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 1st March)
  - Keep until 15th August or 1st 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 1st March

- An **EFA** compliant mix requires <u>two</u> or more of these:

Barley	**Oats**	**Triticale**	**Rye**
Clover	**Vetch**	**Alfalfa**	
Mustard	**Radish**		
Phacelia			

Seed mix components

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

Group	**Crops**			
Cereal	Barley	Oats	Triticale	Rye
Legume	Clover	Vetch	Alfalfa*	Peas
Brassica	Mustard	Radish		Rape
Other	Phacelia		Chicory	Buckwheat

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

Green manures

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

Group	**Advantages**	**Disadvantages**
Cereal	**Establishment, seed availability**	**Pest/disease 'green bridge'**
Legume	**Fixes nitrogen**	**Establishment (back end)**
Brassica	**Establishment, roots open up the soil**	**Clubroot risk, can dominate mix when mature, establishment**
Phacelia	**Beneficial to pollinators**	**Poor frost tolerance**


Radish & mustard
Oats & radish
Oats & vetch & phacelia
Oats & rye

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, vetch & phacelia


Oats & rye

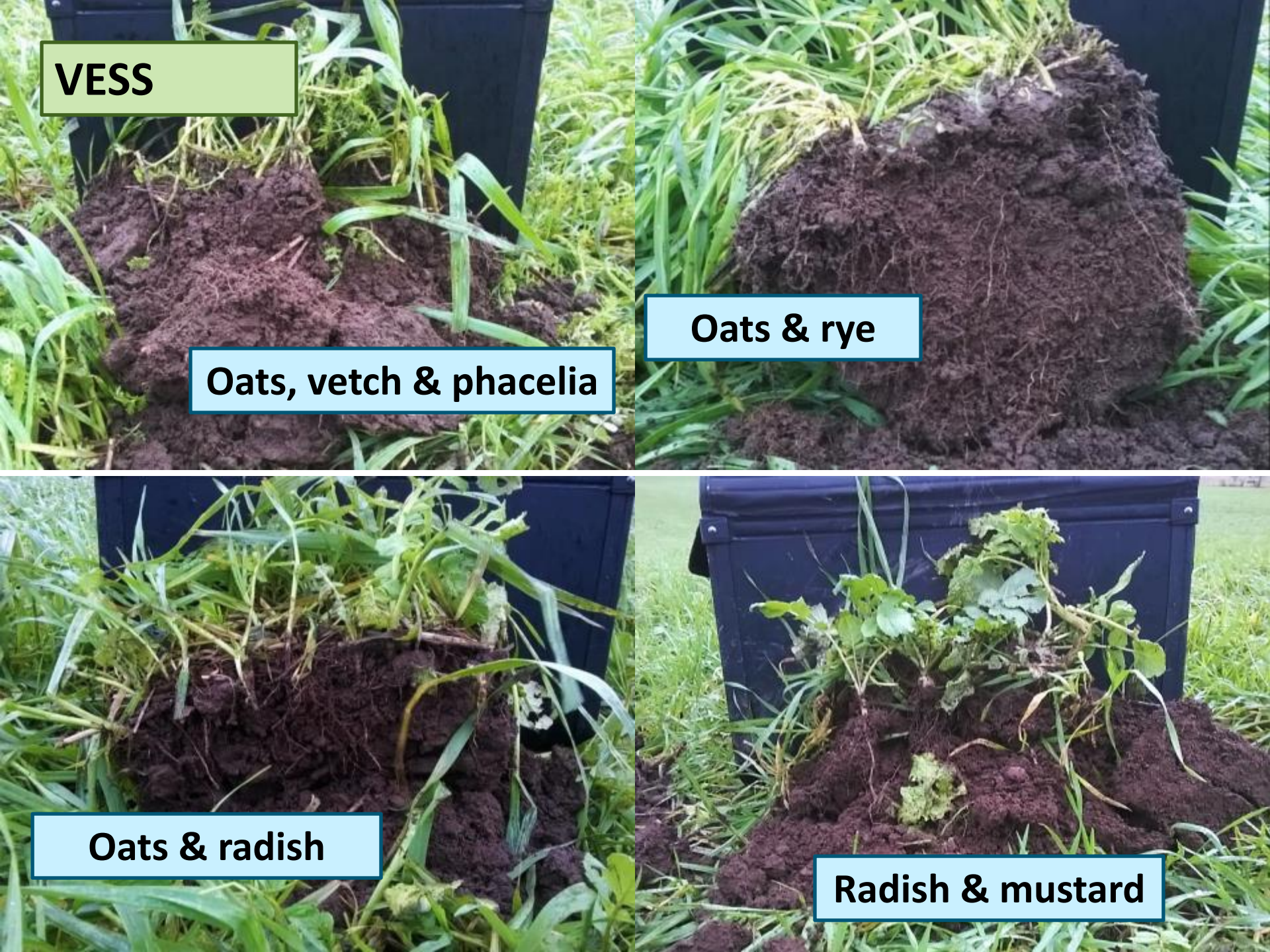

Oats & radish


Radish & mustard

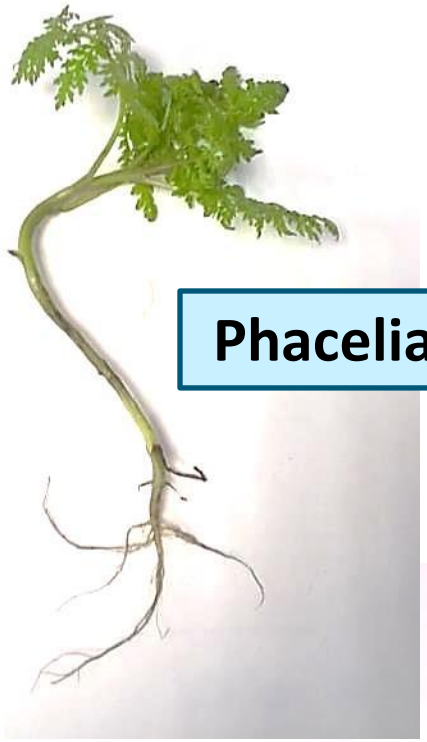
Assessments

- 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)

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


VESS
Oats, vetch & phacelia
Oats & rye
Oats & radish
Radish & mustard

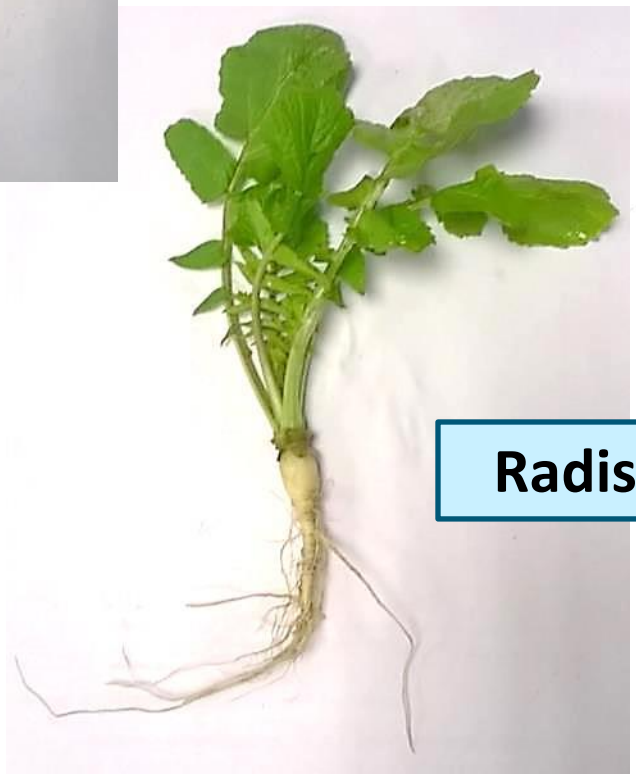
February



Phacelia

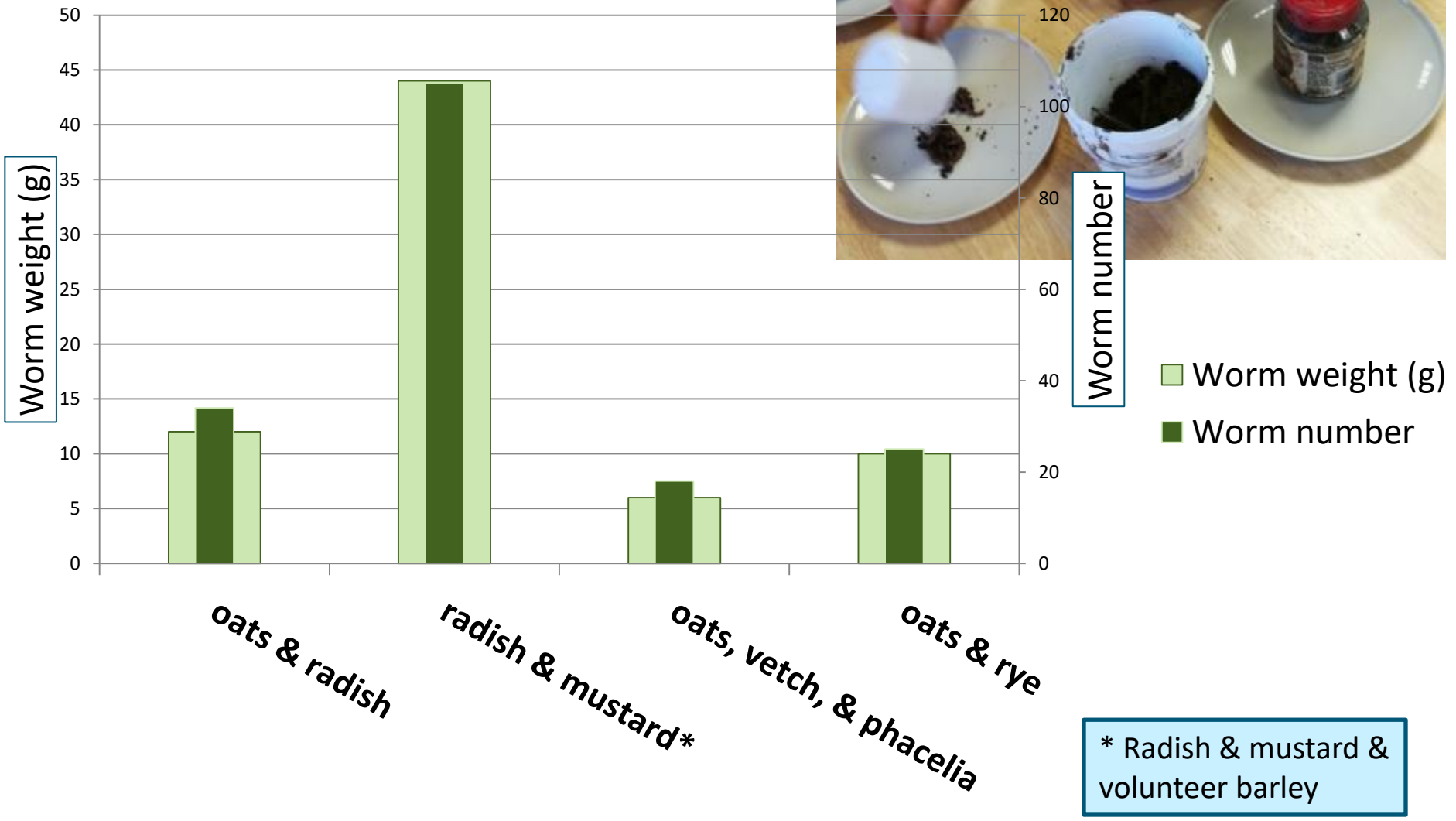
Rye

Vetch



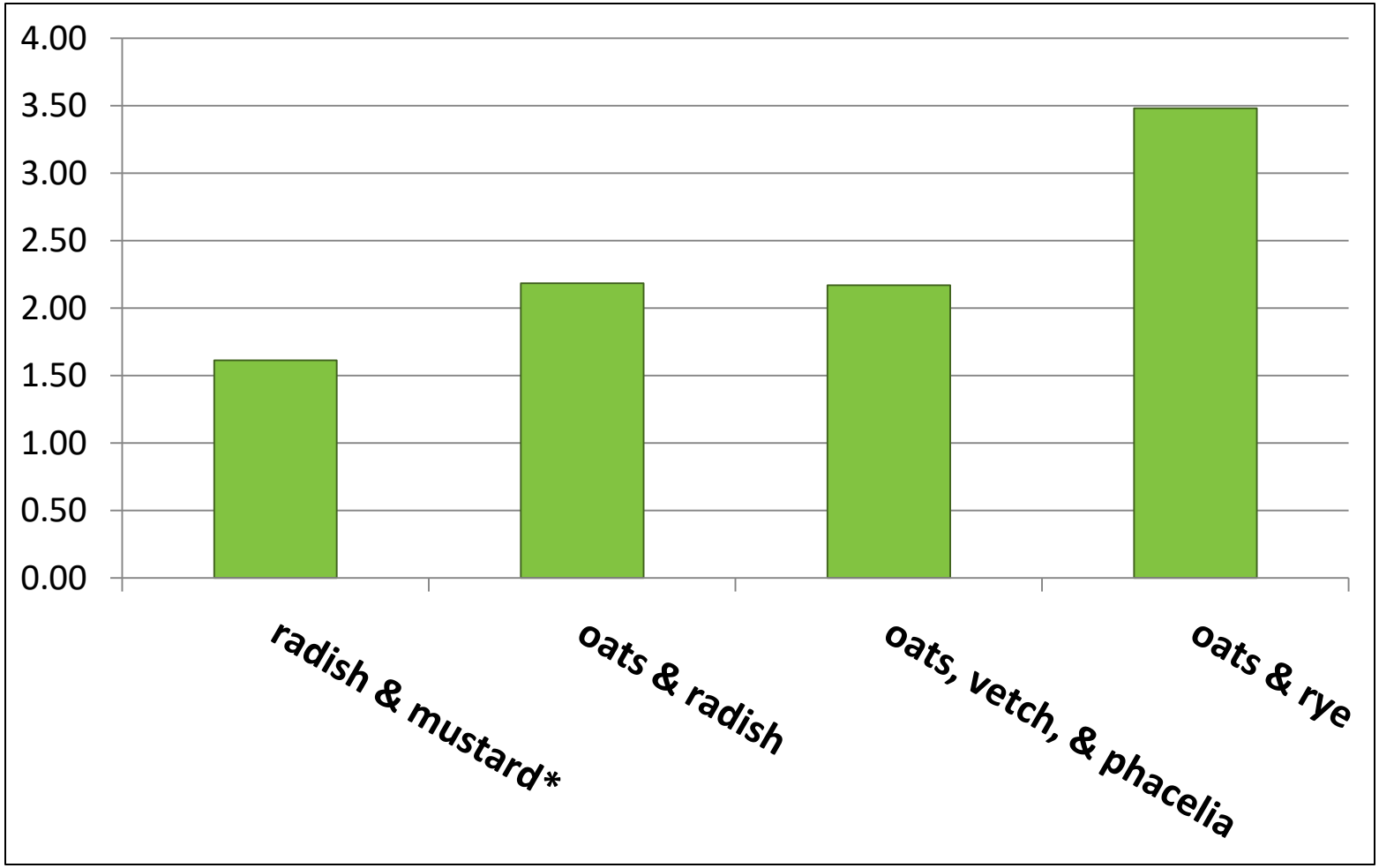
Radish

Earthworms



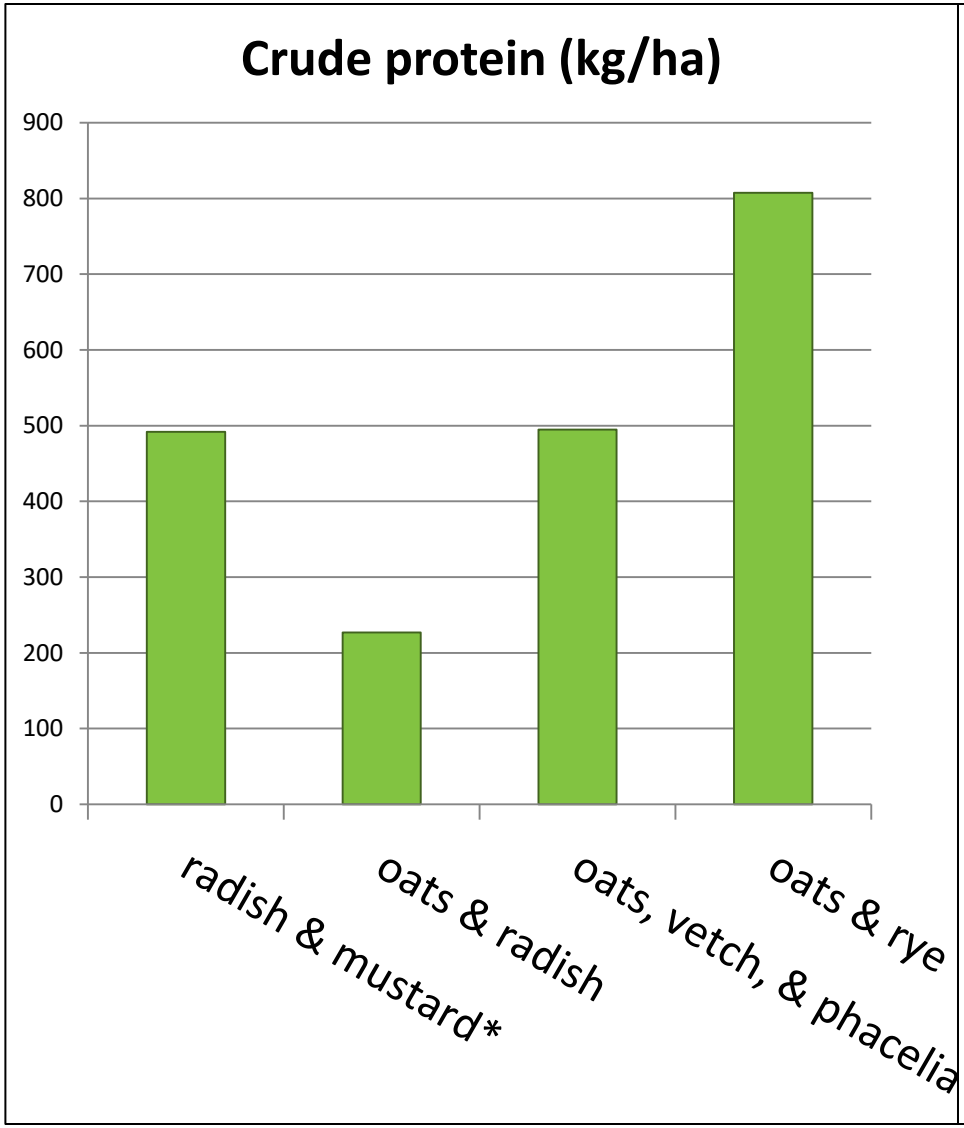
* Radish & mustard & volunteer barley

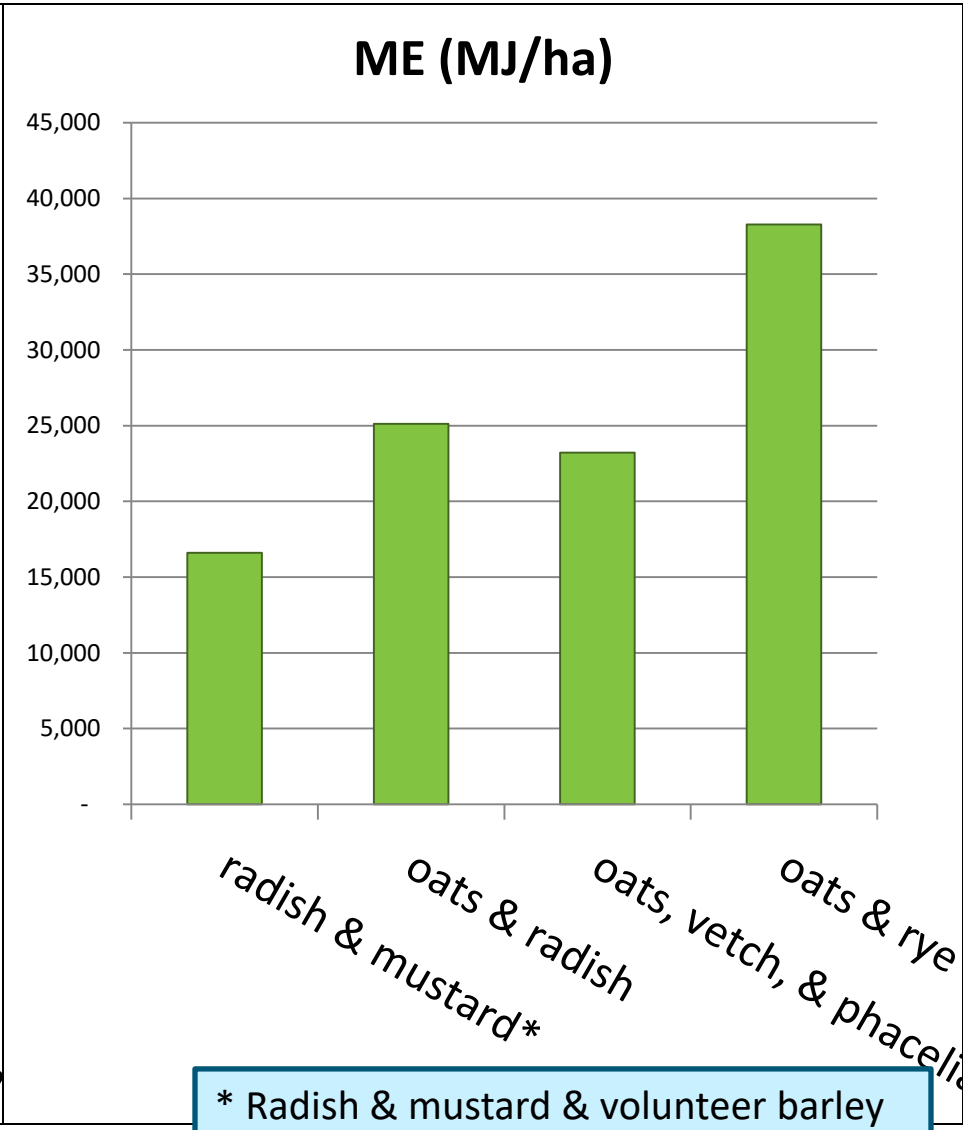
Dry matter yield (t/ha)



* Radish & mustard & volunteer barley

Protein and ME (per ha)





* Radish & mustard & volunteer barley


Oats, vetch & phacelia
Oats & rye

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

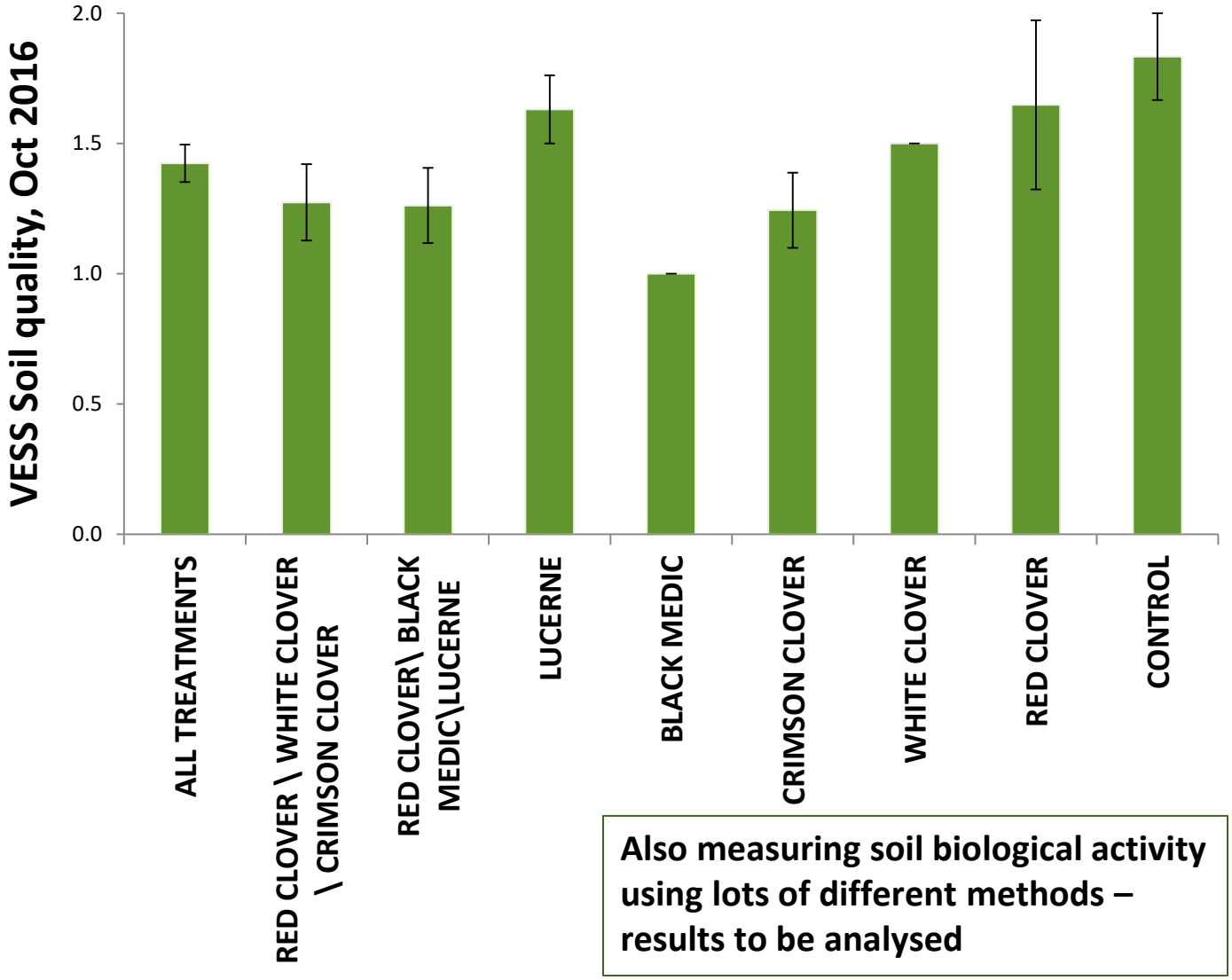
- Intercrops with legume component 
- **CAP greening**
  - strict rules – not always sensible!
  - N fixing crops
  - **cover crops**
- Protein crops 
- Multifunctional end-uses 

This information is from SRUC work funded through Scottish Government, RERAD, and the Loirston Trust

SRUC

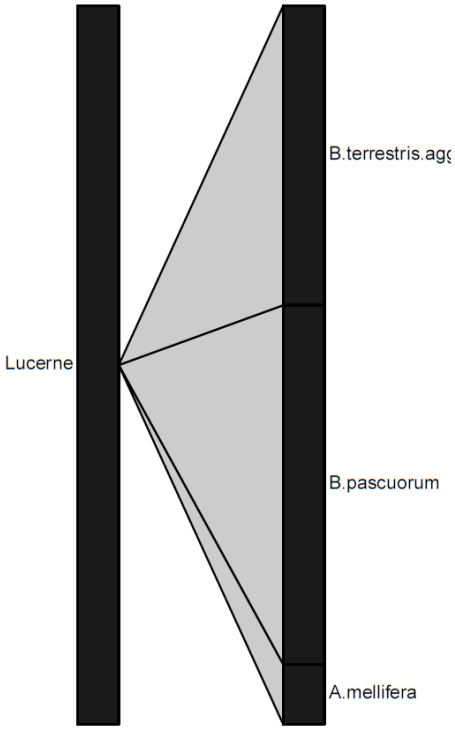
The Scottish Government

VESS: N-fixing cover crops

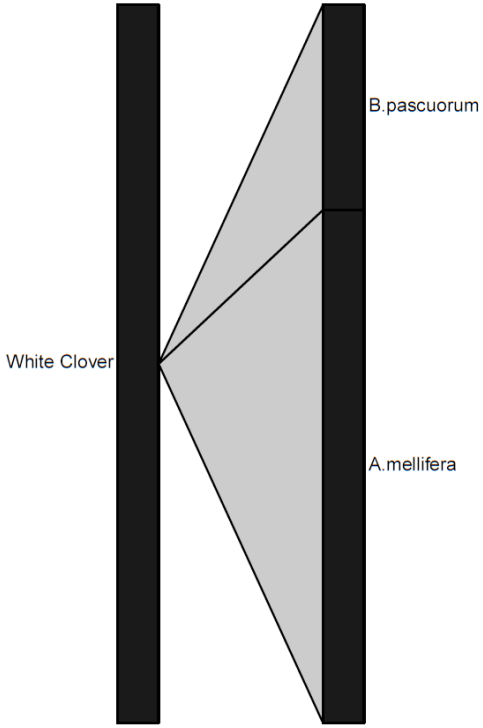


Also measuring soil biological activity using lots of different methods – results to be analysed

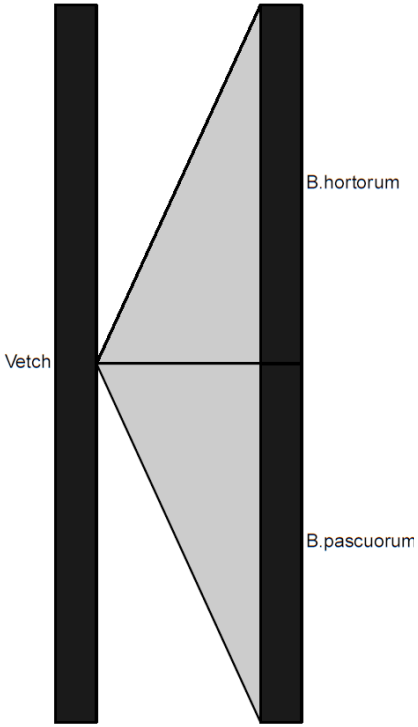
Initial bee plant networks



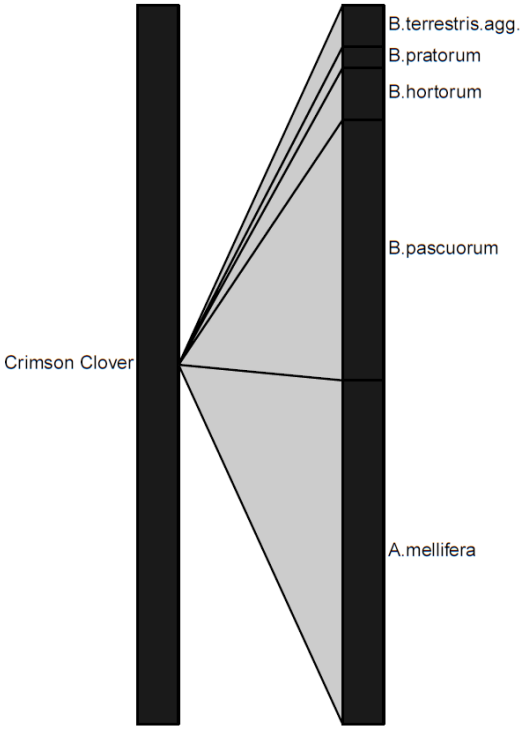
Lucerne



White Clover

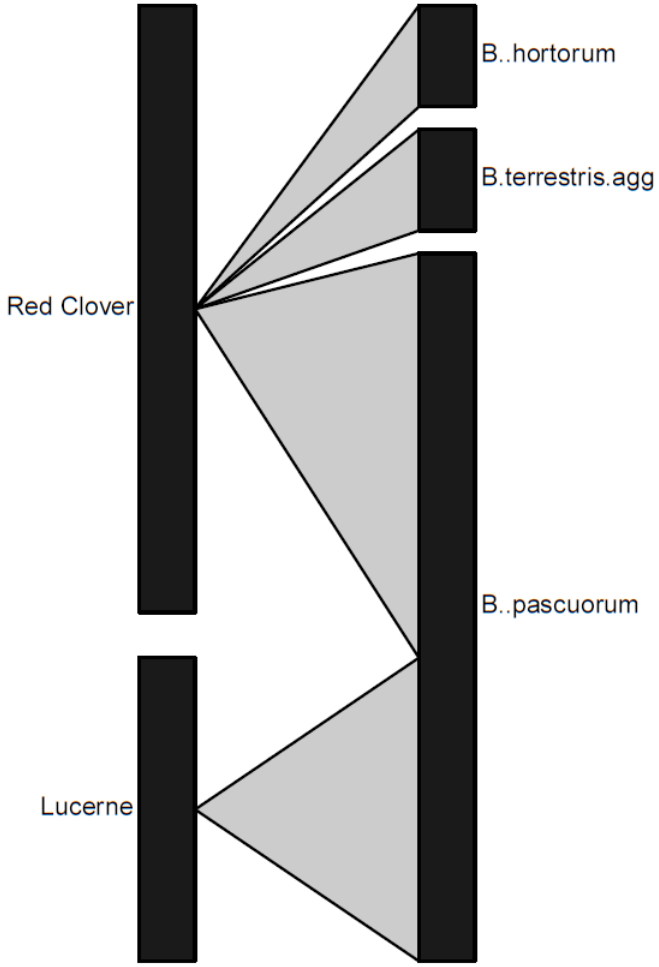


Winter Vetch

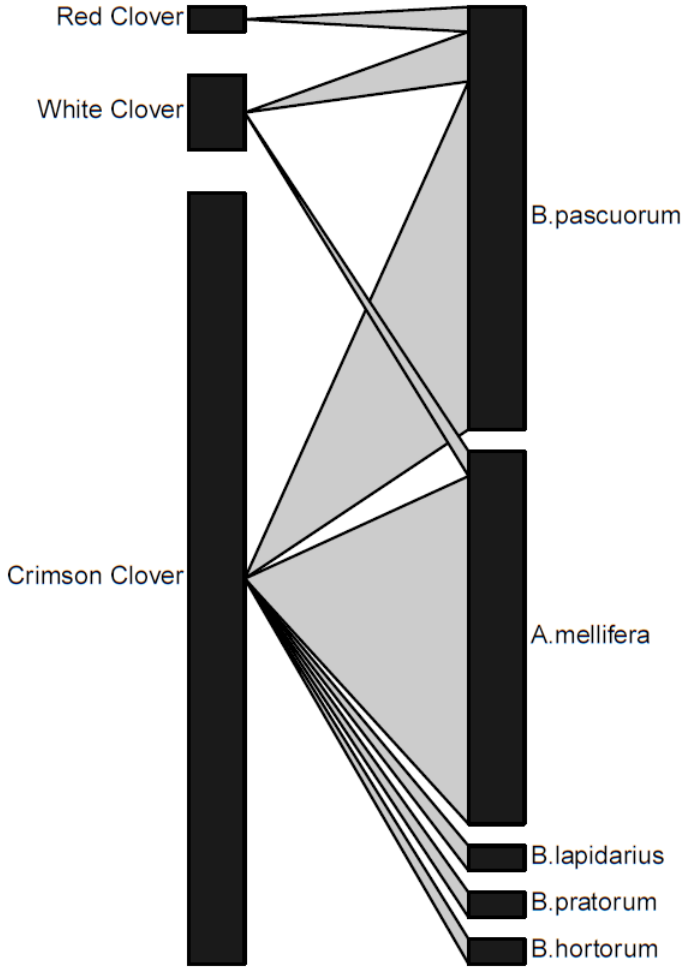


Crimson Clover

Initial bee plant networks



Red Clover / Black Medic / Lucerne



Red Clover/White Clover/Crimson Clover

The European Agricultural Fund for Rural Development: **Europe investing in rural areas**

The Scottish Government

QMS

Forestry Commission Scotland

The Princes Charities

Innovative Farmers

Part of the Duchy Future Farming Programme