FUTUREDAIRY

T E C H N O T E

Growing forage rape in autumn

(*Brassica napus*)

by Bill Fulkerson

Managing forage rape for dairy cows

For best results:

- Sow early (February/March) for maximum autumn feed (3½ kg/ha, superstrike-coated seed, sown at less than 2cm depth).
- Grow enough area for continuous grazing for at least 16 days (min 2ha/100 cows, max 4ha/100 cows).
- Provide adequate soil fertility, especially phosphorus and nitrogen.
- Allow up to three days for cows to fully accept forage rape.
- Maximise regrowth by removing only leaf and petiole, leaving growing point in the rosette at the top of the stem to regrow.
- Limit daily intake to 5kg DM/cow/day to prevent nitrate toxicity.
- Supplement with a high fibre source (hay/silage) to prevent acidosis.
- Monitor crop for butterfly and diamond back moth; control wth chlorpyrifos-based pesticide if needed.
- Do not grow forage rape on the same area for more than two years, to prevent fungal disease (blackleg).

WHAT ARE BRASSICAS?

Brassicas include forage rape, turnips, broccoli, canola, kale and swedes. Although the information presented in this Tech Note relates specifically to forage rape, most of the agronomic and animal health issues are applicable to all brassicas. The main difference between type is grazing management.

WHY GROW BRASSICAS?

The value of brassicas in dairy feeding systems include:

- part of a forage rotation
- rapid autumn growth
- high yield potential
- high forage quality
- low establishment costs
- water and nitrogen efficiency.

Brassicas in forage rotations

Brassicas can be used as a disease break crop. For example canola is a brassica that is commonly used in a cereal rotation. Brassicas contain 'glucosinolates' which enable biofumigation of the soil on break down of plant debris.

Brassicas are also commonly used as part of a pasture renovation program as they provide an added opportunity for soil preparation and to control weeds.

Rapid autumn growth and high yield

Under favourable conditions forage rape germinates rapidly (2-4 days) in late summer and early autumn.

Brassicas offer significant opportunities to boost autumn feed supply because they grow faster than most alternatives.

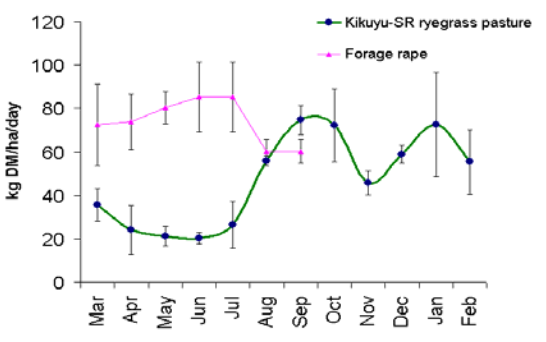
Feed grown at this time of year is more valuable than extra feed grown in winter and spring, making autumn-sown forage rape an excellent option for filling feed gaps and enabling longer pasture grazing intervals.

If sown early enough, growth rates of more than 100kg DM/ha are achievable.

For example, Figure 1 shows the average growth rate of forage rape over three years at Camden, compared with a typical kikuyu/short rotation ryegrass/pasture.

In the Macalister Irrigation District at East Gippsland forage rape was sown in late March then grazed at the end of May 2007. Growth rates exceeded 100kg DM/ha/day for more than half of the growing period.

Figure 1: Monthly growth rate (kg DM/ha/day) of forage rape sown in early March and kikuyu oversown with short rotation ryegrass pasture in mid March at Camden, NSW. (means for three years).



Forage quality

Forage rape has a very high nutritive value, with metabolisable energy levels of 11.5MJ ME/kg DM and crude protein of 26%. It has a low neutral detergent fibre (NDF) content (less than 15%). Table 1 shows the nutritive values for forage rape compared to perennial ryegrass and in relation to cow requirements.

Table 1. Nutrient content (%DM), metabolisable energy (MJ/kgDM) and water use efficiency of perennial ryegrass in its vegetative stage of growth compared with forage rape and cow requirements.

Nutrient (% DM) All figures are in % FM except where otherwise stated	Perennial Ryegrass (Vegetative)	Brassica	Cow requirements[b]
Metabolisable energy (MJ/kg DM)	11.4	11.5	10.3
Nitrogen	3.9	4.3	2.4
Non-protein N	0.9	3.5	
Nitrate N	0.1	1.2	0.14[d]
Crude protein	24.3	27	15
Acid detergent fibre	23	15	18
Neutral detergent fibre	49	15	45
Water soluble carbohydrate	7.8	15-17	
Calcium	0.53	0.9	0.51
Phosphorus	0.22	0.3	0.33
Potassium	2.2	2.5	0.9
Magnesium	0.28	0.27	0.2
Sodium		0.51	0.18
Chloride	0.1	2.2	
Sulphur	0.43	0.5	0.2
ERDP:FME[a] (g/MJ)	17		10
Water use efficiency[c] (MJ ME/mm water)			
Winter	360	230	
Summer	160		

a Rate of effective rumen degradable protein (ERDP) to fermentable metabolisable energy (FME)
b Requirements for a 600kg Holstein-Friesian cow giving 20 litres milk/day
c Includes all water – irrigation, rain and use of soil moisture
d Maximum content

Low establishment cost

A well-grown forage rape crop can be a cheap source of feed, due to its low sowing rates and good water and nutrient efficiency.

Our Partner Farm in East Gippsland produced forage rape yielding 10t DM/ha. Variable costs were 0.4c/MJ ME. Annual ryegrass grown on the same farm cost 0.6c/MJ ME.

High water and nitrogen efficiency

Brassicas are exceptionally efficient in their use of water and nitrogen. Table 2 compares short rotation ryegrass and forage rape.

Water use efficiency is the amount of dry matter (DM) grown per megalitre of irrigation water applied.

Nitrogen efficiency is DM grown per kilogram of nitrogen applied. As forage rape can access nutrients from different parts of the soil profile nitrogen demand is less.

Table 2. The water use efficiency (kg DM/ML irrigation) and Nitrogen use efficiency (kg DM/kg N applied) for forage rape and annual ryegrass grown on farm in East Gippsland.

Forage	Efficiency of use of:	
	Water (t DM/ML irrigation)	Nitrogen (kg DM/kg N applied)
Short rotation ryegrass	8	66
Forage rape	10	151

CROP ESTABLISHMENT

Area to sow to forage rape

The maximum area to sow is limited by the fact that cows cannot eat more than about 4-5kg DM forage rape per day. This is due to the high nitrate and low fibre content of forage rape.

The minimum area sown should allow for enough crop for animals to adapt to the plant (2-3 days) and then to provide a continuous period of grazing (at least 14 days) after adaption.

Plant at least 2ha for every 100 cows. The optimum or maximum area is about 4ha/100cows. For a continuous supply of forage rape, sow early in two to three staggered plantings, 10-14 days apart.

Time of sowing

If adequate water is available, sow as 'early' as oats (mid-February in southern Australia and early -March in northern Australia).

Sowing after the end of March tends to lose the benefit of the forage rape as an autumn feed. But its fast growth rate still makes it useful in winter for extending pasture grazing rotations.

Seeding rate

Sow superstrike-coated seed at 3½kg/ha to achieve a plant density of 40-50 plants/m^2. The superstrike coating contains anti insect and anti fungal agents and molybdenum.

A plant density of 40-50 plants/m^2 reduces wastage at grazing because the growing point (at the top of the stem) remains closer to the ground. Cows can graze to a lower residual without removing the apical growing point and setting back regrowth.

Earlier recommendations were to sow at 4kg/ha to give a density of 80-100 plants/m^2 at first grazing. However recent trials (Table 2) and farmer experience, indicate that this is too high to optimise utilization of the forage by grazing animals.

At 2kg/ha or less, the canopy remains too open and weed infestation can be high. The new recommended sowing rate of 3½kg/ha represents a middle ground.

Table 2. The effect of sowing rate on plant density at first and second grazing and level of utilisation of forage rape at first grazing at Camden NSW.

Seed Rate (kg/ha)	1st Grazing			2nd Grazing
	Pre Grazing (kg DM/ha)	Utilised (kg DM/ha)	Plants/m^2	Plants/m^2
1	5700	3307	13	11
2	6220	3701	28	9
4	5740	2927	102	13
6	5320	2836	145	19
8	5110	2871	136	21
10	4760	1893	201	27

Source: S.Farina and S.Garcia , 2007 from trials at Camden, NSW.

Sowing methods

Direct drill forage rape with a tyned or disc drill. Sink the fertiliser tynes or discs to about 5-10cm deep to place fertiliser at the right depth and to provide some soil to cover seed. Ensure that the seed box hoses are left to hang free so that the seed is not drilled in.

Follow with a heavy rolling unless soil is really wet. Harrowing, rather than rolling is quicker as the harrows can be attached to the drill and this may be suitable under ideal moisture conditions, but otherwise rolling is far better.

Ensure that the seed is not buried too deep. Forage rape seed requires good soil/seed contact to germinate but establishment can be adversely affected if the seed is buried deeper than 2cm.

Forage rape seed is very vigorous, emerging after four days under ideal conditions. Under non-ideal conditions (variable sowing depth/suboptimal moisture) seeds can emerge up to two weeks after sowing.

If direct drilling into crusting clay soil, rotary hoe or power harrow to 2cm depth then follow as above.

There has been limited experience in growing forage rape under flood irrigation. Variable germination has been a problem. Anecdotal evidence suggests good establishment can be achieved by pre-watering, followed by the recommended sowing procedure above.

Sowing into summer grass

Forage rape can be sown into kikuyu or paspalum pastures in mid-March. Apply 3L/ha of the dessicant herbicide 'gramoxone' to set back grass growth until cooler temperatures allow the forage rape to compete.

If sowing later (when soil temperatures at 10cm are below 12^{0}C) simply graze hard and slash the summer grass if needed.

Oversowing with ryegrass or clover

Forage rape sown in late summer/ early autumn will provide three to four grazings up to about early August. For forage after this, broadcast short rotation ryegrass or Persian clover (at 20kg/ha), preferably before the first grazing. This allows the cows to trample the seed into the ground and improves germination.

If planting before grazing, sow in the afternoon when it is dry so the seed will fall to the ground. Sowing after first grazing also provides good establishment.

The grass or clover emerges but stays fairly dormant under the shade of the forage rape until the forage rape density declines after the third grazing in August/September.

SOIL NUTRIENT REQUIREMENTS

Soil tests

Brassica crops need a high soil nutrient status.

For example, brassicas are very susceptible to phosphorus deficiency and are sometimes used as an indicator of soil phosphorus adequacy. Symptoms of phosphorus deficiency are stunted plants with small, yellow/purple leaves. Olsen phosphorus levels should be more than 25mg/kg and extractable potassium greater than 300mg/kg.

If soil pH ($CaCl_2$) is below 5.3 consider applying lime. As a general rule, 5t lime/ha should raise soil pH by approximately 0.8pH units; however, this will depend on soil type, so seek local advice.

Fertiliser applications

A forage rape crop yielding 8t DM/ha would remove about 307kg/ha nitrogen, 22kg/ha phosphorous and 144kg/ha potassium.

Actual fertiliser requirements would be 215kg/ha nitrogen (assume 20% of nitrogen comes from recycled soil organic matter and 10% return in dung and urine), 20kg/ha phosphorus and 130kg/ha potassium (assume only 10% nutrients are returned in dung and urine).

The low value for nutrient return in dung or urine is due to on-off strip grazing whereby most excreta is transferred to the next location.

Suggested fertiliser application rates:

First Year	
Pre-sowing	100kg molybdenum superphosphate and 600kg 23-0-25 fertiliser mix/ha
At sowing	100kg DAP/ha
After first grazing	100kg urea/ha
Second year or if Molybdenum adequate	
Pre-sowing	500kg 23-0-25 mix/ha
At sowing	120kg DAP/ha
After first grazing	150kg urea/ha

Brassicas are unique in that they require molybdenum for growth. It can be applied as a molybdenum superphosphate mix or, if molybdenum has been recently applied, use a seed-coating such as superstrike seed. Even if soil phosphorus and potassium are well above recommended levels still apply some fertiliser (say 50% of requirements) to provide some readily available nutrients.

GRAZING MANAGEMENT

Forage rape can be grazed a number of ways. The best option depends on when the feed is required and available labour resources. Below are examples which provide a starting point for establishing an efficient grazing system.

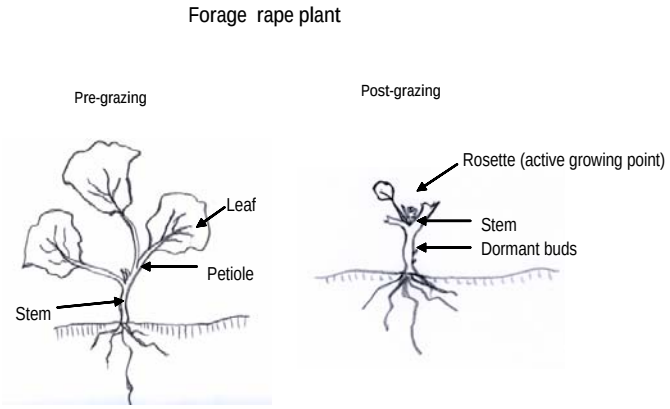
Graze to optimise regrowth

To optimise regrowth, graze when at least 50cm high, which is usually about seven to eight weeks after sowing. At this stage the plant should have more than eight mature leaves.

If grazed too early palatability is low due to high levels of nitrate and moisture. For example, dry matter changes from 5% to 8% between weeks four and seven after sowing. Nitrate content is highest at the first grazing (1.5-2%) compared to <0.1% for ryegrass. This is partly related to nitrogen fertiliser application. The nitrate content falls substantially after the first grazing (to less than 0.5%).

Ideally, cows should only remove the leaves and petioles leaving the active (apical) growing point intact to ensure maximum re-growth (see Figure 2).

Figure 2. Forage rape before and after grazing to recommended level, removing all leaf and petiole leaving the growing point at the apex of the stem.



Some cows may develop a real preference for forage rape and eat excessively, leading to illness or even death from nitrate poisoning. The risks can be greatly reduced by grazing an allocated area only for a short time (1-2 hours).

If cows are allowed prolonged access they will continue to graze more and more rosettes at the top of the stem which contain the active growing points. If this happens, the plant has to wait until 'dormant' buds burst (See Figure 2) on the stem setting back regrowth by several weeks. Regrowth is also set back as more and more of the stem is removed because more and more plant reserves (water soluble carbohydrates) are removed.

Provide a relatively square area allowing 8-10m^2/cow for maximum utilisation, and least damage to the plants. Giving a larger area or a narrow section will encourage cows to be more selective and explore more, doing more damage in the process.

Calculating a strip of forage rape for grazing

Collect the leaves and petioles from three, 1m x 1m representative areas, leaving the rosette (growing point) at top of stem intact. This effectively simulates what the cows should eat.

Weigh the leaves and petioles and calculate dry matter according to the example below.

Average wet weight of three 1m x 1m samples	5kg
Assume dry matter content of	8%
Target allocation per cow of	4kg DM/cow/day
Number of cows to graze crop	250

$$\text{Area to be grazed} = \frac{250 \text{ cows} \times 4\text{kg DM/cow/day}}{5\text{kg} \times 0.08 \times 10{,}000\text{m}^2}$$

$$\text{Area to be grazed} = \frac{1000\text{kg DM/day}}{4000\text{kg DM/ha}}$$

Area to be grazed = 0.25ha

Graze for total removal

To make the most of autumn-sown forage rape, sow early (mid-February in the south and mid March in the north). This allows time for at least two or three staggered sowings, 10-15 days apart, which provides continuous feed from the first grazing. Continuous feeding of rape maximises the nutritional benefits to cows. If it is fed intermittently the rumen must adjust each time.

Start grazing when 6 to 7t DM/ha is on offer, then graze to ground level for next four to six weeks.

Graze for optimal regrowth, then total removal

Sow the whole area early. Graze the first half to optimize regrowth. It should have 3-5t DM/ha on offer at five to seven weeks growth.

When the feed on offer exceeds 7t DM/ha, graze to ground level. At this stage it could have 6-8t DM/ha, allowing up to 5t DM/ha utilisation. This will slow the grazing rotation and allow more feed to accumulate ahead of the cows. It will give the first half a chance to regrow which can then be grazed again, either to ground level or for optimal regrowth.

In a total removal grazing situation, sow Persian clover or ryegrass immediately after grazing. If the grazing is late in the season (after mid-April), better growth will be gained from using ryegrass or a winter cereal rather than Persian clover.

The last two grazing options have the benefit of enabling most of the forage to be utilised in autumn and potential utilisation is a lot higher. Management is simpler in that cows can be left on the forage rape without fear of nitrate toxicity or damaging plants.

SUPPLEMENTING FORAGE RAPE

Forage rape is low in fibre so should be supplemented with a high-fibre sources such as hay, grass or maize silage, kikuyu or paspalum. To prevent acidosis, feed supplements to cows before or after forage rape. Table 4 gives some typical autumn rations for dairy cows. The first is well balanced; the second will give the cows a stomach-ache and the rest are alternatives that are typical but balanced to varying degrees. The ration examples are for a 20Lmilk/day cow in late lactation in autumn.

Table 4. Typical rations fed to dairy cows producing 20L milk'day in autumn.

	Intake kg DM/ cow/day	Metabolisable energy (MJ/kg DM)	Acid detergent fibre (%)	Neutral detergent fibre (%)	Protein (%)
Recommended	***18***	***10.8***	***≥19***	***<40***	***16***
Well balanced ration 4kg forage rape 7kg pasture 3kg maize silage 4kg conc. (16% protein)	18	10.9	18	33	20
Stomach-ache ration (wasted ME, v. low fibre) 4kg forage rape, 8kg Pasture, 6kg concentrates	18	11.1	11.6	28	22
Alternate ration 1 (OK for fibre, low ME) 4kg brassica 5kg pasture 4kg concentrates 3kg straw	16	9.8	17	28	19
Alternate ration 2 (protein a bit high) 4kg brassica 10kg pasture 4kg medium quality ryegrass hay	18	10.6	22	39	23

Time of day to graze forage rape

Graze forage rape after milking to avoid milk taint. Cows will graze better after the afternoon milking than morning milking because nitrate content is lower and water soluble carbohydrates (sugars) higher. The sugars are higher in the afternoon because the plants photsynthesise during the day producing sugars (energy) to make protein and use up nitrate in the process.

It may be inconvenient to graze forage rape after afternoon milking as cows have to be removed late at night. Alternatively feed forage rape after the morning milking, but *never* graze it immediately before milking.

Fibre supplements can be fed at any time of day to complement the low fibre levels in forage rape.

Symptoms of nutritional diseases

Acidosis: cows stand around and do not eat or ruminate. Rumen is static. Very loose faeces.

Nitrate toxicity: if severe, cows gasp for breath, will go down rapidly. May be fatal.

Red water: loss of appetite, ill thrift and passing red urine. Do not graze flowering forage rape crops as it causes digestive upsets resulting in the symptoms above.

Rape scald or photosensitization: reddening and swelling of skin on face and sometimes the udder. Affected animals are agitated and seek shade. Risk is greater when immature rape crops are grazed.

PESTS AND DISEASES

White butterfly and diamond back moths

White butterfly and diamond back moths can infest forage rape crops, with impact being severe, particularly on plants stressed due to lack of moisture or nitrogen. If close to grazing, graze before too much damage is done.

Control: spray with chlorpyrifos-based pesticides at label rates. Threshold for spraying: 1 grub/leaf. Severe impact occurs after about four days.

Blackleg

Brassica crops are susceptible to the Leptosphaeria fungus, commonly known as black leg. Fungal attack tends to set in during the third year of continually growing forage rape although they have been discovered in the second year. Evidence of infection is black lesions on the stem and in severe cases, rotting of stem leading to wilting and death of plants.

There is no chemical control for blackleg and no resistant forage rape varieties are available. The only option is to avoid sowing forage rape in the one area for more than two years in a row and allow a two or three-year break before growing forage rape again.

ACKNOWLEDGEMENT

Knowledge on growing and managing forage rape has been gained through a range of FutureDairy research and development activities. This Tech Note is based on research results and the experience of our Partner Farmers, Bill and Alison Jessep in the Macalister Irrigation District, Wayne Clark and family on the North Coast of NSW and the Berkfelds in SE South Australia.

About FutureDairy

FutureDairy aims to help Australia's dairy farmers manage the challenges they are likely to face during the next 20 years. The challenges are expected to be related to the availability and cost of land, water and labour; and the associated lifestyle issues.

Our activities are structured around three priority areas – Forages, Feeding and Innovations. These are where there are opportunities to address the challenges related to water, land and labour resources.

FutureDairy's approach is unique in that our work considers Science, Systems and People issues. In addition to conducting trials on research farms (Science), we explore how our findings work under commercial conditions on Partner Farms (Systems). We also use social research to help understand the social issues (eg labour, lifestyle and practical implications) involved in taking on new practices and technologies (People).

Our Forages work is all about producing more home-grown feed from the same area of land. We are investigating the potential to concentrate resources (water, fertiliser and management) on the better ground. Our target is to produce more than 40t DM/ha/yr in a sustainable way. To achieve this we are trialling a 'complementary forage rotation' based on growing three crops a year:

- a bulk crop (eg maize);
- a legume for nitrogen fixation (eg clover); and
- a forage to provide a pest/disease break and to improve soil aeration (eg a brassica).

Our Feeding work is researching if it is more profitable to use extra bought-in feed to feed more cows (ie increase stock numbers) or to increase production per cow.

FutureDairy is investigating a number of Innovations that could improve farm efficiency, labour management and lifestyle. We have a major study on automatic milking systems (AMS), the obvious labour saving innovation. We are adapting automatic systems to be profitable and suitable for Australia's pasture-based, large herd situation.

We are also studying innovations that allow precision farming without increasing labour needs. Some examples include remote sensing of animal function and pasture status, and the use of video cameras to monitor paddock activities (eg calving) remotely via a computer.

Contact us

Project leader:	Prof Bill Fulkerson ph (02) 9351-1635 email billf@camden.usyd.edu.au
Science:	Dr Sergio (Yani) Garcia ph (02) 9351-1621 email: sgarcia@usyd.edu.au
Systems:	Mr Sean Kenny ph (03) 5624-2328 email: seank@camden.usyd.edu.au
Social Research:	Dr Mark Paine ph (03) 8344-8096 email: mspaine@unimelb.edu.au