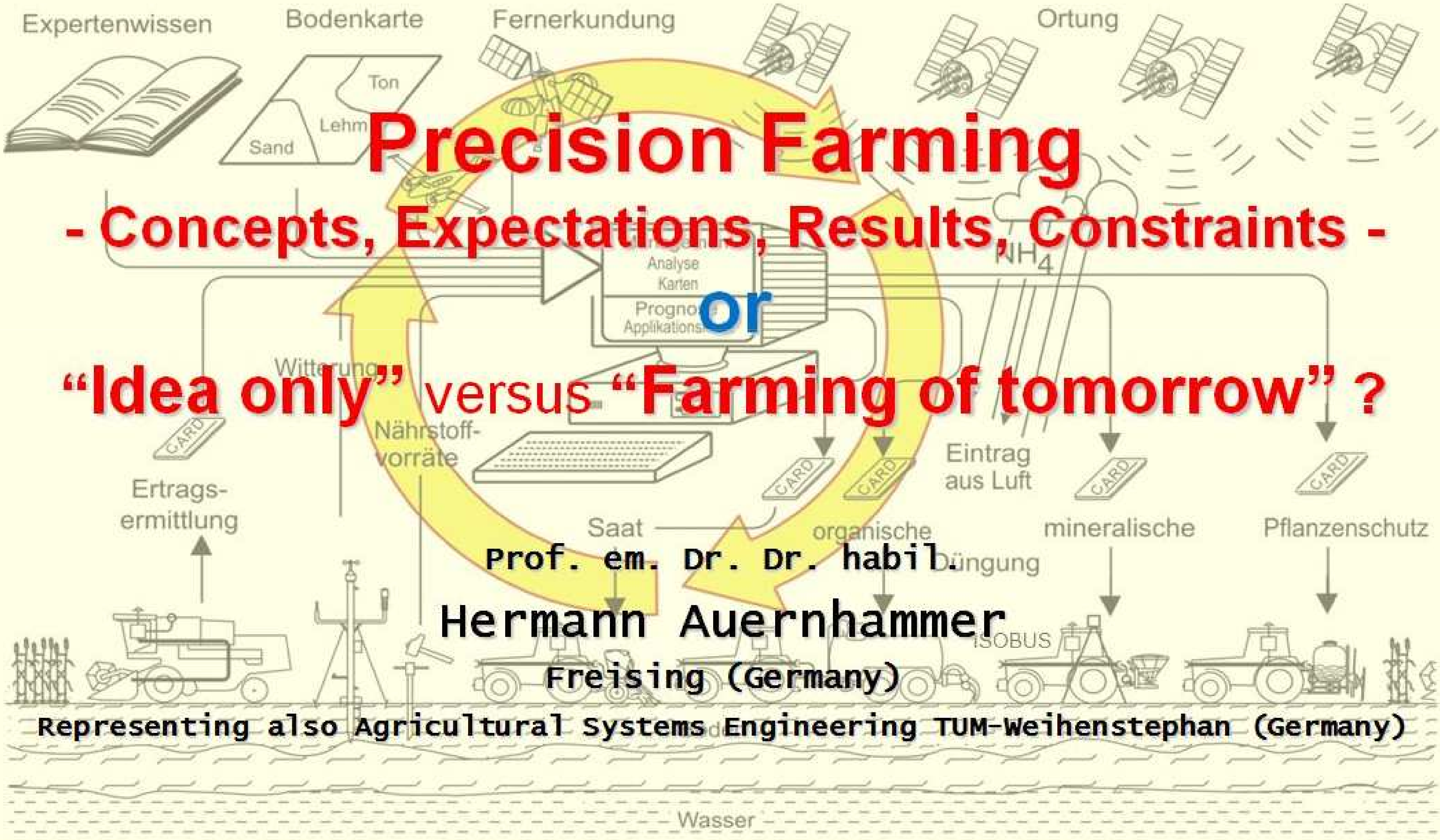
Precision Farming
- Concepts, Expectations, Results, Constraints -
or
"Idea only" versus "Farming of tomorrow" ?

Prof. em. Dr. Dr. habil.
Hermann Auernhammer
Freising (Germany)
Representing also Agricultural Systems Engineering TUM-Weihenstephan (Germany)



ECPA / EFITA / ECPLF

JIAC Conference Cross-Theme Session „Commonalities of Technological Innovation Adoption"

July 8, 2009

Wageningen (The Netherlands)

From the Diary of a young Farmer.

A small utopia of agricultural technologies in 2010

Writter in **1949**

What do we learn from this expectations:

Mai 20, 2010: In the region behind ...

Mai 25, 2010: A memorable day ...

June 2, 2010: Yesterday I attended the Agricultural Exhibition in Detroit with an ultra sonic jumbo ...

June 5, 2010: Today we got a presentation of the newest model from the Atomin-Tractor Company by the after-sales service on 3D-Television. It's a "Double-base Robot" build from two tractors. The operating control unit is loaded in the morning on the farm. The robot is autonomously doing all tasks. There are expectations that the present pre-defined operation time of two hours could be extended. The in-build 10-body plough has an independently depth control by radar sensors.

June 18, 2010: The extension officer ...

Planes are big and fast **!**

Nuclear power is the power of the future **?**
(don't forget that at this time atomic power determined the policy – like today again)

Robots are doing agricultural operations **!**

Robots are build from tractor units **!?**

The plough is "in-build" or the plough has one robot at the front and one at the rear or the time of tractors is over **!?**

Predefined operation time is limited by storage capacity **??**

Sensors are commonly used **!?**

…

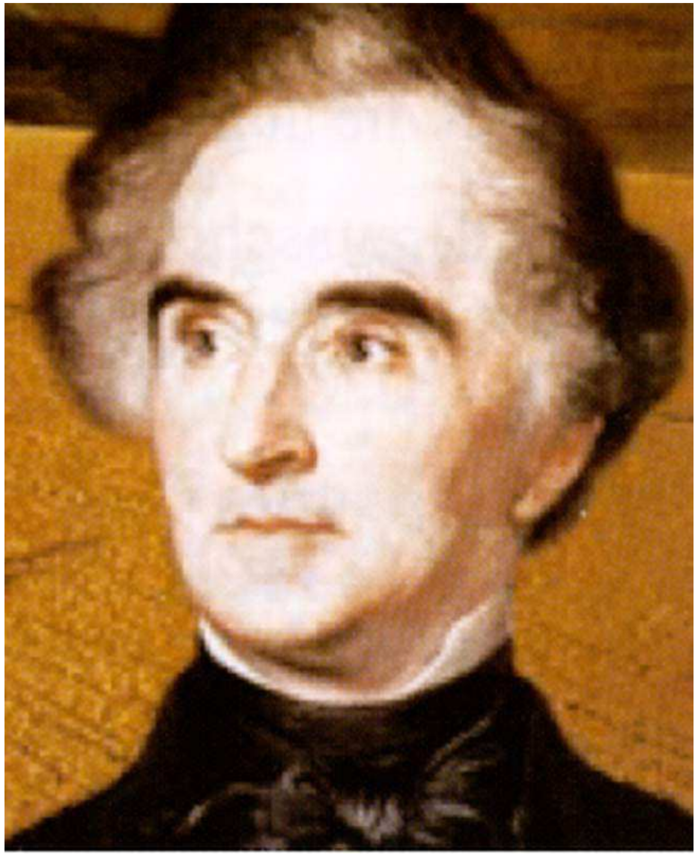
Some very true expectations and still some open questions!

http://www.landlive.de/images/144589/

The Vision by J. v. Liebig (A great natural scientist and a great European)

„... . One day (it was around 1850) Liebig said:

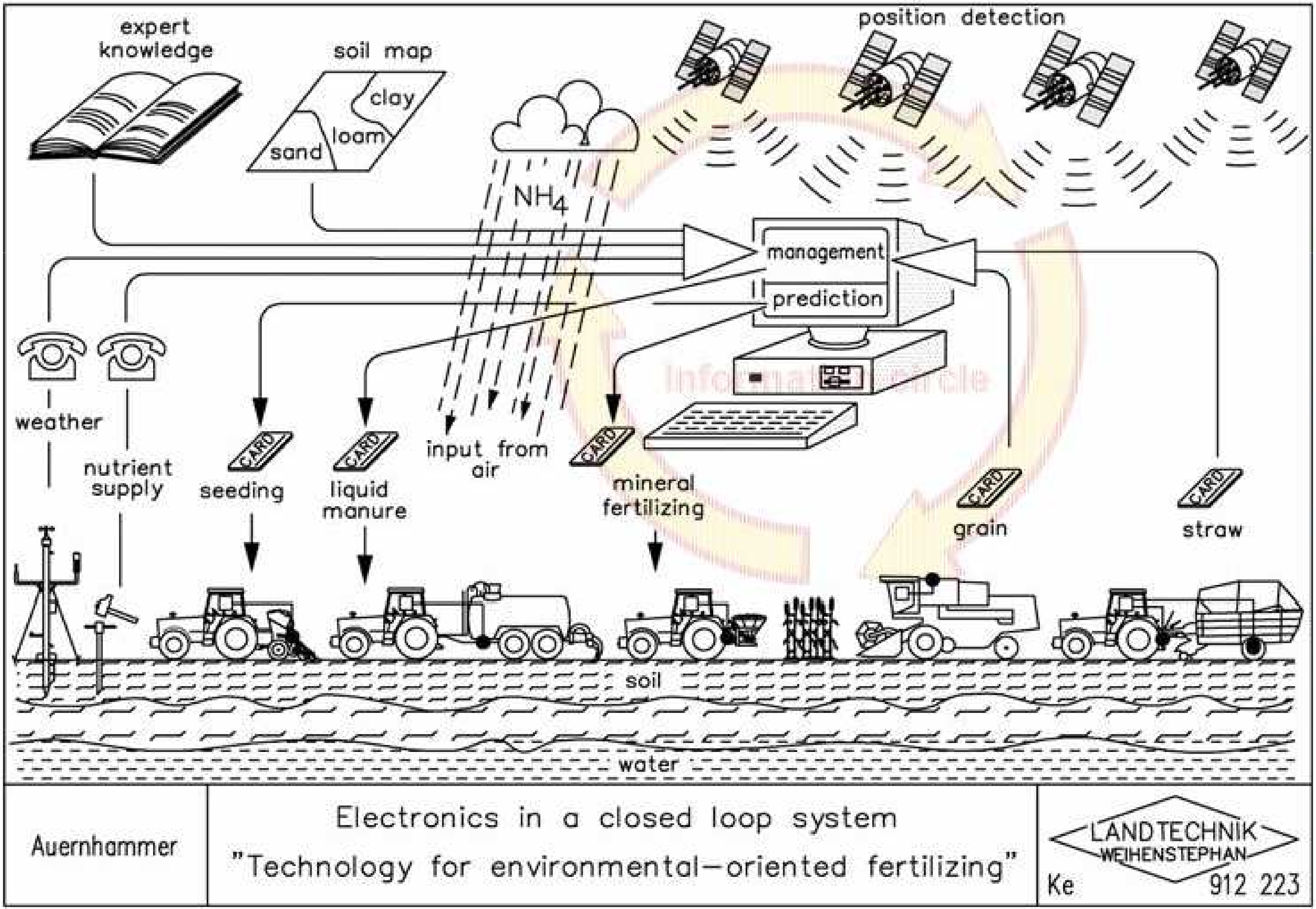
The farmer will be able to assess the exact yield during harvest like a bookkeeper is doing in a well controlled factory; then by simple calculations he could determine highly precise all substances which he has to replace in each field, also by amount, to restore the fertility (85).



→ ***This is "Precision Farming by Balance on Field-scale", in a "Mapping Approach"!***

Brock, H.: Justus von Liebig. Braunschweig: Vieweg Verlagsgesellschaft 1999, p. 148, own translation

Precision Farming 1991 – human driven to information driven



Automated Agriculture in the 21st Century, St. Joseph (USA) 1991, pp. 494-402

Careful Valuation "Precision Farming Approach" 2009

	Scientists	Manufacturers	Farmers
Expectations	More data	Increased product value	Reduced costs
	Site-specific information	To get lead over competitor	Higher benefits
	Improved data quality		Improved farm management
	More understanding		Increased recognition by society
Results	Data flood	Data files	Extra investments/costs
	Proprietary interfaces	(coloured pictures)	Coloured pictures
	Proprietary data contents	Questions about "What to do"	Consultant/company specific advices
	Valid and invalid data		Inherent data communication
	New questions		Less/no yield increase
Constraints	Sensors all in all	"Still blacksmith" (intelligent sheet folders)	Reservation against new technologies
	Well customised sensors	Problematic OEM-situation (globalisation)	Less competence/qualification in ICT
	Sensor quality/stability	No "Full-line"	Fit to farm management (heterogeneity, nitrogen)
	Data algorithms	Existing patents	Existing farm mechanisation
	Given/accepted agronomic rules	Clear committment to standards	Willingness of contractors
			No standard solution
			No accepted communication standard
			No financial reward for environment protection

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No fit to farm management
(heterogeneity, nitrogen fertilisation)

No real widely accepted
communication standard

Questionnaire on Precision Farming 2006

Germany, 27 Farmers; average farm size 2.500 ha (by WAGNER)

No.	Responces	Question	yes [%]	
1	27	Do you think PA makes sense in an economical point of view	88 %	
2	27	Do you think PA makes sense in an ecological point of view	96 %	
3	27	Will PA be the only farming system of the future	52 %	
4	12	If you do not use PA on your farm, what are the reasons?		
		No benefit	*8* %	
		Investment costs to high	*83* %	
		Additional labor required to high	*66* %	
5	15	What are your site-specific treatments?		
		Tillage	*46* %	
		Drilling	*27* %	
		Basic fertilization	*55* %	
		N-Fertilization (Mapping approach)	*36* %	91 %
		N-Fertilization (Sensor approach)	*55* %	
		Fungicide / stem stabilizer application	*27* %	63 %
		Herbicide application	*36* %	
6	14	How is the labor requirement through PA		
		Much more higher	*29* %	
		Marginally higher	*36* %	
		Similar	*14* %	
		Smaller	*21* %	
7	13	What are your future strategies for the usage of PA on your farm?		
		Will be extended	*84* %	
		Same level	*8* %	
		Reduced level or even no PA	*8* %	

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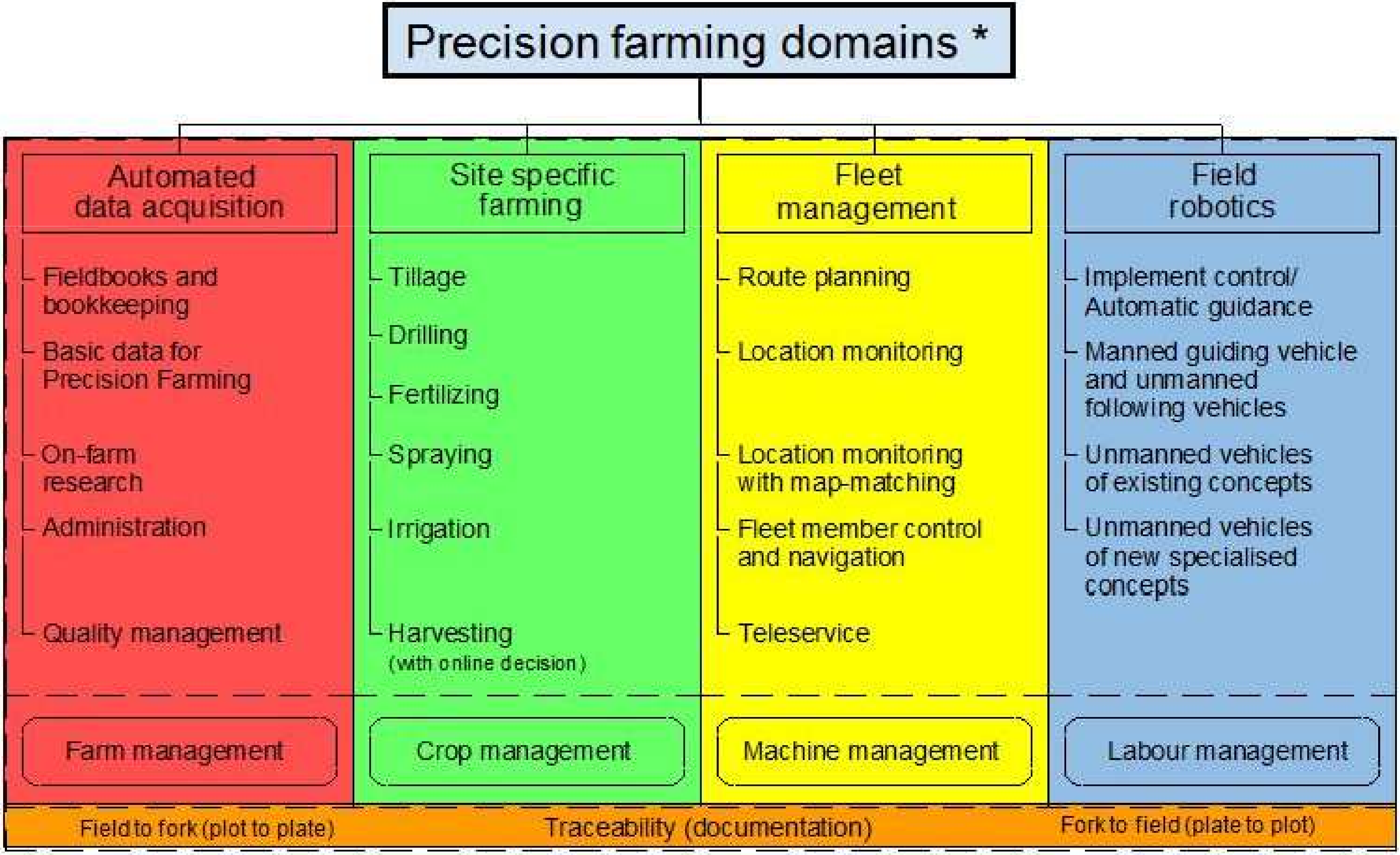
? How to overcome the constraints ?

(each solution creates
new expectations, results and constraints)

„Precision Farming“ more than “Site-specific Farming”

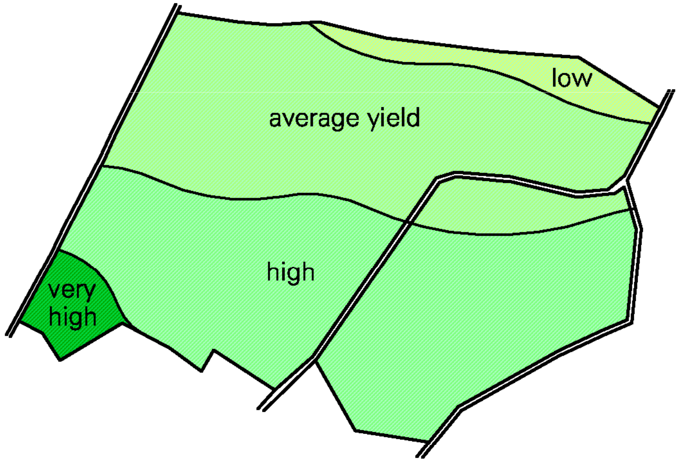


*) First draft established 2001, Dec 4 by the author

Approaches for Site-specific Part Field Management

Site-specific crop management

Large-scale farming

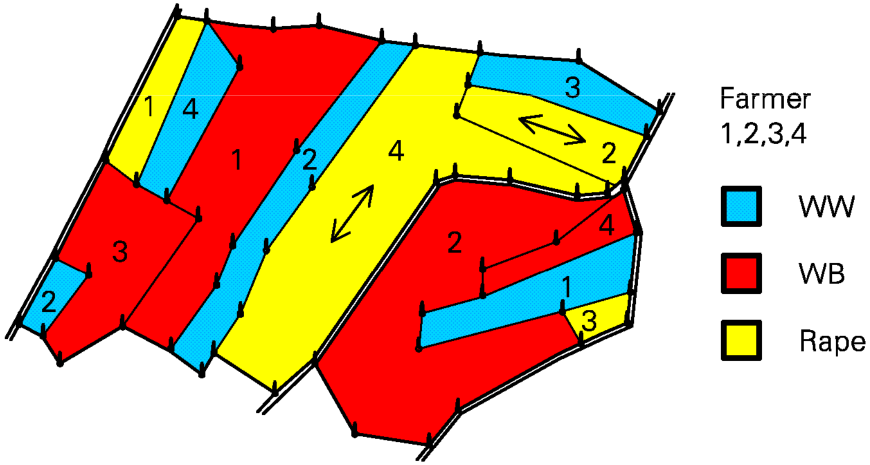


Derivation and determination of homogeneous partfields

- Determination of heterogeneities
- Determination of management zones (same yields) under consideration
  - Technical differentiation
  - Economical efficiency
  - Ecological efficiency

Part field determination by minimum field sizes
(> 3 ha to > 10 ha)

Small-scale farming

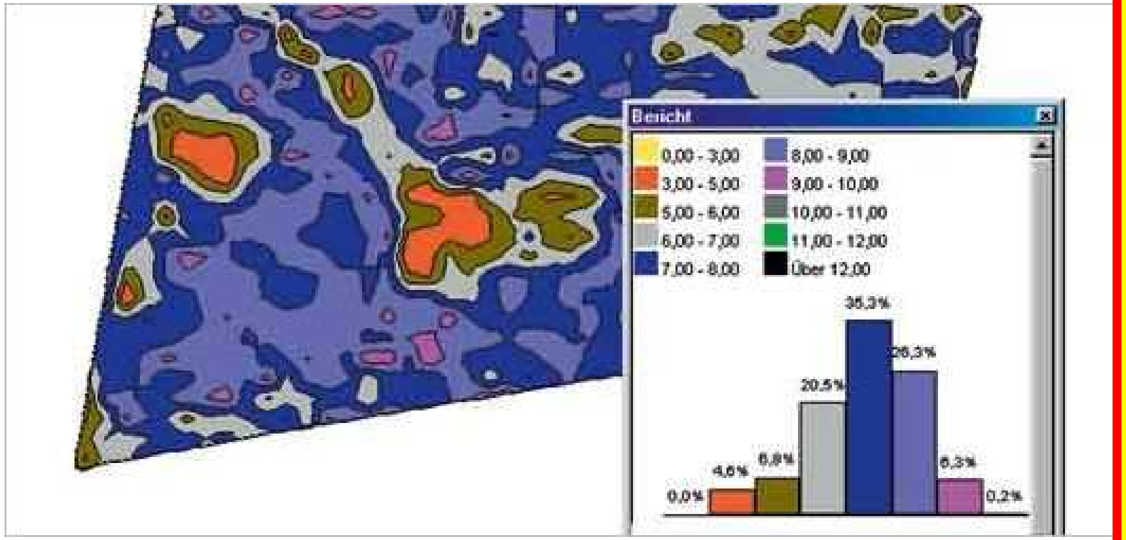


Consideration of part fields from different land lords in a transborder field

- Assembling of small fields with equal crop rotation
- Definition of part fields from ownership/field operators
- Field operations by common operation target
  - Ownership
  - Common yield target
  - Heterogeneity

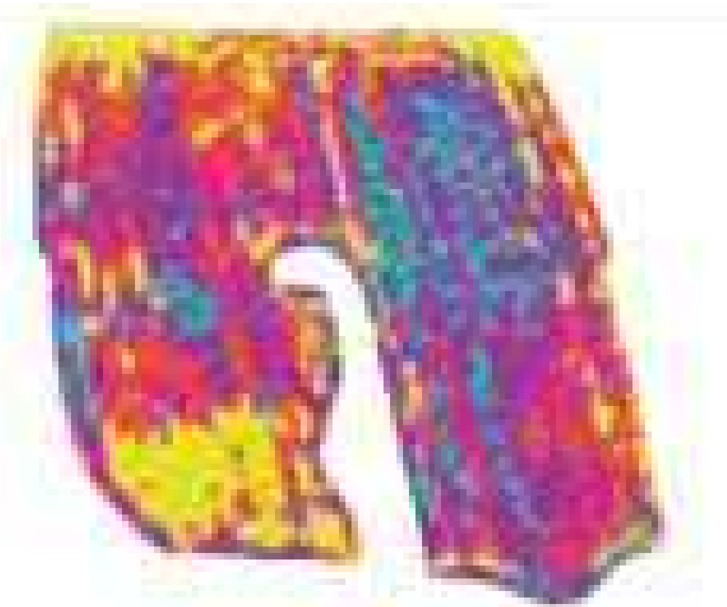
Size of transborder fields limited by existing infra structure (roads, ditches, ...) and crop rotation

Yield maps – what we get !



http://www.claas.com/countries/generator/cl-pw/de/products/agrarmanagement/ertrag

Downloaded July 7, 2009



http://www.deere.de/de_DE/products_ag/ams1/ertragskartierung.html

Downloaded July 7, 2009

Coloured pictures!

Why:

- Yield classes separated by 1 t/ha ?
- Colour “black” is highest yield (black means “mourning”) ?
- Other colours used by other companies ?

What to do:

- Using combines of different companies on same field at same crop ?
- Using combines of different companies year by year ?
- Having combinable and non-combinable crops in the rotation?
- …

Yield maps – what we need !

1) Yield means absolute yields (dry matter, protein, starch, ...

2) Yield classes must be separated by need/capability of adjacent technology,
   - related to significant different amount,
   - minimum working length,
   - minimum acreage

3) A decision tree differs to a maximum of 4 different yield types
   - no in-filed yield variation (uniform application/processing),
   - high and low yield zone(s),
   - low, average and high yield zone(s)
   (- very low, low, average, high and top yield zone(s))

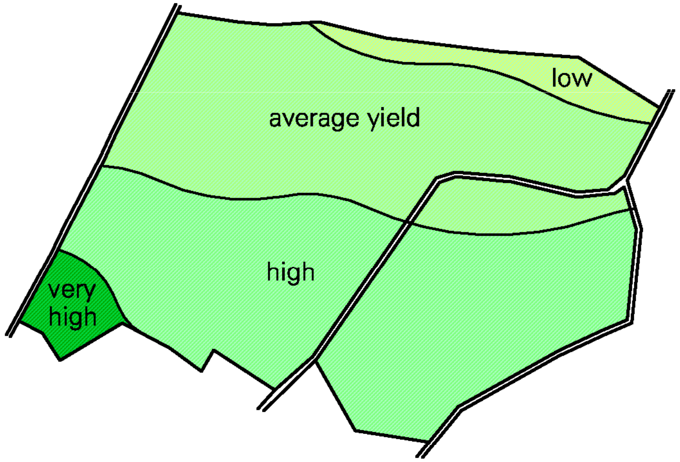
4) Standardised colours enable simple understanding and true reproducibility like “traffic lights”, related to
   - economics (**red “costs higher than benefit”,** yellow “…”, …)
   - quality (**red “poor”,** yellow “..”, …)
   - environment (**red “high pollution”,** yellow “…”, …)

No beneficial On-farm use without an ISO-standard !

Approaches for Site-specific Part Field Management

Site-specific crop management

Large-scale farming



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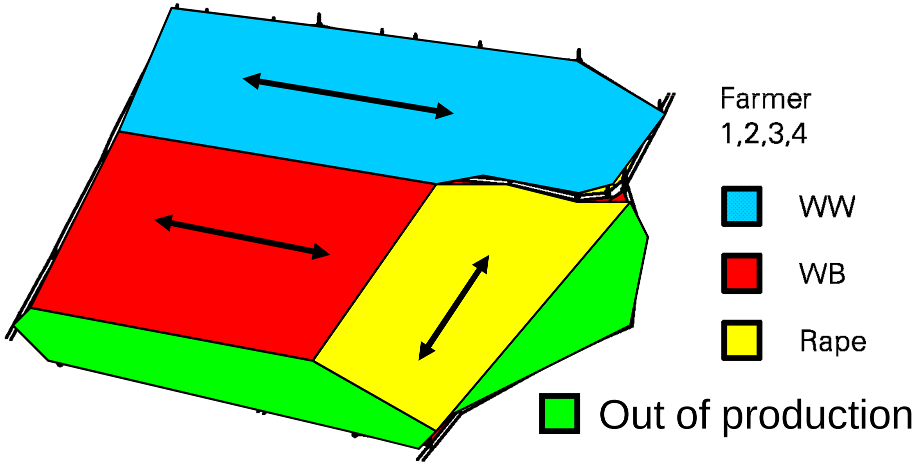

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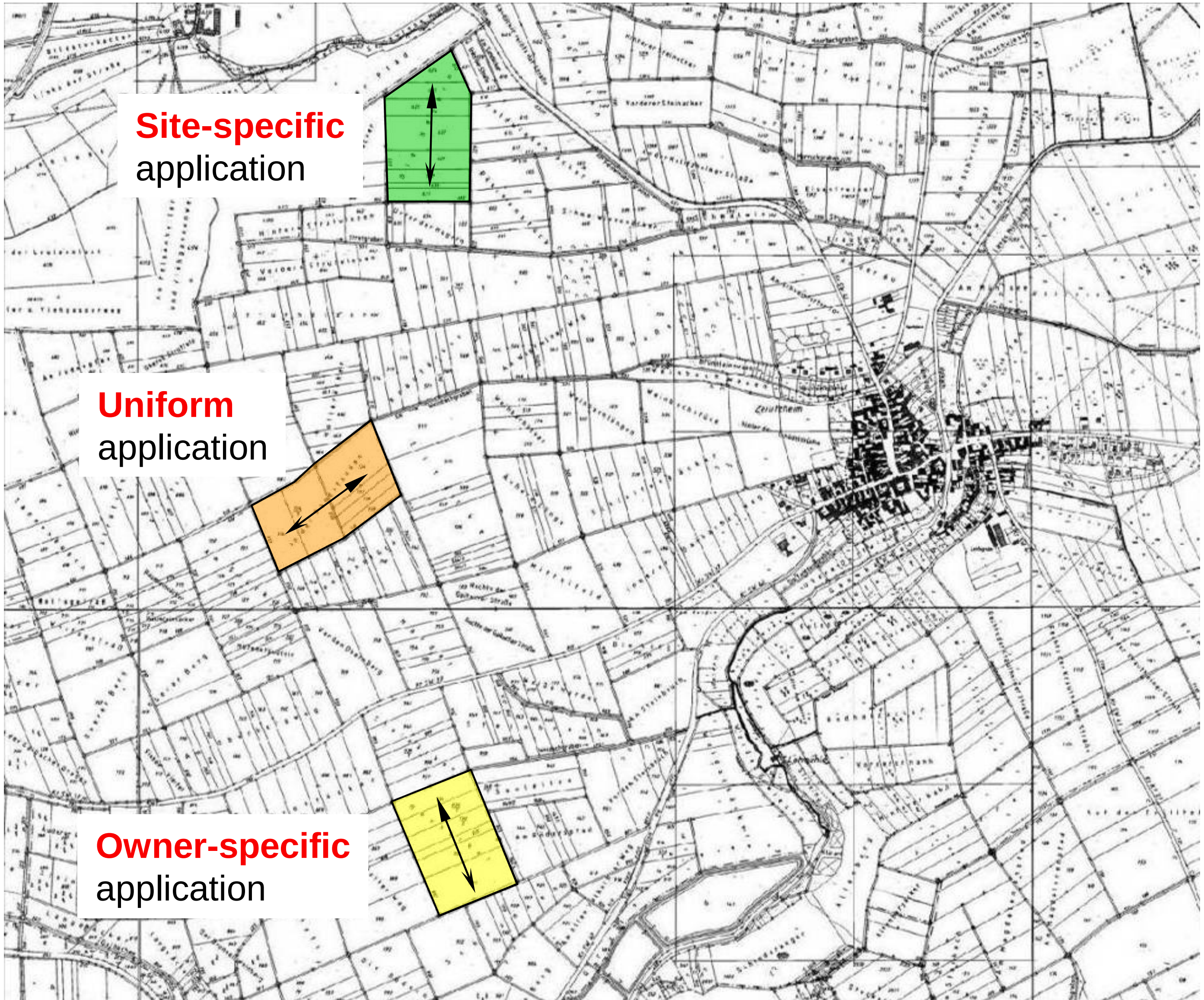
Experiment "Transborder Fields" (Zeilitzheim, Germany 2002 - 2005)



20 single fields from **5** different farmers were taken into **3** **transborder** fields

Consolidation factor was **7:1**

Labor saving was about **35%**

Savings in variable machinery costs was about **30%**

Economical benefit was about **315 €/ha**

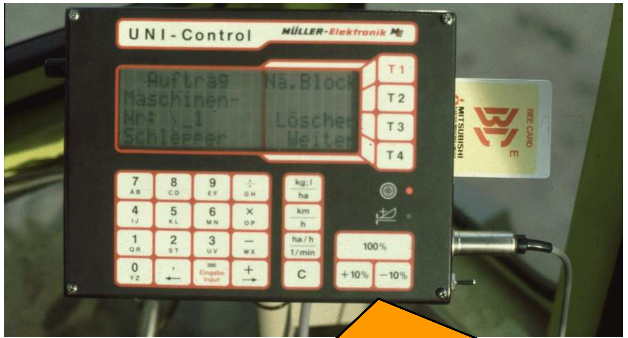
In the meantime several transborder systems are in operation, one of them for **more than 10 years !**

Careful Valuation "Virtual Land Consolidation"

	Scientists	Manufacturers	Farmers
Expectations	Reduction of labour time	Sales of larger equipment	Less usage of own techology, increased costs
	Reduction of fuel	Intensified use of equipment	Less freedom in own decisions
	Reduction of soil compaction	High-tech prerequisite	Intervention into ownership
	Intensified social contacts		Slow loose of ownership
Results	Savings according to simulations	Requirements difficult to fullfill	Significant savings in labour
	Social impacts higher than expected	Data interfacing not resolved	Significant savings in costs
	Conviction difficult		Increased social contacts
			Worthless own old technology
			Over capacity in manpower per farm
Constraints	Knowledge in urban sociology	Still no standardised interfaces	Reservation against cooperation
	Competition with established administrations	Multiple controllers necessary	Change of own mind
		Certain equipment preferred by farmers may be excluded	Still enough income (to less pressure)
			Future uncertainty of children
			Contractors not prepared
			Advisory service not up-to-date
			Land consolidatition administration worried to loose jobs

N-Fertilisation: Human Sensors and Experience

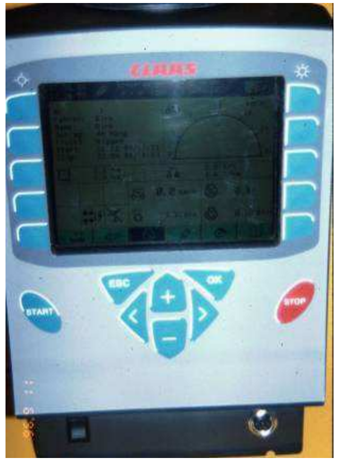
(more than **40.000** multi-purpose control units in Europe since 1985 in use)



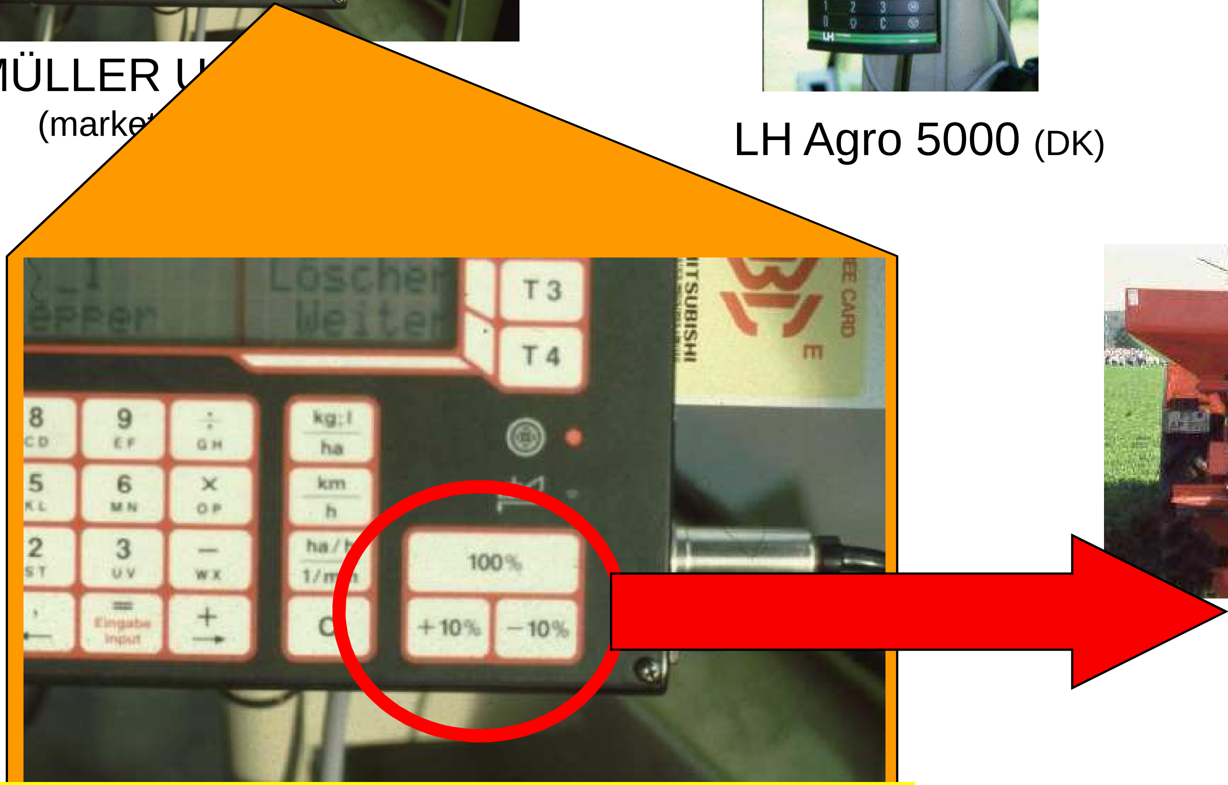
MÜLLER U

(marke

LH Agro 5000 (DK)



CLAAS agrocom. ACT (D)



+/- keys together with the **100%-key** allow a fast and convenient adjustment

Real-time Growth Detection

Mech. Resistance

Detection on small detection area inside the tram-lines

First sensors in use

NIR passiv

NIR active

Canopy reflection (→ indirect bio mass) on wider detection area

The standard sensor

Laser

Crop condition,
Crop density
Crop height
measured on two strips
(height x density = bio mass)

Still not on the market

NIR Sensor Approach (example YARA N-Sensor)

N-Sensor® (*Passive System*)

N-Sensor® *ALS* (*A*ctive*L*ight*S*ource)

*More than **600 systems** in use worldwide:*

- *about **550 systems** used in **Europe**,*
- *out of them about **400 systems** used in **Germany**,*
- *average field capacity per system around **4.000 ha**,*
- *standard procedure applies **more nitrogen** on part fields with **lower bio mass**,*
- *for last dressing application may be changed to the **opposite control strategy**,*
- *systems almost used for **nitrogen fertilisation only.***

Careful Valuation "N-Fertilisation with Real-time Sensing"

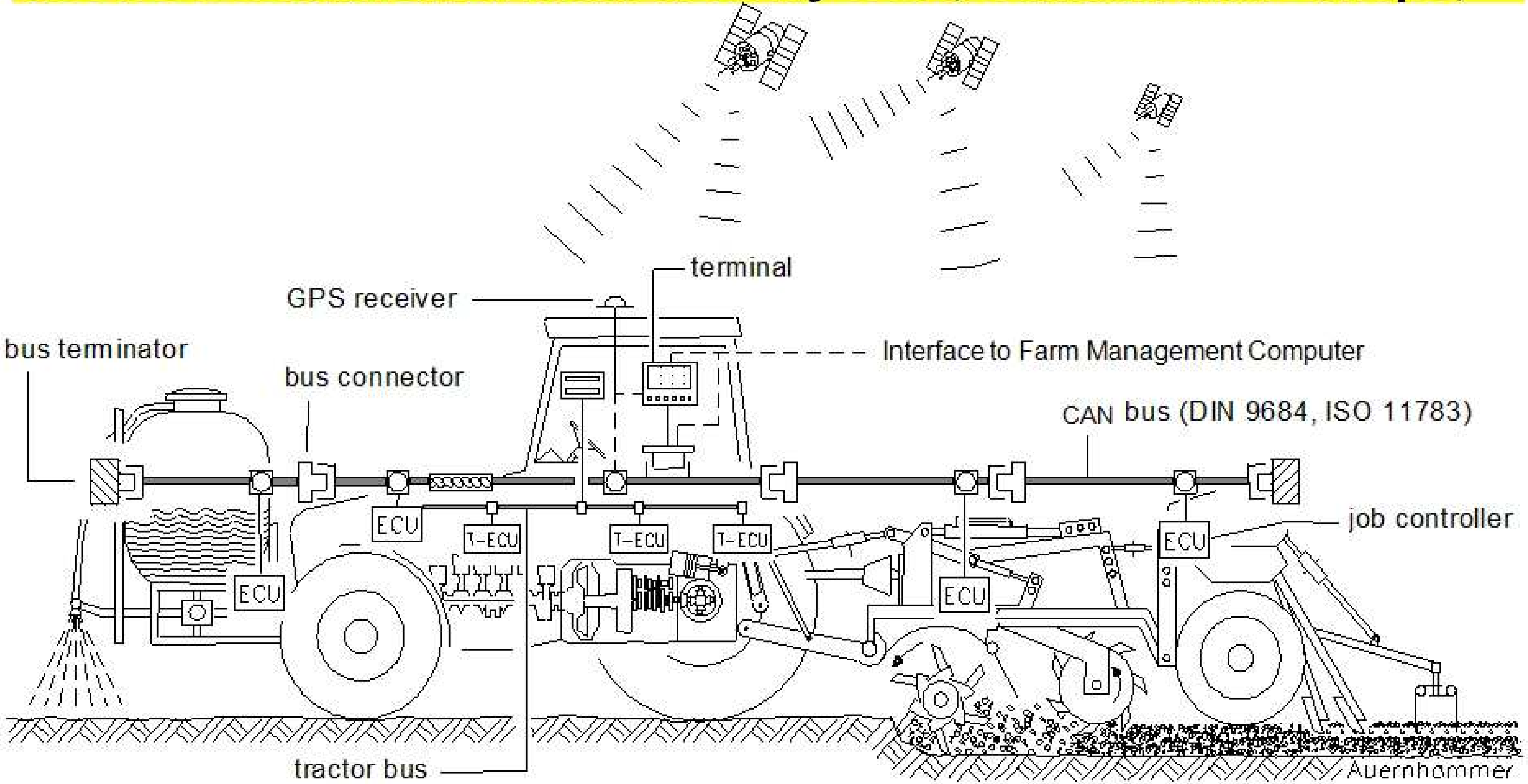
	Scientists	Manufacturers	Farmers
Constraints	Limited sensor performance	Basic knowledge in sensor technology	High investment
	No real "closed-loop control" available	Basic knowledge in crop reaction	Difficult integration in existing equipment
	Map-Overlay not realised	Interfacing	No solution for small/young crops
	Usability in small crops with less canopy		Un-secured control algorithms for certain crops

Agricultural BUS Systems by DIN 9684 and ISO 11783

Agricultural BUS Systems by DIN 9684 and ISO 11783

LBS established 1987 – 1997 in Europe by a team of D, NL, DK consulting with GB, F (predecessor and initiator of the ISOBUS)

ISOBUS established from 1994 by USA, Canada and Europe,



Careful Valuation "ISOBUS"

	Scientists	Manufacturers	Farmers
Constraints	Standard meanwhile to complex	No honest commitments	Lost believe to ISOBUS announcements
	Tractor manufacturer don't allow "tractor-control by implement"	SME's still have no own electronic people	Plug and "have problems"
		Still scepticism against electronics in some enterprises	Less assistence and help (left allone) in mixed manufacturers ISOBUS systems
	Tractor manufacturer impose pressure against SME's	No overall communication concepts	Existing farm mechanisation
	Sensor fusion not standardised		Difficult incorporation of existing implements
	No real-time ability in CAN		Sometimes to many unusable extra features

Commonalities related to "Precision Farming"

Scientists

- Have very often restricted understanding of "real farming" of today and tomorrow
- Are often "Lone Fighters" or have no teamwork abilities/facilities
- Should do more in sensor development and sensor integration
- Should things make simple

Manufacturers

- Have still problems with ICT, especially related to in-house acceptance and in-house integration
- Try to be dominant and have company-specific "add on's"
- Have a certain distrust to standards
- Need pressure from competitors

Farmers

- Are willing to accept and adopt ICT solutions, bigger farms more than smaller ones
- Lost believe in well formulated announcements
- Be often "alone with their problems"
- Prefer "simple solutions"
- Need more farm-specific/regional-specific solutions

"Plug and ..."

• **Plug and play**	What we like to have
• **Plug and have problems**	What we get
• **Plug and pray**	An optimistic attitude
• **Plug and pay**	Otherwise no running system