Characterising and localising HNV farming in Germany for an improved conservation of farmland biodiversity

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The Johann Heinrich von Thünen Institute (vTI) - in brief: Thünen Institute - is the Federal Research Centre for Rural Areas, Forestry and Fisheries under the German Ministry of Food, Agriculture and Consumer Protection (www.ti.bund.de)

The Institute of Biodiversity:

- **investigates** the role of biodiversity in agricultural landscapes to better understand the functional role of biodiversity and to assist its protection in order to contribute to a sustainable use of agroecosystems

- **combines** a strong experimental and observational expertise with local to regional scale studies

- **provides** scientific support for political decision makers
INTRODUCTION

Background

The High Nature Value (HNV) farming concept recognises the fact that the conservation of species-rich European habitats and landscapes is to a large part linked to the continuation of low-intensity farming systems (e.g. Beaufoy et al. 1994, Bignal & McCracken 1996)

- Supporting and maintaining HNV farming has been a priority for EU rural development policy since 2005
- HNV farming is an important backbone of biodiversity conservation in European agricultural landscapes
INTRODUCTION

Background

Biodiversity

Intensity of agriculture

HNV farmland

Intensive farmland

Types of HNV farmland (according to Andersen et al. 2004, Paracchini et al. 2008)

**Type 1:** Farmland with a high proportion of semi-natural vegetation

**Type 2:** Farmland with a mosaic of low-intensity agriculture and natural and structural elements, such as field margins, hedgerows, stone walls, patches of woodland or scrub, small rivers etc.

**Type 3:** Farmland supporting rare species or a high proportion of European or World populations

**EU regulatory reporting obligations**

- member states were committed to develop and implement indicators in order to identify and measure the extent and condition of HNV farmland and to track changes over time
INTRODUCTION

HNV Farmland Indicator (sample-based approach)

HNV land-use types (e.g. grassland, arable and fallow land)

HNV landscape elements (e.g. hedges, field margins, mixed orchards)

Stratified randomised sampling design: sample plots (n = 915) for HNV-farmland in Germany (Source: own illustration based on data of BfN)
Objective:

To explain and predict the distribution of HNV farmland in Germany in order to

- enable distinctions between prime and marginal agricultural areas (high-input vs. low-input farming)
- contribute to the spatial targeting of agri-environmental policy instruments
MATERIALS & METHODS

Explanatory variables (n = 30)

Compilation of data sets related to 30 variables (resampled to 1 km spatial resolution)

<table>
<thead>
<tr>
<th>TOPOGRAPHY</th>
<th>AGRICULTURE</th>
<th>LANDSCAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>- altitude</td>
<td>- area of crop types, grassland</td>
<td>- area of land use/cover types (arable land, grassland, forest etc.)</td>
</tr>
<tr>
<td>- slope</td>
<td>- crop yield</td>
<td>- diversity of land-use types</td>
</tr>
<tr>
<td></td>
<td>- milk production</td>
<td>- edge density</td>
</tr>
<tr>
<td></td>
<td>- fertiliser input</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- crop diversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- livestock units</td>
<td></td>
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<table>
<thead>
<tr>
<th>CLIMATE</th>
<th>SOIL</th>
<th>POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>- radiation</td>
<td>- field capacity</td>
<td>- population density</td>
</tr>
<tr>
<td>- temperature</td>
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<tr>
<td>- precipitation</td>
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</table>
MATERIALS & METHODS
Modelling approach

Steps:

"Explanation" plot-scale

1. **Factor analysis (FA)**
   - dimension reduction, orthogonal (uncorrelated) gradients in agri-environment space

2. **Mixed effect models**
   - %HNV ~ PC1+PC2+PC3+PC4+PC5+two-way interactions, random=1|surveyor

Models were compared via AIC, residuals were not spatially autocorrelated

"Prediction“ national-scale

1. FA axes were calculated at 1-km spatial resolution
2. mixed model coefficients were used to predict HNV farmland
## RESULTS

### Factor analysis (plot-scale, n = 915)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Correlation</th>
<th>Explained variance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Factor 1 (Arable farming)</strong></td>
<td><strong>Correlation</strong>&lt;br&gt;Rye (0.81)&lt;br&gt;Winter wheat (0.80)&lt;br&gt;Winter wheat (0.79)&lt;br&gt;Rye (0.66)</td>
<td><strong>13</strong></td>
</tr>
<tr>
<td>Fertilisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop yield</td>
<td></td>
<td></td>
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<tr>
<td><strong>Factor 2 (Topography/Milk production)</strong></td>
<td><strong>Correlation</strong>&lt;br&gt;Mean elevation (0.85)&lt;br&gt;<em>Milk production</em> (-0.71)&lt;br&gt;Radiation (0.69)</td>
<td><strong>13</strong></td>
</tr>
<tr>
<td>Topography</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Milk production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate</td>
<td></td>
<td></td>
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<tr>
<td><strong>Factor 3 (Agricultural land use)</strong></td>
<td><strong>Correlation</strong>&lt;br&gt;<em>Grassland/cropland ratio</em> (-0.81)&lt;br&gt;<em>Extensive livestock farming</em> (-0.72)&lt;br&gt;Winter wheat area (0.61)&lt;br&gt;Arable land (0.59)</td>
<td><strong>12</strong></td>
</tr>
<tr>
<td>Farm management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land-use</td>
<td></td>
<td></td>
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<tr>
<td><strong>Factor 4 (Landscape structure)</strong></td>
<td><strong>Correlation</strong>&lt;br&gt;Edge density (0.80)&lt;br&gt;Edge density agricultural fields (0.62)&lt;br&gt;Habitat type diversity (0.62)</td>
<td><strong>9</strong></td>
</tr>
<tr>
<td>Landscape structure</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Factor 5 (Livestock farming)</strong></td>
<td><strong>Correlation</strong>&lt;br&gt;Maize area (0.73)&lt;br&gt;Intensive livestock farming (0.67)</td>
<td><strong>6</strong></td>
</tr>
<tr>
<td>Land-use</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm management</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>53</strong></td>
</tr>
</tbody>
</table>
MATERIALS & METHODS

Modelling approach

Steps:

"Explanation" plot-scale

1. Factor analysis (FA)
   dimension reduction, orthogonal (uncorrelated) gradients in agri-environment space

2. Mixed effect models
   \%
HNV ~ PC1+PC2+PC3+PC4+PC5+two-way interactions, random=\sim 1 | surveyor

Models were compared via AIC, residuals were not spatially autocorrelated

"Prediction" national-scale

1. FA axes were calculated at 1-km spatial resolution

2. mixed model coefficients were used to predict HNV farmland
RESULTS

Relationships between HNV farmland and factors (plot-scale)

Factor 3 (Agricultural land-use)
- Grassland/cropland ratio
- Extensive livestock farming
+ Winter wheat area
+ Arable land

Factor 4 (Landscape structure)
+ Edge density
+ Edge density agricultural fields
+ Habitat type diversity

Factor 5 (Livestock farming)
+ Maize area
+ Intensive livestock farming

Factor 2 (Topography/milk production)
Low
Medium
High
MATERIALS & METHODS

Modelling approach

Steps:

"Explanation" plot-scale

1. Factor analysis (FA)
   dimension reduction, orthogonal (uncorrelated) gradients in agri-environment space

2. Mixed effect models
   \( \%\text{HNV} \sim \text{PC1} + \text{PC2} + \text{PC3} + \text{PC4} + \text{PC5} + \text{two-way interactions} \), random=\( \sim 1 | \text{surveyor} \)

Models were compared via AIC, residuals were not spatially autocorrelated

"Prediction" national-scale

1. FA axes were calculated at 1-km spatial resolution

2. mixed model coefficients were used to predict HNV farmland
RESULTS
Factors at national-scale (1km x 1km squares, n = 356778)

Factor 3: Agricultural land-use

Factor 5: Livestock farming
RESULTS

HNV farmland predicted at national-scale (1km x 1km squares)

HNV landscape elements

HNV land-use types
DISCUSSION

Strengths:
- contributes to delineating agricultural areas at a national scale that illustrate the approximate location and extent of HNV farmland
- mapping approach can be used as a tool to inform and guide strategic planning in farmland biodiversity conservation actions ("priority areas" for conservation actions)

Weaknesses:
- coarse spatial resolution of GIS-data
- farm-level data (e.g. farm size, farm type) is not included (farming systems can not be derived)

Next steps:
- farming system approach (incorporate criteria that reflect the characteristics of HNV farming systems)
**DISCUSSION**

**Production landscapes**

"Remnants" of HNV farmland

Conservation approaches (intensively managed, structurally simple landscapes)

- targeted and evidence-based agri-environment schemes
- Natura 2000 payments
- greening measures of the CAP (Pillar 1)

**Marginal landscapes**

"Hotspots" of HNV farmland

Conservation approaches (extensively managed, structurally complex landscapes)

- targeted financial support of HNV farming systems (ensure socio-economic viability)
- marketing of high-quality products, labeling of products
- payments for providing cultural ecosystem services
THANKS FOR THE ATTENTION!

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