

SOIL HEALTH AND FERTILITY

5. New Zealand cover crop literature review

Key points

- Cover crops are short term crops, sown after a main crop has been harvested or undersown into a main crop, grown over the winter and then grazed or incorporated into the soil before the next crop is sown.
- Cover crops can provide nutrients to the following crop, provide grazing, prevent nutrient leaching, protect the soil, control weeds, and leguminous cover crops fix nitrogen.
- All cover crops need to be sown as early as possible to maximise their benefits.
- It is usually worth grazing rather than cultivating-in to get a return on the investment and to reduce N lockup in high C:N ratio crops.

1. Nitrogen fixing cover crops

- Tick beans, lupins or forage peas are flexible and productive, but require early sowing.
- Mixed legume/cereal green feeds are a good idea.
- Winter legumes need to be sown early, used early, and grazed rather than ploughed in.

2. Cereals and ryegrass

- Oats or triticale are the most flexible and productive.
- Modern feed varieties perform best.
- Early planted mixed legume/cereal green feeds work well.
- Winter grasses/cereals need to be sown early (can tolerate slightly later sowings than legumes) and give best results if not grazed.
- Triticale, ryecorn and ryegrass tolerate early winter grazing best.

3. Forage brassicas

- Winter brassicas need to be sown early to achieve a high yield.
- Brassicas can be a useful break crop in the cropping rotation.

4. Grazing the cover crop (rather than incorporating it into the soil) before cultivating and sowing the subsequent crop can improve yield of the following crop and provide valuable spring grazing. However some nutrients will be lost to the animals and from leaching.

5. Undersowing cereal crops with a legume had little effect on yield and provided a well established leguminous green crop after harvest.

6. A good review of overseas literature can be found at <http://www.sare.org/publications/covercrops/covercrops.pdf>

A review of the New Zealand literature on cover crops has been done by David Musgrave. Much of the information comes from research done in Canterbury on green feed crops (grown for stock feed), and their effects on subsequent crop yields.

An interesting point that emerged during the research for this review was that during the 1970's and 80's a lot of very innovative agricultural research was done in the arable field that is highly relevant to organic cropping because it was before the widespread use of nitrogenous fertilisers.

Why use cover crops? (also known as green feed or green manure crops):

Cover crops provide nutrients to subsequent crops and grazing, and also have a role in preventing nutrient loss, fixing nitrogen (in the case of legumes), reducing erosion, and weed control.

1. Nitrogen fixing green crops

Lupins are a minor forage crop in New Zealand (Douglas 1980); more recent work has demonstrated the possibilities of using tick beans and forage peas. A trial of a wide range of green feed legumes at Winchmore, sown in early March on a heavily

cropped soil, gave some useful results (Janson & Knight 1980).

DM=dry matter

	Mid Aug DM	DM utilised by sheep	Subsequent wheat yield	Mid Oct DM	DM utilised by sheep
Sub Clover	0.2	0.2	1.2	2.5	2.5
Tick Beans	4.4	3.1	3.7	6.6	3.9
Peas	2.8	2.1	3.9	1.9	0.6
Lupins	1.4	0.9	1.5	3.7	2.9
Rye-grass /oats	2.8	2.7	1.6	3.8	3.3

The tick beans were not utilised by the sheep until they had started flowering in early August but provided the most feed at both grazings. The peas deteriorated rapidly by early August but provided very useful amounts of feed and along with the tick beans, gave the best subsequent wheat crop.

Further detailed work at Winchmore (Janson 1984) looked at planting dates:

Crop	DM yield (t/ha) in late May, for sowing dates:		
	Feb 10	March 4	April 6
Tick beans	4.3	2.2	0.3
Lupins	4.0	1.6	0.2
Forage peas	3.6	2.5	0.3
Tama ryegrass & oats	3.7	4.0	0.5

Tick beans and peas reached their peak yields by the end of May. The lupins did not grow as well from the March sowing, but handled the frosting better, so DM peaked by late July. All the legumes lost substantial dry matter by late winter from frosting/disease. In contrast, the ryegrass/oats were not as sensitive to later planting and continued to grow throughout the winter.

The early planted legume crops gave a 50% increase in subsequent wheat grain yield (3.2 t/ha to 4.8 t/ha).

Grazing immediately prior to cultivating and sowing the wheat gave a 22% increase in wheat grain yield compared to ploughing in the green manure 6 weeks prior to sowing. For wheat planted in early August, grazing in mid May rather than mid July made no difference to wheat grain yields.

Summary: N-fixing cover crops

- Tick beans, lupins or forage peas are flexible and productive
- Mixed legume/cereal green feeds are an attractive proposition
- Winter legumes need to be:
 - **sown early**
 - used early
 - grazed rather than ploughed in

2. Cereals and ryegrasses

Most trials where a range of cereals is planted show that the best yields come from planting oats (Douglas 1980). Early planting in January/February gives the best yields, but cultivars need to be selected with care to ensure they don't go to seed before winter or succumb to leaf diseases like rust. Late planting in April/May only gives useful feed in early spring.

Both ryegrass and cereals were planted from mid Feb – late March on ten sites in northern Canterbury (Stephen et al. 1978). Amuri oats were planted in each trial, so the other cultivars are presented as a percentage of the oats' yield.

	Mean	Max	Min
Amuri oats (kg/ha)	4231	6740	1520
CRD ryecorn %	78	105	38
Arawa wheat %	48	71	20
Paroa ryegrass %	56	86	34
Tama ryegrass %	65	95	48
Tama & Amuri oats %	95	100	90

Two trials with a wider range of cultivars and two planting dates (Stephen & Saville 1993) also got the highest yield from oats although oats and Tama ryegrass gave similar yields by late winter.

A trial at Lincoln (Agricom 2002) with modern cultivars looked at the potential for multiple grazing of cereals planted from mid March onwards.

Doubletake triticale gave the best yield up to early June and regrew rapidly after grazing to give higher yield than the ungrazed. Tama ryegrass also demonstrated potential for regrowth after early grazing, but the early yield was much less than the triticale. Modern rust resistant ryecorn gave the best yield when taken ungrazed until late winter.

Doubletake should be sown as early as possible from late February. Every week that sowing is delayed will reduce total autumn growth by 500–700 kg DM/ha/week, i.e., a late February sowing versus a late March sowing will result in approximately 2000 kg DM/ha more feed (Agricom 2002).

Cumulative yields of ungrazed green feed crops sown in mid April at Invermay and Palmerston North (Taylor & Hughes 1979) still got the highest yield from oats even from late planting.

Quality issues were addressed by Hughes & Haslemore (1981) who showed that uninterrupted growth of winter oats results in tall stalky plants. Digestibility of winter oats starts to decline shortly after stem elongation starts.

Planting date crucial

Hughes et al. (1984) made a very useful attempt to develop a predictive model to describe the growth of oats at any site in New Zealand from any planting date. They reviewed data from all the autumn planted oat trials in New Zealand from 1966–84 and were able to fit the data to a simple model driven by temperature and solar radiation.

The key finding from the model is that there is no yield until about 325 degree days are accumulated. Yield then increases in proportion to degree days until about 1.2 t/ha DM are accumulated (920 degree days), thereafter yield increases in proportion to accumulated solar radiation. The implications of this model are that since the climatic variation between seasons is relatively minor, the biggest driver of yield is sowing date and that it is very possible to predict potential yield knowing only sowing time, mean temperature and solar radiation for any given farm.

Summary: cereals and ryegrasses

- Oats or triticale are the most flexible and productive
- Modern feed varieties perform best
- Wheat and less winter active ryegrasses are a waste of time
- Early planted mixed legume/cereal green feeds are an attractive proposition
- Winter grasses/cereals need to be sown early (can tolerate slightly later sowings than legumes); give best results if not grazed; triticale, ryecorn and ryegrass tolerate early winter grazing best
- Probably worth grazing rather than cultivating in to get a return on the investment

3. Brassicas

Brassicas have a long history of use in New Zealand to generate large quantities of quality feed in autumn and winter. They are not related to the major arable crops so can be a useful break crop in a cropping rotation. They have been quite prone to pests and diseases, but the more modern cultivars can give very substantial lifts in production compared to traditional cultivars.

Early summer planted brassicas in the Central Plateau (Percival et al. 1986) showed that the new cultivars such as Barkant turnips and Pasja hybrid

forage brassica (Chinese cabbage x turnip hybrids) consistently gave better late autumn yield than the more traditional turnips, swedes, rapes and kales.

Similarly, modern rape cultivars gave superior yields compared to older cultivars both from spring and late summer (February) plantings (Banfield & Rea 1986). Baraska and Arran were the most consistent.

A trial at Lincoln looked at a range of late summer/early autumn plantings of turnips. Three turnip cultivars (Green Globe, York Globe and Appin stubble turnip) were planted after pasture on five sowing dates (Collie & McKenzie 1998). Delaying sowing after early February resulted in a loss of about 170 kg/ha DM per day of delay. Appin produced the greatest leaf yield and a much higher proportion of leaf/root at all sowings, but total yield was 17% down on Green Globe (assuming the entire bulb is eaten).

Summary: brassicas

- Forage brassicas (Hunter and Pasja) and stubble turnips (Appin) are best suited to late summer or early autumn planting
- Winter brassicas need to be sown early
- Probably worth grazing rather than cultivating in to get a return on the investment

4. Graze or cultivate?

Just one direct comparison of grazed versus cultivating-in crops was found, the Winchmore trial described earlier (Janson 1984), which gave a 22% wheat yield increase from grazing immediately prior to cultivating and sowing compared to ploughing in the green crops 6 weeks prior to sowing. The recent trial at the BHU also gives some clues (Dastgheib, Jenkins & Barnett 2006). The high C/N ratios of the cereals and brassicas and the lower chlorophyll reading from the subsequent wheat crops strongly suggest that when these crops are cultivated directly into the soil they lock up some nitrogen for a period which may inhibit the growth of the following crop. Predigesting by grazing is likely to reduce this effect.

However, grazing in some cases can have disadvantages: some nutrients are retained by the animal and some N may be lost through volatilisation or leaching, although this can be minimised if grazing occurs as close to cultivation and sowing time as possible to avoid the predominant leaching time of May to early September. Also, as a recent FAR report (FAR 2005) highlights there is a significant cost to establishing a cover crop and an effective way of getting a return on this investment is to graze prior to cultivation in late winter/early spring. High quality feed at this time is always valuable.

5. Undersowing cereal crops

Wheat (Otahe) was sown at Winchmore from July to October with red and white clover as undersown cover crops (Deo et al. 1993). The undersown crops had little impact on wheat yield, and provided a well established leguminous green crop after harvest. (See Organic Update 19: Undersowing.)

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