Grass & herbal leys farm network
Agenda - morning

• Value of grass/herbal leys in improving soil quality
  • Anne Bhogal, ADAS

• Using leys to manage weeds in arable rotations
  • Lynn Tatnell, ADAS

• Integrating herbal leys into arable rotations
  • Tom Chapman, Easthall Farm & St Paul’s Walden Bury Estate

#LeysNetwork
Agenda - afternoon

- Introduction to the network and long term aim & vision
  - Lizzie Sagoo, ADAS

- **Break out session**: Network priorities

- **Panel discussion**: Practical issues of managing leys within the rotation

- Summary & next steps

#LeysNetwork
Value of grass/herbal leys in improving soil quality

Anne Bhogal
ADAS Gleadthorpe

Grass/herbal leys network meeting; 19th April 2018
Overview

• Defining soil health
• Importance of soil organic matter
• Managing soils to keep them healthy
  ➢ Grass leys
• Integrating livestock into arable rotations
Soil Health

“The ability of a soil to act as a living system to sustain, in the long term, its most important functions ...”

www.soilsecurity.org; How do we measure and define soil health (March 2016)

Soil Quality: ‘Fitness for use’ (Agricultural production)

Soil Sustainability: Continued ability of soils to function; resistance & resilience to change
Components of soil health

Physics ↔ Chemistry ↔ Biology
Key aspects of soil health

**Soil**

- Chemical, physical & biological properties:
  - *Inherent* e.g. texture, depth, stoniness – ‘boundaries of the soil habitat’
  - *Dynamic* e.g. SOM, nutrients, biology – *nature & composition of the habitat*

**Crop**

- Residues
- Rooting & rhizosphere
- Plant/soil interactions:
  - Mycorrhiza
  - Rhizobia
- Seedbank
Soil organic matter (SOM)

- The majority of soil functions are driven by biological processes, underpinned by SOM decomposition
- The ‘major currency’ in soil systems

SOM measurements – an overall indicator of soil health
Benefits of OM

• Improved soil structure and workability
• Increased water holding capacity and infiltration
• Increased biological activity
• Improved retention and turnover of nutrients
• Greater resilience to dry weather conditions
‘Typical’ SOM levels

Source: Verheijen et al., 2005
SOM accumulation rates change over time

- Annual rate of increase declines as a new equilibrium is reached
- SOM will not accumulate indefinitely
Measuring the impacts of management on SOM....

- A needle in a haystack?

Landuse change: -1.7 - +1.4 t/ha/yr

Apply organic materials: 0.5 - 2.5 t/ha/yr

Change cultivation practices: -1.7 - +0.7 t/ha/yr

Grow higher yielding crops: 0.17 - 0.34 t/ha/yr

SOM @ 120 t/ha

Data from Dawson & Smith, 2006
What can we do to maintain and increase SOM?

- **LIVESTOCK**
  - OM (roots/residues/manures)
  - INCREASE INPUTS

- **SOIL ORGANIC MATTER**
  - CO₂
  - CH₄
  - Rainfall
  - REDUCE LOSSES
  - Dissolved OM; Sediment

- **VEGETATION**
Managing soils to maintain soil health

We will seek out ways to work with farmers to achieve good soil management practices, including appropriate tillage choices, reintroducing grass leys into arable rotations and the use of cover crops.
Introducing grass & livestock into the rotation

- Leys – taking land out of cultivation
- Grazing animal – manure inputs
Introducing grass into the rotation:
Increase in SOC following arable reversion to ungrazed grassland

24% increase in SOC after 6 years of arable reversion to grassland (heavy clay soil)
Change in SOC under grass/arable and ley arable rotations

(Courtesy of D. Powlson, RR)
Changes in soil organic matter over 70 years in continuous arable and ley–arable rotations at Woburn

Johnston et al., 2017 EJSS Volume: 68, Issue: 3, Pages: 305-316, DOI: (10.1111/ejss.12415)
Decline in organic matter following ploughing grassland

- **SITE A** (33% clay; pasture until 1964)
- **SITE B** (18% clay; pasture until 1963)
Benefits of grass leys to soil quality

Length of ley: 5 yrs | 3 yrs | 2 yrs | 1 yr

Topsoil organic carbon (%):

- 6 yr rotation in Sweden

SOC

Bulk density

Earthworms

Jarvis et al. (2017)
https://doi.org/10.1016/j.agee.2017.06.042
Network Survey:
Q. Is soil quality an important factor?

“Water holding capacity is greatly increased & erosion reduced”

“I haven’t needed slitters or subsoilers since growing leys”

“I’ve seen a huge improvement in our soils over 3 years”

Online survey March 2018
Grassland management

How to maximise the benefits?
• Organic material additions
• Cutting vs. grazing
• Grazing intensity
  • Stocking rates
  • Grazing interval
• Sward composition:
  • Legumes
  • Herbal leys (biodiverse swards)
  • Deep rooting species
Organic manures - a good source of organic matter

<table>
<thead>
<tr>
<th>Organic material</th>
<th>Dry Matter</th>
<th>Application rate (t/ha) NVZ 250kg N/ha</th>
<th>Organic matter applied (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle FYM</td>
<td>25%</td>
<td>42</td>
<td>5.5</td>
</tr>
<tr>
<td>Broiler litter</td>
<td>60%</td>
<td>8</td>
<td>2.5</td>
</tr>
<tr>
<td>Green Compost</td>
<td>60%</td>
<td>33</td>
<td>4.5</td>
</tr>
<tr>
<td>Green/Food Compost</td>
<td>60%</td>
<td>22</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Sward composition

- Legumes: N supply
- Herb-rich/biodiverse swards: rooting

Managed as a hay meadow – can’t extrapolate to more intensively managed grasslands

Soil carbon changes between 2002 and 2011 as affected by (log) plant species richness and the presence (orange triangles) and absence of legumes (blue circles);

Integrating beef production into arable systems

- AHDB Beef & Lamb project (2016-2022)
Norwood Farm, Somerset

- Grass/herbal leys est autumn 2017
  - Grass & clover mix
  - Grass, clover & herbal mix
  - Arable comparison

- Measurements
  - Forage quality & DLWG
  - Economics
  - Effect of grass/herbal ley on
    - Soil quality
    - Blackgrass
    - Yields of the following arable crop
Soil Biology and Soil Health Partnership Research and Knowledge Exchange

• Five years research & knowledge exchange on soil biology and soil health

• Improve on-farm understanding of soil health

• Developing and validate indicators of soil biology and soil health
Network survey results – soil testing

Q. Do you take samples for soil analysis?

- 93% Yes (nutrients & pH)
- 60% included organic matter
Summary

• Organic matter is key for soil health

• Grass & herbal leys
  • Effective at increasing SOM
  • Increase soil N supply
  • Soil quality benefits

• What are the best ways to manage leys to maximise the benefits?
  • Establishment & destruction techniques
  • Species mix
  • Cutting vs. grazing....
THANKYOU
Using leys to manage weeds in an arable rotation

Lynn Tatnell, ADAS Boxworth
Outline

• Why do we need to manage weeds?
  • Herbicide resistance
  • Loss of actives
  • Yield loss

• Breaking the weed seed cycle
  • Seed return
  • Seed bank

• Species as future weeds!

• Monitor and manage

• Long term thinking
UK resistant species: year 1\textsuperscript{st} detected

Glyphosate resistance is a real threat!
Counties with herbicide-resistant Black-grass (by 2016)

First found 1982

20,000 farms in 37 counties
(Angus and Shropshire added)
Counties with herbicide-resistant Italian rye-grass (by 2016)

First found 1990

Now >475 farms in 34 counties (Cheshire added)
Counties with herbicide-resistant Wild-oats (by 2016)

First found 1993

Now >250 farms in 28 counties
Reality of resistant black-grass: Familiar sight?
Essex

Photo source: Syngenta UK Ltd

ADAS
Cambridgeshire
46% of black-grass samples exhibited resistance to all 3 mechanisms.

Enhanced metabolism: 66%
ACCase target site: 84%
ALS resistance: 75%

46% of samples exhibited resistance to all 3 mechanisms.

2% samples were all S or R?
Rotation essential for sustainable weed management
Weed seed cycle

Young plants → Competition → Flowering plants → Non seed set → Seeds

Seeds → Predation, decay → Seed bank & germination → Dormancy, competition → Young plants
Black-grass and yield loss

100 BG heads/m² = 13% yield loss

500 BG heads/m² = 63% Yield loss
And then there’s seed return!

<table>
<thead>
<tr>
<th>1 plant</th>
<th>10 ears</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeds/ear</td>
<td>80-150</td>
</tr>
<tr>
<td>Seeds/ Plant</td>
<td>200-2000</td>
</tr>
</tbody>
</table>
Black-grass seed return per head

![Graph showing the relationship between Black-grass heads/m² and Seed return/m². The graph includes a linear trend line and data points.](image-url)
Seed return for black-grass

100 heads/m² = 7,000 seeds/m²

500 heads/m² = 54,000 seeds/m²
How fast can it increase?

1 plant ➔ 10 heads ➔ 1000 seeds
Seed return from 10 plants/m²

- 100 heads per m² before harvest
- 100 million seed return per ha
- 1 billion seed return in 10 ha field

1 shot of seed
0.8 of ton bag
8 ton bags
Seed return from 50 plants/m²

- Heads per m² before harvest: 500
- Seed return per ha: 500 million
- Seed return in 10 ha field: 5 billion

1.2 pints/m² → 4 ton bags/ha → 40 ton bags/10ha
Managing the seedbank
-the heart of all good weed control!

• Soil contains many weed seeds – the ‘seedbank’

• Weeds generally emerge only from the top 5cm of soil

• Cultivations stir the seedbank, bury fresh seed and bring old seed up

• Some buried seed becomes dormant, some dies

• Prevent weeds from setting and shedding seed
## Seed longevity

<table>
<thead>
<tr>
<th>Longevity</th>
<th>Grasses</th>
<th>Broad-leaved weeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under 1 year</td>
<td>Soft brome, rye brome, barren brome, volunteer cereals, oats</td>
<td>Volunteer sunflower, linseed</td>
</tr>
<tr>
<td>1-5 years</td>
<td>Perennial rye-grass, black-grass and winter wild-oat</td>
<td>Chickweed, crane’s bill, creeping thistle, mayweed</td>
</tr>
<tr>
<td>Over 5 years</td>
<td>Wild-oat, Italian rye-grass and many others</td>
<td>Black-bindweed, charlock, common poppy, speedwells, volunteer rape</td>
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</tbody>
</table>
Weed germination periods differ

<table>
<thead>
<tr>
<th></th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
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<tbody>
<tr>
<td>Black-grass</td>
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<td>Spring wild-oat</td>
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<td>Cleavers</td>
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<tr>
<td>Barren brome</td>
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<tr>
<td>Annual meadow grass</td>
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</tr>
<tr>
<td>Crane’s bill</td>
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<tr>
<td>Chickweed</td>
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<tr>
<td>Volunteer cereals</td>
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</tbody>
</table>

5-20%  over 20%
Network survey results for weeds

Q: Does your use of grass/herbal ley help you control black-grass?

- Yes, but low black-grass: 32.5% (13 responses)
- Yes: 47.5% (19 responses)
- No black-grass: 20% (8 responses)

Total responses: 40
Network survey results for weeds

Q: Do you see an increase in any other weed species in crops following a ley?

- No problems: 70%
- Yes: 15%
- Too early: 15%

40 responses
Species reported in survey to have increased as a weed problem

• Broad-leaved weeds generally
• Polygonums
• Fat hen
• Dandelions
• Thistle (*sow thistle? Creeping?*)

• Not the ley species but need careful consideration
• Grazing compaction can lead to weed germination or colonisation
Preventing future weeds!

• Carefully consider ley species mix
• Ensure seed rate high enough to compete with weeds
• Consider your own soil type
• Consider your rotational crop choices
• Think about weed seedbank – prevent seed return
• Manage individual species if problematic
• Monitor success/failure of control
• **Longer term thinking** for weed control- essential
Long term benefits of a rotational ley

- Integrated Weed Management – IWM
  - Widens the choices – herbicides, cultural control
  - Reduces weed seed bank
- Resistance management improved
- Retain current herbicides
- Improves crop yields
- Improves soil health
Questions?

#LeysNetwork
Integrating Herbal Leys into Arable Rotations

Tom Chapman
Farmer, Estate Manager & Consultant
St Paul’s Walden Estate

- 2,000 acres
- 150 sucklers plus followers
- 900 acres arable contract-farmed
- 500 acres woodland
- Let houses
- Commercial & office lets
- Boreholes for drinking water
- Photovoltaic
- Shoot
- Sawmill & wood drying kiln
Nuffield Scholarship – Part 1
N American mob graziers
Nuffield Scholarship – Part 2
S American mixed farmers
Difference between a Grass & a Herbal Ley

- Grass Ley: Usually Ryegrass & Clover
- Herbal Ley: Many different broadleaf and grass varieties
Why We Farm

\[ 6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \]
Photosynthesis Equation

\[ \text{Carbon Dioxide} + \text{Water} \rightarrow \text{Glucose} + \text{Oxygen} \] (Sunlight Energy)

Sun’s energy is captured and locked into the glucose molecule
Releasing the Sun’s Energy
Capturing the sun
Capturing the sun
Soil OM is captured sunlight
Why herbal leys rather than grass leys?

**Above Ground:**
- Improved capture of sunlight
- More diverse & balanced diet for livestock
  - Anthelmintic & other properties
- Wider growing window & more balanced growth curve
  - At either end of the season
  - During the heat of summer
- Species self-select for different soil types
- Naturally controls many arable weeds eg blackgrass
Why herbal leys rather than grass leys?

**Below Ground:**

- Different rooting depths
  - Reduces competition for water – larger volume of soil
  - Pulls nutrients to the surface from a greater depth of soil
- More organic matter at varying depths means soil improves more quickly = FERTILITY!
Plants for Soil Fertility
Incorporating leys into an arable rotation

• Where to locate the ley?
  – Infrastructure: Fencing, water, access, handling pens etc
  – Weed control: eg blackgrass infestation etc
  – Term of ley: what is length of arable rotation? How will it fit in? What crop should follow the ley?
Choice of plant species

• Cool season & warm season grasses & broadleaves
• What is suited to your local climate & soil types?
• How are you planning to use the ley?
• Use seedsman for advice
## Plant Groups

<table>
<thead>
<tr>
<th>Cool Season Grasses</th>
<th>Cool Season Broadleaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Lentil</td>
</tr>
<tr>
<td>Rye</td>
<td>Pea</td>
</tr>
<tr>
<td>Wheat</td>
<td>Forage Radish</td>
</tr>
<tr>
<td>Triticale</td>
<td>Sweet clover</td>
</tr>
<tr>
<td>Cocksfoot</td>
<td>Chicory</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warm Season Grasses</th>
<th>Warm Season Broadleaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>Buckwheat</td>
</tr>
<tr>
<td>Sorgum</td>
<td>Hairy Vetch</td>
</tr>
<tr>
<td>Sudangrass</td>
<td>Sunflower</td>
</tr>
<tr>
<td></td>
<td>Cowpea</td>
</tr>
</tbody>
</table>
Establishment

• Straight after harvest (as per OSR) works best in my experience
  – Soil still warm
  – Usually some moisture
  – Plants establish before winter and allows earlier grazing in spring

• Plough, or Direct Drill, or Broadcast?
  – Retention of soil structure is key
  – Aim for maximum soil coverage
  – Drill larger & broadcast smaller?

• Rolling is essential, especially if ploughing, to reconsolidate
Wet weather – new leys
Establishment (continued)

- Canvassed the opinions of other farmers:
  - d/d westerwolds or festoliums for 1 year ley
  - Biodrill mounted to rolls
  - d/d straight into stubbles
  - Broadcast into standing crop
  -Undersow spring oats using Einbock, then roll
Utilising the ley

- Grazing
- Silage
- Hay
Utilising the ley

• Grazing
  – Requires suitable infrastructure: Fences, water, handling facilities
Fencing ideas – arable land
Water Options

• Permanent mains-fed supply

• Water bowser

• Temporary overground pipes

• Water pump and temporary trough
Water
Utilising the Ley

• Silage
  – Do you have a use for it?
  – Alternatively, do you have a ready market locally (costly to transport)
Utilising the Ley

• Hay / haylage
  – Specialist area, especially if trying to enter the horse market
  – Difficulties in making hay if using multi-species herbal leys
  – Storage required (hay) and possible issues with rodents (haylage)
How To Become A Mixed Farm

What you need:

Access to Land

Livestock Farmer

Capital investment
How To Become A Mixed Farm

Livestock Farmer

- Neighbouring Farmer
- Farmer’s Son
- New Entrant / College Leaver
- Grazing management company
How To Become A Mixed Farm

- Change in Rotations
  - More cover crops / More spring cropping
  - 4/5 year grass / forage leys

- Land tenure
  - Grazing licence / share farming / FBT / Other
How To Become A Mixed Farm

- Landowner
- Existing Livestock Farmers
- Private Individual
- ‘Green’ Investment Funds
Destroying the crop

• Chemical
  – eg spray off with dessicant

• Mechanical
  – eg plough & power harrow

• Alternatives?
  – Heavy grazing / stubble turnips followed by shallow cultivation in spring
Establish the following crop

- Concern over frit fly and leatherjacket damage esp after grass ley
Establish the following crop

- Should a grass ley be followed by a legume crop to ‘clean’ the ground?
- Conversely, a herbal ley may have more broadleaf volunteers in the following crop so would a cereal be a better option?
- Work required on savings: fertiliser; herbicides etc for crops following herbal ley
Soil Crop Health Timeline

![Soil Crop Health Timeline Diagram](image-url)
The Golden Rules

1. Always keep soil covered
2. Try to keep a growing crop in the ground at all times
3. Grow a mixture of plant types through the year
4. Do not cultivate or disturb the soil
5. Include grazing livestock in your rotations
Heifers Grazing Cocktail-Mix Ley
Heifers Grazing Cocktail-Mix Ley

Lucerne
Chicory
Red & white clovers
Birdsfoot trefoil

Cocksfoot
Timothy
Sweet clover
Sainfoin

Plus: Peas, forage rape, stubble turnips, maize, sunflowers, wheat and forage rye
The Future (by Tom Chapman!)

Capturing Sunlight

Healthy Soils

Grazing Livestock
Grass & herbal leys farm network
Long term aim & vision

• Network of farmers, researchers & industry partners

• Platform to investigate long term (>5-10 yrs) impacts of leys in rotations
  • Impact on soil quality
  • Benefits to following crops in rotation
  • Effectiveness at controlling blackgrass
  • Other...

• Link to other organisations and on-going projects
Grass & herbal leys network

- **Farmer**: 51%
- **On-farm adviser or agronomist**: 16%
- **Research**: 9%
- **Other**: 24%

128 registered with the network (14th April)
Web-based survey - aim

• To register people with the network
• Collect information on use of/interest in leys
• Farmers with leys -
  • Management of leys
  • Willing to take part in research?
• www.smartsurvey.co.uk/s/grassandherballeysnetwork/
Web-based survey - responses

• Currently 94 responses
• Including 52 from farmers
  • 42 farmers with leys in rotation
  • 10 farmers without leys
• 90% of farms with leys willing to take part in monitoring
  • Includes farms across the country on range of soil types & with a range of management regimes
Location & soil types

- Deep clayey: 32%
- Medium: 34%
- Shallow: 13%
- Light sand: 10%
- Organic: 4%
- Peat: 2%
- Deep silty: 5%
Seed mixes

- Herbal mix: 35%
- Grass: 9%
- Grass & clover: 34%
- Lucerne: 5%
- Red clover: 17%
Management of grass/herbal leys

Use of grass/herbal ley

- Grazing beef cattle: 29%
- Cutting (hay/silage): 32%
- Grazing dairy cattle: 6%
- Grazing sheep: 28%
- Other: 5%

Length of ley

- 4-5 years: 51%
- 3 years: 18%
- 1-2 years: 19%
- >5 years: 12%
Management of grass/herbal leys

Method of ley establishment

- Spring sown: 41%
- Autumn sown: 37%
- Undersown: 22%

Cultivations prior to following crop

- Plough based cultivation: 40%
- Minimum tillage: 27%
- Strip tillage: 2%
- No tillage (following crop direct drilled): 31%
Network priorities – break out session

• *Identify and prioritise areas for research*

• What are the knowledge gaps and barriers to -
  • Increasing the adoption of grass/herbal leys within rotations
  • Improving the utilisation & efficiency of leys

• How do you want to engage with the network?

• 45 minutes
Summary & next steps
What next?

• Continue to expand the network
• Collate feedback from today and from survey
• Future network strategy report
• Email update to network July 2018
Thank you