Winter forages such as kale and fodder beet are important single-graze species for livestock. This guide focuses on the use of catch crops after forage crop grazing to take up nitrogen (N) during the coolest months of the year. It aims to explain the whys and hows to help manage your expectations and decision making.
Forages for Reduced Nitrate Leaching

Guidelines for catch crops

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Forages for Reduced Nitrate Leaching is a DairyNZ-led collaborative research programme across the primary sector delivering science for better farming and environmental outcomes. The aim is to reduce nitrate leaching through research into diverse pasture species and crops for dairy, arable and sheep and beef farms. The main funder is the Ministry of Business, Innovation and Employment, with co-funding from research partners DairyNZ, AgResearch, Plant & Food Research, Lincoln University, Foundation for Arable Research and Manaaki Whenua-Landcare Research.
# Contents

What is a catch crop? .................................................................................................................. 2

What is the difference between a catch crop and a cover crop? .......................................... 2

What are the costs? ....................................................................................................................... 2

Gross margins ............................................................................................................................. 2

Further examples of gross margins ............................................................................................ 3

Why should I use catch crops? ................................................................................................... 4

Environmental benefits ............................................................................................................. 4

How much N is typically lost after winter grazing? ................................................................. 7

Additional feed and dry matter production ............................................................................ 7

Reducing imported supplement ............................................................................................... 8

Ground cover ............................................................................................................................ 8

How does winter grazing increase runoff risks? .................................................................... 9

Organic matter returns ............................................................................................................ 10

What sort of catch crop is best and when is it too late? ........................................................ 10

What sort of catch crop should I use? ..................................................................................... 10

Fit into your farm system ......................................................................................................... 15

The earlier the crop is established, the greater the potential to reduce leaching .................. 15

Modelled catch crop outcomes ............................................................................................... 16

How should I establish and manage a catch crop? ................................................................. 18

Establishment methods .......................................................................................................... 19

Establishment trial ................................................................................................................... 19

Nitrate management ................................................................................................................ 20

Soil N testing for crops ............................................................................................................ 20

Links ......................................................................................................................................... 21
What is a catch crop?

A catch crop is any crop that is grown with the primary objective of mopping up excess nitrate in soils, which may otherwise be lost through leaching. The reduction in nitrate leaching losses results from the crop’s rapid uptake of residual mineral N and the reduction of the water content of soil, which reduces the risk of drainage.

The primary objectives of catch crops are to:

- Reduce nitrate leaching losses during high risk periods
- Increase annual dry matter production
- Aid soil restoration

Although ‘catching’ this N is an important aim, catch crops can also add to annual production. Importantly, the effectiveness of catch crops varies between sites and years, and depends on climate, soil and management factors. The influence of these factors on catch crop performance is discussed below.

What is the difference between a catch crop and a cover crop?

The terms “catch crops” and “cover crops” are often used interchangeably, however, technically, they are different. “Cover crop” is an umbrella term that includes all crops grown to ‘protect or improve’ between periods of regular crop production. Cover crops provide a range of functions such as weed suppression, organic matter returns, surface soil protection and capturing N that may otherwise be vulnerable to leaching. A cover crop sown with the primary purpose of reducing nitrate leaching is referred to as a “catch crop”.

What are the costs?

Gross margins

The gross margins of catch crops will vary depending on the end-use and the individual farm system. Factors such as sowing date of the next crop or timing of feed requirements will need to be taken into consideration. The gross margin examples below provide an indication of the costs involved.

Table 1. Financial analysis of oat catch crops sown in July after grazing of kale by dairy cows, harvested for green chop silage in late November 2016, Canterbury. No nitrogen was applied to the catch crops.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t DM/ha)</th>
<th>Revenue ($/ha)¹</th>
<th>Costs $/ha</th>
<th>Costs c/kg DM</th>
<th>Margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>9.6</td>
<td>2400</td>
<td>719</td>
<td>7.5</td>
<td>1680</td>
</tr>
<tr>
<td>Direct drilled</td>
<td>8.4</td>
<td>2100</td>
<td>499</td>
<td>5.9</td>
<td>1601</td>
</tr>
<tr>
<td>Broadcast²</td>
<td>7.7</td>
<td>1925</td>
<td>577</td>
<td>7.5</td>
<td>1347</td>
</tr>
</tbody>
</table>

¹assuming $0.25/kg DM; ²included surface grubbing and tyne crumbling
Further examples of gross margins

Table 2. Financial analysis of oat catch crops sown in July after grazing of fodder beet by dairy cows, harvested for green chop silage in late November 2016, Canterbury.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t DM/ha)</th>
<th>Revenue ($/ha)(^1)</th>
<th>Costs</th>
<th>Margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$/ha</td>
<td>c/kg DM</td>
</tr>
<tr>
<td>Conventional</td>
<td>9.0</td>
<td>2250</td>
<td>719</td>
<td>8.0</td>
</tr>
<tr>
<td>Direct drilled</td>
<td>6.9</td>
<td>1725</td>
<td>499</td>
<td>7.2</td>
</tr>
<tr>
<td>Broadcast(^2)</td>
<td>6.8</td>
<td>1700</td>
<td>577</td>
<td>8.5</td>
</tr>
</tbody>
</table>

\(^1\)assuming $0.25/kg DM; \(^2\)included surface grubbing and tyne crumbling

Table 3. Financial analysis of oat, triticale and Italian ryegrass catch crops sown in July 2018 after grazing of kale, harvested for green chop silage in early December 2018, Canterbury.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t DM/ha)</th>
<th>Revenue ($/ha)(^1)</th>
<th>Costs</th>
<th>Margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$/ha</td>
<td>c/kg DM</td>
</tr>
<tr>
<td>Oats</td>
<td>12.1</td>
<td>3025</td>
<td>474</td>
<td>3.9</td>
</tr>
<tr>
<td>Triticale</td>
<td>10.1</td>
<td>2525</td>
<td>588</td>
<td>5.5</td>
</tr>
<tr>
<td>Italian ryegrass(^2)</td>
<td>5.9</td>
<td>1475</td>
<td>502</td>
<td>8.5</td>
</tr>
</tbody>
</table>

\(^1\)assuming $0.25/kg DM; \(^2\)the Italian ryegrass is a multi-grazed crop but the gross margins presented here are for a single grazing event.

Table 4. Financial analysis of oat, triticale and ryecorn catch crops sown in August 2018 after grazing of fodder beet, harvested for green chop silage early December 2018, Southland.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yield (t DM/ha)</th>
<th>Revenue ($/ha)(^1)</th>
<th>Costs</th>
<th>Margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$/ha</td>
<td>c/kg DM</td>
</tr>
<tr>
<td>Oats</td>
<td>3.7</td>
<td>925</td>
<td>560</td>
<td>15.1</td>
</tr>
<tr>
<td>Triticale</td>
<td>5.6</td>
<td>1400</td>
<td>644</td>
<td>11.5</td>
</tr>
<tr>
<td>Ryecorn</td>
<td>5.5</td>
<td>1375</td>
<td>609</td>
<td>11.1</td>
</tr>
</tbody>
</table>

\(^1\)assuming $0.25/kg DM

Table 5. Financial analysis of oat catch crops sown in August 2018 after grazing of kale or fodder beet, harvested for green chop silage early November 2018, Canterbury.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Previous crop</th>
<th>Method</th>
<th>Yield (t DM/ha)</th>
<th>Revenue ($/ha)(^1)</th>
<th>Costs</th>
<th>Margin ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>$/ha</td>
<td>c/kg DM</td>
</tr>
<tr>
<td>Kale</td>
<td>Cultivation</td>
<td>10.4</td>
<td>2600</td>
<td>560</td>
<td>5.4</td>
<td>2040</td>
</tr>
<tr>
<td></td>
<td>Direct drill</td>
<td>9.6</td>
<td>2400</td>
<td>300</td>
<td>3.1</td>
<td>2100</td>
</tr>
<tr>
<td>Fodder beet</td>
<td>Cultivation</td>
<td>7.5</td>
<td>1875</td>
<td>474</td>
<td>6.3</td>
<td>1400</td>
</tr>
<tr>
<td></td>
<td>Direct drill</td>
<td>7.3</td>
<td>1825</td>
<td>214</td>
<td>2.9</td>
<td>1610</td>
</tr>
</tbody>
</table>

\(^1\)assuming $0.25/kg DM
Why should I use catch crops?

In a recent survey of farmers from all sectors, *environmental* benefits were the main reasons cited for planting catch crops. Other benefits identified, in order of importance, were *additional feed*, *ground cover* and *organic matter returns*. These are discussed below.

![Oat catch crop after winter grazed fodder beet.](image)

**Environmental benefits**

Nitrate leaching is a naturally occurring process, but when excess N is lost from N fertiliser and urine it can pollute both ground and surface water. This pollution is the focus of national and regional government strategies to improve water quality.

N from fertiliser or urine can be problematic because when added to the soil, a large proportion is converted to nitrate (NO₃⁻) which is especially susceptible to leaching (Figure 1). This conversion process is known as “nitrification”. Nitrification occurs relatively slowly in winter, offering a window of opportunity for catch crops to capture some N before it is lost. Catch crops sown after winter grazing can take up significant quantities of N (Figure 2) and reduce N leaching losses by up to almost 50% (Figure 3).
Figure 1. The nitrogen cycle

Winter grazing of kale.
Figure 2. Plant nitrogen (N) uptake of oat catch crops sown in late June/early July after simulated winter grazing (2015–2018), Canterbury and Southland.

Figure 3. Cumulative mineral nitrogen (N) leached in a wet year from a light soil, following artificial urine deposition, after sowing of an oat catch crop in early July or August, Canterbury.
How much N is typically lost after winter grazing?

If soils are left fallow for several months following the winter grazing of forage crops like kale and fodder beet, there is a high risk of nitrate leaching from large numbers of urine patches deposited during grazing. This is because rainfall normally exceeds evapotranspiration in winter and early spring, resulting in soil drainage and nutrient loss. Losses typically range from 50–180 kg N/ha, which is a risk to the environment and an expense to the farm business.

Additional feed and dry matter production

Establishing a cereal catch crop after winter grazing can offer additional per hectare annual biomass production, and in turn, higher farm productivity.

Trials in Canterbury found that oats sown in July after winter-grazed fodder beet or kale could produce yields of between 6 and 12 t DM/ha (e.g. refer to Figure 4) by 24 November at relatively low cost (<$0.11/kg DM).

Timing of harvest can have important implications for productivity and crop quality, especially metabolisable energy (ME). Generally, for oats the ideal time to harvest is at green-chop silage maturity (growth stage 43-59). After the green-chop silage maturity stage, stem growth and fibre production cause a temporary reduction in the overall feed value. Delaying harvest time beyond the green-chop silage maturity stage results in an initial decline in ME per kg of DM, and then an increase as starch is stored during grain filling.

More information about catch crop yields can be found in the section What sort of catch crop is best and when is it too late?

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**Additional information on oat yield in rotation with kale can be found in the DairyNZ Factsheet Sequence cropping kale and oats.**
Figure 4. Yield (t DM/ha) of oat catch crops sown in mid-July 2016 after winter grazed fodder beet and kale on Balmoral/Lismore stony silt loam at Lincoln University's Ashley Dene Research and Development Station.

Oat catch crop trial, Canterbury.

Reducing imported supplement

For dairy and dairy support operations, the ability of catch crops to reduce nitrate leaching on the milking platform or dairy support block is affected by how the feed generated by the catch crop is used. If the catch crop is harvested and used to increase both the amount of feed offered and the stocking rate, it may not reach desired outcomes. The benefits for reducing N leaching are maximised where the catch crop is used to both mop up N that is at risk of leaching, and to reduce reliance on imported feed and the N that comes with it.

Ground cover

Catch crops provide important ground cover that can reduce the risk of soil loss due to runoff. Runoff represents a loss of an important resource (e.g. soil organic matter and nutrients) and also contributes to negative downstream impacts such as flooding and siltation of waterways.

Careful site selection for winter grazing by avoiding critical source areas (vulnerable parts of the landscape with high risk of sediment loss) and establishing a catch crop as soon as possible after winter grazing, can mitigate runoff losses. Good grazing management should be carried out at all times as it will reduce nutrient and contaminant losses to streams and waterways and minimise damage to soils and paddocks.

Further information can be found in the Beef+LambNZ Factsheet Winter forage crops: management during grazing
How does winter grazing increase runoff risks?

Winter grazing is typically carried out when soils are wet or saturated and the repetitive pressure of animal hooves can result in breakdown of the soil structure, making it prone to runoff (see photo below). A fallow period with no ground cover following winter grazing increases the potential for the movement of fine sediment off the paddock. Treading can compact soil pores which are required for drainage, and the resulting reduction of infiltration rates can also increase the risk of runoff. Risks are especially high where hill country is developed for winter forages as the gradient can lead to a greater risk of erosion.

Weed suppression can be an additional benefit of the ground cover provided by catch crops. In a 2018 Canterbury trial, catch crops listed in Table 6 were sown at the end of June 2018 and the yields were compared with fallow and triticale and barley crops sown early in August 2018 (Table 6). The Faba bean catch crop was significantly weedier than any of the other catch crops. Ryecorn, followed by the triticale catch crops, had the least weed pressure (Figure 5).

Table 6. 2018 catch crop trial treatments and biomass production harvested at approx. green chop (beginning of November 2018) or at approx. whole crop silage stage (end of December 2018).

<table>
<thead>
<tr>
<th>Catch crop/s (and cultivar)</th>
<th>Green chop (t DM/ha)</th>
<th>Whole crop (t DM/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>June treatments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faba bean (Ben)</td>
<td>5.44</td>
<td>18.3</td>
</tr>
<tr>
<td>Ryecorn (Rahu)</td>
<td>7.41</td>
<td>16.5</td>
</tr>
<tr>
<td>Triticale (Wintermax)*</td>
<td>8.09</td>
<td>14.7</td>
</tr>
<tr>
<td>Oats (Intimidator)*</td>
<td>8.05</td>
<td>17.8</td>
</tr>
<tr>
<td>Oats (Intimidator*) &amp; plantain (Oracle*)</td>
<td>9.61</td>
<td>15.7</td>
</tr>
<tr>
<td>Oats, Faba &amp; plantain</td>
<td>8</td>
<td>17.3</td>
</tr>
<tr>
<td>Oats, triticale, ryecorn, Faba &amp; plantain</td>
<td>8.29</td>
<td>15.0</td>
</tr>
<tr>
<td>Weedy Fallow</td>
<td>2.7</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>August treatments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fallow then August sowing of triticale (Wintermax)*</td>
<td>6.32</td>
<td>12.4</td>
</tr>
<tr>
<td>Fallow then August sowing of barley (Sanette)</td>
<td>4.55</td>
<td>9.1</td>
</tr>
</tbody>
</table>

*Triticale (Wintermax), oats (Intimidator) and plantain (Oracle) were kindly provided by Plant Research (NZ) Ltd, Luisetti and Cropmark Seeds (respectively).
Organic matter returns

Catch crops have an important role to play in returning organic matter to the soil via the root carbon inputs from the increased below ground biomass (and also from any biomass above ground that is not removed or grazed). Carbon is a key determinant of soil quality because it plays a key role in most soil biological, chemical and physical processes. Soil function is improved by increasing organic matter (which is on average 58% carbon). Benefits include preservation of soil structure, improved aeration, water infiltration and water storage, and encouragement of earthworms and other soil fauna. The quantity of organic residues returned to the soil by catch crops varies depending on plant species and the length of the growing season.

What sort of catch crop is best and when is it too late?

The key attributes of catch crops when following autumn or winter grazed crops are that they:

- are cold tolerant.
- are winter active.
- have fibrous deep root systems capable of removing N at depth.

What sort of catch crop should I use?

Cereals (e.g. oats, ryecorn, triticale, wheat or barley) make good catch crop choices after winter grazing and are proven more effective than grass species (e.g. Italian ryegrass, Figure 6). Cereal catch crops can be successfully established under harsh winter conditions, even if in some years, particularly on fine-textured soils, sowing is not possible until late winter early spring.

Figure 5. Weed biomass (t/ha) in the fallow and single species catch crops sown in June 2018, harvested for green chop silage early November 2018, Canterbury.
In Canterbury, a wide range of cereal species (ryecorn, triticale, wheat and barley) are comparable to oats in terms of growth, N uptake and effect on soil N. This provides a degree of flexibility to select catch crops that best fit within the rotation. In colder climates, such as Southland, ryecorn and triticale can have marginally better environmental performance than oats. In a Southland trial, earlier growth activity of June-sown ryecorn and triticale resulted in 26–37% more N captured in the respective crops than June-sown oats (Figure 7). Such differences were not apparent when catch crops were sown in August. Weighing up the importance of early environmental gains and feed value is critical when selecting which cover crop species to use on your farm. In terms of biomass production and quality at green-chop silage, oats have consistently outperformed other cereals.
Figure 7. Cumulative nitrogen (N) uptake (kg/ha) for catch crops sown in late June 2018 after simulated winter grazing, Southland.
Yields will vary depending on season and region. Figure 8 shows yields from Waikato (2016), Canterbury (2017) and Southland (2018).
Figure 8. Cumulative biomass (t DM/ha) of a) oats and Italian ryegrass catch crops sown in early May 2017, Waikato, b) oat, rye corn, triticale, wheat and barley catch crops sown in late June 2017, Canterbury and c) oat, rye corn and triticale catch crops sown in June 2018, Southland.
The choice of catch crop species will depend on the farm system (i.e. crop rotation) and the end use for that catch crop. Sufficient time must be allowed between catch crop establishment and the sowing of the subsequent spring crop to maximise the benefits of catch crops. The timing around when spring feed is required (particularly on the milking platform where it will become part of a grazing rotation), and whether there is sufficient irrigation for the following crop, may also be important considerations. For some systems, main cereal crops such as triticale, wheat and barley could be planted early and used as a catch crop as well as a main crop.

The earlier the crop is established, the greater the potential to reduce leaching

The ability of a catch crop to reduce nitrate leaching is strongly driven by the timing of its establishment after a winter grazing event (Figure 9).

The high-risk drainage period is typically between June and mid-October (Figure 3), although this will vary by season, region and soil type. After this time catch crops can be taken through to maturity for maximum yield potential (grain or forage) or terminated earlier (late October) through grazing or incorporation as green manure crops, without compromising the likely environmental gains.

Shallow stony soils will drain earlier and faster than deeper and heavier soils. More substantial reductions in leaching occur in the mid to late part of the catch crop growth cycle, from mid-September onwards under Canterbury conditions, when a rapid increase in canopy expansion creates demand for N uptake by the crop. Figure 10 shows leaching losses over the high-risk period in Canterbury, and although the August sown oat catch crop did not reduce leaching as much as the earlier sown July catch crop it still reduced N losses by 33%.
Figure 10. Monthly mineral nitrogen (N) leached in wet year from a light soil in 2017 following artificial urine deposition, after sowing of an oat catch crop in early July or early August, Canterbury.

The earlier the catch crop is established, the greater the potential to reduce N leaching. However, there can be significant challenges with sowing of catch crops in the middle of winter, particularly in wet and cold conditions. The weather will be an important factor affecting whether you can get onto the paddock after the grazing event to establish a catch crop. In some years, particularly on heavily pugged and/or fine-textured soils, sowing may not be possible until late winter/spring. On heavy poorly-drained soils where N leaching losses are not as prevalent, delaying sowing until spring may not actually compromise potential environmental gains. Importantly, trial data has indicated that successful catch crop emergence is only hindered by gravimetric soil moisture contents that are 40% or above for prolonged periods of time, therefore, only under particularly rare circumstances is it likely that catch crops will fail due to high moisture content.

Modelled catch crop outcomes

Table 7 shows simulated reduction in nitrate leaching at 80cm, in a typical winter-spring (average of historical weather data, 1975-2000). The simulation scenarios included four different climatic regions by considering different rainfall amounts per region and four sowing dates (June, July, August and September). The table presents modelled catch crop effectiveness to reduce N leaching from residual N left in a soil with low water-holding capacity after a simulated grazing of fodder beet. The model was calibrated based on a fodder beet-oat catch crop trial. Although the methods of sowing (i.e. direct drill vs cultivation) are not considered in this modelling exercise, these and other factors also influence catch crop performance (refer to Establishment methods section).
Table 7. Simulated paddock-scale nitrate loss reductions (%) on a low water-holding capacity soil.

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Southland</th>
<th>Canterbury</th>
<th>Hawkes Bay</th>
<th>Waikato</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>Low rain¹</td>
<td>Mid rain²</td>
<td>High rain³</td>
<td>Low rain¹</td>
</tr>
<tr>
<td></td>
<td>25%</td>
<td>22%</td>
<td>29%</td>
<td>65%</td>
</tr>
<tr>
<td>July</td>
<td>22%</td>
<td>17%</td>
<td>27%</td>
<td>53%</td>
</tr>
<tr>
<td>August</td>
<td>12%</td>
<td>8%</td>
<td>19%</td>
<td>41%</td>
</tr>
<tr>
<td>September</td>
<td>5%</td>
<td>0%</td>
<td>3%</td>
<td>18%</td>
</tr>
</tbody>
</table>

¹≤25th percentile of long-term average rainfall; ²>25th percentile, <75th percentile; ³≥75th percentile.

Note that estimated “relative" efficiency of catch crops (% of fallow) is 1 to 7 percent units lower for high water-holding capacity soils because these have intrinsically lower amounts of nitrate leaching (kg/ha), particularly in southern regions (Canterbury and Southland).

Note that the table indicates most frequent values for 25 years of current climatic conditions. However, catch crop benefits vary largely across years depending on weather conditions. For example, for Canterbury where the value was 41%, unfavourable-weather years can show values ranging from 10% to 60% depending on annual weather conditions.
How should I establish and manage a catch crop?

There are a number of things to consider when establishing a catch crop. A selection of these are outlined in the table below.

<table>
<thead>
<tr>
<th>General catch crop considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Termination</strong></td>
</tr>
<tr>
<td>Timing of harvest affects metabolisable energy. Green-chop stage (GS 43-59) is when crop quantity and quality components are most balanced. Delaying harvest beyond green-chop silage maturity results in an initial decline in ME (causing a temporary reduction in feed value) which then increases again as starch is stored during grain filling. The best time for whole-crop silage harvest is when moisture content is within the range of 35-42% DM, which may occur before the completion of grain fill (GS 87).</td>
</tr>
</tbody>
</table>

| **Winter activity**              |
| Cereals such as oats, ryecorn, triticale, wheat and barley all have good winter activity. |
| Ryecorn and triticale can have marginally better environmental performance compared with oats in colder climates such as Southland. |

| **Ground conditions**            |
| Always aim to sow catch crops with as little prior cultivation as possible, while still achieving good soil-to-seed contact. Cultivation could further destroy soil structure and enhance N mineralisation, which can increase the risk of nitrate leaching. Direct drilling is the preferred method of establishment, but under particularly poor ground conditions (wet/pugged), some form of cultivation may be necessary. |

| **Irrigation and water management** |
| Catch crops reduce leaching by using water and reducing drainage. In dryland areas or where irrigation restrictions may arise, water availability for the main spring crop will need to be considered and carefully managed. |

| **Nutrient needs of the next crop** |
| Catch crops may deplete the soil of essential nutrients. Nitrate reduction is the objective, but other nutrients will be taken up by crops. Soil testing to determine what needs to be applied to the subsequent crop is recommended, particularly on light soils following a wet winter/spring period. For more information see Soil testing. |

| **Sowing rates**                 |
| Target high populations (300 plants/m²) with cereals to minimise the time it takes for crops to reach canopy closure. Aim to sow seed at about 3cm depth, to ensure good soil-to-seed contact, and reduce the risk of bird damage. |
Establishment methods

Your establishment method of choice will depend on local factors revolving around soil and climatic conditions (including the amount of crop residues remaining). There is unlikely to be a common method for all situations. In a recent farmer survey, direct drilling of catch crops was the most common method of establishment. Direct-drilling or light cultivation pre-drilling should be targeted methods of establishment to minimise additional N input through mineralisation. Physical protection of soil carbon using no tillage and minimum tillage are also important to reduce structural breakdown of soil. More intensive cultivation may be necessary after heavy stock trampling and pugging. If cultivating is the only way to ensure the catch crop can be sown, then this is the preferred option over leaving fallow.

Establishment trial

In a dry winter in Canterbury (i.e. approx. 55 mm rainfall during July and August), trials have shown that a comparison of pre-drilling tillage and direct-drilling after grazing kale can result in equally successful oat catch crops. Cultivation after fodder beet was necessary to remediate a greater degree of soil compaction, caused by a higher stocking density than that of kale. Broadcasting oat seed after light cultivation is a very cheap option and was successful but had poorer establishment (Figure 11). As proof-of-concept for an alternative method of establishment, some oats were broadcast before fodder beet grazing; however, due to heavier trampling and surface capping, oats did not establish, i.e. <1% emergence.

Figure 11. Plant population (plants/m²) of oat catch crops sown in late July 2016 following grazing of either kale fodder beet comparing three establishment methods, Canterbury.
Nitrate management

It is well known that excessive use of nitrogenous fertiliser is not just financially unwise but also results in surplus N that can be lost to the environment. Using catch crops after winter grazing and getting N application right (right source, right rate, right time and right place) can collectively reduce N leaching. Without information about how much available N is in the soil profile, incorrect amounts may be applied so soil testing is important to maximise environmental and financial efficiencies. This is true for the forage crop, catch crop and subsequent spring crop.

See also information on DairyNZ’s website Soil fertility for pasture

Soil N testing for crops

The nutrient (especially N) inputs (dung and urine) from livestock grazing of forage crops are typically very high and sufficient to meet the requirements for good catch crop green chop yields. Different amounts of N may remain in the soil profile following harvest of catch crops, depending on the inputs from grazing and the amounts removed in the catch crop. Consequently, we recommend soil N testing before establishing any subsequent crops to determine whether any fertiliser N additions are needed to meet crop demand. The recommended protocol for sampling and analysis of plant available N is outlined below.

Samples should be taken from 10-12 points in the paddock. Keep samples frozen until they are sent to the lab for testing. Where possible it is a good idea to sample at least to 60 cm for cereals and to 30 cm for ryegrass. It is important to keep the different sample depths separate (i.e. 0-15 cm, 15-30 cm, 30-60 cm) as this gives an indication of where the available N is in the profile. For example, N at
depth can reflect N that will only be available to more developed plants, or N that is about to be lost from the profile.

The results obtained from a soil mineral N test (Min N) are typically given as mg N/kg soil. To convert this to plant available N (kg N/ha) use the following equation:

Plant available N (kg/ha) = Min N (mg/kg) x sampling depth (cm) x volumetric weight (g/mL) x 0.1

(Mineral N (mg/kg) and Volumetric weight (g/mL) will be provided with the soil test results). If volumetric weight is not provided, use 1.1 as the default value.

Once you have determined how much N is already in the soil, determine how much your crop is likely to require, based on expected yield.

You can then calculate how much extra N you will need to apply:

The total N requirement of the crop – Mineral N (0-60cm for wheat and 0-30 cm of ryegrass) = an approximate N fertiliser rate required to optimise yield in your crop.

For further information see
FAR Cropping Strategy Issue 4: Nitrogen application in wheat and barley
FAR Cropping Strategy Issue 5: Nitrogen in perennial ryegrass seed crops

Links
DairyNZ Factsheet Sequence cropping kale and oats:
https://www.dairynz.co.nz/media/3360233/sequence_cropping_kale_and_oats.pdf

Beef+LambNZ Factsheet Winter forage crops: management during grazing

DairyNZ’s website Soil fertility for pasture
https://www.dairynz.co.nz/feeds/pasture-management/growing-pasture/soil-fertility-for-pasture/

FAR Cropping Strategy Issue 4: Nitrogen application in wheat and barley
https://www.dairynz.co.nz/feeds/pasture-management/growing-pasture/soil-fertility-for-pasture/

FAR Cropping Strategy Issue 5: Nitrogen in perennial ryegrass seed crops