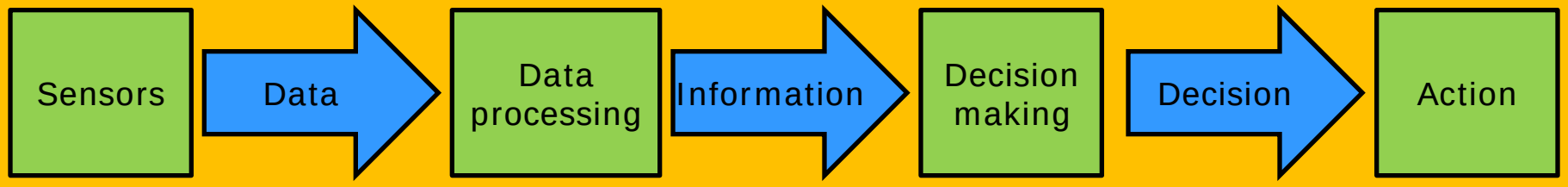
Leibniz-Institute for Agricultural Engineering
Potsdam-Bornim, Germany

# Precision Agriculture Perspectives

Robin Gebbers

9th European Conference on Precision Agriculture
July 8th 2013, Lleida, Catalonia, Spain

# Outline




- Matching requirements of algorithms
- Reliable
- Cheaper
- Faster

- Cleaning
- Calibration
- Interpolation
- Standards

- Match to data / information
- Automation (smartness)
- Flexibility (match to conditions, on-farm-research, machine learning)
- Standards
- User friendliness

- Applicators need to be precise and reliable
- Automation (robots)

**Applications: Tillage, crop protection, horticulture …**

**Cooperation: PA centres & schools**

# Soil sensors for mapping

# Soil sensors for mapping: Overview

**Mechanical**
- Fuel consumption — 0
- Draft force — 0
- Vertikal penetrometer — ?
- Horizontal penetrometer — 0

**Chemical**
- Galvanic (SoilDoctor) — ?
- Ionenselective elektrodes (pH) — +
- Field effect transistors — –
- Artificial nose — –
- Antibodies — –

**Optical**
- Vis-NIR spectroscopy — ? 0
- Camera — ? 0
- Raman spectroscopy — –
- Plasma spectroscopy — –

**Electrical**
- Geoelektrical (Res, EMI, Cap) — +
- TDR, FDR — 0
- Geo-radar — 0
- THz — –

**Radioactivity**
- Gamma spectroscopy (pass.) — +
- Impulse neutron (active) — –
- Röntgen fluorescence XRF — 0

**Acoustic**
- Seismics — –

**Pneumatical**
- Conductivity of air — –

+ **Commercial, acknowledged / regularly used**

? **Commercial, rarely used / problematic**

0 **Under development, promising / intensive research**

– **Research only**

# Soil sensors for mapping: Global Workshop on Proximal Soil Sensing 2013

- Soil spectroscopy and EC received most attention
- Gamma spectroscopy gained a lot of interest
- Sensor fusion
- Calibration issues
- New sensors
  - Lab scale: THz, photo-accoustic spectroscopy, …
  - Field scale: Geophilus, Capacitance

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# Soil sensors for mapping: New geo-electrical sensors

Geophilus

- Galvanic coupled resistivity sensor
- 5 depths
- diffenten frequencies
- & Gamma ray sensor

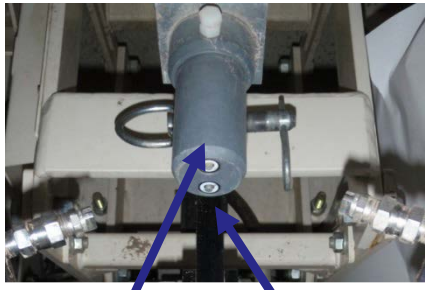
*Jörg Rühlmann, IGZ, Germany, www.igzev.de*

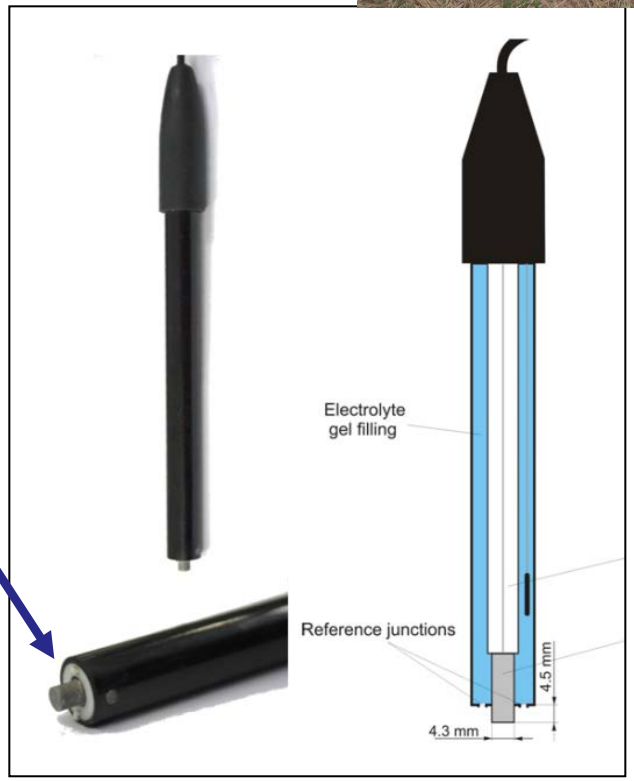
*Michel Dabas, geocarta, France, www.geocarta.net*

geocarta MPG

- Capacitively coupled sensor
- 3 depths

# Soil sensors for mapping : Veris pH-Manager ionselective elektrodes






Antimony elektrodes

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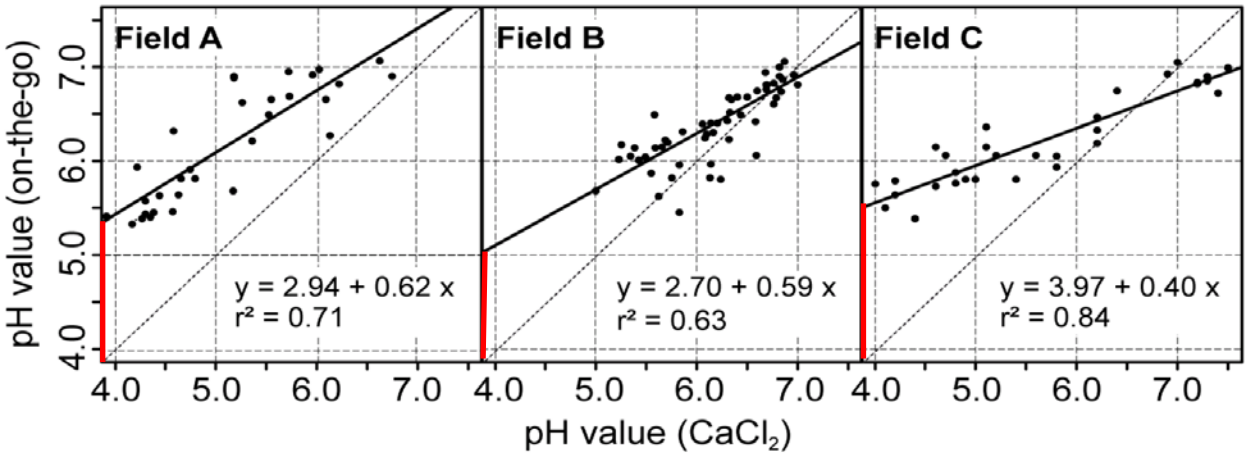
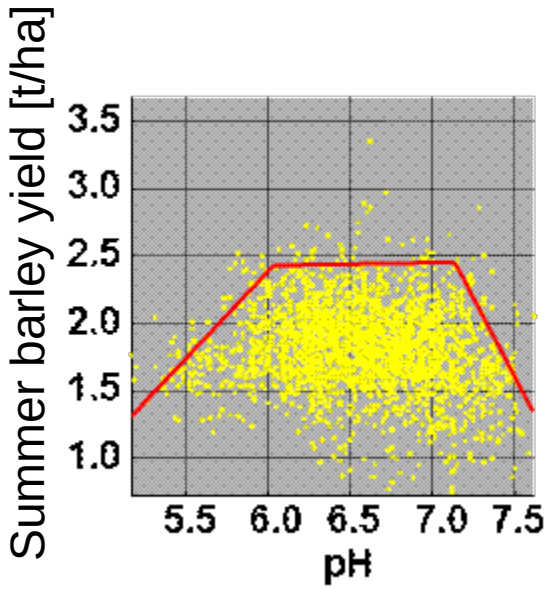
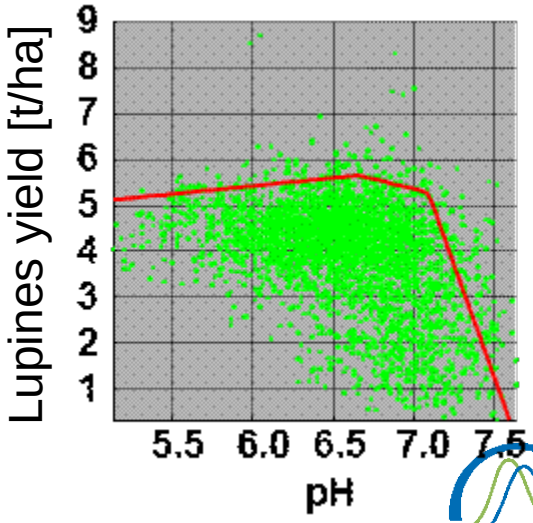
# Soil sensors for mapping: Veris pH-Manager ionselective elektrodes



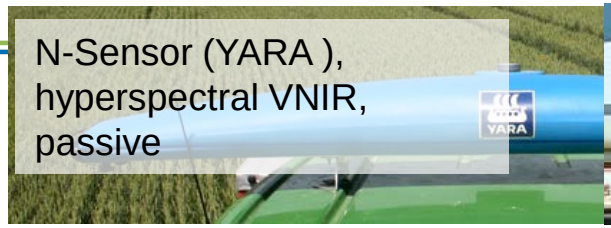
# Soil sensors for mapping: Challenges

- Need for „true“ nutrient sensor
- Need physical soil condition sensors (tillage)

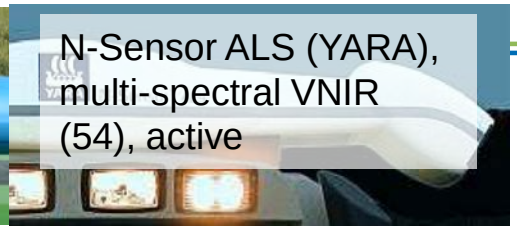
# Crop sensors

# Crop sensors: Multiplicity of commercial products

N-Sensor (YARA ), hyperspectral VNIR, passive

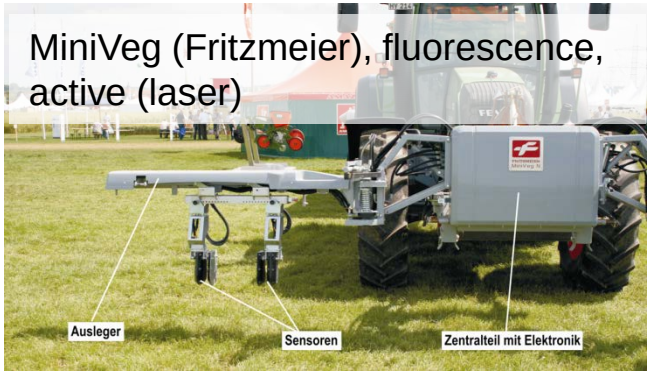



N-Sensor ALS (YARA), multi-spectral VNIR (54), active



CropSpec (TOPCON ), 2 WVB, active (laser)

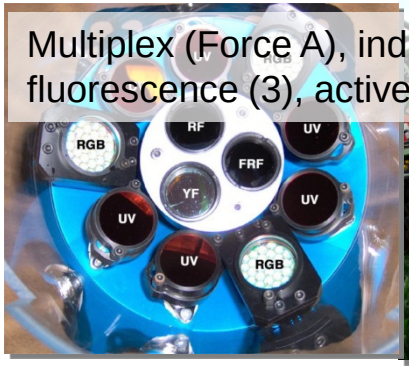
MiniVeg (Fritzmeier), fluorescence, active (laser)




Isaria (Fitzmeier), 5 WVB, active

CropMeter (Claas agrocom), mechanical, passive

Multiplex (Force A), induced fluorescence (3), active (LED)



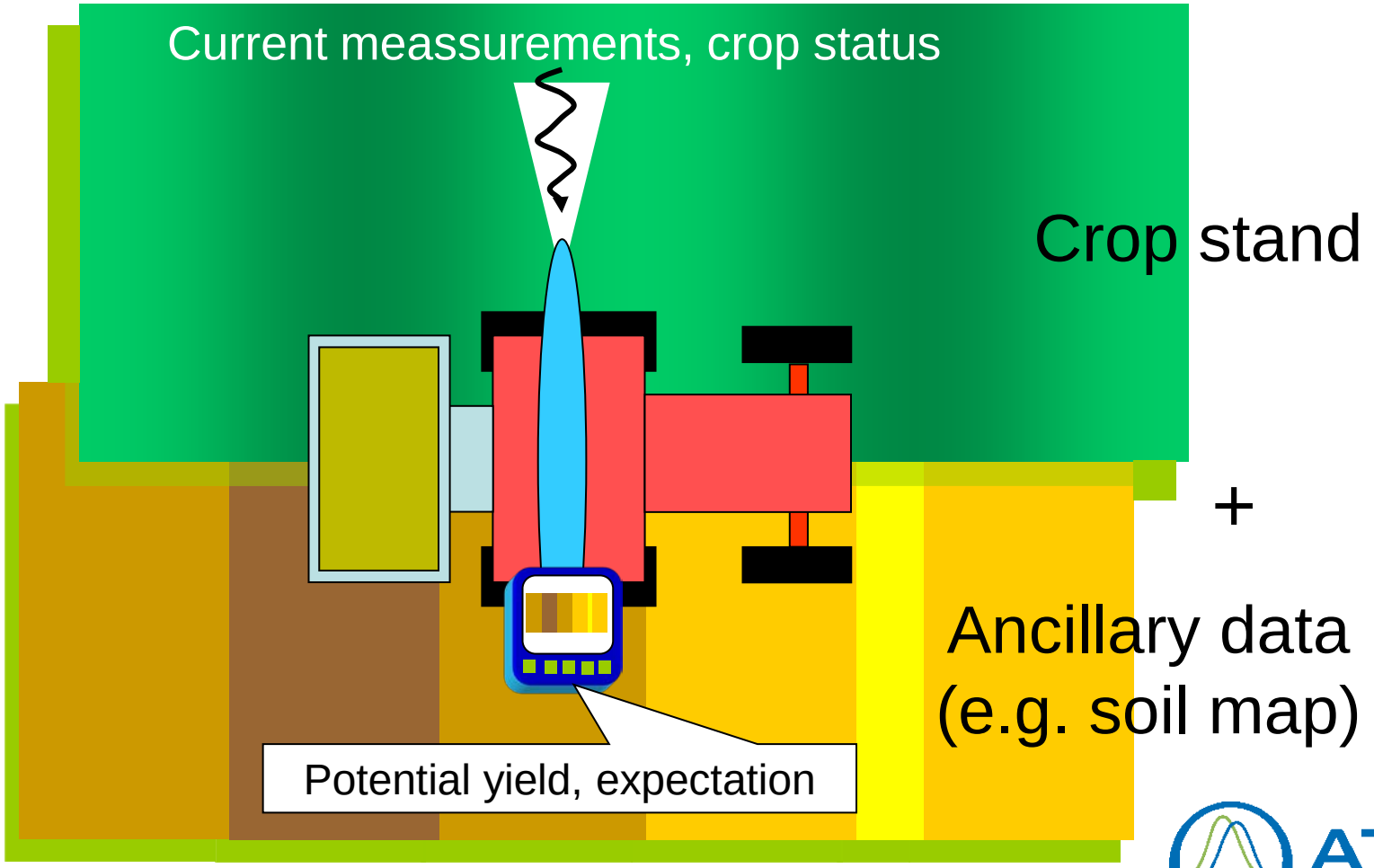

GreenSeeker (N-Tech, Trimble), 2 WVB, active


P3 (Agri Con), ultrasonic, active


P3 (Agri Con), ultrasonic, active

# Crop sensors: On-line measurements with map-overlay

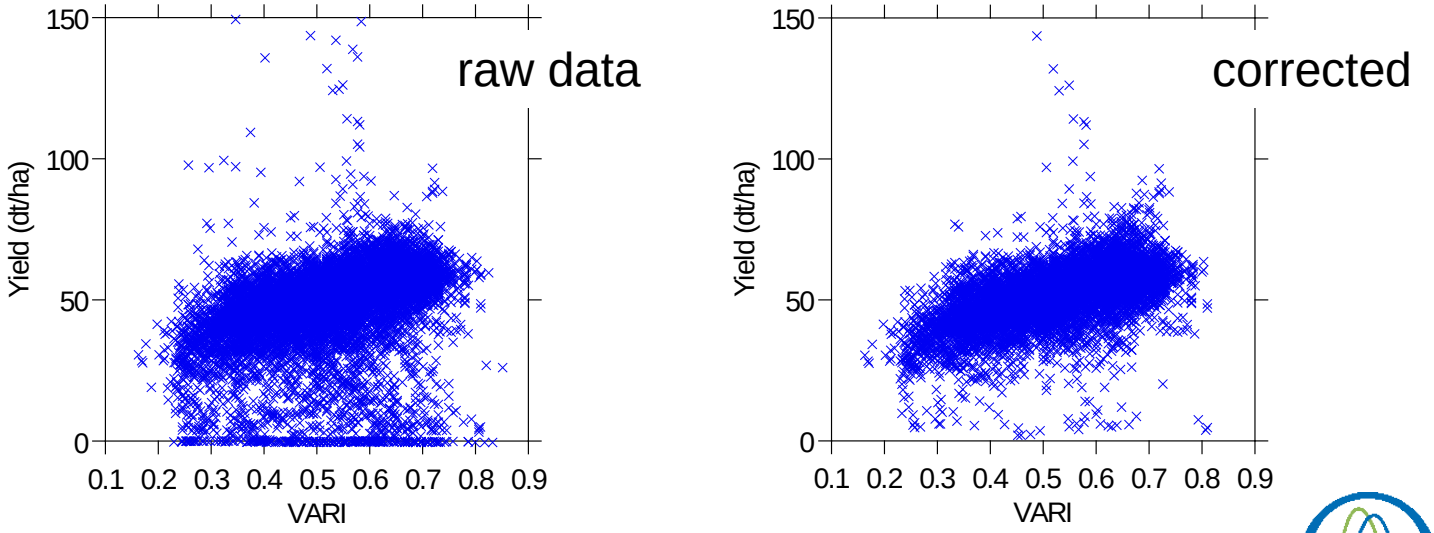
Early N application becomes more important!



# Crop sensors: Renaissance of yield mapping?

- Yield maps are important for decision making
  -> better yield monitors, better training
- Claas reports increase in sales of yield monitors after a period of decline

Importance of yield map correction



# Crop sensors: Summary

- Combination of on-line and off-line approaches
- Need for discrimination of stresses (N, H2O, pests)
- Crop protection: Weeds, infections, pests
- Don’t forget yield mapping

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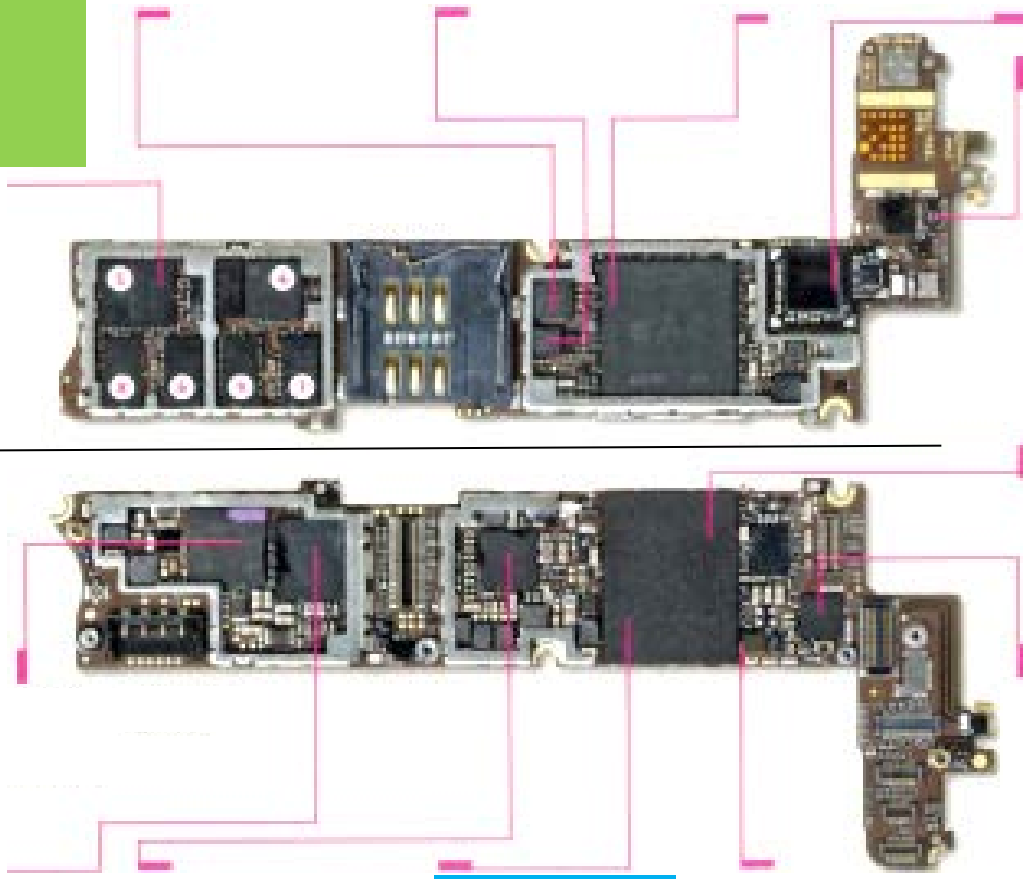
# Cell phone
# = Swiss army knife


*Technology Review 03/2011 (Cover, modified)*

# Cell phone: Sensors



Radio receiver / transmitter for GSM, GPRS, EDGE

Gyroscope

Accelerometer

CPU

WLAN and BlueTooth

Positioning unit GPS, GSM and WLAN

Front

Audio chip

Back

Touch screen controller

UMTS processor

Power management

Storage 32 GB

Digital compass

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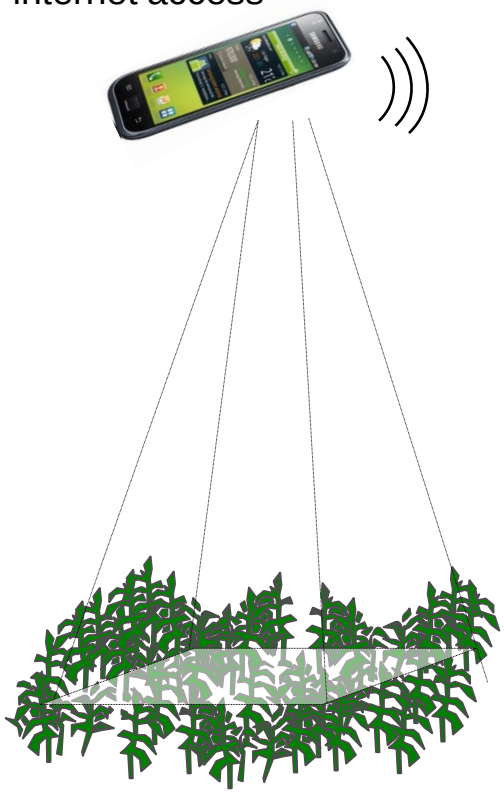
*Technology Review 03/2011, p. 71, modified*

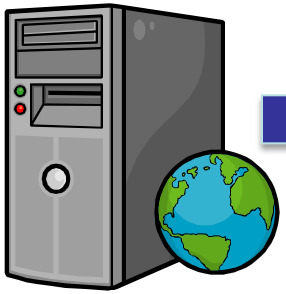
# Cell phone: YARA ImageIT app, determination of N-requirememts of rape seed in spring

Smartphone with camera and internet access



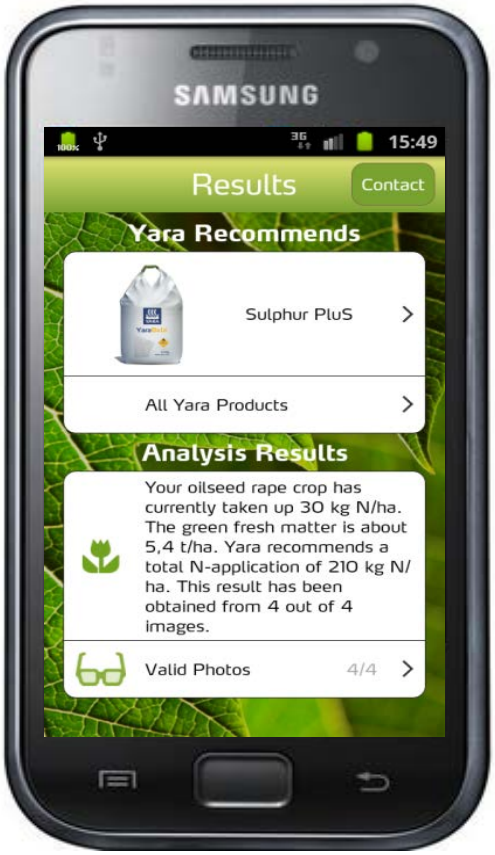
Acquire and transmit images

Central server:
Image + position processing
Generation of response



YARA

N recommendation




*Stefan Reusch,*
*YARA, Germany*
*http://www.yara.de/media/apps/imageit/index.aspx*

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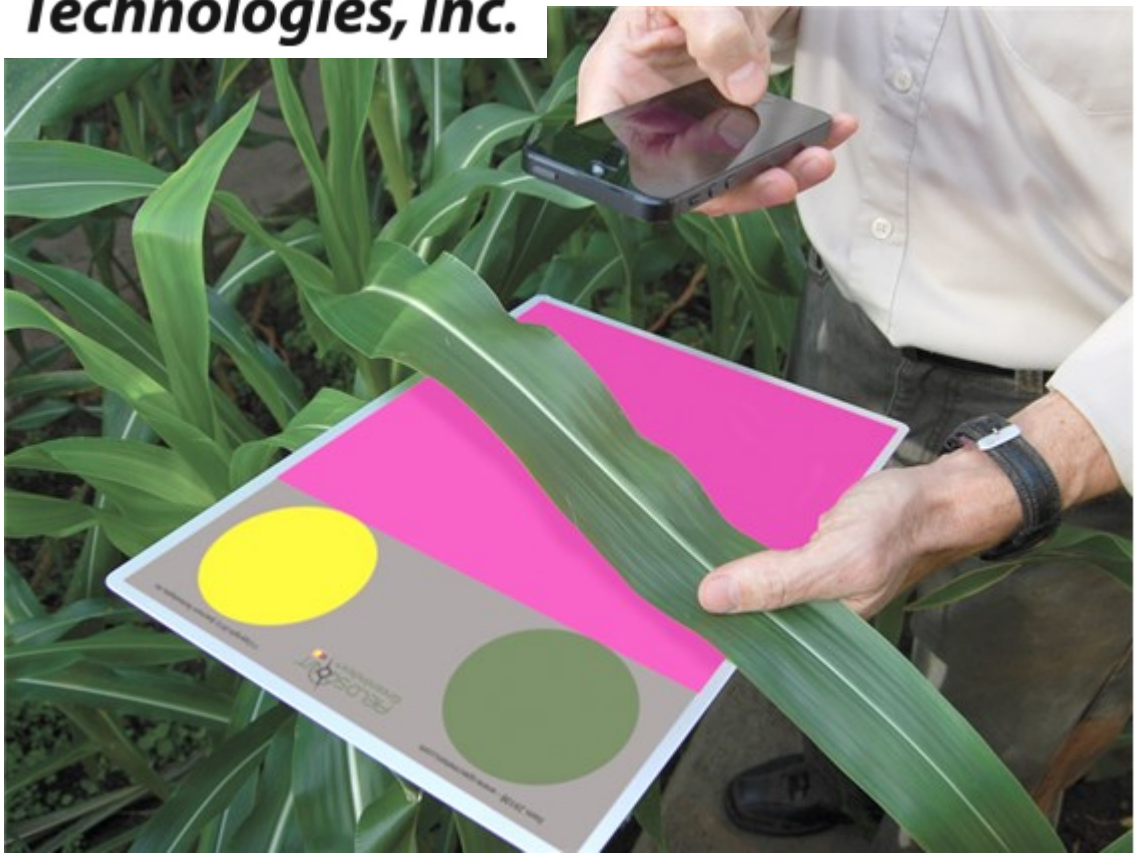
# Cell phone: FieldScout GreenIndex+ Nitrogen App and Board: Determination N requirements of Corn

Spectrum Technologies, Inc.



FIELDSCOUT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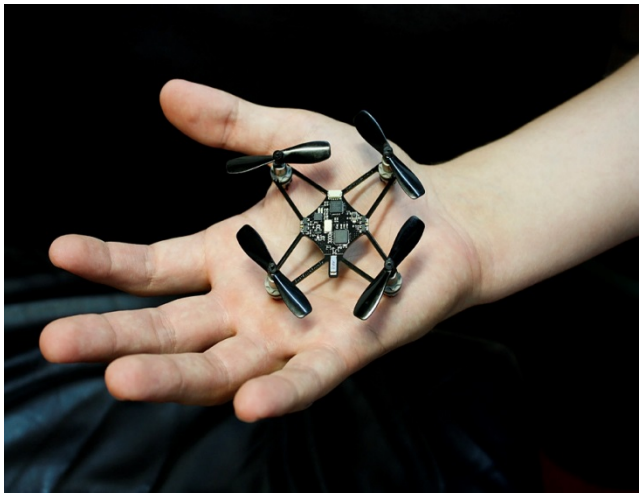
*Spectrum Technologies, Inc.*
*http://www.specmeters.com/nutrient-management/chlorophyll-meters/chlorophyll/greenindex/*

# UAV* = Another Swiss army knife?

* Unmanned aerial vehicle

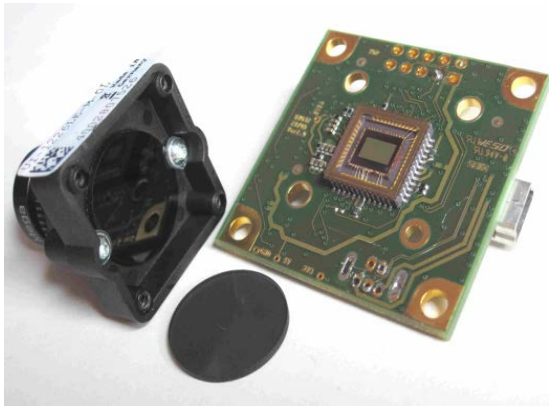
# UAV: Rotary wing

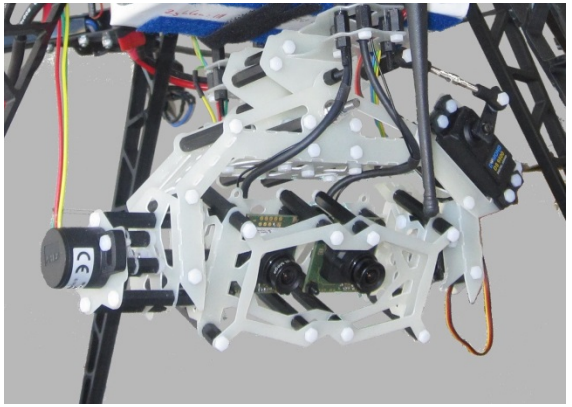


# UAV: Low cost

agricopter

- Build a system for less than 3000 €





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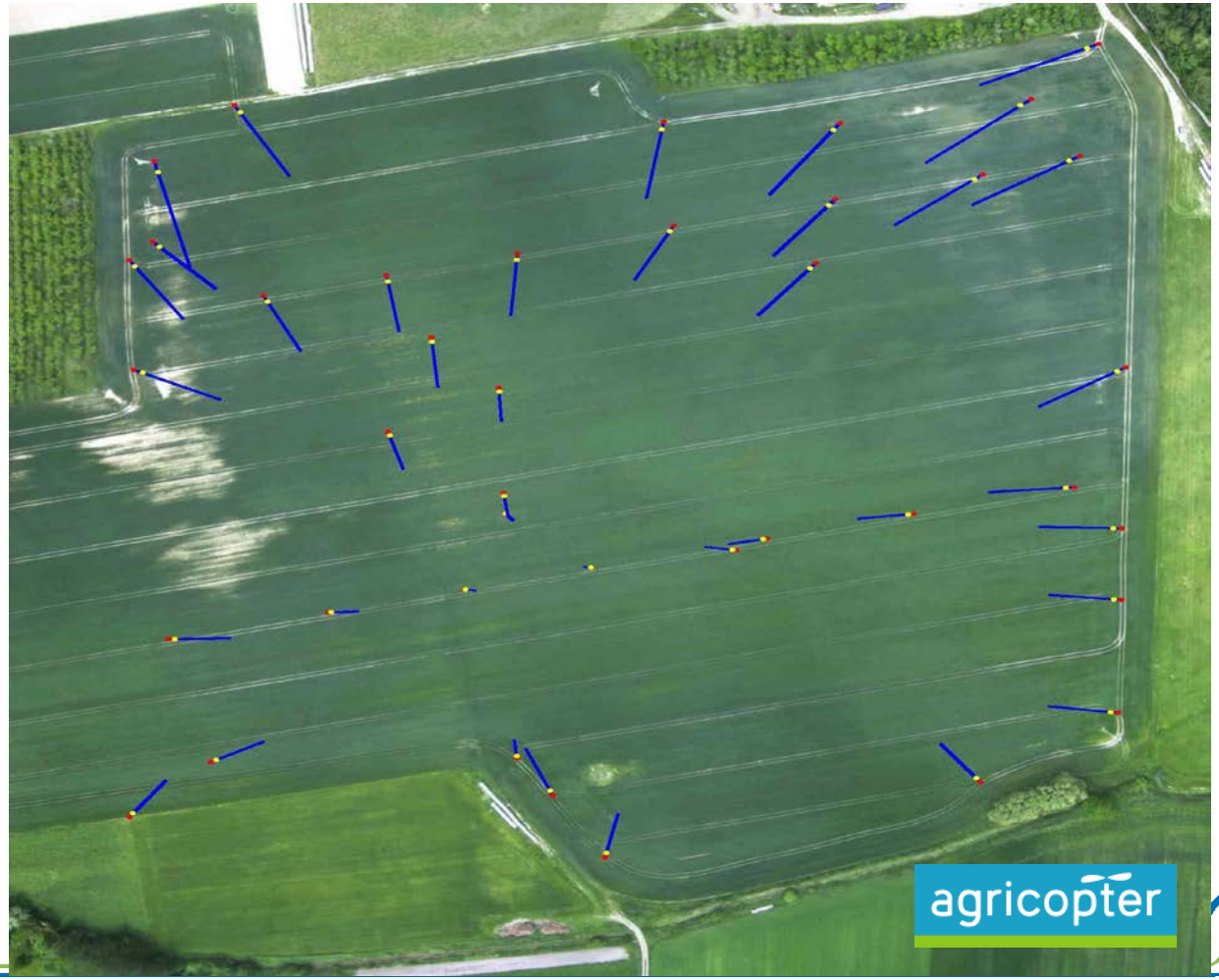
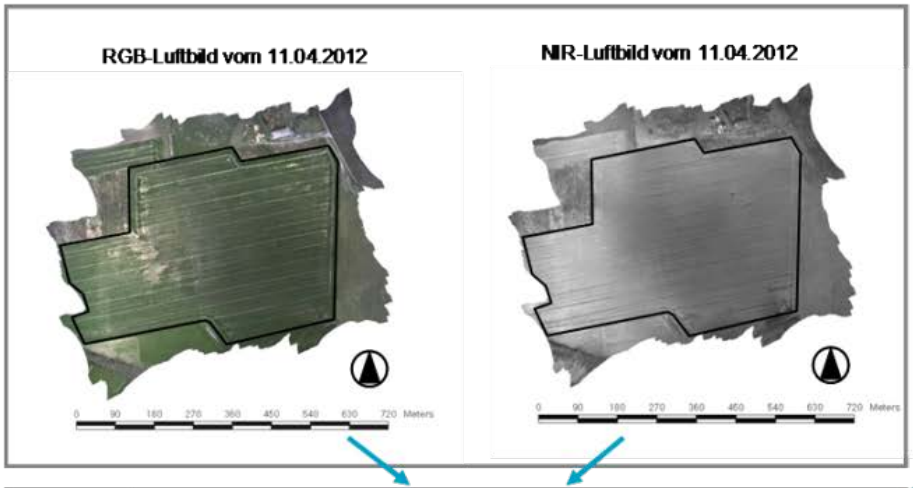
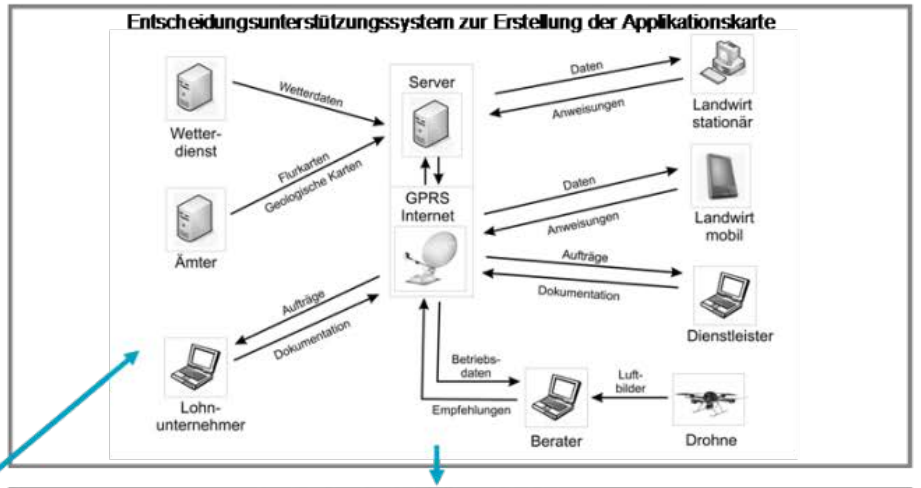
# UAV: Ortho-photo

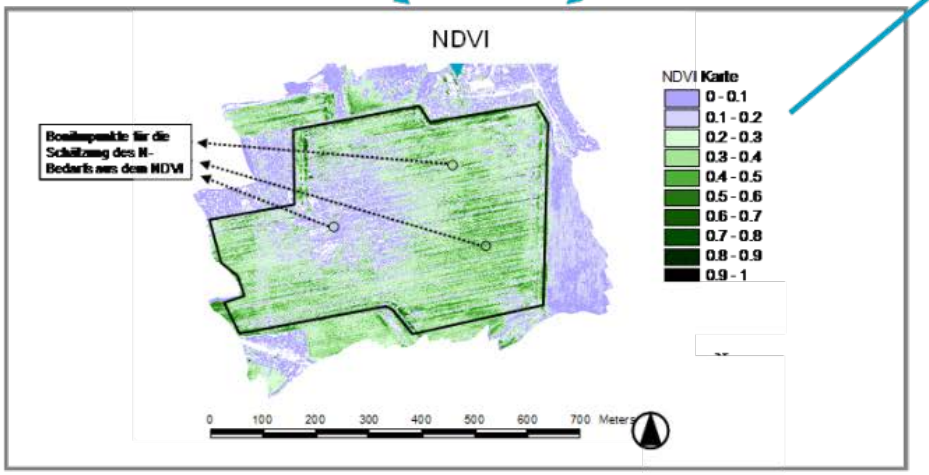
Automatic mosaiking and ortho-photo generation with AgiSoft ( < m 2 error)

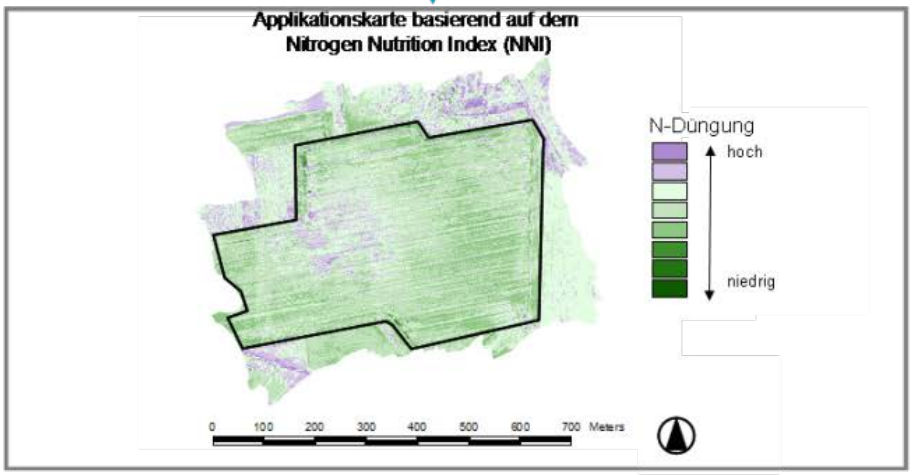


# UAV: Site-specific N application




*Ruprecht Herbst, HU Berlin, Germany,*
*ADLER - agricopter project, http://agricopter.de*

agricopter

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# UAV: Discussion

- Challenge to traditional remote sening
- Many applications: crop protection, N-management, cattle management, fish ponds, meteorology

- Limitations:
  - Batteries (duration of flight) for rotary wing UAV
  - National and EU wide privacy and security regulations

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# Applications
# Precision horticulture – a continent still to explore

# Applications: Precision horticulture

- Opportunity for PA: High value crops with intensive management (e.g. apple growers are spraying > 16 times per season)

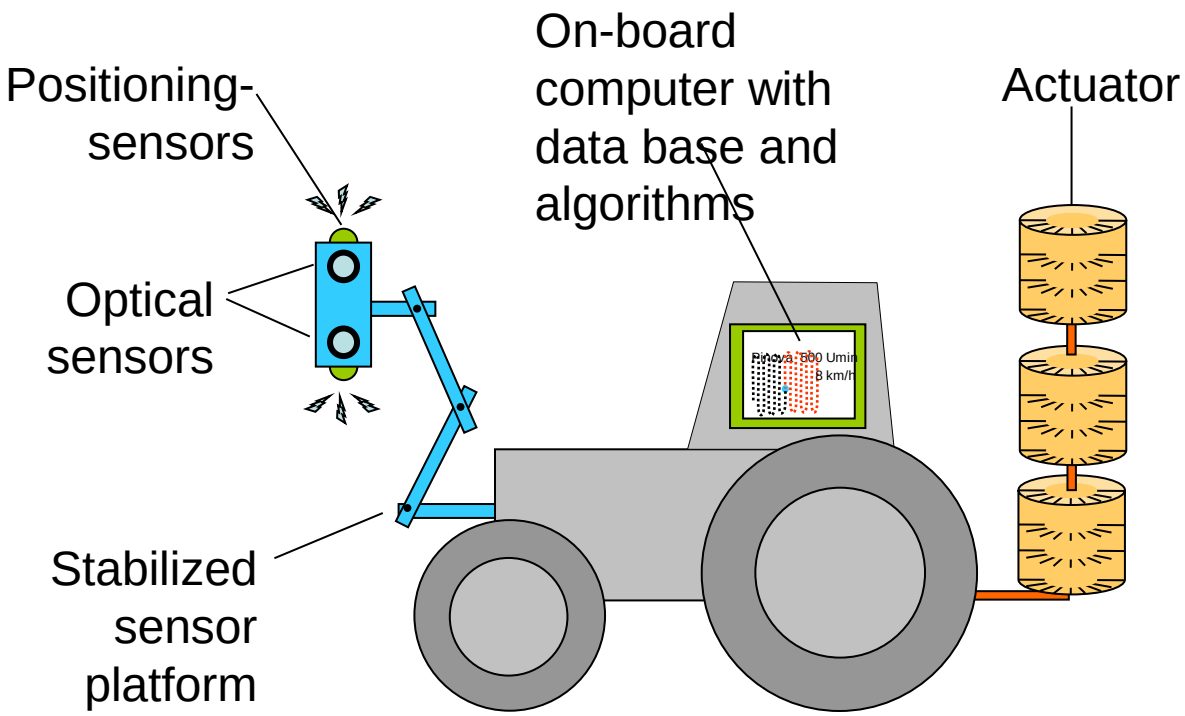
# Applications: Tree specific thinning

- Alternate bearing: Biannual cycle of yields with many small apples and a few big apples every other year (alteration between many and few flowers).
- Different from to tree to tree
- Thinning of flowers can regulate alternate bearing

Different number of flowers ⇨ Different number of apples ⇨ Different sizes of apples

# Applications: Tree specific thinning

OptiThin

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*www.gil-net.de/Publikationen/25_95.pdf*

# Applications: Discussion of precision horticulture

Problem: Diversity of applications

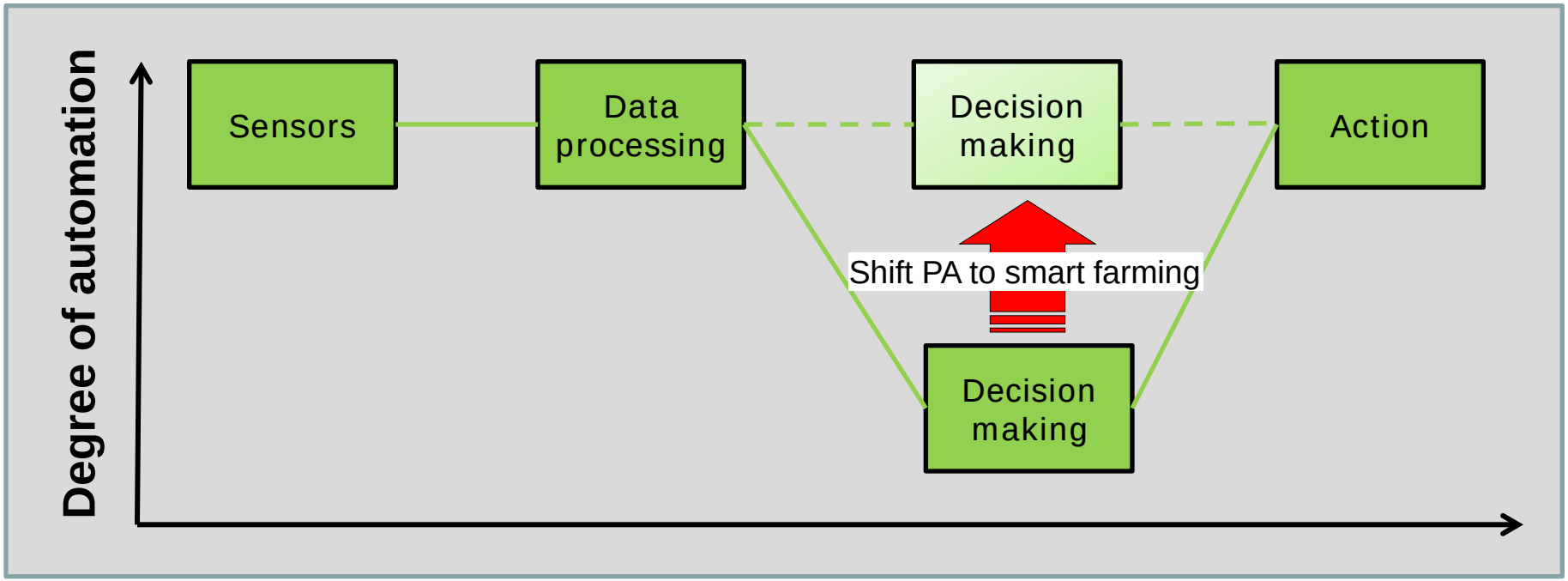
- Segmented market
- Lack of standards

Opportunities for small companies?

# Decision making
# From PA to “smart farming”

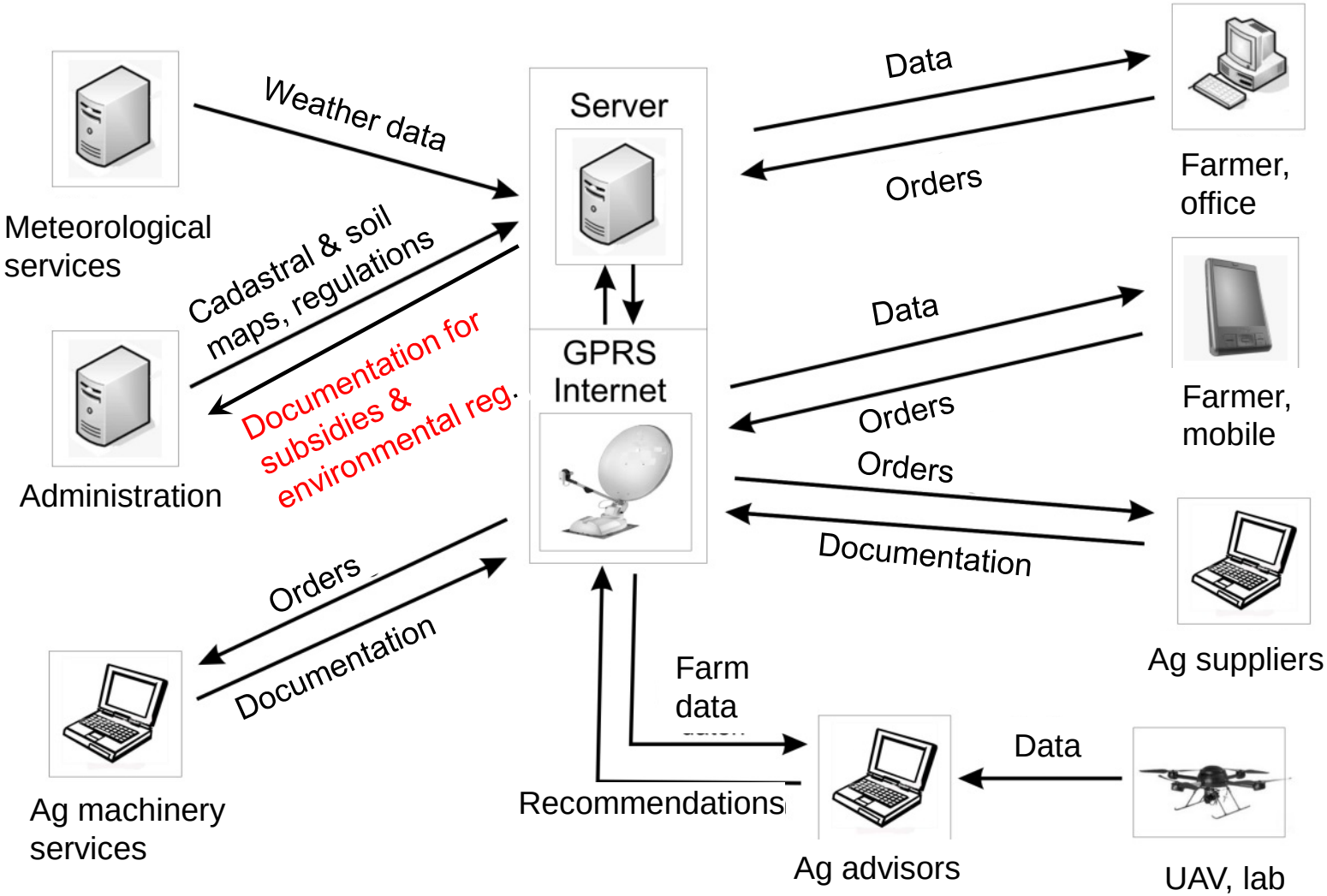
# Decision making: Smart farming

- The term “smart farming” became popular at the agritechnica 2011




*Hans Werner Griepentrog, Univ. Hoheheim, modified, www.uni-hohenheim.de/person/hans-w-griepentrog-1*

# Decision making: Network of location-based services




*Jörg Ruppe, GEO Net Terra, Germany, modified, www.geonetterra.de*

# Decision making: iGreen project

iGreen 2009 – 2013

Aims

- **network of location-based services** and knowledge, integrating various public and private information sources based on "**semantic technologies**"
- **mobile decision assistant systems** which facilitate the decentralized support and optimization of cooperative production processes.

24 partners, including 12 private companies:

- SAP AG, John Deere, CLAAS , Krone, Amazonen-Werke, Grimme, LEMKEN, RAUCH

Results

- **Machine-Connector**: communication of machines from different brands
- **GeoBox & MapChat**: Geo data services ag services providers
- **Test case potato production**

# Decision making: Summary

Growing demand. Farmers ask for:

- “smart” systems
- web based services
- mobile applications

Challenges

- Integrating / developing PA decision support algorithms
- Own experience (on-farm-research) vs instant black box (smart) solutions
- Data: privacy, security, ownership

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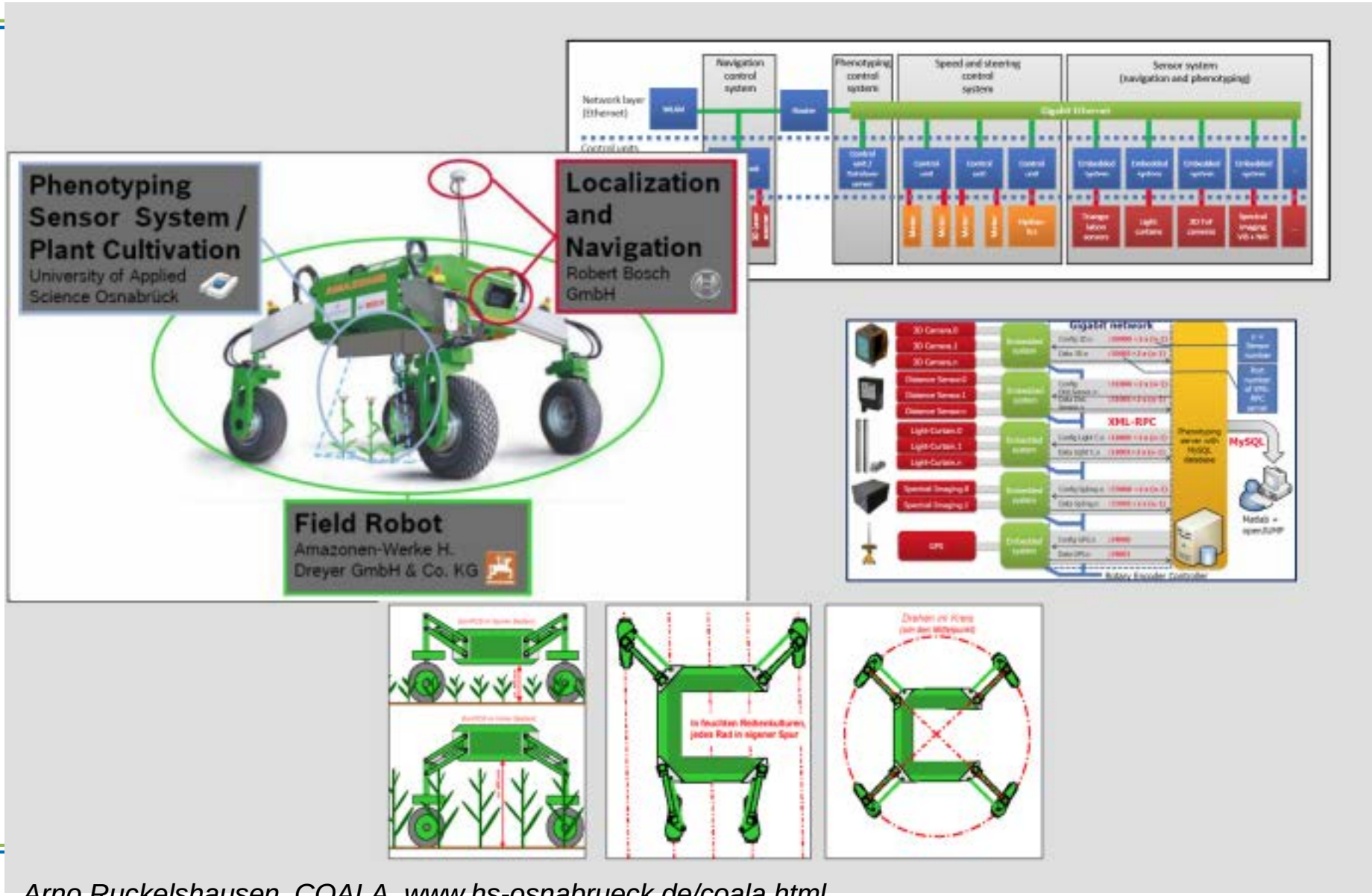
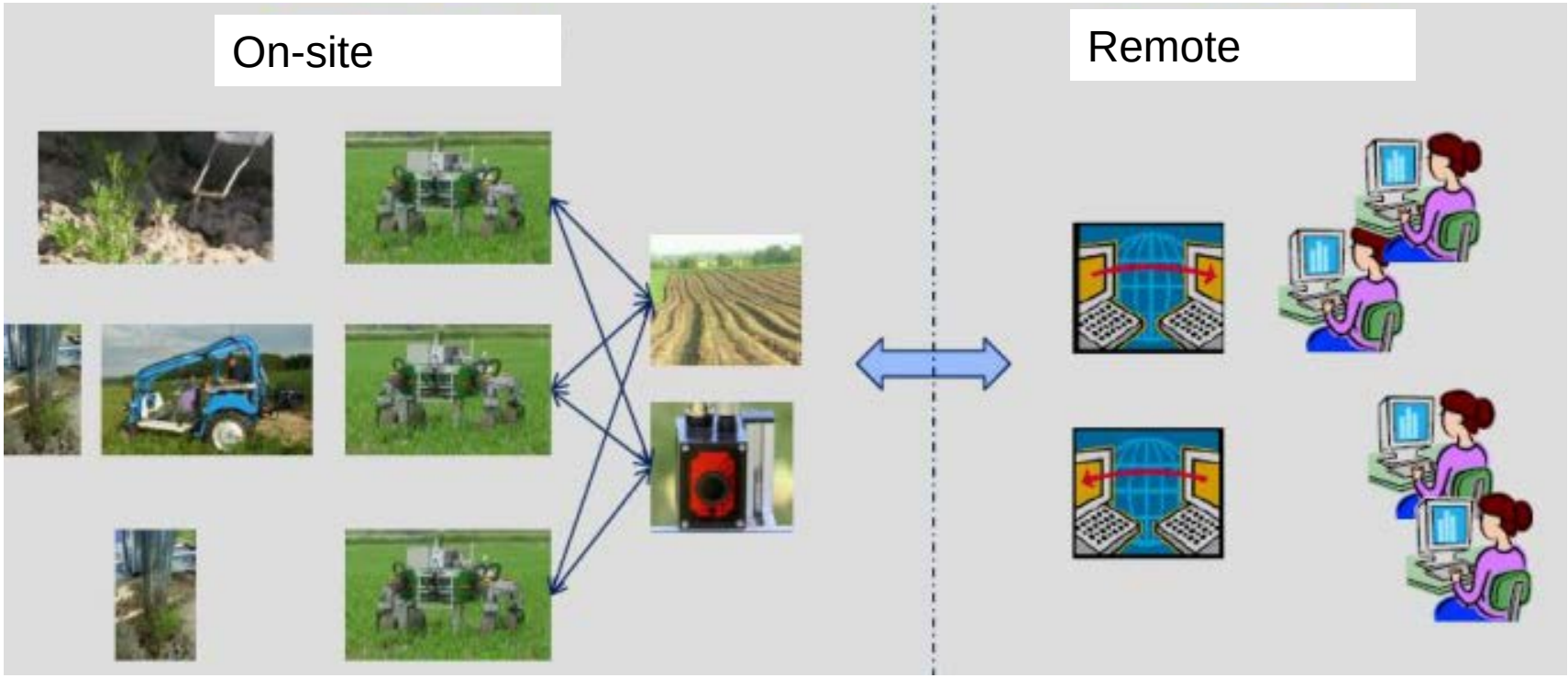
# Action

# Action: COALA field robot „BoniRob“ (crop scout)




*Arno Ruckelshausen, COALA, www.hs-osnabrueck.de/coala.html*

# Action: COALA Field robot „BoniRob“ (crop scout) and remote farming




| | |
|---|---|
| RemoteFarming.1a: „ | “Manual“ remote weed control |
| RemoteFarming.1b: | Image Processing proposed weed control |
| RemoteFarming.1c: | Self-learning based automatic weed control |

# Improving PA research by focussing and cooperation: Towards European PA centres

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# Cooperation: Agricultural Industry Electronics Foundation (AEF)

Established 2008
Seven AEF founding members
**About 140 members today**

Aim
provide resources and know-how for the **increased use of electronic and electrical systems in farming**.

ISOBUS was the main focus initially (**ISOBUS Test Center**, Univ. Osnabrück)

Shift to **standardization of agricultural applications in general**, e.g. farm management information systems (FMIS), electric drives camera systems

Introducing of **guidelines for ISO** (International Organization for Standardization) standards

*www.aef-online.org/de/*

# Cooperation: Competence Center ISOBUS

- Founded 2009 by AMAZONE, GRIMME, KRONE, KUHN, LEMKEN und RAUCH
- Common development of ISOBUS components:
  - **ISOBUS-Terminal CCI 100/200**
  - CCI.Apps
- Member in ag technology boards
- Information about ISOBUS for service suppliers, dealers and students
- New intiatitves for data managment, stearing by implement (TIM), on-board high voltage power supply

CC ISOBUS


*www.cc-isobus.org/*

# Cooperation / focusing: John Deere's European Technology and Innovation Centre (ETIC)

- 2010 John Deere has officially opened its European Technology and Innovation Centre (ETIC) in Kaiserslautern, Germany.

- Focus is on
  - intelligent solutions,
  - integration of electronics into tractors and harvesting equipment
  - technologies that help to automate machine operation, reduce operator fatigue and increase machine productivity in the field.

- John Deere has recently become a shareholder in the German Research Centre for Artificial Intelligence (DFKI)

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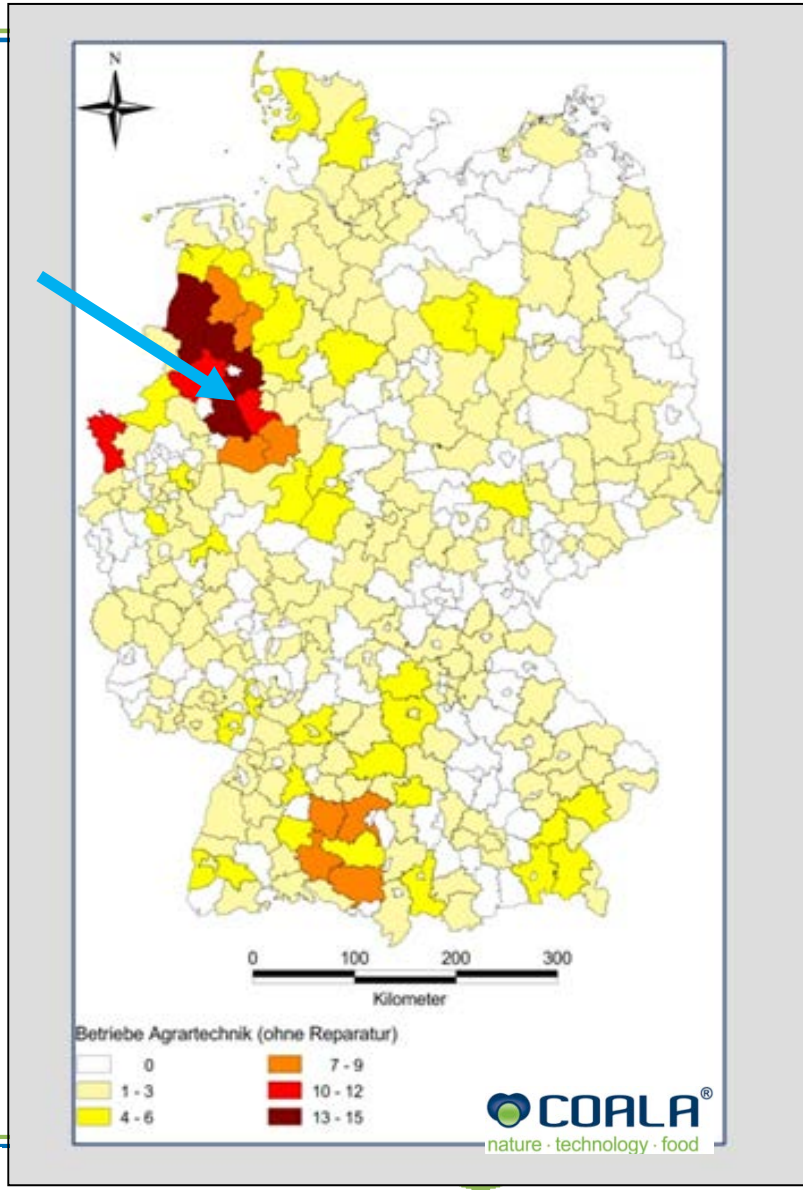
# Cooperation: The COALA experience from Germany

www.hs-osnabrueck.de/coala.html

- Competence Of Applied Agricultural Engineering
- Outreach centre of the University of Applied Sciences Osnabrück, Germany
- Located in the heart of Germany's "Agrotech Valley"




*www.hs-osnabrueck.de/coala.html*

*Niedersächsisches Institut für Wirtschaftsforschung (2009): Die Agrartechnik-Branche im Osnabrücker Land. NIW, Hannover, Germany*

# Cooperation: COALA network
# http://www.hs-osnabrueck.de/coala.html

Technology Transfer

Startups

R & D

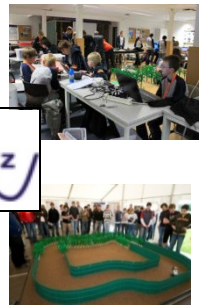
Education

Funding

Schools

Networks

Cooperation



# Cooperation: COALA results

BoniRob field robot

COALA®
nature · technology · food

KOMOBAR
Decision support and communication structures for mobile machinery


Der Abfahrer startet die Zeitnahme.


Wie lange dauert es, bis der Anhänger mit Mais gefüllt ist?

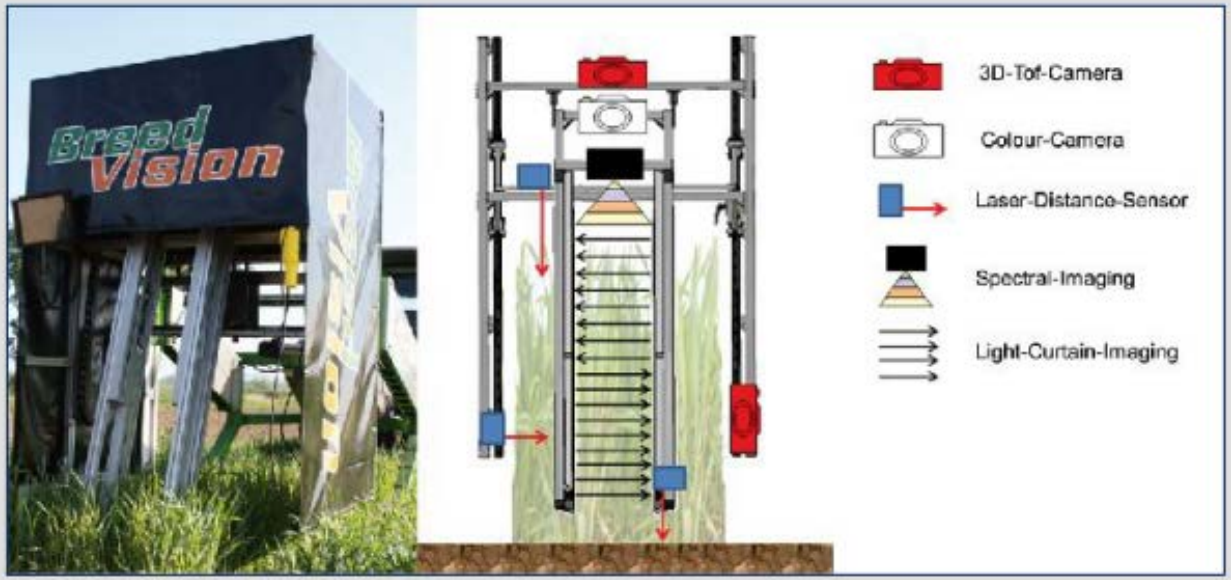

Der Countdown gibt an, wann der Abfahrer wieder beim Häcksler sein sollte.


Alle an der Häckselkette Beteiligten sind mit einem Fingerdruck erreichbar.

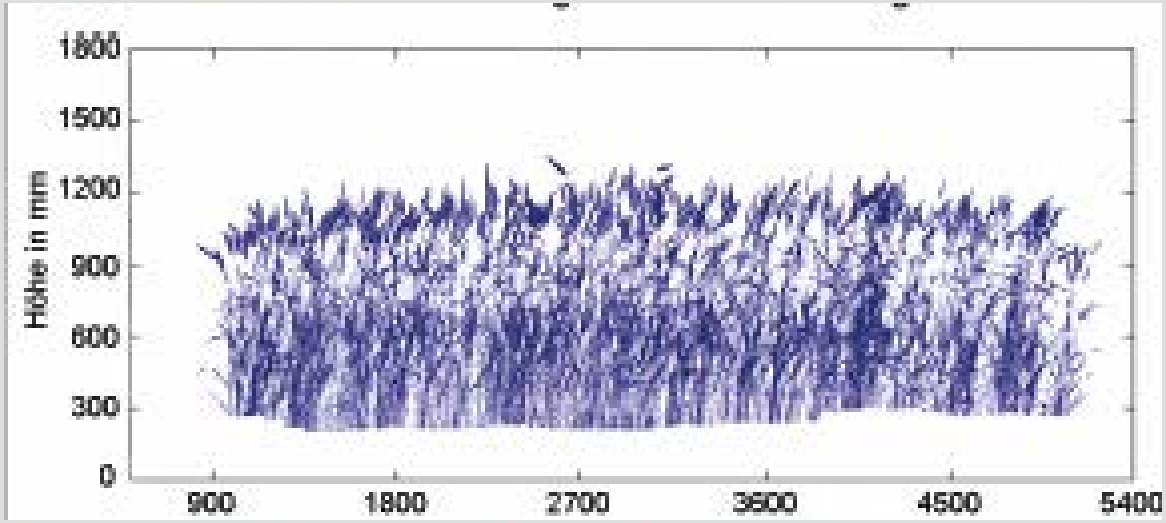
Nach Auswahl des Kamera-Symbols erhalten die Fahrer Einblick in den Anhänger.


*COALA, www.hs-osnabrueck.de/coala.html*

# Cooperation: COALA phenotyping system




Phenotyping system
Breed Vision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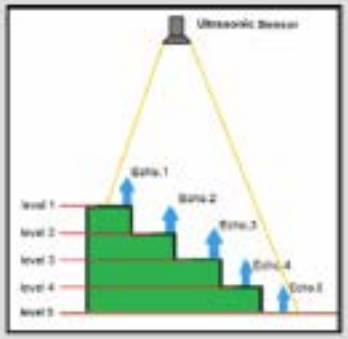
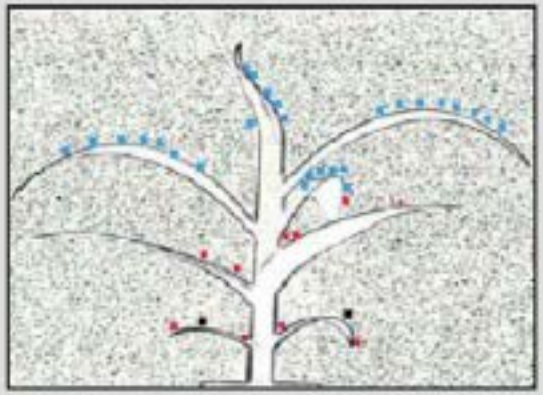
*Arno Ruckelshausen, COALA, www.hs-osnabrueck.de/coala.html*

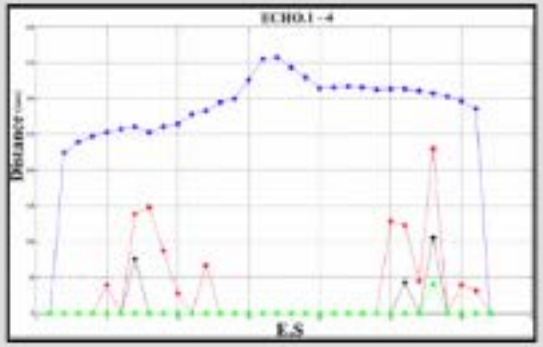
# Cooperation: COALA ultrasonic sensor


P3-Sensor Agricon / Yara / Hochschule Osnabrück

Agritechnica 2011







# Cooperation: Summary

- Cooperation can promote precision ag
- Cooperation is possible, even with competing companies

- It takes time to get results
- It needs favourable conditions (people, infrastructure, money etc.)

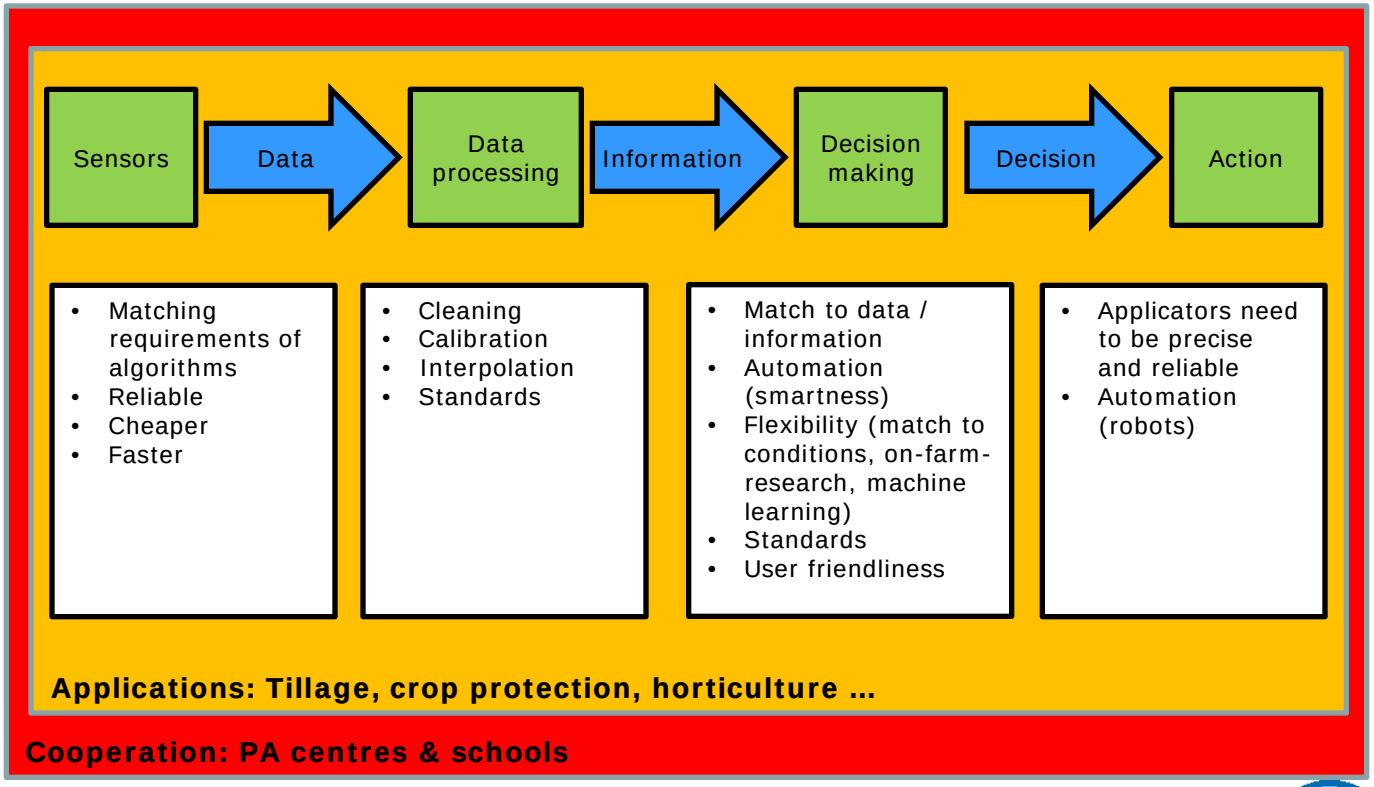
- **Towards European PA centres?**

ATB

# Summary

# Summary

Step by step: Evolution not revolution

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