Transborder Farming
Virtual Land Consolidation for Improved Farming in Small-Scale Farming Systems

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• Different situations of farming in Germany
• The idea of Transborder Farming
• Technical requirements and implementations
• Data processing and management
• Experimental results
• Conclusions
Situation of farming in Germany

Farms: ~ 372,000
Farm land (ha): ~ 17,000,000
Farm size (ha): ~ 45
Situation of farming in Germany

Farms: ~ 372,000
Farm land (ha): ~ 17,000,000
Farm size (ha): ~ 45

Farm size (ha): ~ 300
Field size (ha): > 30
Situation of farming in Germany

Farms: ~ 372,000
Farm land (ha): ~ 17,000,000
Farm size (ha): ~ 45

Farm size (ha): ~ 25
Field size (ha): ~ 1.5
Situation in small-structured landscapes

In agriculturally small-structured regions, many farmers have competitive disadvantages due to small-sized fields and a multitude of single plots resulting in

- Long road times (farm to fields, fields to fields)
- Long operating times and low effective working times
- Many overlapping areas
- Increased use of fuel, fertilisers and plant protection agents
- Ineffective use of expensive harvesters

- Increased environmental and soil damage
- High average costs per unit
Expected effects of field enlargement

• Decrease in work and road times
• Decrease in labour and variable machine costs
• Increase in crop yields and decrease of resource use
• Increase in gross margins per hectare
The idea of Transborder Farming – A Virtual Land Consolidation

Small single fields

Joint Transborder Fields

Property structure

But: No change of land ownership!
Transborder Farming – joint cultivation

Previous cultivation of single fields

Lengthwise joint cultivation as Transborder Field
Joint cultivation with ownership based accounting

Spatial distributed values of yield and resource use

Allocation of logged data points to part fields

Calculation of part field specific values for accounting

Farmer A
Farmer B
Farmer C

Data processing

Data processing
Technical requirements for Transborder Farming

- Systems for georeferenced yield measurement
- Systems for automatic process data acquisition
- Systems for data management and accounting

➢ Automated or semi-automated management tools
Georeferenced yield measurement for cereals and sugar beet

Combine harvester

GPS antenna and receiver

Yield sensor

Data logger

Sugar beet harvester
Maps are nice to have, but we need to work with the data in databases!
Powerful databases for storing high amounts of data

We use SQL-databases with support for geographic objects!
Geographic data processing for property based values
Web based user interfaces for Transborder Farming management

Rechnung über Maschineneinsatz/Arbeitsleistung
bearbeitet am 17.06.2004 erstellt am 17.06.2004

Kunde: Reiner Mößlein
Dienstleister: Werner Herbert
Krauthämer Str. 11
97500 Zeilitzheim

Maßnahme: Saat am 02.10.2002 von 11:03 bis
Fahrer: Herbert

<table>
<thead>
<tr>
<th>Teilshlag</th>
<th>Teilshlaggröße [ha]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hegern/Mößlein</td>
<td>1.0400</td>
</tr>
<tr>
<td>Hegern/Herbert1</td>
<td>0.7300</td>
</tr>
<tr>
<td>Hegern/Herbert2</td>
<td>1.1600</td>
</tr>
<tr>
<td>Hegern/Drescher</td>
<td>2.9200</td>
</tr>
<tr>
<td>Hegern/Danzberger</td>
<td>0.0700</td>
</tr>
</tbody>
</table>

Datum | Schlag | Verfahren |
02.10.2002 | Hegern/Mößlein | Saat |

Traktor: Case CS (160PS)
Einheit: Stunden
Preis/Einheit (€): 35.00
Anzahl Einheiten: 0.48
Betrag (€): 16.80

Gehlen-Drillkombination
Einheit: Hektar
Preis/Einheit (€): 40.00
Anzahl Einheiten: 0.95
Betrag (€): 38.00

Summe Maschinen: 54.80

Arbeitszeit: Stunden
Preis/Einheit (€): 15.00
Anzahl Einheiten: 0.48
Betrag (€): 7.20

Pauschale: 0.00

Gesamtbetrag: 54.80 €
Experiments on three trial Transborder Fields
Experiments on three trial Transborder Fields

Transborder field “Hausaecker” 6.95 ha
uniform application

Transborder field “Hegern” 6.72 ha
field-specific application

Transborder field “Baundstauden” 7.20 ha
site-specific application

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<table>
<thead>
<tr>
<th>Transborder field</th>
<th>Hausaecker</th>
<th>Hegern</th>
<th>Bandstauden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer</td>
<td>A  B  C</td>
<td>D  E  F1  G  F2</td>
<td>F3  F4  F5  F6  F7  F8</td>
</tr>
<tr>
<td>Latitude [m]</td>
<td>217 216 218</td>
<td>102 182</td>
<td></td>
</tr>
<tr>
<td>Longitude [m]</td>
<td>147 71 102</td>
<td>43 137 52</td>
<td>51 33 197 114 26 30 27</td>
</tr>
<tr>
<td>Area [ha]</td>
<td>3.19 1.54 2.21</td>
<td>0.80 2.96</td>
<td>1.12 1.10 0.71 1.62</td>
</tr>
<tr>
<td>Headland old [ha]</td>
<td>0.35 0.17 0.24</td>
<td>0.10 0.33</td>
<td>0.12 0.12 0.08 0.20</td>
</tr>
<tr>
<td>Headland new [ha]</td>
<td>0.26 0</td>
<td>0.26</td>
<td>0</td>
</tr>
<tr>
<td>Headland new [%]</td>
<td>8 0</td>
<td>12</td>
<td>33</td>
</tr>
<tr>
<td>Ratio [new/old*100]</td>
<td>68 68</td>
<td>36</td>
<td></td>
</tr>
</tbody>
</table>
## Reduction of transportation times by building Transborder Fields

<table>
<thead>
<tr>
<th>Season 2001/2002</th>
<th>Transborder field “Hausaecker”</th>
<th>Transborder field “Hegern”</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of participating farmers</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Kind of cultivation</td>
<td>Single fields</td>
<td>Transborder field</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Farmer</th>
<th>Farmyard-field distance (km)</th>
<th>Dist. travelled/operation (km)</th>
<th>No. of operations</th>
<th>Total distance (km)</th>
<th>Time effort (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farmer 4</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

| Reduction | 61 % | 71 % |

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Correction of work time after joint cultivation in Transborder Field

\[ t_{kj} = t_{ai} + A_i \sum_{i=1}^{n} t_{wij} + t_{ui} \]

<table>
<thead>
<tr>
<th></th>
<th>Farmer A</th>
<th>Farmer B</th>
<th>Farmer C</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating time (h)</td>
<td>1.53</td>
<td>0.67</td>
<td>1.22</td>
<td>3.42</td>
</tr>
<tr>
<td>Working time (h)</td>
<td>1.36</td>
<td>0.66</td>
<td>0.91</td>
<td>2.93</td>
</tr>
<tr>
<td>Turning time (h)</td>
<td>0.11</td>
<td>0.00</td>
<td>0.18</td>
<td>0.29</td>
</tr>
<tr>
<td>Standing time (h)</td>
<td>0.06</td>
<td>0.01</td>
<td>0.12</td>
<td>0.19</td>
</tr>
<tr>
<td>Time to account (h)</td>
<td>1.57</td>
<td>0.81</td>
<td>1.04</td>
<td>3.42</td>
</tr>
<tr>
<td>Avg. draft force (kN)</td>
<td>51.2</td>
<td>49.3</td>
<td>49.3</td>
<td></td>
</tr>
</tbody>
</table>

\( n \) = number of part fields
\( i \) = part field index
\( A_g \) = area of transborder field
\( A_i \) = area of part field
\( t_{ki} \) = corrected operating time of part field
\( t_{ai} \) = working time of part field
\( t_{wi} \) = turning time of part field
\( t_{ui} \) = standing time of part field
Calculated economical effects of joint Transborder Farming

- Less working costs
- Less machinery costs
- Less resource costs
- Higher price for yield
- Higher yield bei less edge areas
- Higher yield bei know-how effect

Weighted average
Conclusions – a positive view to Transborder Farming

**Economy**
- Reduction of labour time and costs over 30%
- Efficient machinery use and increasing yields
- Use of the best available technologies
- Use of the best available know-how

**Ecology**
- Reduction of soil compaction and resource use
- Reduction of traffic
- Reduction of soil erosion by slope adjusted cultivation
- Building of ecologic cells

**Technology**
- Participation in technological progress
- Use of site specific technologies in small-structured areas
- Efficiency effects by joint machinery use
- New challenges produce new (better) solutions

**Sociology**
- Increase of corporate feeling
- Benefits from specialised know-how one another
- Better (stronger) market position
Conclusions – a critical view to Transborder Farming

Sociology
- Decreasing autonomy of decision
- Reservations against each other
- Necessity of change in traditional thinking
- Risk of paternalism of bigger farmers

Ecology
- Risk of uncontrolled enlargement of field structures
- Risk of decrease of biodiversity
- Risk of soil damage by using bigger machines
- Risk of higher soil erosion not considering the slope
- Risk of increasing intensity in plant protection and fertilising

Technology
- High technological requirements (costs, know-how)
- Older machinery may become useless
- Reservation against new technologies among the farmers
- Slowdown of development of small autonomous vehicles

Landscape
- Risk of decrease of attractive landscape structures
- Risk of decrease of traditional landscape forms