Off-Road Automation Technology in European Agriculture
- State of the art and expected trends -

Prof. Dr. Hermann Auernhammer

Center of Life Sciences Weihenstephan
Department of Bio Resources and Land Use Technology
Crop Production Engineering

Automation Technology for Off-road Equipment (ATOE)
Keynote Lecture
Kyoto (Japan)
October 7-8, 2004
Off-Road Automation Technology in European Agriculture

1. Europe
2. Agriculture in Europe
3. Agricultural mechanization in Europe
4. Off-road automation in European agriculture
5. Future trends
6. Conclusions
Off-Road Automation Technology in European Agriculture

1. Europe *(just a view words)*

2. Agriculture in Europe
3. Agricultural mechanization in Europe
4. Off-road automation in European agriculture
5. Future trends
6. Conclusions
Unification of Europe

EU$_{15}$ in 1995, 330 million citizens
Unification of Europe

$\text{EU}_{15}$ in 1995, 330 million citizens

$\text{EU}_{25}$ in May 1$^{\text{st}}$, 2004,
10 more countries
105 million more citizens
Unification of Europe

EU$_{15}$ in 1995, 330 million citizens

EU$_{25}$ in May 1$^{st}$, 2004,
   10 more countries
   105 million more citizens

EU$_{27}$ in 2007,
   2 additional countries
   31 million more citizens

In total 466 million citizens
Currencies in Europe

Euro zone
Currencies in Europe

Euro zone

Own currencies old members

Euro zone

Own currencies old members
Currencies in Europe

Euro zone

Own currencies old members

Old currencies, new members

Mention:
- Switzerland
- Norway
belong not to the EU!
Population density 1997

Low and very low density regions

High density regions

Interpretation:
Low = need for automation?
High = no need for automation?
Cross domestic product per capita 1997

Fairly well developed CDP in a wide area of Europe

Interpretation:
= money for more automation ?
= money for more comfort ?
Unemployment ratio 1998

Very large area (about 50%) with high and very high unemployment

Interpretation:

= no need for automation?
= no money for automation?
Two regions:

- Large agricultural area
- Large industrial area
Off-Road Automation Technology in European Agriculture

1. Europe

2. Agriculture in Europe

3. Agricultural mechanization in Europe
4. Off-road automation in European agriculture
5. Future trends
6. Conclusions
## Farms partitioned due to sizes in 1999/00

<table>
<thead>
<tr>
<th>Size (area) from ... up to ... ha</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>less than 5</td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td></td>
</tr>
<tr>
<td>10 - 20</td>
<td></td>
</tr>
<tr>
<td>20 - 30</td>
<td></td>
</tr>
<tr>
<td>30 - 50</td>
<td></td>
</tr>
<tr>
<td>50 - 100</td>
<td></td>
</tr>
<tr>
<td>100 or more</td>
<td></td>
</tr>
</tbody>
</table>

### Number of Farms in 1,000

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3,902.1</td>
<td>834.1</td>
<td>691.2</td>
<td>349.0</td>
<td>389.3</td>
<td>369.0</td>
<td>234.4</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td><strong>6,769.1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Relative Number of Farms based on Overall Number in %

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>70 to 80 % will disappear</strong></td>
<td>5.2</td>
<td>5.8</td>
<td>5.5</td>
<td>3.5</td>
<td>100</td>
</tr>
</tbody>
</table>

### Area of Farms in 1,000 ha

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6,593.4</td>
<td>5,885.8</td>
<td>9,822.7</td>
<td>8,548.1</td>
<td>15,063.8</td>
<td>25,687.0</td>
<td>55,196.7</td>
</tr>
</tbody>
</table>

### Quota of Agricultural used area in %

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.2</td>
<td>4.6</td>
<td>7.7</td>
<td>6.7</td>
<td>11.9</td>
<td>20.3</td>
<td>43.5</td>
</tr>
</tbody>
</table>

Auernhammer, 30.09.2004
Relative area and relative farm number of EU\textsubscript{15} members

### Area (%)

- GB: 12.5%
- DK: 2.1%
- D: 13.5%
- GR: 2.8%
- F: 22.0%
- I: 10.3%
- IRL: 3.5%
- L: 0.1%
- NL: 1.6%
- P: 3.0%
- S: 2.4%
- ?: ?%

### Farm numbers (%)

- GB: 3.4%
- FIN: 1.2%
- GR: 12.1%
- I: 31.8%
- IRL: 2.1%
- L: 0.9%
- NL: 1.5%
- P: 6.1%
- S: 2.9%
- ?: ?%
- D: 7.0%
- E: 19.0%
- F: 9.8%
- ?: ?%
Average farm size in the EU$_{15}$ 1999/00

Need of Automation in small-scale farming?
Which type of automation in small-scale farming?

Crop Production Engineering
Farm decline of each member country (EU$_{15}$) between 1989/1990 and 1999/2000

- **Structural improvements not started yet**
- **Farm structures stabilized**

**EU$_{15}$ Members**

- B
- DK
- D
- GR
- E
- F
- IRL
- I
- L
- NL
- A
- P
- FIN
- S
- GB
- EU$_{15}$
Relative quota of working family members and ownership quota of EU_{15} members 1999/00

High annual costs for land renting!
Automation extra expenditure!?

Quota in %

EU_{15} Members
Number of farms and tractors per EU$_{15}$ member

Low tractor usage!
Extra reason for more automation?

EU$_{15}$ Members

Crop Production Engineering

Auernhammer, 30.09.2004
© 2004
1. Europe
2. Agriculture in Europe

3. **Agricultural mechanization in Europe**
   4. Off-road automation in European agriculture
   5. Future trends
   6. Conclusions
Typical European tractor-implement combination for high performance

Small-scale farming

- Extending in length (combination)
- Self propelled unit
- Fast on road (40 km/h; 50 km/h)
- High concentration at field end
- High concentration during work
- Large demands to the driver

Large-scale farming

- Extending in width
- Towed implements
- Lower max. speed
- Lower concentration during work
- Lower demands to the driver
Self propelled off-road vehicles
(Relative sales figures of tractors and self-propelled harvesters in Germany)

Crop Production Engineering
First self-propelled tillage unit
(LEMKEN Brilliant, 2003)

Following the trend !?
or „missing link“ ?
Off-Road Automation Technology in European Agriculture

1. Europe
2. Agriculture in Europe
3. Agricultural mechanization in Europe

4. Off-road automation in European agriculture

5. Future trends
6. Conclusions
The Agricultural BUS System (LBS) in accordance to DIN 9684 / ISO 11783

High-tech for agriculture
- early-state developed
- easy-to-use

Required by the farmers

7 years after standardization still not available!
- to complicated?
- to complex?
- to expensive?
- more competition between manufacturer?
- no real benefit for the farmer?
- wrong implement segment (tractor sales go down)?
N-online fertilization systems
(regime: 3 to 4 dressings)

High-tech for environment protection!
- closed-loop control
- easy-to-use
Emulates farmers work!

3 years after introduction still only a small number in use!
- to expensive?
- to less financial benefit?
- no extra benefit for environment protection?
Automated headland control with “Teach-In” (FENDT)

Recording - Editing - Storage - Play-back - Control
of up to 16 different functions and 5 devices

Integrated Functions:

- front load lifter
- front pto
- rear load lifter
- rear pto
- hydraulic valves
- cruise control
- engine speed
- four-wheel drive
- differential gear block

Automated execution in dependence of:

- distance
- time
- rear hitch position
- front hitch position
- manual control
Automated headland control with “Teach-In” (FENDT)

Recording - Editing - Storage - Play-back - Control
of up to 16 different functions and 5 devices

Integrated Functions:

Automated execution
in dependence of:

- engine speed
- four-wheel drive
- differential gear block
- front hitch position
- manual control

Acceptance by the farmers?
Steering controller in self propelled combine harvesters

Chopper (CLAAS)
Sugar beet harvester (HOLMER)
Combine harvester (CLAAS)
Steering controller in self propelled combine harvesters

Chopper (CLAAS)
Sugar beet harvester (HOLMER)
Combine harvester (CLAAS)

Fully accepted by the farmer?
- simple to use (just push a button)!
- offers comfort!
- increases performance!
- increases profit!
Automation fully accepted in serialized products

Electronic Hitch Control (EHR) in tractors >40 kW
Four-wheel and anti-slip management (tractors > 80 kW)
VRT (variable rate transmission) with about 40,000 units
Auto-Contour in combine harvesters (> 4 m working width)

Reasons again:
- simple to use (just push a button)!
- offers comfort!
- increases performance!
- increases profit!
Off-Road Automation Technology in European Agriculture

1. Europe
2. Agriculture in Europe
3. Agricultural mechanization in Europe
4. Off-road automation in European agriculture

5. Future trends

6. Conclusions
Large agricultural area
Large industrial area

Interpretation:
Two regions!
Low density population, high unemployment and less income
= no pressure for automation
High density population, low unemployment and high income
= pressure for automation
Small-scale farming with very large farm declines! Automation can assist structural changes (Transborder Farming)!
Parallel tracking

Chopper (CLAAS)  Sugar beet harvester (HOLMER)  Combine harvester (CLAAS)

Yes - fully accepted by the farmer!
- usable to a wide range of applications
- simple to use (just push a button)!
- offers comfort!
- increases performance!
- increases profit (may be seen immediately)!
Cross compliance in the EU

From 2005 onwards EU agricultural policy will change!
- subsidies may be given only in conjunction with documentation
- environment friendly sound measures get an extra value

These are new driving forces for “Precision Farming” with extra values
- in fertilizing
- in spraying
- in mechanical weed control
The administration is one side of the medal,
The administration is one side of the medal, the consumer is the other!
The administration is one side of the medal, the consumer is the other!

and the Society is more and more sceptical against farming!
**Farm-Audit**

Minimum dataset:
- Comprehensive
- Proof

**GMO-Audit**

- Free / not free
- Safety distance
- Others

**Crop Production Engineering**

Auernhammer, 30.09.2004

© 2004

**Crop Production Engineering**
Information is safeguarding the farm!

**But:** Only automated data acquisition guarantees comprehensive and real data!

And this means “Precision Farming”
Off-Road Automation Technology in European Agriculture

1. Europe
2. Agriculture in Europe
3. Agricultural mechanization in Europe
4. Off-road automation in European agriculture
5. Future trends

6. Conclusions
Conclusions I

Agriculture in *Europe is highly heterogeneous.*

To a great extent, agricultural cultivation is done in *disadvantageous small structures* (about 1 ha field size).

The *structural changes towards larger cultivation units are rising.*

The *differences within the member countries are increasing because of the extension of the EU.*
The mechanization has reached a very high level with various cutting edge technologies.

The trend of self-propelled machinery is advancing. For this, electronics is used to relieve the driver in combination with enhancements in performance and safety.

Nevertheless, the tractor will still be the central machine for farming.
Conclusions III

Precision farming concentrates on high yields using optimized nitrogen fertilization strategies.

Site specific farming will overcome the small structures by virtual land consolidation.
All in all, environmental protection is the driving force in precision farming. When having additional investments in technology, at first requirements of the society will be addressed.

The public claims continuous documentation which therefore defines the challenges of automation in future.