Nitrogen Fixing Crops
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John Baddeley
john.baddley@sruc.ac.uk

Leading the way in Agriculture and Rural Research, Education and Consulting

Introduction

- Definitions of common terminology
- Why should we be interested in these crops?
- Examples of N fixing crops
- Some results from current SRUC trials

Definitions

- Nitrogen-fixing crops are grown primarily to benefit soil fertility by increasing N levels
- They always contain legumes, but may be forage species (*e.g.* clovers), grain legumes (*e.g.* beans), mixtures of legumes or mixtures of legumes with non-legumes (*e.g.* grass/clover)
- As well as increasing soil N, they can give useful products such as forage, silage, grain or biomass.

Ways to Grow N-Fixing Crops

Long term leys

- Established for >1 year
- Commonly grass/clover mixtures to maximise N fixation and Organic Matter build up)

Overwinter

- Sown in autumn
- Major use is to minimise N leaching but they can include legumes

Summer

- May be grown for whole season (April to Sep)
- Include legumes to provide N boost mid-rotation.

Intercropping systems

- Leys usually established by **undersowing** them in preceding cereal crop
- Gives legume longer growth period and can help weed control

N-Fixing Crops - Advantages

- Add organic matter to soil
- Increase soil N levels
- Decrease the need for bagged fertiliser (cost and pollution savings)
- Increase biological activity
- Improve soil structure
- Increase soil nutrients
- Reduce leaching losses
- Suppress weeds
- Can reduce pest and disease problems

Crimson clover, Aberdeenshire, Aug 2016

N-Fixing Crops - Disdvantages

- Cost of seed and extra cultivations
- Lost opportunities for cash cropping
- Extra work at busiest times of year
- Exacerbated pest and disease problems (“green bridge” effect)
- Potential to become weeds themselves
- Fixed N might not be available when crops need it (may become pollutant)

Vetch, Aberdeen, Jul 2012

Drivers for SRUC work on N-fixing Crops

- CAP reform – greening regulations in place but do they deliver the intended benefits?
- Scottish Government RESAS core programme 2016-2020 work package on “Novel Crops”
- Brings together many areas of interest: intercrops, mixtures, pastures, organic systems, soils, nutrition and biodiversity

N-fixing crops– why the current interest?

- Some farmers already use (e.g. organic)
- CAP Greening Regulations
  - permanent grassland
  - crop diversification (3-crop rule)
  - ecological focus areas (EFAs) such as:
    - Fallow
    - Margins
    - Agro-forestry
    - Hedges
    - Nitrogen-fixing crops*
    - Catch crop
    - Green cover

- New focus and policies on :
  - Environmental Land Management schemes

What legumes are available?

Birdsfoot Trefoil (*Lotus corniculatus*)

Birdsfoot Trefoil, Craibstone, Aug 2009

- Can out yield clovers when established
- Grown with grasses for support
- Does well on poor quality land

Unst, Jul 2018

Vetch (tares) (*Vicia sativa*)

Vetch, Aberdeenshire, Sep 2016

- High yielding
- Fast establishment
- Suppresses weeds
- Winter hardy
- Can be sown late
- Best mixed with cereals
- Can be lightly grazed but silage best

White clover (*Trifolium repens*)

- Low growing, smothers weeds
- Tolerant of sheep grazing
- Reasonable N fixation

Red clover (*Trifolium pratense*)

- High N-fixation
- High biomass and good recovery from topping
- Good silage option
- Not the best choice for grazing

Other clovers are available…

Crimson clover, Aberdeenshire, Sep 2016

Lucerne (alfalfa) (*Medicago sativa*)


Lucerne, Aberdeenshire, Sep 2016

- Very high yielding over several seasons
- Very deep roots
- High D-value, high protein feed
- Need to inoculate
- c. 13M ha worldwide

Black Medic (*Medicago lupulina*)

- Creeping growth form
- Slowly builds to high biomass
- Shade tolerant – good for intercropping
- Not the best for grazing

Sanfoin (*Onobrychis vicifolia*)

- Probably the highest quality forage legume
- But not good on cool, wet, acidic soils

Sainfoin, Craibstone, Aug 2009

Mixtures of N-fixing Crops for forage

Red clover, birdsfoot trefoil, white clover - Aberdeenshire

Mixtures effects

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- Different root and shoot architectures help complementarity
- Non-legume increases N fixed by legume
- Inbuilt redundancy gives yield stability and resilience to bad weather
- Yields often 20-40% higher than monocrops
- May be better suited for some purposes (e.g. high-protein silage)
- Potential to provide greater biodiversity benefits (e.g. longer flowering period)

Cover crop / N-fixing crop research at SRUC

Three strands of work

- N-fixing crops
- Spring-sown cover crops
- Overwinter cover crops

Closely aligned with CAP greening regs, but some variances

Most treatments shown were trialled at both SRUC sites at Saphock (Aberdeenshire) and Boghall (Midlothian)

All treatments have 3 reps

Most work has been on agronomy, pollinators and soils

Core work sits in the Scottish Government Strategic Research Programme (RESAS 2.1.8, with links to 2.1.1 (NUE), 2.3.8 by examining effects in a following cereal crop and pollinators, and 2.3.4 (soils))

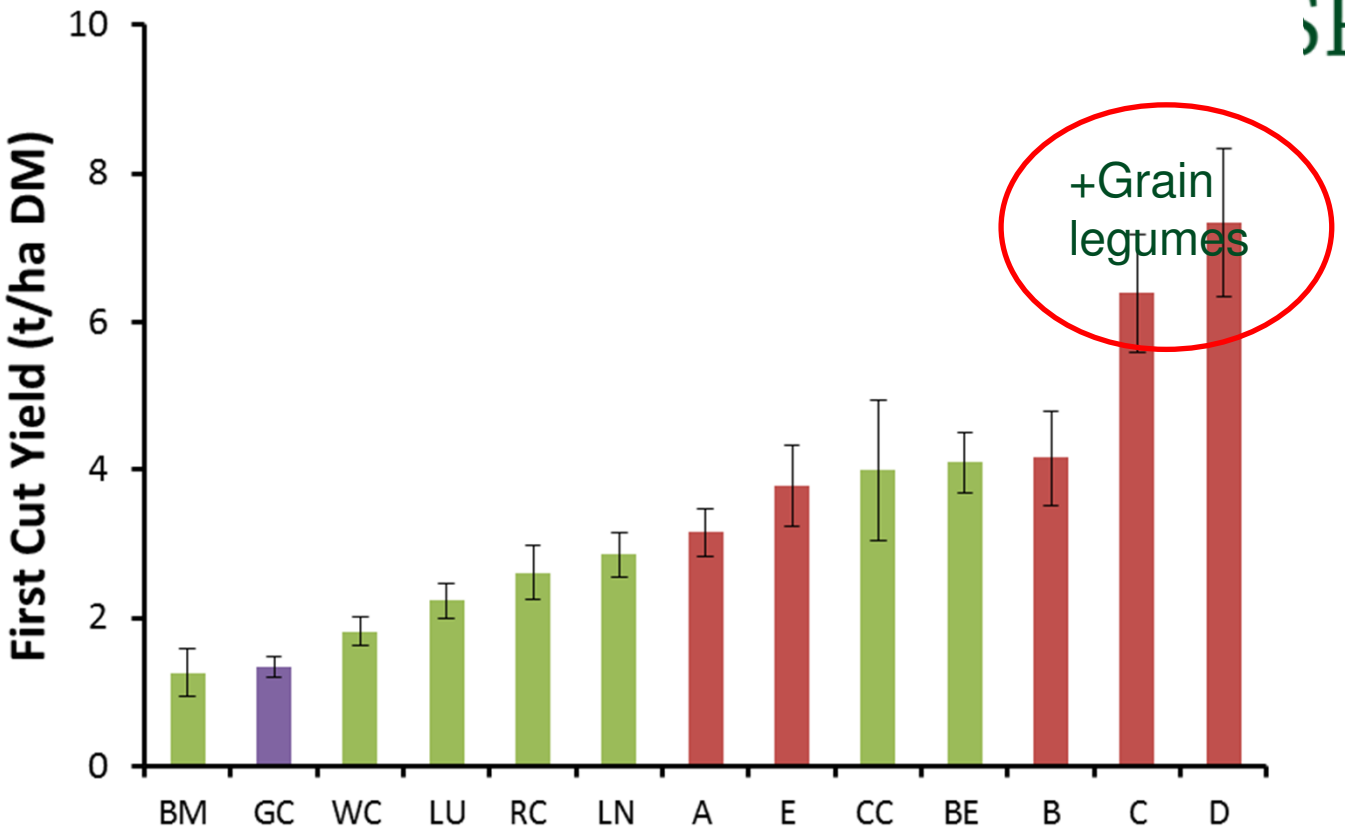
N-fixing Crops

Trials tested the following:-

- Straights of all on list (except lentil & chickpea –unlikely to succeed – and birds foot trefoil – no seed available)
- Five, 3-way mixtures of above
- Mixtures contrast genetic and functional diversity
- Followed on in next season with spring barley overlaid on same sites

Forage	**Grain**	**Mixtures**
Lucerne LU	Beans BE	RC / BM / LU
Red clover RC	Lupin LN	RC / WC / CC
White clover WC	Peas PE	WC / WV / PE
Crimson clover CC	Vetch WV	WC / WV / BE
Black Medic BM		WC / BM / WV

Yield of first cut Year 1 of N fixers and mixes tested

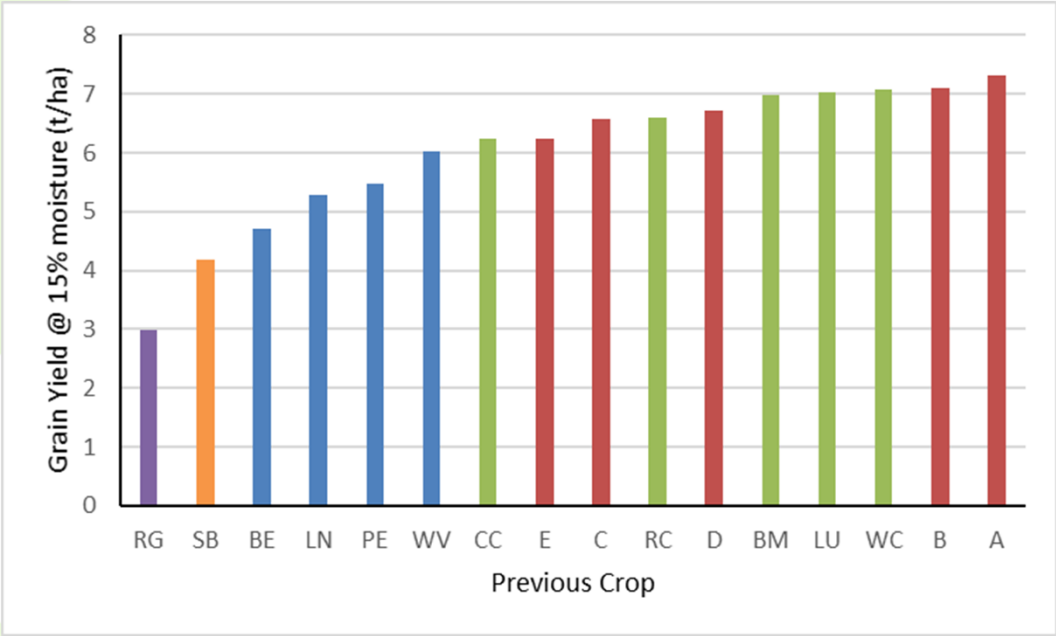


Green – single legume species

Red – 3-component mixtures

Purple – ryegrass/clover

Benefits to a following Spring Barley crop with Zero N fertiliser



Purple – ryegrass

Blue – grain legume species

Green – forage legume species

Orange – Spring Barley

Red – 3 legumes mixtures

- The barley following ryegrass or barley had the lowest yields
- Some mixtures and legume straights gave the greatest yields in the following crop
- Straights of grain legumes gave lower yields in the following crop than legume straights or mixtures, but remember that they gave a grain harvest in the first year.

Summary

- N-fixing crops can take many forms
- Increasing soil fertility is the main aim
- Mixtures offer many benefits
- Taken together, N-fixing crops offer many opportunities to improve farming systems

Thank You

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