Cover and Catch Crops

Tim Martyn
SUSTAINABLE SOILS
GRASsland sediment Phosphorus
The ‘GRASP’ Project

During 2005-2006 at the Rowden Experimental Research Platform we have measured:

- Rainfall
- Drainage from plots - Volume of flow
- Total amount of phosphorus (P) in waters
- Total amount of sediment in waters

Phosphorus in the water
- Creates eutrophication
- Encourages plant and algal growth
- Results in oxygen depletion when plants die and decay
- Results in death of fish and other fauna

Sediment in the water
- Leads to a reduction in channel and reservoir storage capacity
- Increases risk of flooding
- Destroys salmon spawning grounds
- Acts as a vector of sorbed pollutants such as P, pesticides, and pathogens

What are the results found so far?
400 kg of sediment and 1 kg of phosphorus is lost over the year from ONE hectare of grassland
What do these results mean?

- There are circa 11 million hectares of grassland in England and Wales
- 4.4 million tonnes of sediment each year are eroded and
- 11,000 tonnes of phosphorus are lost
- The cost of removal of sediment from waterways is £8 million per year
- The equivalent of about £1.5 million of P fertiliser is literally going ‘down the drain’
- The cost of remediation of eutrophication is £19 million per year
Freshwater eutrophic @ only 35 μg P per litre

OR

35 millionths of a gram
The 'catchment' model
The Nitrogen Cycle

- **Atmospheric nitrogen** ($N_2$)
  - $N_2O, N_2$
- Dead plant matter
- Legume, grass and cereals
- Produce consumed by animals
- Ammonium ($NH_4^+$)
  - Mineralisation
  - Immobilisation
- Nitrite ($NO_2^-$)
  - Nitrification
- Nitrate ($NO_3^-$)
  - Uptake
  - Leaching
- Crop plants
- Inorganic nitrogen in fertiliser
- Wet and dry deposition
- NH$_3$ Volatilisation
- Denitrification
- Organic N (soil organic matter and microorganisms)
- Animal excreta
- Animal urea
- Locked in clays
- Ground water
# Measuring run-off at IGER

<table>
<thead>
<tr>
<th>Method</th>
<th>Undersown</th>
<th>Chisel plough</th>
<th>Stubble</th>
<th>Cover crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (m³ ha)</td>
<td>160</td>
<td>10</td>
<td>433</td>
<td>381</td>
</tr>
<tr>
<td>SS (kg ha)</td>
<td>213</td>
<td>9</td>
<td>719</td>
<td>1551</td>
</tr>
<tr>
<td>PP (g ha)</td>
<td>859</td>
<td>37</td>
<td>3029</td>
<td>5762</td>
</tr>
</tbody>
</table>
Companion cropping
Catch and Cover Crops

• An extra crop between two of the main crops in a rotation
• Fertility building
• Supplementary stock feed
• Replacement of main crops that have failed
• Soil protection
• Assume no livestock for grazing or folding
Pros

• Building soil organic matter (SOM) – green manure, particularly on sandy soils
• Reducing suspended solids in runoff – retaining soil
• Nitrate scavenging
• Nitrogen fixing
• Improving soil structure
• Aeration/Drainage
• Improving soil water retention
• Weed suppression
Cons

• Reliability of establishment – Timeliness of field operations
• Appropriate soil conditions for establishment – not usually suited to heavy or dry land
• Depletion of soil water in spring
• Clean land to minimise weed control problems
• Fertilise - Uptake of soil plant available nutrient
• Delay of seedbed preparation
Pests and Diseases

- Must not harbour pests or diseases of any main crop in the rotation, e.g. rape is highly susceptible to clubroot
- Do not use brassica cover crops in rotation with beet
- Rye, IRG or Westerwold preferred in rotations including cauliflower, swedes or OSR
- Green bridge if grasses present – aphids and cereal fungal diseases
- Slugs
Crop Options

• IRG or rape on a scarified corn stubble following harvest, ploughed in, grazed or sprayed off then strip-tillage
• Rye/IRG/Westerwolds RG establish best when sown in early autumn
• White or Ethiopian mustard between harvest and drilling
• Oilseed radish
• Legumes and phacelia
# Nitrogen Fixing and Accumulating

<table>
<thead>
<tr>
<th>Crops that fix Nitrogen</th>
<th>Description</th>
<th>Sowing rate per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crimson Clover (Trifolium incarnatum)</td>
<td>Fast growing short term clover with fantastic red coloured flowers</td>
<td>15 kilos</td>
</tr>
<tr>
<td>Red Clover (Trifolium Partense)</td>
<td>Best known green manure crop Better N fixation than white clover</td>
<td>15 kilos</td>
</tr>
<tr>
<td>White Clover (Trifolium Repens)</td>
<td>Slower to establish than red clover but more persistent and robust</td>
<td>10 kilos</td>
</tr>
<tr>
<td>Sweet Clover (melilotus officinalis)</td>
<td>Biennial clover with lots of biomas Good weed supressant qualities</td>
<td>15 kilos</td>
</tr>
<tr>
<td>Lucerne (Medicago sativa)</td>
<td>3 year high protein forage crop. Best sown on free draining light land</td>
<td>20 kilos</td>
</tr>
<tr>
<td>Sainfoin (Onobrychis viciifolia)</td>
<td>Perennial forage crop used for hay or Silage</td>
<td>70 kilos</td>
</tr>
<tr>
<td>Crop</td>
<td>Yield t dm / ha</td>
<td>Legume %</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-----------------</td>
<td>----------</td>
</tr>
<tr>
<td>White clover/grass</td>
<td>6.04</td>
<td>67</td>
</tr>
<tr>
<td>Red clover/grass</td>
<td>9.46</td>
<td>79</td>
</tr>
<tr>
<td>Lucerne/grass</td>
<td>7.53</td>
<td>74</td>
</tr>
<tr>
<td>Beans</td>
<td>3.80</td>
<td>100%</td>
</tr>
<tr>
<td>Vetches</td>
<td>7.00</td>
<td>100%</td>
</tr>
</tbody>
</table>
# Nitrogen Accumulating

<table>
<thead>
<tr>
<th>Crops that lift and hold N</th>
<th>Description</th>
<th>Sowing rate per hectare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westerwolds ryegrass <em>(Lolium westerwoldicum)</em></td>
<td>Annual express ryegrass Ideal for reducing N leaching in the winter.</td>
<td>35 kilos</td>
</tr>
<tr>
<td>Italian Ryegrass <em>(Lolium multiflorum)</em></td>
<td>Fast growing tall grass that should last for 3 years spring or autumn sown</td>
<td>30 kilos</td>
</tr>
<tr>
<td>Winter Rye <em>(Secale cereale)</em></td>
<td>Autumn sown, rye will help prevent N Leaching over the winter months</td>
<td>180 kilos</td>
</tr>
<tr>
<td>Phacelia <em>(Phacelia tanacetifolia)</em></td>
<td>Fast establishing with pretty blue flowers makes Phacelia ideal for bees and Insects</td>
<td>10 kilos</td>
</tr>
<tr>
<td>Mustard <em>(Sinapis alba)</em></td>
<td>Fastest growing green manure biomass can be incorporated in a short period of time</td>
<td>20 kilos</td>
</tr>
<tr>
<td>Buckwheat <em>(Fagopyrum esculentum)</em></td>
<td>Very fast growth annual Big broad leaves helps suppress some common weeds</td>
<td>75 kilos</td>
</tr>
</tbody>
</table>
Nitrogen Scavenging

• Work by IGER found growth over-winter of rye to be generally better than Westerwolds or IRG. Other properties of rye included:
  – consequentially higher herbage N recovery
  – greater frost tolerance (leaf proteins)
  – can be established later in autumn but early drilling gives better establishment (regional)
  – establishes better in free-draining (aerobic) soils
  – Faster earlier establishment means higher LAI
Other characteristics of cover crops

• Nematode reduction with oilseed radish and mustards
  – but may also reduce some beneficial nematodes
• Harvest date of cash crop and the time available to sow the cover crop are often challenging
• Most cover crops are best sown in July and August and will need moisture to germinate
• Soil type determines the sowing rate which must be high to give good soil cover
• Ability to mow and incorporate the cover crop in late autumn
<table>
<thead>
<tr>
<th>Type of Nematode</th>
<th>Crops at risk</th>
<th>Resistant Cover Crop</th>
<th>Preventative methods</th>
<th>Host plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beet Cyst Nematode Hs*, Hb*</td>
<td>Sugar Beet, Fodder Beet, Beetroot, Oilseed Rape</td>
<td>Doublet oilseed radish, Smash Mustard</td>
<td>Prevent weeds, Crop rotation</td>
<td>Spinach, Fodder Rape, All Brassicas, Shepherds Purse, Fat Hen</td>
</tr>
<tr>
<td>Root Knot Nematode Mc*, Mf*, Mn*</td>
<td>Potato, Carrot &amp; Parsnips, Peas, Spring Wheat, Flower Bulbs</td>
<td>Doublet Oilseed Radish</td>
<td>Fallow, Short Cycle host cropping</td>
<td>Ryegrass, Maize, Carrot &amp; Parsnip, Rye, Potato</td>
</tr>
<tr>
<td>Stem nematode Dd*</td>
<td>Potato, Onion, Tulips, Lucerne, Winter beans, Sugar Beet</td>
<td>Doublet Oilseed Radish</td>
<td>Clean &amp; healthy seeds &amp; plants</td>
<td>Potato, Sugar beet, Onions, Lucerne</td>
</tr>
<tr>
<td>Stubby Root Nematode Pt*, Pa*</td>
<td>Potato, Sugar beet, Onion, Carrots &amp; Parsnips</td>
<td>Doublet Oilseed Radish, Smash Mustard</td>
<td>Crop rotation</td>
<td>All Arable &amp; Horticultural crops (except Lily &amp; Gladiolus)</td>
</tr>
<tr>
<td>Tobacco Rattle Virus</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Root Lesion Nematode Pp*</td>
<td>Carrots &amp; Parsnips, Some Legumes, Maize</td>
<td>Tagettes Please contact for more details</td>
<td>Crop rotation</td>
<td>Potato, Wheat, Maize</td>
</tr>
<tr>
<td>Potato Cyst Nematode (PCN) Gr*, Gp*</td>
<td>Potatoes</td>
<td>Doublet Oilseed Radish, Smash Mustard</td>
<td>Crop rotation, Resistant Varieties</td>
<td>Potato, Nightshade</td>
</tr>
</tbody>
</table>
Crop Rotations

A few examples of crop rotations are shown below

Winter Wheat → Harvest → Doublet Oilseed Radish → Incorporate → Sugar Beet

Legumes → Harvest → Smash Mustard → Incorporate → Winter Wheat

Spring Barley → Harvest → Doublet Oilseed radish → Incorporate → Potatoes

Cultivated Turf → Harvest → Smash Mustard → Incorporate → Carrots

Early Carrots → Harvest → Biofumigation mixture → Incorporate → Onions

Source: Nickersons
Biofumigation

- Plant breakdown releases chemical substances known as Isothiocyanates (ITC): Ethiopian and white mustards, oilseed radish
- Prussic acid production: Sudan grass
- Used to control, Fusarium, Pythium, Rhizoctonia fungal diseases and soil borne insects.
- Likely to reduce beneficial mycorrhizal soil fungi
- Works well on light textured, low organic matter soils.
- Natural Control of soil borne pests but also beneficial ones too
General benefits of cover cropping

- Traps and re-cycles nitrogen via the plant
- Improves soil structure by increasing organic matter
- Improves soil water retention
- Reduces soil erosion
Carbon:Nitrogen Ratio

- Bacterial biomass has a C:N ratio of 6:1 while well decomposed humus has C:N of between 10 and 12:1.
- Other organic remains have much more C.
- Breakdown of material having wide C:N ratio, such as cereal straw (140:1), is slow unless N is readily available.
- Soil bacteria uses ‘plant available N’ (mineral or inorganic N) in the decomposition process.
- N used (immobilised) becomes organic N, mostly unavailable to the plant. However, it can be made ‘plant available’ at a later date by a process called mineralisation.
Bi-cropping - Pros

- Permanent understorey of a companion crop, i.e. white clover.
- Crop drilled using a Hunter stripseeder (strip-till drill)
- White clover may help to interrupt spread of splash borne fungal disease spores
- Non-inversion of soil promotes beneficial invertebrates and mycorrhizal fungi
- Uniform green appearance may reduce aphid alighting
Bi-cropping - Cons

- Competition for moisture, sunlight and nutrient by companion crop
- Restricts choice of herbicide active ingredient
- Can harbour pests (slugs) but also provides cover for beneficial predators (ground beetles) – balance required