Crop mixtures

Adrian Newton, David Guy, Christine Hackett, Bill Thomas, Roger Ellis, Stuart Swanston, Steve Hoad (SRUC)

Hartwood: John Rattray
Balruddery: John Bennett, Derek Matthew, Euan Caldwell
Monoculture → variety mixtures

Cereal variety mixtures:
✓ Increase yield
✓ Reduce disease
✓ Maintain quality
✓ Increase yield stability

Demonstrated in:
➢ Winter wheat for distilling (and baking)
➢ Winter barley for feed
➢ Spring barley for malting and feed

→ More resilient, efficient crops

Limitations...?
Questions:

Within species
1. How many components?
2. What proportions?
3. What spatial arrangements (structured/random/connectivity/patches)?
4. How diverse can/should components be?
5. What traits complement best (e.g. canopy types, weed competitiveness...)?
6. Straw biomass effects (/harvest index)?
7. Nutrition and pathogen interactions (nitrogen & fungicides)?

Between species
• How different crop species interact (cereal-legume etc.), for either biomass (for anaerobic digestion) or silage use

Practicalities
➢ Quality... As good / better / less variable than monoculture
Mixtures: Disease reduction, yield increase and stability

- Less lodging in mixtures – structural support
- Convergence of heading dates, maturity and height
Component proportions

Disease % cf. monoculture mean

Proportion of second component

Optic-Westminster
Concerto-Quench
Optic-Waggon

The James Hutton Institute
Structured resistance gene deployment

a) Monoculture

b) Homogeneous

c) Structured

Selection for:  
a) Simple  
b) Complex  
c) Simple and Complex and Groups

Mildew\textsuperscript{1}  
4.09\textsuperscript{a}  
4.69\textsuperscript{a}  
2.61\textsuperscript{b}  
LSD 1.06  
\textsuperscript{1}Percentage whole plant infection.
Thoroughly mixed or patchy?

Structure and scale

- Random
  Homogeneous or patchy?
- Regular
  Small or large areas?
- Structure
  Complex and simple?
- Proportions
  Connectivity and ratio?
But on a REAL farm...

Drill hopper

Pre-mixed

Sequential

In situ

Simultaneous

3 different varieties

A

B

C
### Yield

| Patchy arrangements in the field |

<table>
<thead>
<tr>
<th>Yield</th>
<th>In situ</th>
<th>Pre-mix</th>
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<tbody>
<tr>
<td><strong>Mixtures cf. mono mean:</strong></td>
<td></td>
<td></td>
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<tr>
<td>2005</td>
<td>+13%***</td>
<td>-4%</td>
</tr>
<tr>
<td>2006</td>
<td>+17%***</td>
<td>+10%</td>
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<tr>
<td><strong>Rhynchosporium</strong></td>
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<td>2005</td>
<td>-34%***</td>
<td>+10%</td>
</tr>
<tr>
<td>2007</td>
<td>-58%***</td>
<td>-35%</td>
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</table>
Canopy types

- Semi-prostrate
- Dwarf
- Tall
- Erectoid
Mixed canopy habits

% increase yield

ED  TD  TE  SD  SE  TS  2-comp mean  TED  SED  TSD  TSE  3-comp mean  TSED  4-comp mean
Are mixtures always beneficial?

<table>
<thead>
<tr>
<th>Trial</th>
<th>Crop</th>
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<tr>
<td>DC</td>
<td>WW</td>
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<tr>
<td>DP</td>
<td>WW</td>
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<tr>
<td>DZ</td>
<td>WW</td>
</tr>
<tr>
<td>CU</td>
<td>SB</td>
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<td>GCh</td>
<td>WB</td>
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<td>DC</td>
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<td>DP</td>
<td>WB</td>
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<td>WW</td>
</tr>
<tr>
<td>GL</td>
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Practicalities
→ Quality... As good / better / less variable than monoculture
Cereals with legumes...
Regrowth after cutting
2015 trial:

**Digestibility:**
NCGD: neutral cellulose gammanese enzymes

**Total plot bale yield**

**Crude Protein**

**DM**

**Top biomass combinations 2016:**
- Rye+Oats+Vetch: 452
- Rye+Oats: 448 (Wheat not in 2016 trial)
- Rye+Oats+Pea: 433
- Oats+Barley+Pea: 444
- Oats+Barley+Vetch: 428
- Oats+Triticale+Pea: 434

Pea very +ve if N reduced (LAE increased)
Winter cereal-legume biomass crops

Biomass (kg/plot)

Crop mixture

Balruddery-N0.5
Balruddery-N1.0
Hartwood-N0.5
Hartwood-N1.0

BEAN-mix  CLOVER-mix  IRG-mix  mix  PEA-mix  VETCH-mix
Conclusions

Many...
Practical and beneficial...

Thank you!