Breeding of forage varieties for improved agronomic performance and reduced environmental impact

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Breeding programmes

• Perennial, Italian and hybrid ryegrasses
• White and red clover
• Winter and spring oats
• Lupins, Lotus
• Energy crops
Breeding programmes

- Perennial, Italian and hybrid ryegrasses
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- Energy crops
White and red clover: high quality feed for the beef, sheep and dairy sectors

- **White clover**
  - Most important temperate forage legume
  - Major source of home grown traceable protein
  - High intake
  - Good digestibility and mineral content
  - Quality maintained through season
  - Stoloniferous

- **Red clover**
  - High Yields: 15-20 t/ha/annum DM without N
  - Traceable home grown protein
  - Mainly used for silage
  - Particularly important in organic rotations
  - Not stoloniferous
IBERS bred white clover varieties

- More balanced contribution to sward
- Enhanced persistency and reliability
- Flexibility
White clover varieties are grouped into four categories according to their leaf size:

- **Small**: Suitable for hill land or intensive sheep grazing
- **Medium**: Suitable for sheep and cattle grazing
- **Large**: Suitable for rotational sheep, cattle grazing and silage
- **V. Large**: Suitable for lax cattle grazing and silage
Red clover breeding targets

• High yields in third year and beyond
• Tolerance of grazing
• Pest and disease resistance - Sclerotinia,
• Stem nematode
• Improved crown survival
• Improved quality
Plant persistence

Poor

Good
How High Sugar Grass improves the efficiency of nitrogen utilisation

- **Grazed Grass (Nitrogen Input 100%)**
  - **Forage Protein**
    - **High WSC 29%**
    - **↑ More Milk**
    - **Normal WSC 26%**

- **Milk Yield (Nitrogen Output)**
  - **High WSC 29%**
  - **↑ More Milk**
  - **Normal WSC 26%**

- **Urine (Wasted Nitrogen)**
  - Normal WSC 33%
  - ↓ Lower Emissions ↓
  - **High WSC 25%**

- **Faeces (Wasted Nitrogen)**
  - Normal WSC 35%
  - **High WSC 35%**

Photo courtesy of Jon Moorby
UK National List and Recommended Lists

England and Wales

Northern Ireland

Scotland
### Grass varieties - recent

**Forage Perennial ryegrass**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ploidy, Phenology</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>AberStar</td>
<td>diploid, intermediate</td>
<td>NL UK; RL E&amp;W, SAC, DARD, Eire, France</td>
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<tr>
<td>AberGlyn</td>
<td>tetraploid, intermediate</td>
<td>NL UK; RL E&amp;W, SAC, DARD</td>
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<td>AberAvon</td>
<td>diploid, late</td>
<td>NL UK; RL E&amp;W, SAC, DARD, France, Austria, Germany</td>
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<td>AberCraigs</td>
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<td>NL UK, France; RL E&amp;W, SAC, DARD, Eire, France</td>
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<tr>
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<td>NL UK; RL E&amp;W, SAC, DARD, France, Neth’lands, Austria</td>
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<tr>
<td>AberElan</td>
<td>diploid, intermediate</td>
<td>NL UK, Czech</td>
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<tr>
<td>AberGold</td>
<td>diploid, intermediate</td>
<td>NL UK; RL Netherlands</td>
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<tr>
<td>AberMara</td>
<td>diploid, intermediate</td>
<td>NL Czech</td>
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<tr>
<td>AberMont</td>
<td>diploid, intermediate</td>
<td>RL France</td>
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<tr>
<td>AberSilo</td>
<td>diploid, intermediate</td>
<td>NL UK; RL E&amp;W, SAC, Germany, Austria</td>
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<td>AberTorch</td>
<td>tetraploid, early</td>
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<td>AberZest</td>
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<td>AberMagic</td>
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<tr>
<td>AberChoice</td>
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<tr>
<td>AberFarrell</td>
<td>diploid, intermediate</td>
<td>NL UK ; RL E&amp;W, SAC</td>
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<tr>
<td>AberBite</td>
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<td>NL UK ; RL E&amp;W, SAC, DARD</td>
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<tr>
<td>AberSweet</td>
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<td>NL UK ; RL E&amp;W</td>
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<tr>
<td>AberGreen</td>
<td>diploid, intermediate</td>
<td>NL UK ; RL E&amp;W</td>
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</table>
## Grass varieties - recent

### Hybrid ryegrass and Italian ryegrass

<table>
<thead>
<tr>
<th>Variety</th>
<th>Ploidy</th>
<th>Heading</th>
<th>NL</th>
<th>UK</th>
<th>RL</th>
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<tbody>
<tr>
<td>AberEve</td>
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<td>NL</td>
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<td>E&amp;W SAC Eire</td>
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<td>UK</td>
<td>E&amp;W SAC DARD, Austria</td>
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<tr>
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<td>France</td>
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<td>UK, France</td>
<td>E&amp;W, SAC, DARD</td>
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<td>tetraploid</td>
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<td>AberOscar</td>
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<td>AberStorm</td>
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<tr>
<td>AberVision</td>
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<td>early heading</td>
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<td>UK</td>
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<td>AberComo</td>
<td>diploid, Italian Ryegrass</td>
<td>NL</td>
<td>UK, Austria</td>
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<td>AberEpic</td>
<td>diploid, Italian Ryegrass</td>
<td>NL</td>
<td>UK</td>
<td>E&amp;W, SAC, Austria</td>
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<tr>
<td>AberMario</td>
<td>diploid, Italian Ryegrass</td>
<td>NL</td>
<td>UK</td>
<td>E&amp;W, SAC</td>
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<tr>
<td>AberTop</td>
<td>Cocksfoot</td>
<td>NL</td>
<td>UK</td>
<td>E&amp;W, SAC</td>
<td></td>
</tr>
</tbody>
</table>


“New” Breeding Objectives

• Improved use of resources
  – Nitrogen use efficiency
  – Efficient use of protein by the animal
  – Increasing phosphorous use efficiency

• Adaptation to climate change
  – Improved drought tolerance

Incorporated into good agronomic background
Breeding LINK projects

- White and red clover, ryegrasses and hybrids
- N use efficiency (soil, plant, rumen)
- P use efficiency (soil & plant, and livestock)
- Water use efficiency (uptake & within plant)
Improving nitrogen use efficiency (NUE) in perennial ryegrass and red clover

Why?

Water Framework Directive – reduce N use to protect water courses and groundwater

Cost and availability of nitrogen fertiliser

Poor conversion of forage nitrogen into milk and meat
Phosphorus - vital to yield and environmental quality in agriculture

Crops recover less than 10% of applied fertiliser P

Phosphorus - key to modern farming & has no synthetic alternative

Livestock sector must maintain production, profit and protect the environment

Improving perennial ryegrass and white clover to increase phosphorus use efficiency (PUE)
Drought resistant grasses and clovers that make better use of water

- Drier summers (rainfall now lower than ’61-’90 av)
- Less soil water means lower yields (typically 2-4t/ha in UK)
- DEFRA: need to conserve water and adapt to climate change

White clover
Organic seed – breeders perspective

• Ensure organic producers have access to best varieties
• Seed of best varieties available to organic producers
• Welsh Government funding
  – Organic seed problems
  – Develop organic seed production techniques?
Organically produced forage seed

Farmer concerns-

• Availability of organic seed
• Cost of organic seed
• Is organic seed of suitable varieties available?
  – Constraint?
  – Who will produce organic seed and how?
  – Existing seed growers or organic producers
Challenges for organic forage seed production

- Establishment and weed control
  - necessary for crops to meet official standards
  - reduce cleaning costs
- Supply of nutrients
  - Nitrogen for grasses
- Maximising seed yields
Nitrogen supply is a major issue

- Replace inorganic N used in conventional systems
- Options
  - Mixed farms
    - animal manure
  - Arable farms
    - sow into previous fertility building crop
    - sow with N producing companion legume
Reproductive tillers

![Bar chart showing reproductive tillers (% of control) for different treatments (T1, T2, T3) and varieties (IRG, PRG, HRG). The chart compares conventional to experimental treatments.](chart.png)
Seeds per spikelet

Variety/treatment

Seeds per floret (as % of control)

IRG PRG HRG IRG PRG HRG IRG PRG HRG
T1 T2 T3

Conventional
Seed yield

Variety / treatment

Seed yield (% of control)

Conventional
Weed content

Weight per 2g sample

Weeds
Inert Matter
Seed
New varieties build on agronomic platform of yield and forage quality

“New traits”
- Increased resource use efficiency
- Environmental benefits

Organic producers must have access to best varieties

Organic seed availability can be a constraint

Techniques required to maximise yield in organic systems