GOOD GREEN MANURES

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Green manures

- *Crops grown with the intention that they will be ploughed in to benefit the following crop*
  - Green manures
  - Green cover
  - Cover crops
  - Catch crops
Why grow them?

- **Greening compliance**
  - Counts as an EFA (environmental focus area)
  - Establishment of a temporary crop in the **autumn**
  - Weighting factor of 0.3 x
  - **Incorporate** before spring crop
  - Must not be used for agricultural production, i.e. no grazing
Why grow them?

• AECS option
  – Stubbles followed by green manure in an arable rotation
  – £498.49 /ha*
  – No sprays: before or during
  – No nutrients (fertiliser, dung, etc.): during
  – Establish in **spring** (after 1\(^{st}\) March)
  – Keep until 15\(^{th}\) August or 1\(^{st}\) March

* Some AECS options have reduced in value
Agronomic benefits

- Soils?
- Weeds and pests?
- Yield?
- Biodiversity?
Soils

• Big root system benefits:
  – Soil structure
  – Organic matter
  – Soil biology

• Provides ground cover during soil erosion risk periods

Information taken from:
Cover crops: a practical guide to soil and system improvement, NIAB (2015)
Weeds and pests

• Short term weed control
  – Suppression of weeds before following crop

• Longer term weed control (i.e. sterile brome)
  – Stale seedbed approach: allow weeds to germinate, then destroy before they set seed

• Pest control
  – Brassicas may have biofumigant activity against soil-borne pests – roll straight after incorporation – effect on other beneficial soil organisms?
Yield

• Nitrogen retention – ‘catch’ crop
• Nitrogen fixation from any legumes in the mix
• Improved soil structure
• Weed reduction?
• Increase in pollinators (for oilseed rape and pulse crops)
Biodiversity

- Winter cover and habitat
- Benefits birds, mammals, and insects
- Flowering species in summer benefits pollinators
Seed mixes

• An **AECS** mix must have at least one annual flowering plant, e.g. clover, phacelia, vetch, and must be established from 1\textsuperscript{st} March

• An **EFA** compliant mix requires **two** or more of these:

<table>
<thead>
<tr>
<th>Barley</th>
<th>Oats</th>
<th>Triticale</th>
<th>Rye</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clover</td>
<td>Vetch</td>
<td>Alfalfa</td>
<td></td>
</tr>
<tr>
<td>Mustard</td>
<td>Radish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phacelia</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Seed mix components

- These components can be split into 4 broad groups
- These groups have different characteristics

<table>
<thead>
<tr>
<th>Group</th>
<th>Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>Barley, Oats, Triticale, Rye</td>
</tr>
<tr>
<td>Legume</td>
<td>Clover, Vetch, Alfalfa*, Peas</td>
</tr>
<tr>
<td>Brassica</td>
<td>Mustard, Radish, Rape</td>
</tr>
<tr>
<td>Other</td>
<td>Phacelia, Chicory, Buckwheat</td>
</tr>
</tbody>
</table>

*Unlikely to do well in wetter, more acidic Scottish soils*
Green manures

• The different characteristics of the groups give them advantages and disadvantages

<table>
<thead>
<tr>
<th>Group</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereal</td>
<td>Establishment, seed availability</td>
<td>Pest/disease ‘green bridge’</td>
</tr>
<tr>
<td>Legume</td>
<td>Fixes nitrogen</td>
<td>Establishment (back end)</td>
</tr>
<tr>
<td>Brassica</td>
<td>Establishment, roots open up the soil</td>
<td>Clubroot risk, can dominate mix when mature, establishment</td>
</tr>
<tr>
<td>Phacelia</td>
<td>Beneficial to pollinators</td>
<td>Poor frost tolerance</td>
</tr>
</tbody>
</table>
Field lab: seed mixes

Oats, vetch, & phacelia
- oats @ 100 kg/ha;
- vetch @ 20 kg/ha;
- phacelia @ 5 kg/ha

Oats and rye
- oats @ 90 kg/ha;
- rye @ 90 kg/ha

Oats and radish
- oats @ 120 kg/ha;
- radish @ 15 kg/ha

Mustard & radish*
- mix @ 20 kg/ha

*Established following discing winter barley stubbles, and then sowing. Lots of winter barley volunteers.
Oats & rye

Oats, vetch & phacelia

Oats & radish

Radish & mustard
Assessments

• Green manure
  – Yield (organic matter); protein (residual N)

• Soil
  – Visual Evaluation of Soil Structure (VESS);
    earthworm number, weight and diversity

• Cost
  – Seed, cultivations

• Following crop
  – **Yield**; weeds / volunteers; visual assessment
    (residual N)
<table>
<thead>
<tr>
<th>Structure quality</th>
<th>Size and appearance of aggregates</th>
<th>Visible porosity and Roots</th>
<th>Appearance after break-up: various soils</th>
<th>Appearance after break-up: same soil different tillage</th>
<th>Distinguishing feature</th>
<th>Appearance and description of natural or reduced fragment of ~1.5 cm diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sq1 Friable</strong></td>
<td>Mostly &lt; 6 mm after crumbling</td>
<td>Highly porous</td>
<td>Root cluster</td>
<td>Fine aggregates</td>
<td>The action of breaking the block is enough to reveal them. Large aggregates are composed of smaller ones, held by roots.</td>
<td></td>
</tr>
<tr>
<td><strong>Sq2 Intact</strong></td>
<td>A mixture of porous, rounded aggregates from 2mm - 7 cm. No clods present</td>
<td>Most aggregates are porous</td>
<td>Roots throughout the soil</td>
<td>High aggregate porosity</td>
<td>Aggregates when obtained are rounded, very fragile, crumble very easily and are highly porous.</td>
<td></td>
</tr>
<tr>
<td><strong>Sq3 Firm</strong></td>
<td>A mixture of porous aggregates from 2mm - 10 cm. Less than 30% are &lt;1 cm. Some angular, non-porous aggregates (clods) may be present</td>
<td>Macropores and cracks present</td>
<td>Porosity and roots both within aggregates.</td>
<td>Low aggregate porosity</td>
<td>Aggregate fragments are fairly easy to obtain. They have few visible pores and are rounded. Roots usually grow through the aggregates.</td>
<td></td>
</tr>
<tr>
<td><strong>Sq4 Compact</strong></td>
<td>Mostly large &gt; 10 cm and sub-angular non-porous; horizontal/plate also possible; less than 30% are &lt;7 cm</td>
<td>Few macropores and cracks</td>
<td>All roots are clustered in macropores and around aggregates.</td>
<td>Distinct macropores</td>
<td>Aggregate fragments are easy to obtain when soil is wet, in cube shapes which are very sharp-edged and show cracks internally.</td>
<td></td>
</tr>
<tr>
<td><strong>Sq5 Very compact</strong></td>
<td>Mostly large &gt; 10 cm, very few &lt; 7 cm, angular and non-porous</td>
<td>Very low porosity. Macropores may be present. May contain anaerobic zones. Few roots, if any, and restricted to cracks</td>
<td>Grey-blue colour</td>
<td></td>
<td>Aggregate fragments are easy to obtain when soil is wet, although considerable force may be needed. No pores or cracks are visible usually.</td>
<td></td>
</tr>
</tbody>
</table>
February

Vetch

Phacelia

Radish

Rye
Earthworms

Worm weight (g)

- oats & radish
- radish & mustard*
- oats, vetch, & phacelia
- oats & rye

* Radish & mustard & volunteer barley
Dry matter yield (t/ha)

* Radish & mustard & volunteer barley
Protein and ME (per ha)

**Crude protein (kg/ha)**

- radish & mustard*: 500 kg/ha
- oats & radish: 300 kg/ha
- oats, vetch, & phacelia: 800 kg/ha
- oats & rye: 10,000 kg/ha

**ME (MJ/ha)**

- radish & mustard*: 15,000 MJ/ha
- oats & radish: 25,000 MJ/ha
- oats, vetch, & phacelia: 40,000 MJ/ha
- oats & rye: 45,000 MJ/ha

* Radish & mustard & volunteer barley
So what’s best?

• In this trial...
• **Oats, vetch, and phacelia** for **soil structure**
• **Mustard and radish** (least cultivations in establishment) is best for **earthworms**
• **Oats and rye** for **bulk (organic matter)** and **nitrogen**

• We won’t really know until the following crop of spring barley is ready
What next?

• Compare the results with following crop performance

• SRUC and the James Hutton Institute are also doing green manure trials, look at their findings

• Are green manures worth sowing?
SRUC: intercrops

• Intercrops with legume component
• CAP greening
  – strict rules – not always sensible!
  – N fixing crops
  – cover crops
• Protein crops
• Multifunctional end-uses

This information is from SRUC work funded through Scottish Government, RERAD, and the Loirston Trust
VESS: N-fixing cover crops

Also measuring soil biological activity using lots of different methods – results to be analysed
Initial bee-plant networks

Lucerne

White Clover

Winter Vetch

Crimson Clover
Initial bee plant networks

Red Clover / Black Medic / Lucerne

Red Clover/White Clover/Crimson Clover