

It must be noted that these results were achieved on pure swards and may not represent a mixed pasture. Increases in copper concentration have been measured from lambs grazing pastures containing 20% Tonic, although increases were of a lower magnitude.
3. Companion Species with Brassicas

A consistently greater proportion of lambs grazing pasture which included Tonic plantain (25%) reached target slaughter liveweight on a common date compared with those grazing perennial ryegrass. Essentially, where pasture contained 25% Tonic plantain, improved growth rates resulted in earlier slaughter weight.

Figure 8. The percentage of lambs achieving a slaughter target liveweight at the same date from a perennial pasture with and without Tonic plantain in three successive years.

Perennial pastures and high performance mixes

The addition of Tonic plantain to both perennial pastures and to high performance mixes has significant benefits, these include:
- Provides valuable feed during the transitional feed gap
- Increased dry matter production
- Extends freeze/defreeze period of seasonal production
- Improved quality at key times of the year
- Positive impact on animal performance
- Improves supply of some trace elements to animals

Tonic plantain can be sown at:
- 2-3 kg/ha in a perennial pasture mix (e.g., perennial ryegrass, Phalaris or cocksfoot)
- 3 kg/ha broadcast in early spring after weed control
- 8-10 kg/ha as a pure stand as a specialist pasture
- 3-4 kg/ha with prairie grass, chicory and clover as a specialist crop
- 2-3 kg/ha in a lucerne stand
- 3-4 kg/ha sown into existing kikuyu

Establishment

Establishment vigour is rapid - similar to ryegrass, particularly as Tonic is cool-season active

Tonic can be:
- Sown into cultivated ground
- Broadcast - from ground or air
- Mulch sown - into summer grass
- Oversewn - drilled into existing pastures

Plantain can be prone to damage from Red Legged Earth Mite and slugs, especially at establishment. Chemical protection is recommended.
3. Companion Species with Brassicas

3.6 Red clover

Red clover, like chicory, is an essential forage component for high performance stock systems. High palatability, a tap root that supports summer production and a high degree of acceptance by all stock, makes it excellent for use in a wide range of pasture situations.

Red clover usually persists for 2-4 years with lax or long summer grazing rotations. In perennial pastures it is often included, at 4-6 kg/ha with white clover and herbs, or at 4-6 kg/ha with short rotation ryegrasses or supplementary feed paddocks. Red clover can also be established with other legumes and herbs (without grass) as a short term, high quality summer forage for young stock finishing, with a sowing rate of 6-8 kg/ha in this situation. This is one of the possible options for a clover-herb multiple grazing brassica crop. Sowing red clover with a multiple grazing brassica will allow the successful establishment of the clover in the first instance, and an increasing dietary contribution over time. Red clover cultivars vary in their growth habit, with erect types being more suited to hay but less persistent under grazing.

Red clover cultivars can be divided into early and late flowering types. Early types not only flower earlier but commence spring growth earlier, and are generally more cool-season active. This may be useful in production systems that require early legume content. Late flowering types tend to be more winter dormant. Colenso and Sensation were selected for lower oestrogen levels.
4. Brassica Crop Husbandry

4.1 Successful brassica establishment

Planning

Planning is the key to success. The planning checklist should include the following:

- **Paddock selection**
  - Which paddocks have poor performing pasture, have undesirable species and/or low nutrient content?
  - Has fertility status been limiting pasture production? Will this need addressing to ensure a good brassica crop and a successful renovation phase?
  - Is the paddock selected in close proximity to a run-off paddock, supplementary feed source, and water supply?
  - How easily will the paddock be subdivided?
  - Is the right farm equipment available for successful subdivision of paddock, water supply requirements etc?
  - What is the proposed crop sequence for this paddock?
  - Do any other issues need addressing prior to a permanent sown-down, e.g. elimination of volunteer ryegrass before AR1/AR57 endophyte ryegrass establishment?

- **Pre sowing preparation**
  - A soil analysis should be done to assist in applying the correct time or fertilizer requirements prior to sowing.
  - Successful weed control starts with careful identification of species (e.g. Bent grass), growth stage and vigour. This will determine herbicide selection. Seek advice from a technical representative for specific recommendations.
  - Early work should aim to stimulate weed germination (ideally 2 months prior sowing).
  - Spray paddock using a knockdown herbicide, e.g. Glyphosate or equivalent. Cultivate paddock only after total kill is achieved.
  - Cultivate to a fine, moist, firm seedbed, allowing the small seed to be planted at an even 1-2cm depth.
  - Roll paddock to achieve good seed to soil contact for even germination.

---

**What is vernalisation?**

Vernalisation is the requirement of some plants to have a period of cold temperatures in order to trigger the flowering process. The actual length of the cold period needed to trigger the flowering process will differ between cultivars and species. Most forage brassicas have a high requirement.

---

Planting

**Conventional cultivation**

Conventional cultivation is generally the most reliable way of eliminating weeds and establishing brassicas. Best practice is the broadcasting of fertilizer prior to planting. For a minimal pass operation pull hoses out of coulters and drop fertilizer in a surface band, with incorporation by light harrowing and rolling.

**Direct drilling**

Direct drilling with modern drilling equipment is suitable if spray control of weeds is successful and fertilizer applications are considered carefully. For detailed information on no-tillage and direct drilling refer to "Successful No-Tillage in Crop and Pasture Establishment", Ritchie et al, 2000.

Nitrogen applications are a key component of successful establishment from direct drilling. Under no-tillage regimes crop residues are broken down by microbial activity (not burning, oxidation or mineralisation as in tillage systems) that temporarily locks up nitrogen. Therefore N will not be available at the time of the brassica establishment, and hence this delay in N availability needs to be compensated for at sowing time.

- **Broadcasting**
  - Broadcasting, the scattering of seed onto a worked seedbed, can be successful, but a higher sowing rate and subsequent light harrowing and rolling is recommended.

- **Sowing rates and timing**
  - Refer to individual species for specific sowing information. Best practice establishment techniques should include the use of a commercial seed treatment for seedling protection.

- **Sowing depth**
  - Brassicas have a small seed, thus sowing depth can play a critical part in crop establishment. A maximum sowing depth of 2cm is recommended for all brassica species. Having a fine, firm, even and moist seedbed will allow greater control of sowing depth and subsequent successful establishment.
## 4. Brassica Crop Husbandry

### 4.2 Winter gross margin comparison per hectare

#### Gross Margin Analysis: Winfred Forage Brassica Vs Coolabah Oats

<table>
<thead>
<tr>
<th>Cattle Grazing - Steers</th>
<th>Rate</th>
<th>Income</th>
<th>Oats</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats + hay 6000kg/dm/ha @ 70% utilisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4200 kg/dm/ha per ha / 8kg per head per day = 525 steer grazing days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>525 grazing days / 150 days = 3.5 steers/ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Return = 3.5 steers/ha x 1kg/head/day x 150 grazing days x $2.00/kg</td>
<td>525</td>
<td>2</td>
<td>1050</td>
</tr>
<tr>
<td>B.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brassica + hay 8000kg/dm/ha @ 70% utilisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5600 kg/dm/ha per ha / 7kg per head per day = 800 steer grazing days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 grazing days / 150 days = 5.3 steers/ha</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Return = 5.3 steers/ha x 1kg/head/day x 150 grazing days x $2.00/kg</td>
<td>795</td>
<td>2</td>
<td>1590</td>
</tr>
<tr>
<td>Total Income $/ha</td>
<td>1050</td>
<td>1590</td>
<td></td>
</tr>
</tbody>
</table>

#### Gross Margin Analysis: Winfred Forage Brassica Vs Canola

<table>
<thead>
<tr>
<th>Sheep Grazing - Lambs</th>
<th>Rate</th>
<th>Income</th>
<th>Canola</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6000kg/dm/ha @ 70% utilisation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4200 kg/dm/ha per ha / 1.5kg per head per day = 2800 sheep grazing days</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2800 grazing days / 150 days = 19 lambs/ha</td>
<td>713</td>
<td>1.8</td>
<td>1283</td>
</tr>
<tr>
<td>B. Short Fallow Canola Yields 1.8t/ha</td>
<td>1800</td>
<td>0.6</td>
<td>1080</td>
</tr>
<tr>
<td>$600/t on farm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Income $/ha</td>
<td>1080</td>
<td>1283</td>
<td></td>
</tr>
</tbody>
</table>

#### Variable Costs

<table>
<thead>
<tr>
<th></th>
<th>Rate</th>
<th>Cost $/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glyphosate</td>
<td>0.8L/ha</td>
<td>$13.00/L + $6.50/ha</td>
</tr>
<tr>
<td>Cultivation</td>
<td>0.17hrs/ha</td>
<td>$50/hour</td>
</tr>
<tr>
<td>Sowing</td>
<td>0.20hrs/ha</td>
<td>$55/hour</td>
</tr>
<tr>
<td>Canola Gaucho Treated Seed</td>
<td>3kg/ha</td>
<td>$15/kg</td>
</tr>
<tr>
<td>Winfred Gaucho Treated Seed</td>
<td>4kg/ha</td>
<td>$10/kg</td>
</tr>
<tr>
<td>Fertiliser (DAP)</td>
<td>150kg/ha</td>
<td>$1400/t</td>
</tr>
<tr>
<td>Urea</td>
<td>100kg/ha</td>
<td>$700/t</td>
</tr>
<tr>
<td>Insecticide (Fastac)</td>
<td>0.3L/ha</td>
<td>$9/L</td>
</tr>
<tr>
<td>Grass Weed Control (Trifluralin)</td>
<td>1L/ha</td>
<td>$7.00/L + $6.50/ha</td>
</tr>
<tr>
<td>Broadleaf Weed Control (Lontrel)</td>
<td>0.3L/ha</td>
<td>$58/L + $6.50/ha</td>
</tr>
<tr>
<td>Vaccine (6 in 1)</td>
<td>8-16ml/ha</td>
<td>$0.25/head</td>
</tr>
<tr>
<td>Drench (Genesis)</td>
<td>40-80ml/ha</td>
<td>$0.13/head</td>
</tr>
<tr>
<td>Pasture Hay (0.4kg per head on oats, 3kg per head on brassica)</td>
<td>2 - 3kg/head/day</td>
<td>$0.18/kg/dm</td>
</tr>
<tr>
<td>Total Variable Costs $/ha</td>
<td>567</td>
<td>807</td>
</tr>
</tbody>
</table>

### Assumptions

- Liveweight gains are based on average growth rates and may be higher or lower depending on the age, sex and genetics of the animals.
- In similar rainfall environments, Winfred forage brassica can be more profitable than oats (+$300/ha) and canola (+$342/ha).

Winfred forage brassica offers mixed farms an economic alternative to traditional feed sources and break-crops and can be used as a fix to increase farm profitability.

This gross margin was compiled by FGG Seeds representatives, using recognised crop and animal statistics, and the latest farming costs available at the time of printing. Cost may vary slightly due to regional differences and variable costs.
4. Brassica Crop Husbandry

4.3 Fertiliser guidelines for brassicas

Typically less productive pastures are sown out into brassicas, often meaning they are established into less than optimum conditions. Brassicas tend to differ from other crops in certain aspects of their fertiliser requirements. Brassica yields are sensitive to nitrogen and phosphorus status. In addition, boron deficiency may impact on plant health, especially in the bulb brassicas. The seed is particularly prone to germination injury if soluble fertiliser or boron is placed too near the seed. Inappropriate levels of certain nutrients can induce the risk of animal disorders, e.g. the sulphur compound SMCO.

### Phosphorus (P)
Early purpling, stunted and erect leaves are an indicator of P deficiency (this can also be induced by cool weather, so herbage testing is the best form of identification). Phosphorus is the main element required by brassica crops. In many cases farmers do not see brassica crops reach their full potential because P levels are limiting growth. Phosphorus rates of 15-20 kg/ha (the equivalent to 170-230 kg/ha single superphosphate) are a minimal requirement for most soil types. Drilling the fertiliser in at sowing allows a quick response to the available P. Starter or compound type fertilisers (containing varying amounts of P, N, and S) are commonly used, especially on poorer soil types. The opportunity for lifting soil P status should also be considered at this time.

### Sulphur (S)
Sulphur deficiency is characterised by stunted, pale or yellowed growth (particularly the young growth) and leaf curling and distortion. It is not necessary to use S on brassicas unless S levels are low (2-3). If S is required a fertiliser containing Sulphate S is preferable over an elemental S fertiliser. See Section 5 on Kale anaemia, page 32.

### Nitrogen (N)
Paleness (yellow and/or reddening and old leaf dieback) usually indicates N deficiency.

The amount of N required for successful crop growth is dependent upon the paddock history. When establishing a brassica into a run-out pasture the crop will require starter N and several side dressings of N. No more than 20 units of N (equivalent to 75-125 kg/ha DAP) should be sown with brassicas. Paddocks low in fertility may require more N in the form of ammonium nitrate or urea. This can be applied 2-4 weeks after crop emergence. Urea is best applied just before rain to minimise volatilisation losses to the atmosphere. Approximately 50 kg/ha of N is commonly used and this can increase both yield and crude protein content. Excessive N will increase the risk of nitrate problems with grazing stock, and increase leaf growth at the expense of bulb growth for root crops. See Section 5 on nitrates, page 31.

### Boron (B)
The condition "brown heart" in bulb brassicas is the most common symptom of boron deficiency. Other brassicas may show swelling, hollowing, browning and rotting of stems. Brassicas crops have a greater requirement for B than grasses. Whilst relatively rare, B deficiencies are more likely to occur on light textured soils with less organic matter to retain soil B from leaching, recently limed soils, or soils with a high pH. Do not put B down the spout with your seed.

For paddock specific fertiliser recommendations contact your local fertiliser representative.

**Table 14. Optimum soil fertility status**

<table>
<thead>
<tr>
<th>Soil Test</th>
<th>Ranges (for maximising production)</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (H2O)</td>
<td>5.5-7.5</td>
</tr>
<tr>
<td>(CaCl2)</td>
<td>4.4-6.5</td>
</tr>
<tr>
<td>Olsen P (mg/kg)</td>
<td>25-30+</td>
</tr>
<tr>
<td>Colwell P (mg/kg)</td>
<td>20-35</td>
</tr>
<tr>
<td>Sulphate-S (mg/kg) (MCP)</td>
<td>12-20</td>
</tr>
<tr>
<td>Potassium (mg/100g)</td>
<td>0.5-5</td>
</tr>
<tr>
<td>Magnesium (mg/kg)</td>
<td>1.6-30</td>
</tr>
</tbody>
</table>

**Table 15. General fertiliser application***

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Application Units/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>10 (starter)</td>
</tr>
<tr>
<td></td>
<td>Up to 50 (per app.)</td>
</tr>
<tr>
<td>Sulphur</td>
<td>Maintenance variable up to 20</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>20-30</td>
</tr>
<tr>
<td></td>
<td>10 (pre-plant)</td>
</tr>
<tr>
<td>Potassium</td>
<td>0-80</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>0.5-0.1 (acidic soils)</td>
</tr>
</tbody>
</table>

* When optimum soil fertility is present, fertiliser needs to be applied to support good crop growth. Figures quoted relate to recommendations for dryland brassica crops, Southern Victoria, sandy loams and clay loams.

This information has been kindly provided by Incitec Pivot Fertilisers.

---

**pH (H2O)** 5.5-7.5  
**(CaCl2)** 4.4-6.5 
**Olsen P (mg/kg)** 25-30+ 
**Colwell P (mg/kg)** 20-35 
**Sulphate-S (mg/kg) (MCP)** 12-20 
**Potassium (mg/100g)** 0.5-5 
**Magnesium (mg/kg)** 1.6-30 

---

When optimum soil fertility is present, fertiliser needs to be applied to support good crop growth. Figures quoted relate to recommendations for dryland brassica crops, Southern Victoria, sandy loams and clay loams.

This information has been kindly provided by Incitec Pivot Fertilisers.
For many years, farmers have seen the benefit of Gaucho on pasture species and have often noticed that there seems to be something more than just insect control happening in their pasture. Now scientists have been able to describe what is occurring.

Research has now proven that the active ingredient of Gaucho protects plants not just from insect pests, but also from abiotic stresses. These are stresses caused by non-living factors, for example excess or deficit of heat, light, oxygen or moisture.

The result is a potential for overall better plant vigour and growth. Therefore, even in the absence of any obvious insect pressure, pastures potentially establish, thrive and produce more dry matter than those not treated with Gaucho. This ultimately means cutting more hay, grazing stock sooner or running more head to the hectare if the response to abiotic stresses is realised.

Gaucho is professionally applied by accredited applicators, simply order Gaucho when you order your seed and watch your pasture perform to its optimum.
### 4. Brassica Crop Husbandry

#### 4.5 Brassica pest and disease summary

Brassica establishment can be compromised by occasional localised and seasonal pest and disease attack. Their impact can usually be minimised by management. Once established, brassicas are normally relatively disease-free compared with other crops.

Summary of the key pests and diseases that affect brassica crops

<table>
<thead>
<tr>
<th>Condition</th>
<th>Impact on plant</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Plant pests</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Red legged earth mite</td>
<td>Sap sucked from plant tissue, gives plant a burnt appearance.</td>
<td>• Chemical</td>
</tr>
<tr>
<td><em>(Halotydeus destructor)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. White butterfly</td>
<td>Leaf feeding, leaves a skeletonised leaf with leaf ribs remaining.</td>
<td>• Chemical</td>
</tr>
<tr>
<td><em>(Pieris rapae)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Lucerne flea</td>
<td>Leaf feeding, feed between leaf veins, plants left with a white blanched look.</td>
<td>• Chemical; • Heavy grazing</td>
</tr>
<tr>
<td><em>(Sminthurus viridis)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Cutworm</td>
<td>Plants, especially seedlings, and leaves are ripped off at or below ground level.</td>
<td>• Chemical; • Crop hygiene</td>
</tr>
<tr>
<td><em>(Agrotis ipsilon aneiturna)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Cabbage moth</td>
<td>Young larvae burrow in and feed on internal leaf tissue, older larvae feed on lower leaf surface, larval damage is similar to that caused by leaf miner.</td>
<td>• Chemical</td>
</tr>
<tr>
<td><em>(Plutella xylostella)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Leaf miner</td>
<td>Larvae create tunnels and live within leaf tissue, tissue damage may reduce photosynthetic activity and limit growth at this time, damage is similar to that caused by Cabbage moth.</td>
<td>• Chemical</td>
</tr>
<tr>
<td><em>(many species)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Aphids</td>
<td>Sap suckers that weaken plants, reduce yields, carry viral diseases, mainly attack summer crops.</td>
<td>• Chemical; • Tolerant cultivar; • Some resistant cultivars</td>
</tr>
<tr>
<td><em>(many species)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Viruses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Turnip Mosaic</td>
<td>Stunted growth, mottling and crinkling of leaves, yellowing, leaf death, poor bulb development.</td>
<td>• Control of vector aphids</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Beet Westerns Yellows</td>
<td>General stunted growth, purpling of leaves.</td>
<td>• Control of vector aphids</td>
</tr>
<tr>
<td>10. Cauliflower Mosaic</td>
<td>Poor vigour, can attack all brassica species.</td>
<td>• Control of vector aphids</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 4. Brassica Crop Husbandry

<table>
<thead>
<tr>
<th>Condition</th>
<th>Impact on plant</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fungal Diseases</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clubroot (Plasmidophora spp)</td>
<td>Causes irregular swelling, wilting, stunted growth, plant death.</td>
<td>• Crop rotation (9 years in high risk areas)</td>
</tr>
<tr>
<td>Ring spot (Mycosphaerella brassicola)</td>
<td>Small dark lesions and dark sooty mould on leaves, may lower yields.</td>
<td>• Chemical</td>
</tr>
</tbody>
</table>
| Fungal blackleg (Leptosphaeria maculans) | Whitish spots and patches on leaves containing small black spots, development of cankers at base of stem, plant death. | • Crop rotations  
• Crop hygiene                                      |
| Sclerotinia stem rot (Sclerotinia sclerotiorum) | White lesions and white cottony growth in wet weather, black sclerotia form inside stem, wilting and stem death. | • Rotation with grasses and cereals            |
| Leaf spot (Alternaria spp) | Small dark spots on older leaves in cool wet conditions.                          | • Chemical                                    |
| Black rot (Xanthomonas campestris) | Attack on vascular system in warm, humid conditions, yellowing of leaf margins, wilting, leaf loss. | • Crop rotation                               |
| **Nutrient deficiencies**  |                                                                                 |                                              |
| Brown heart | Boron deficiency, swedes and turnips | • Soil testing  
• 8 fertiliser applications to some species                                      |
5. Grazing Management and Animal Welfare

5.1 Best practice brassica grazing
The successful grazing of livestock on brassicas requires farmers to be aware of a number of factors that may impact on the productivity and health of animals; feed quality, crop utilisation, crop access, feeding fibre, animal health issues eg rape scald, photosensitivity, SMCOs, Goitre nitrates.

5.2 Feed quality comparisons
The quality parameters of a feed influence stock performance. Adequate energy, protein and mineral supplies are especially important for high producing stock. A general guide to crude protein (CP) requirements for ruminants is (as percentage of DM): 10-14% CP – minimum required for adequate growth, 15-18% CP – minimum required for adequate lactation.

Table 16. Approximate nutritive values for a range of feeds

<table>
<thead>
<tr>
<th>Crop</th>
<th>Crude Protein (%)</th>
<th>Digestibility (%)</th>
<th>Metabolisable Energy (MJME/kgDM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green pasture</td>
<td>22</td>
<td>82</td>
<td>12</td>
</tr>
<tr>
<td>Dry pasture</td>
<td>10</td>
<td>53</td>
<td>7</td>
</tr>
<tr>
<td>Hunter forage brassica*</td>
<td>17</td>
<td>86</td>
<td>12</td>
</tr>
<tr>
<td>Winfred forage brassica*</td>
<td>22</td>
<td>78</td>
<td>11</td>
</tr>
<tr>
<td>Turnips</td>
<td>12</td>
<td>88</td>
<td>13</td>
</tr>
<tr>
<td>Corn</td>
<td>8</td>
<td>71</td>
<td>10</td>
</tr>
<tr>
<td>Millet</td>
<td>10</td>
<td>65</td>
<td>9</td>
</tr>
<tr>
<td>Sorghum</td>
<td>11</td>
<td>65</td>
<td>9</td>
</tr>
<tr>
<td>Tonic plantain*</td>
<td>22</td>
<td>78</td>
<td>11.3</td>
</tr>
<tr>
<td>Chicory*</td>
<td>23</td>
<td>79</td>
<td>11.7</td>
</tr>
</tbody>
</table>

*Dairy cow research
Research into the use of brassicas for subtropical dairy farms by the Wollongbar Agricultural Institute concluded that brassicas provide an excellent source of energy and protein for lactating dairy cows in the autumn/winter period when grazed at the 6 leaf stage of regrowth (equivalent to a 30 day grazing interval on the north coast of NSW), in conjunction with the use of a high fibre supplement (Slack & Fulkerson, 2002).
5. Grazing Management and Animal Welfare

5.3 Crop utilisation
Strip grazing (break feeding) is the best practice for manipulating utilisation rates, diet quality, crop life, and crop regrowth potential. Generally, as crop utilisation increases animal intake per head decreases.

Figure 9 illustrates a typical strip grazing method. Aim to position the front hot wire parallel to the longest side, to give a large front face and a shallow depth of break. This will minimise wastage from soiling. A back wire is recommended when using a multiple grazing brassica to maximise regrowth potential. An adjacent run-off or sacrifice paddock can be used to hold stock overnight, or during periods of cold/wet weather, or as an area for feeding of supplementary crops.

Figure 9. An example of a strip grazing method for brassicas.

5.4 Crop access
Ruminant animals take some time to attain maximum voluntary intake when changed from a pasture to a brassica diet. The adjustment time may vary with stock type and class. The rumen bacteria population needs to adjust from a grass diet to a brassica diet, and this may take several weeks. To limit the effects of this diet change, the following guidelines should be practiced:

- Introduce animals slowly to a crop, from an initial 2-3 hours to full allocation by 7-10 days. This allows rumen microbes to adjust and may reduce the “grazing check” effect.
- Do not introduce hungry animals to the crop. Gorging may occasionally lead to blast or nitrate poisoning problems.
- Offer an alternative source of feed, pasture, hay or silage, during introductory stage, and throughout grazing of crop.
- Stock performance will be improved if transitions from grass to brassica to grass are minimised as much as possible, e.g. by grazing a smaller number of animals for a longer time period rather than grazing a larger number of animals for a shorter time.
- Feed milking cows no more than 30% of their daily diet as brassicas. A suggested grazing routine for dairy cows on brassicas includes a morning grazing on brassica, supplementary crop late morning, and pasture grazing in the afternoon until, and after, the evening milking. Grazing brassicas immediately following morning milking, for 1-2 hours, avoids any potential taint of milk in subsequent milkings (Black & Fullerton, 2002).
- Ensure stock have ready access to drinking water at all times.

Where to get fibre
Brassica crops typically have highly digestible, high ME and protein content but are often low in fibre. Fibre (NDF and ADF) is required for efficient rumen function.

Fibre:
- Helps maintain rumen pH by encouraging saliva production through chewing.
- May dilute any possible anti-nutritional plant chemicals and therefore reduce their effect on livestock.
- Increases the number of grazing days on the crop.
- Must be palatable so stock consume it. May be detrimental to animal performance if there is excessive use of low quality fibre.
5. Grazing Management and Animal Welfare

5.5 Rape scald (Photosensitisation)

**Cause**
Rape scald is a reaction by livestock to photosynthetic plant chemicals in brassicas.

**Symptoms**
Symptoms include reddening and swelling of the skin, particularly on the ears and face and possibly callosities of sheep and cattle. Affected livestock generally attempt to seek shade, rub affected areas, and may appear generally distressed. This condition is most commonly seen in lambs grazing immature or second growth rape or hybrid brassicas.

**Control**
The risk of rape scald can be minimised by delaying first grazing until crops have ripened (purple/blue lunge on leaf margin), avoiding excessive nitrogen and sulphur fertilisers and being vigilant to early signs. Some cultivars have minimal pruning requirements and are suited to situations when feed is required quickly and where opening may be delayed by climatic conditions. However, under certain environmental conditions, photosensitivity has been known to occur beyond the normal period of ripening.

**Photosensitivity from turnips**
Photosensitivity is also possible with dairy cows grazing summer turnips and with other brassicas on summer turnips and regrowth turnips.

The cause of this condition is well understood, for dairy cows the risk factors include consuming large volumes of turnips (greater than 30% of diet) and feeding crops under environmental stress.

In lambs grazing summer turnips (including Hunter) this condition is rare and unpredictable but may be associated with adverse and overcast weather conditions. This may be of particular concern to stud stock owners, where photosensitivity may cause cosmetic issues to sale animals.

5.6 Nitrates

**Cause**
Protein manufacture cannot keep up with nitrogen uptake in plants, the excess accumulates as nitrates, which are then converted to nitrites in the rumen and when consumed can cause toxicity problems with grazing animals. This may occur in most pasture species when nitrate levels (as NO3) reach 5% of the dry matter. When animals ingest high levels of nitrates, nitrites build up in the bloodstream, here they bind with the oxygen-carrying compound, haemoglobin, to form a compound that is no longer able to carry oxygen. Simply, the animal suffers oxygen deprivation.

**Symptoms**
The most common symptoms of nitrate toxicity are: excessive salivation, rapid gasping breath, rapid pulse (>150 beats/min), pale blue or brown colouration of membranes, tremors, and muscle weakness. Sudden death can occur without any other signs at all. Pregnant animals surviving may abort. Nitrates can build up in any situation where environmental conditions promote plant growth but limit photosynthetic activity. These include sudden temperature changes, dry periods followed by rain, frost and shading, overcast days, insect damage, some herbicides, some nutrient deficient soils, excessive nitrogen fertiliser use, soils with deficiencies in sulphur, phosphorus, molybdenum, or high acidity levels. Nitrate toxicity can occur on a range of grasses, brassicas and weeds. Young plants and plant material close to the ground are more likely to have high nitrate levels.

**Awareness and management of nitrate problems**
- Recognise environmental conditions that cause nitrate build-up.
- Get suspect crops analysed before grazing, introduce stock gradually to allow rumen adjustment.
- Do not put hungry animals on suspect crops.
- Avoid overstocking of suspect crops as high grazing pressure will increase the amount of high nitrate plant parts eaten.
- When strip grazing watch utilisation levels or graze for short periods.
- Dilute high nitrate feed with a low nitrate feed source, e.g. hay, pasture, silage.
- Make high nitrate forages into silage. Fermentation generally reduces nitrate levels.
- Manage nitrogen applications carefully to match plant requirements, and therefore avoid excess uptake and nitrate build-up.
- Do not allow animals access to nitrogen fertilisers, fertiliser storage areas, fertiliser spills, or grazing on recently fertilised paddocks.
- Take care when using nitrogen fertiliser around waterways, to avoid nitrate build-up in drinking water.
- Ensure that soil nutrient levels are in the optimum range for the farming system, as some nutrient deficiencies lead to nitrate build-up.
- Healthy animals are less likely to be affected than animals in poor health.
- Remember that nitrate levels in animals are a combination of the nitrate consumed in their feed and their drinking water.

**Treatment of nitrate toxicity**
Seek immediate veterinary assistance.
5.7 SMCOs, Kale Anaemia, Red Water

**Cause**
As the name suggests, this disorder is most commonly found when animals graze kale. However, it can occur in all brassicas. It is most likely to occur in brassicas that have bolted or are flowering in spring. It may also become a problem if crops are grown in soils high in sulphur, or after sulphur fertilisers have been used.

Brassicas contain a non-protein amino acid called S-methyl cysteine sulfoxide (SMCO). During rumination SMCO is converted into a compound that can potentially damage the red blood cell membrane, allowing leakage of haemoglobin from the cell and ending up in the urine (hence the term, red water).

**Symptoms**
Moderate levels of SMCO may cause loss of appetite, ill thrift, milk anaemia and digestive upsets. High levels can cause severe anaemia and red-coloured urine. After an attack of poisoning, death can occur suddenly.

**Control**
Follow best practice guidelines for feeding brassica crops, e.g. slow introduction, access to an alternative feed source, etc. Do not graze crops that have started flowering. Be vigilant if you suspect there may be a problem. Soil testing prior to sowing will indicate the levels of key nutrients, including sulphur and nitrogen.

If kale anaemia is suspected, remove animals from the crop and keep under close watch until health is regained.

5.8 Goitre

**Cause**
In some situations, iodine (I) deficiency can occur when livestock are fed brassica crops. This is because brassicas are naturally low in iodine and contain plant chemicals (glucosinolates) which are goitrogenic and inhibit iodine uptake. Iodine is important for growth and cell differentiation of tissues through its inclusion in thyroid hormones. Consequently, iodine deficiency has its greatest effect on the developing foetus and therefore may play an important role where pregnant livestock graze brassicas for extended periods in the final stages of pregnancy.

**Symptoms**
The most marked sign of iodine deficiency is enlarged thyroid glands (goitre), but weak newborn lambs, low birth weights and a high rate of perinatal mortality may be sub-clinical signs, along with poor wool growth and lower fertility in older stock.

**Control**
Be aware of the iodine status of pregnant livestock grazing a brassica crop and consider an iodine supplement.

5.9 Trace elements

There is some evidence that animals grazing solely brassica crops do not receive sufficient trace elements and begin to deplete their liver stores. A trace element supplementation programme should be considered if animals are offered a sole diet of brassicas for an extended period, or animals have a low trace element status prior to crop introduction. This may require solid, herbage and blood analysis and consultation with a veterinarian to establish current trace element status and the appropriate supplementation programme.

Mixing herbs with brassica crops is a strategy that may assist to increase trace element availability to stock.
<table>
<thead>
<tr>
<th>Suggested Sowing Time</th>
<th>Suggested Sowing Rate (kg/ha)</th>
<th>Time to First Grazing</th>
<th>Number of Grazings</th>
</tr>
</thead>
<tbody>
<tr>
<td>LR: Late+ August to September</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>2-4</td>
</tr>
<tr>
<td>HR: Mid-October to early November</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>3-4</td>
</tr>
<tr>
<td>February to March</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-2</td>
</tr>
<tr>
<td>April to May*</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>2-4</td>
</tr>
<tr>
<td>Mid October to early November</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-3</td>
</tr>
<tr>
<td>February to March</td>
<td>3-4</td>
<td>10-12 weeks</td>
<td>1-2</td>
</tr>
<tr>
<td>HR: Mid+ October to November</td>
<td>4</td>
<td>6-8 weeks</td>
<td>3-4</td>
</tr>
<tr>
<td>February possible</td>
<td>4</td>
<td>8-10 weeks</td>
<td>2-3</td>
</tr>
<tr>
<td>March to April</td>
<td>4</td>
<td>8-10 weeks</td>
<td>2-3</td>
</tr>
<tr>
<td>LR: September*</td>
<td>4</td>
<td>8 weeks</td>
<td>2</td>
</tr>
<tr>
<td>September to November January to April</td>
<td>8-10</td>
<td>6-8 weeks</td>
<td>2-4</td>
</tr>
<tr>
<td>September to November</td>
<td>1-2</td>
<td>12-14 weeks</td>
<td>1</td>
</tr>
<tr>
<td>January to March</td>
<td>1-2</td>
<td>12-14 weeks</td>
<td>1</td>
</tr>
<tr>
<td>January to March</td>
<td>1-2</td>
<td>16-20 weeks</td>
<td>1</td>
</tr>
<tr>
<td>September to January</td>
<td>1-2</td>
<td>12-14 weeks</td>
<td>1</td>
</tr>
<tr>
<td>Late November to late December</td>
<td>4</td>
<td>18-24 weeks</td>
<td>1</td>
</tr>
<tr>
<td>Late November to early December</td>
<td>1kg drilled 1.5kg broadcast</td>
<td>24-30 weeks</td>
<td>1 (possibly the tops in February/March)</td>
</tr>
</tbody>
</table>

* LR: Low rainfall or short spring
* HR: High rainfall or long spring
* Plants will vernalise and require good grazing pressure in early spring. Be aware of potential animal health issues if grazing vernalising plants. To minimise vernalisation, plants need to be grazed heavily in early spring. Vernalisation is the breaking of reproductive dormancy by plant exposure to a period of cold conditions. See page 23.
<table>
<thead>
<tr>
<th>Potential Yield (depending on number of grazings)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-12 t/ha</td>
<td>Late Aug-Sep sowings are suitable for farms with short spring conditions and where it can get hot early. The yield and number of actual grazings are extremely climate dominated in these areas.</td>
</tr>
<tr>
<td>10-12 t/ha</td>
<td>Very traditional spring sowing dates. The number of grazing is most influenced by grazing management with faster rotations allowing more grazing.</td>
</tr>
<tr>
<td>5-8 t/ha</td>
<td>Late summer and early autumn sowing helps provide a large volume of standing feed for late autumn or winter. The number of grazings are influenced by winter grazing management. Potential yield is highly dependent on sowing date.</td>
</tr>
<tr>
<td>10-12 t/ha</td>
<td>April-May sowing in environments that have short springs is another way of securing spring and early summer feed. It is important to have sufficient stock available as most rapes will vernalise through winter and will throw reproductive stem through Sep-Oct which needs to be controlled by grazing pressure.</td>
</tr>
<tr>
<td>5-8 t/ha</td>
<td>A traditional rape predominately used for summer grazing in situations that will eventually be sown in pasture or crops the following autumn.</td>
</tr>
<tr>
<td>5-8 t/ha</td>
<td>Late summer and early autumn sowing helps provide a large volume of standing feed for late autumn or winter. The number of grazings are influenced by winter grazing management. Potential yield is highly dependent on sowing date.</td>
</tr>
<tr>
<td>10-12 t/ha</td>
<td>Number of grazings is most influenced by grazing management with 8cm residuals and faster rotations allowing more grazing.</td>
</tr>
<tr>
<td>10-12 t/ha</td>
<td>Most suitable for the sub-tropical zones where February-sown Hunter will provide the 1st grazing during the feed pinch in April-May.</td>
</tr>
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<td>10-12 t/ha</td>
<td>Most suitable for the sub-tropical zones where February-sown Hunter will provide the 1st grazing during the feed pinch in April-May.</td>
</tr>
<tr>
<td>6-8 t/ha</td>
<td>Autumn-sown Hunter is best used where it can be managed for regrowth as it has the potential to regrow strongly throughout winter. It will go reproductive in early spring and die out.</td>
</tr>
<tr>
<td>Up to 10 t/ha</td>
<td>September sowing is suitable for short spring conditions. High temperatures will kill Hunter so getting in early and grazing early is important in these conditions. Sow early in cold climates may see vernalisation occur which will lead to higher than normal amounts of reproductive development.</td>
</tr>
<tr>
<td>6-8 t/ha</td>
<td>Uniquely smooth-leaved, low-crowned and late-flowering. Can be spring or autumn sown. Can be utilised as a pure stand or in mixes with brassicas or pasture herbs in grazing systems.</td>
</tr>
<tr>
<td>6-8 t/ha</td>
<td>Traditional sowing time for APT’s. Later sowing dates can provide less exposure to insect pests, however, these are heavily weather dependent.</td>
</tr>
<tr>
<td>6-8 t/ha</td>
<td>March-sown APT for winter feed is a very traditional autumn-winter feed system in colder climates. These crops can sometimes be with a low sowing rate of Crusader or Pronto.</td>
</tr>
<tr>
<td>6-8 t/ha</td>
<td>Traditional early main crop turnip for winter feed. Although best turnips result from crops sown by themselves, New York can be successfully mixed with low rates of Crusader Italian or Pronto annual ryegrass.</td>
</tr>
<tr>
<td>Up to 10 t/ha</td>
<td>An early-maturing, summer turnip, bred for high leaf production. Ideally used as part of a pasture renovation programme within dairy farms. Rival turnips provide increased volumes of high ME and high protein feed.</td>
</tr>
<tr>
<td>12-14+ t/ha</td>
<td>Most suited to the high altitude areas of the Tablelands where it may provide very high yields of winter feed. Best suited to paddocks with the potential to be strip-grazed with electric fences.</td>
</tr>
<tr>
<td>10-14 t/ha</td>
<td>Most suited to milder, moister, summer conditions such as found in parts of Tasmania and the high altitude areas of the Tablelands.</td>
</tr>
</tbody>
</table>