Ecosystem service provision by establishing temporal habitats in agricultural environments

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Background

• Intensification of arable production
  • specialisation, larger farm size, monoculture

• Decline in area of semi-natural grasslands and field margins
  ➢ Simplified the structure of agro-ecosystems
  ➢ Lower agrobiodiversity

• In several European countries, agri-environment support schemes are targeted to enhance biodiversity
How to diversify agricultural landscape?

- Wider field margins
- Wildflower strips
- More open field-forest ecotones
- Diverse crop rotations
- Semi-natural habitats
- Wider field margins
- Wildflower strips
Use of agricultural area in Finland 2010

<table>
<thead>
<tr>
<th>Use of area</th>
<th>1 000 ha</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
<td>1012.2</td>
<td>44.2</td>
</tr>
<tr>
<td>(dominated by spring barley and oats)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grasslands under 5 years</td>
<td>659.3</td>
<td>28.8</td>
</tr>
<tr>
<td>(inc. hay, silage, green fodder</td>
<td></td>
<td></td>
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<tr>
<td>pasture and seed production</td>
<td></td>
<td></td>
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<tr>
<td>Grasslands at least 5 years</td>
<td>33.0</td>
<td>1.4</td>
</tr>
<tr>
<td>(inc. natural meadows, pastures and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>grazing grounds)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fallows (inc green, stubble, bare</td>
<td>82.2</td>
<td>5.3</td>
</tr>
<tr>
<td>fallows)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental fallows</td>
<td>162.8</td>
<td>7.1</td>
</tr>
<tr>
<td>Green manure</td>
<td>61.9</td>
<td>2.7</td>
</tr>
<tr>
<td>Other crops</td>
<td>274.9</td>
<td>10.2</td>
</tr>
</tbody>
</table>

'Seminatural grasslands'

The Finnish Agri-Environment Scheme
- 92% of area (90% of farmers) under AES in 2010
- AES includes obligatory and optional support measures
  - mainly aimed to water protection (reducing nutrient run-off)
  - only a few measures targeted to enhance biodiversity
    - organic production (7%), management of traditional biotopes (1%),
      promoting biological and landscape diversity (0.5%)
Background and Objectives

- AES (agri-environment schemes): currently *not* sufficient to protect and enhance biodiversity in intensively cultivated landscapes

Aim: to study *establishment and management of temporal habitats in agroecosystems*

**Develop old practical measures:**
- Rotational fallows
- Long-term set-asides

**Create new ones:**
- Wildflower strips
- Field-forest ecotones
Ecosystem services and their measurement

**Seed food production for farmland birds**
Number of all seeds on soil top layer (~2-3 cm)

**Insect food production for farmland birds**
All insects caught by sweep net (or D-vac sampler)

**Pollination**
- honey bee (*Apis mellifera*)
- bumblebees (*Bombus* and *Psithyrus*)
- butterflies
- diurnal moths
  - found in transect counts

**Natural enemies of pests**
Ground-living arthropods by pitfall traps
Rotational fallows 2003-2006

Field experiment:

- type of set-aside: green, stubble
- duration: 1 or 2 years
- seed mixture:
  - ‘standard’
    (Festuca pratensis - Phleum pratense - Trifolium pratense)
  - ‘less competitive’
    (Agrostis capillaris - Festuca ovina)
- establishment
  - undersown, not undersown

row-column design (4 replicates, 8 treatments)
plot size 0.3 ha
Long-term set-aside 2003-2008

Field experiment:
• strip-plot design
• 4 replicates
• plot size 0.25 ha (50 m x 50 m)

Establishment: 3 seed mixtures

"Standard"  "Less competitive"  "Meadow plants"

Management: mowing / no m.
Long-term set-aside 2003-2008

Long-term set-aside 2003-2008

Wildflower strips 2007-2010

Field experiment:

- **Strips vs. matrix**
  - Wildflower strips
    - *Centaurea jacea*, *C.phrygia*, *Leucanthemum vulgare*, *Trifolium repens*, *Agrostis capillaris*
  - Monoculture strip (*C. jacea*)
  - Control (*Phalaris arundinacea*)

- **Placement of the strip**
  - Next to forest
  - Next to field margin
    - lengthwise/crosswise
  - In the middle of the field
Wildflower strips 2007-2010

Butterfly species

Moth species

Butterfly individuals

Moth individuals

1-6: wildflower strips
10-13: field margins

Alanen et al. (unpublished)
Idea: **Biodiversity zones in forests adjacent to fields**

- Open meadow like habitats increase biodiversity
- Income from forest logging can compensate for costs

**Management**

- Meadow strip (no trees) 5m

**Control**

- Light selection logging 20m
Field-forest ecotones 2009→

Butterflies

Alanen et al. (unpublished)
How to improve the effectiveness of agri-environment scheme?

- **Rotational fallows**
  - Stubble or seed of less competitive grasses best for pollinators
  - Less pests, more natural enemies in two-years fallows than in cereal fields

- **Long-term set-aside**
  - can maintain/enhance pollinator populations, if established using a suitable seed mixture (inc. nectar and pollen plants or less competitive grasses)
  - Old (> 5 year) set-asides important to butterflies and moths
  - The age of set-aside and vegetation structure are more important than seed mixture or plant species richness in supporting insect food for birds

- **Wildflower strips**
  - Placement of the strip next to forest

- **Field-forest ecotones**
  - Open meadow habitats increase bd of pollinators
How to support ecosystem services?

• **The promotion of each ecosystem service requires specific management**

• **Seed food production for farmland birds**
  - Short-term rotational fallows or new set-asides (specific seed-bearing crops)

• **Insect food production for farmland birds**
  - Set-asides of various ages, wildflower strips
  - Availability depends on vegetation height, density, heterogeneity

• **Pollination**
  - The long-term set-aside can maintain/enhance pollinator populations
  - Set-asides of various ages
    - social bees respond faster to set-aside (nectar and pollen)
    - butterflies and moths colonize slower (larval food plants)
  - Network of field margins important in the long run
  - Placement of wild-flower strips next to forest

• **Pest control by natural enemies**
  - Permanent grasslands, non-crop habitats
Conclusions

• *Ecosystem services can be promoted by establishing temporal habitats*

• *The most beneficial management varies between ecosystem services*

• *Area of temporal habitats supported by AES should be increased in agricultural landscape*
Thank you!