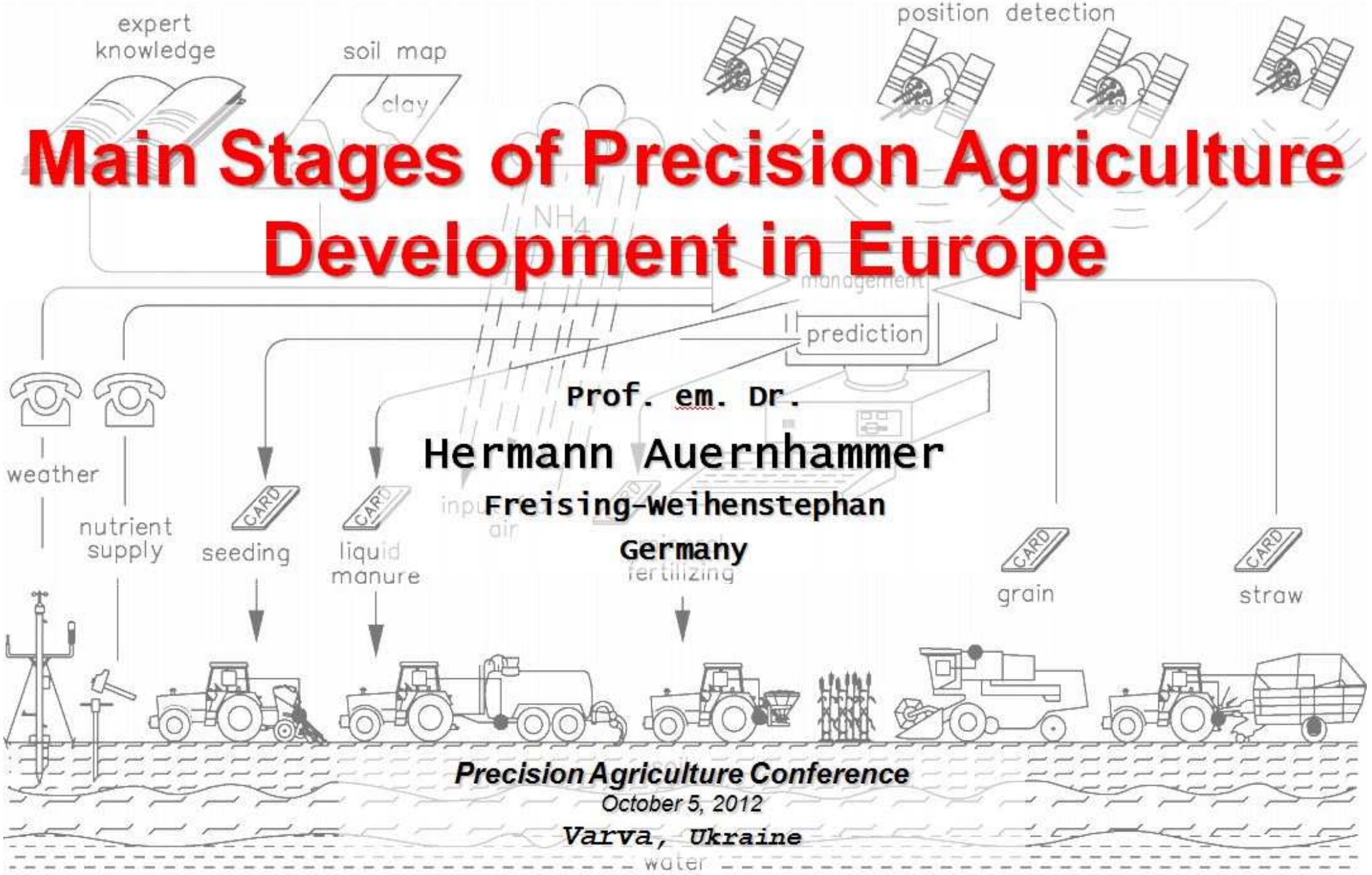


Main Stages of Precision Agriculture Development in Europe

Prof. em. Dr.
Hermann Auernhammer
Freising-Weihenstephan
Germany

Precision Agriculture Conference
October 5, 2012
Varva, Ukraine

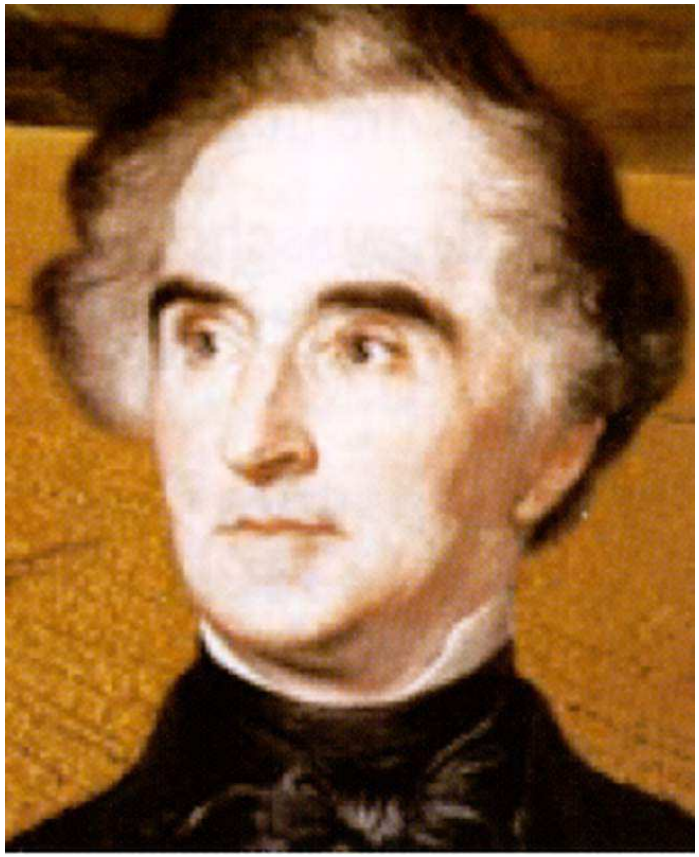
Agenda

1. Visions from yesterday
2. Tramlines in the 70s
3. Multi-Purpose controllers in the 80s
4. Yield Measurement and LBS in the 90s
5. Fertilizing with Online Sensors in the early new decade
6. Guidance Systems for Everyone in the last 5 years
7. ISOBUS at the Farm Gate ?
8. Conclusions

The Vision by J. v. Liebig

„... . 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).



→ ***"Precision Farming by Balance on Field-scale" !***

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

The (A) first vision/dream of Precision Farming in 1770 ?

As we will get soon a new map from our prince-bishop it would be also desirable to have a similar one where, with an adjusted enlargement, the nature of the soil should be shown. This could be done simply by different colors e.g. with **dark green** for the best grazing areas, a **lighter green** for the average and a more **lighter green** for the worst ones.

…

One could also mark every spot with numbers according to the depth of the different soils from a certain supposed line, like it is done in nautical maps …

Beside this map we need another one in which the situation in a depth of 6, 7 or 8 shoes is shown, so that, if the first map will be layered above the second one, the nature there could be seen. One would investigate this with an earth drill and would do the location geographically …

Source: Möser, J. A useful Appendix to the Journal of Intelligence of Osnabrück, May 26, 1770 (own translation)

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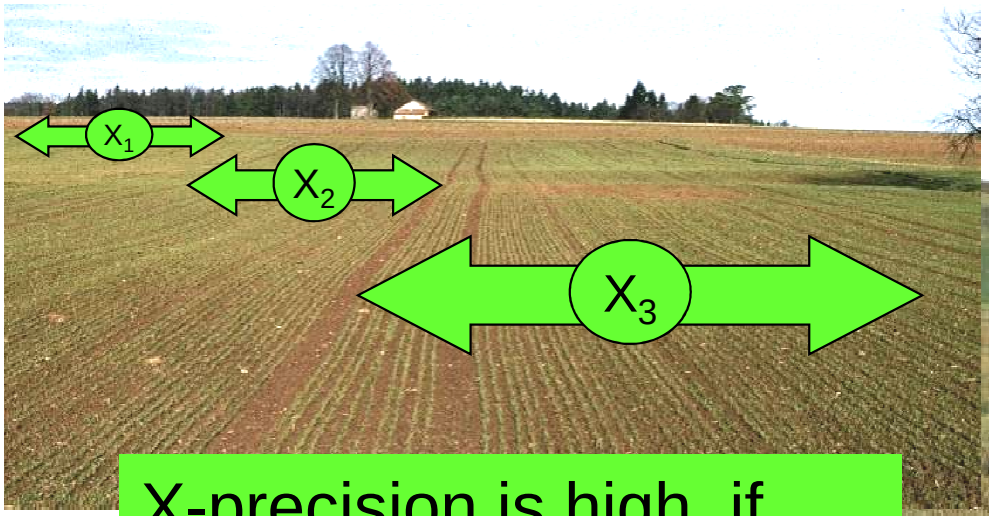
Tram lines in grain production since the 70th

Appearance at early state

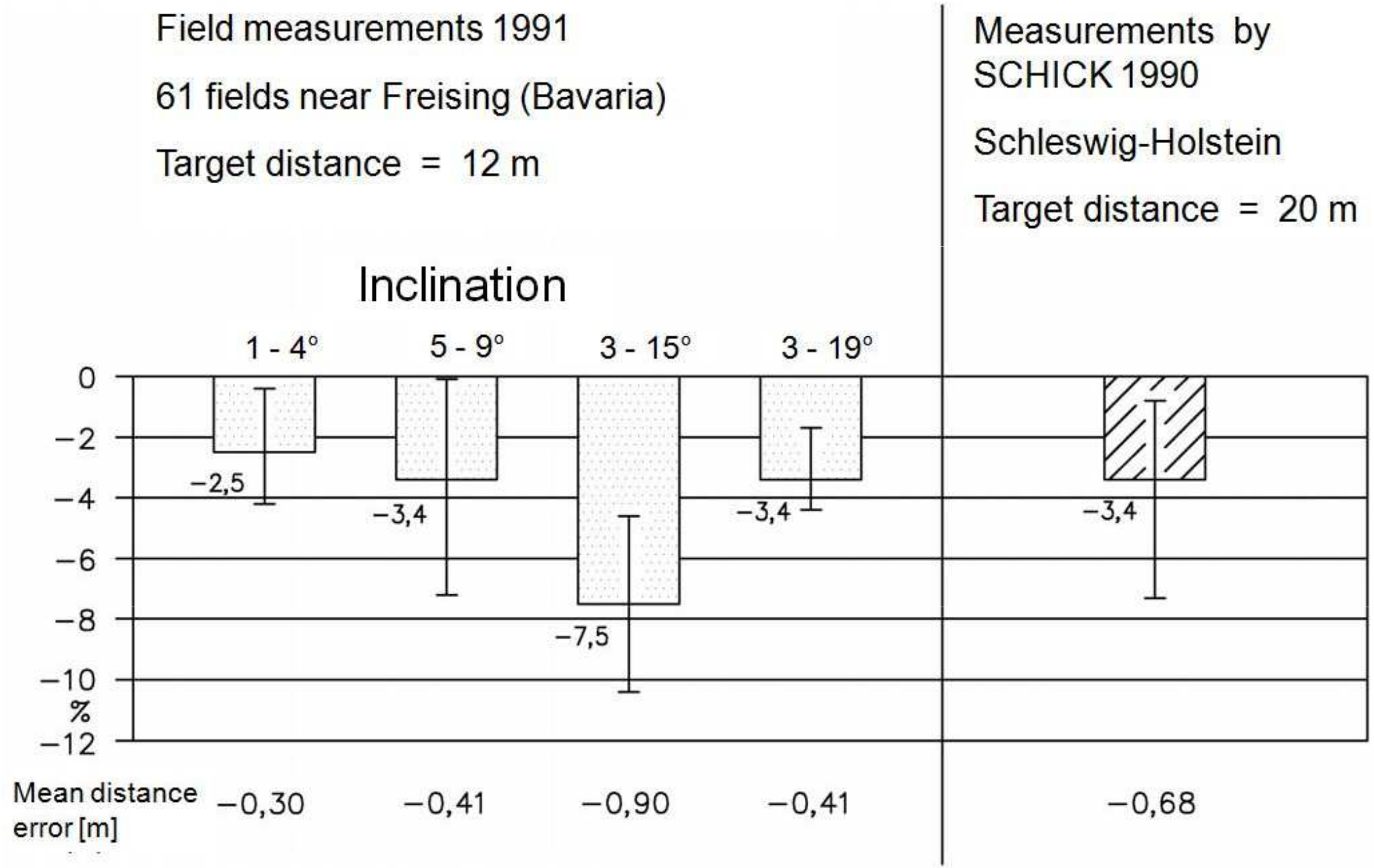


X-precision is high, if drilling was well done !

Appearance before harvesting

- **Used for fertilization (2 to 3 passes) and spraying (1 to 2 passes) operations mainly, sometimes also for harvesting in "skipped passes" (when tramline distances correlates with multiple harvester working widths)**
- **Less overall soil compaction**
- **No significant reduction in yield**

Tramline distances at field scale



Source: Auernhammer, H., Peisl, S. 1991

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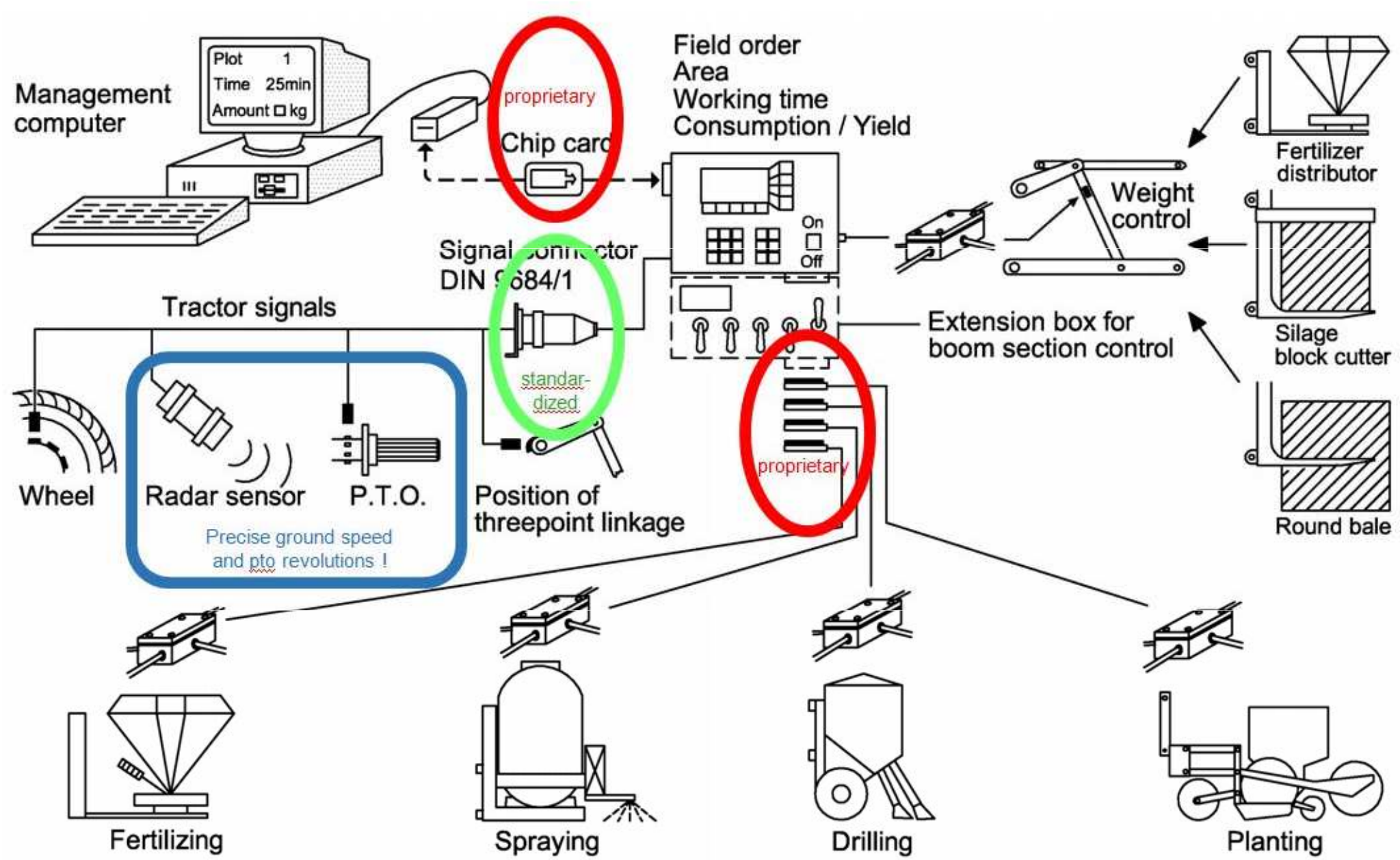
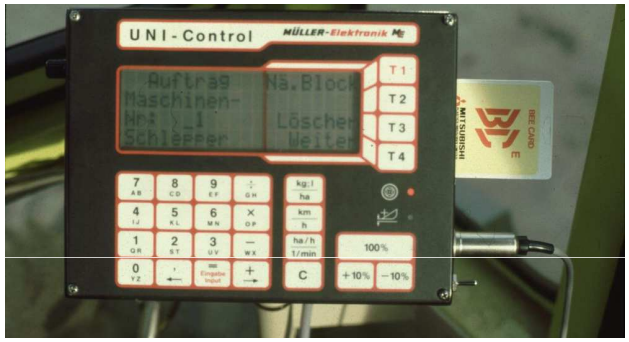
Mobile Process Controller (MPC) – proprietary solution



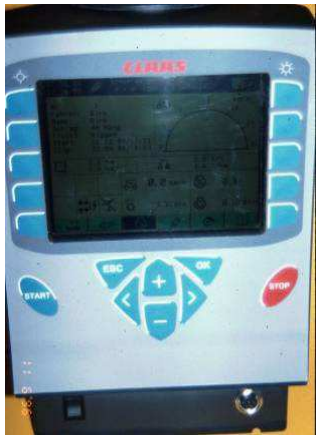
MPC + radar sensor → uniform precision

(nearly **100,000** multi-purpose control units in Europe since 1985 in use)



MÜLLER
Unicontrol
> 45,000 (D)

LH Agro 5000
> 40,000 (DK)



CLAAS
agrocom.
ACT
> 1,000 (D)

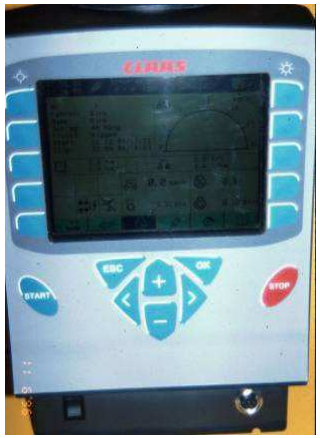
- **Portable** from tractor to tractor and to self propelled machinery
- Only **one** well known **man-to-machine interface** (M2M)
- Selection of the adjusted **control software by plug-identification**
- Normally used for distribution equipment (**spreaders and sprayers**)
- Sometimes also for **loss-detection** in combine harvesters
- Simplified **data acquisition** (working area, working time, processed agents)
- Manual or chip card based data transfer to the field book in the FMC

MPC + Human Sensor + Experience → site-specific precision

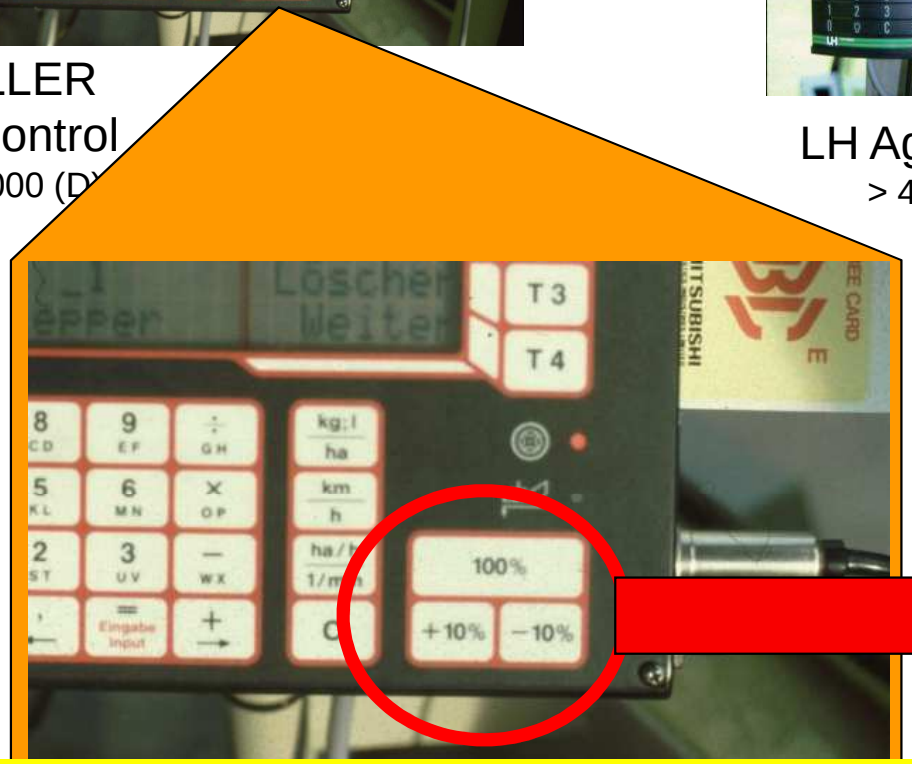
(nearly **100,000** multi-purpose control units in Europe since 1985 in use)

MÜLLER
Unicontrol
> 45,000 (D)

LH Agro 5000
> 40,000 (DK)



CLAAS
agrocom.
ACT
> 1,000 (D)



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

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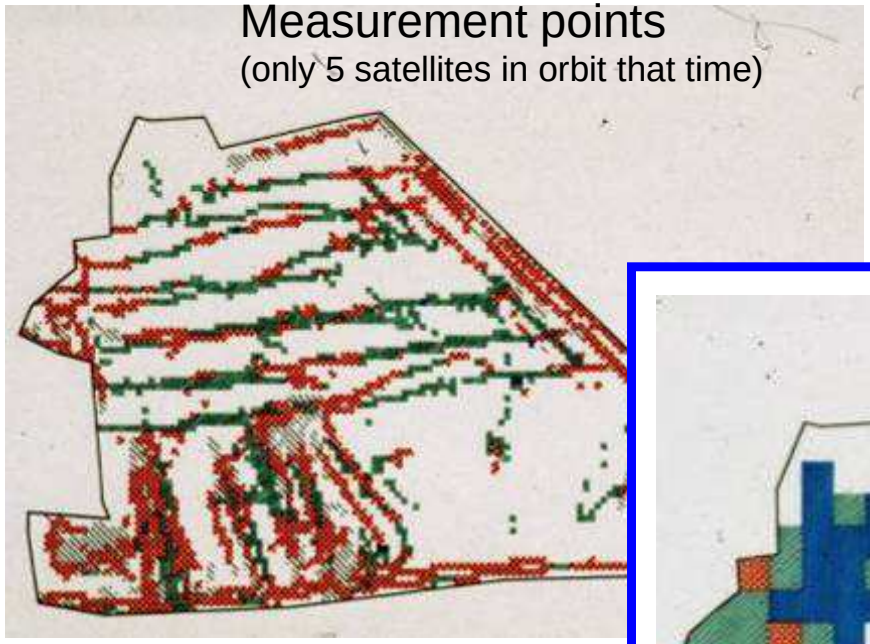
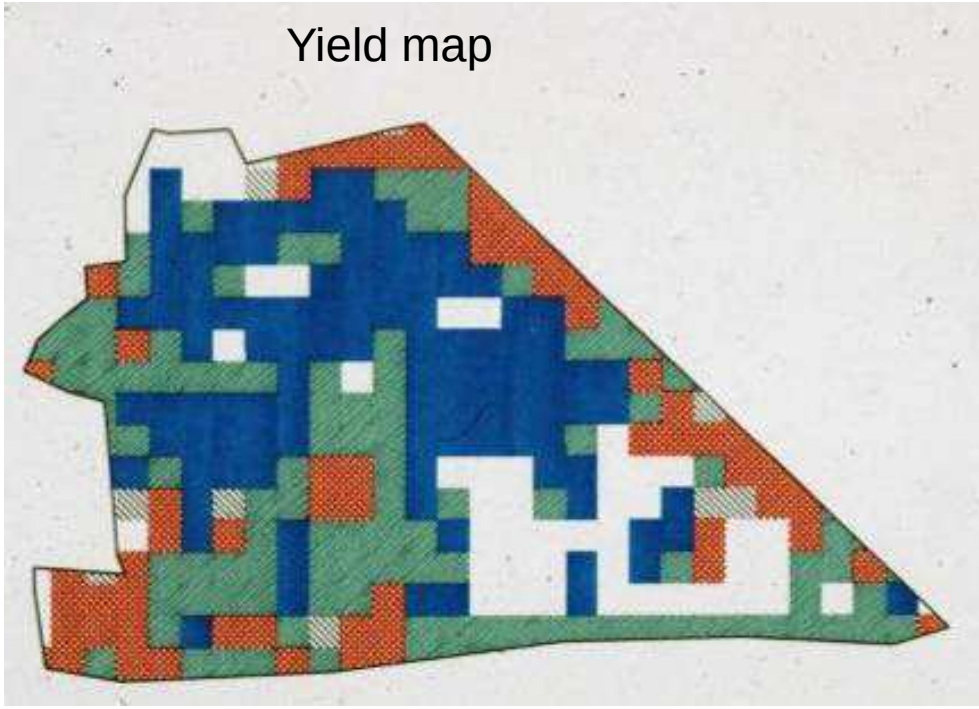
The first step into „Precision Farming“ 1990

1990 A commercially available combine harvester with a **yield sensor** was equipped with a **GPS receiver** in Weihenstephan and tested on 25 ha of winter wheat *(Download of data with KERMIT took more time than harvesting !)*

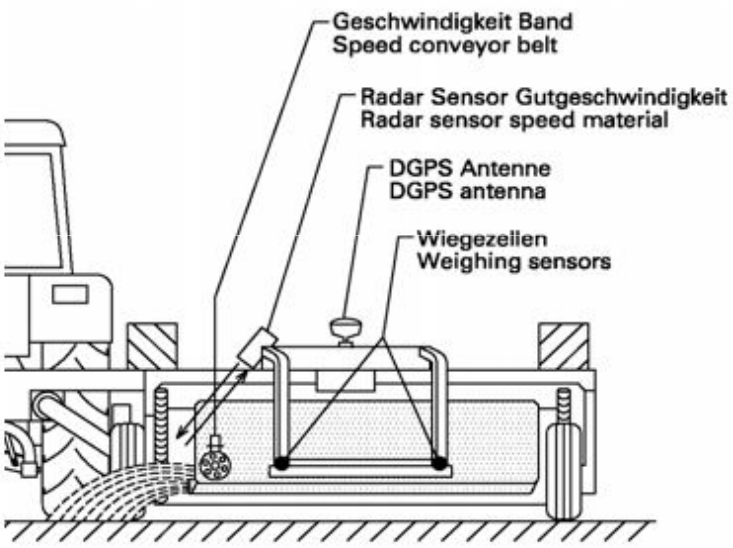


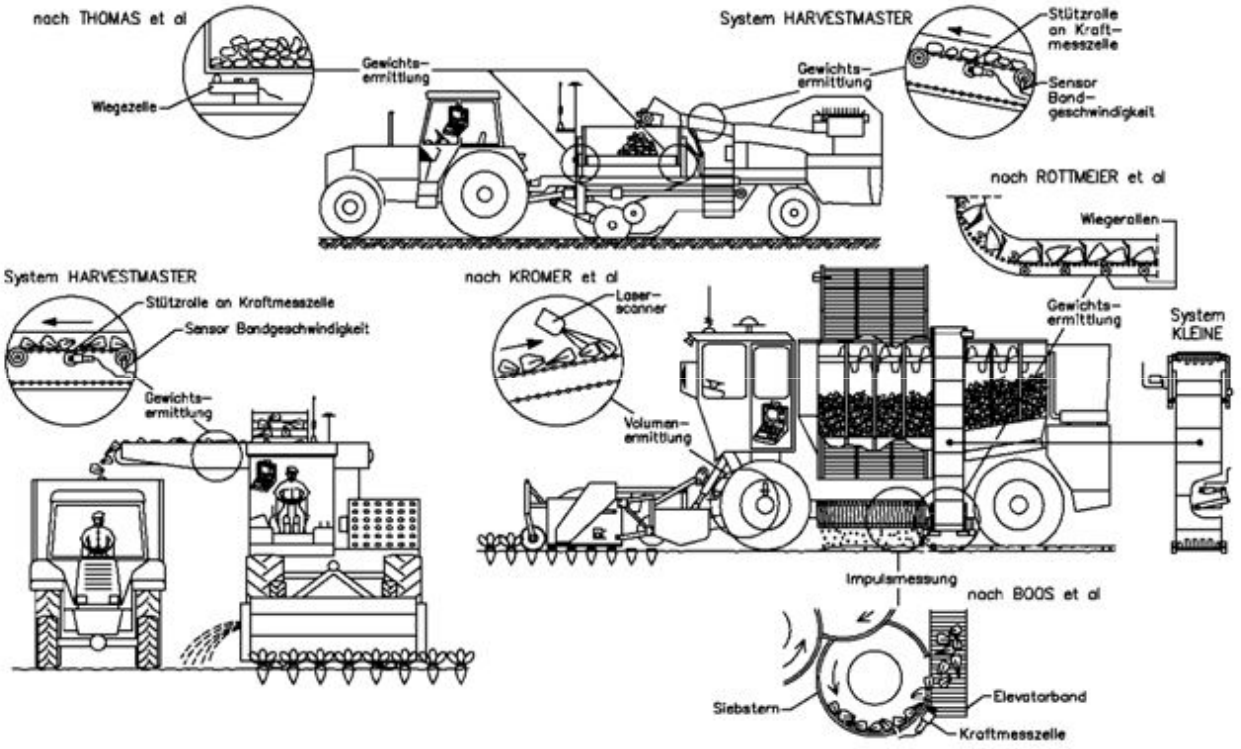


Precision Farming in the 90s - Yield monitoring

Yield monitors for all crops

- After the combine harvesters solutions for (nearly) all crops came up (**sugar beets, potatoes, pea nuts, cotton, rice, forage harvesters, balers,** …)
- Farmers as well as scientists realised, that **the accuracy** of a yield sensor is different to those of weigh bridges for commercial use
- **Different solutions for data transmission** to the farm PC and for yield mapping are available





See also: Vansichen and de Baerdemaeker, 1993; Wilkersen et al., 1994; Wild et al., 1994, Schueller et al., 1999; Durrence et al., 1999; Shinners et al., 2000

European Ag Machinery Manufacturers – powerful SME's

Equipment manufacturers (selection only)

KRONE (D)

GREENLAND (NL)

And others !!!

PÖTTINGER (A)

HARDI (DK)

KUHN (F)

KVERNELAND (N)

Tractor manufacturers (selection only)

FENDT (D)

Interaction only through a standard !

STEYR (A)

And others !!!

VALMET (SF)

RENAULT (F)

MF (GB)

SAME (I)

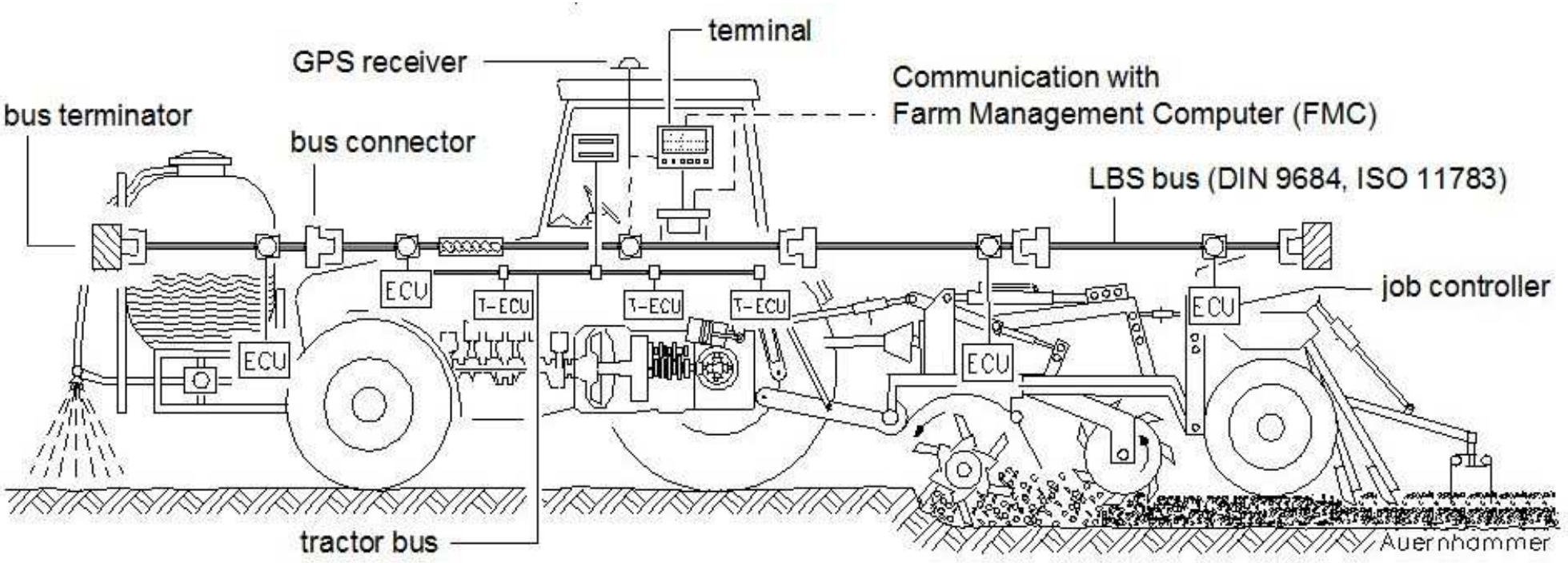
Full liner

None !

Precision Farming in the 90s – Electronic communication

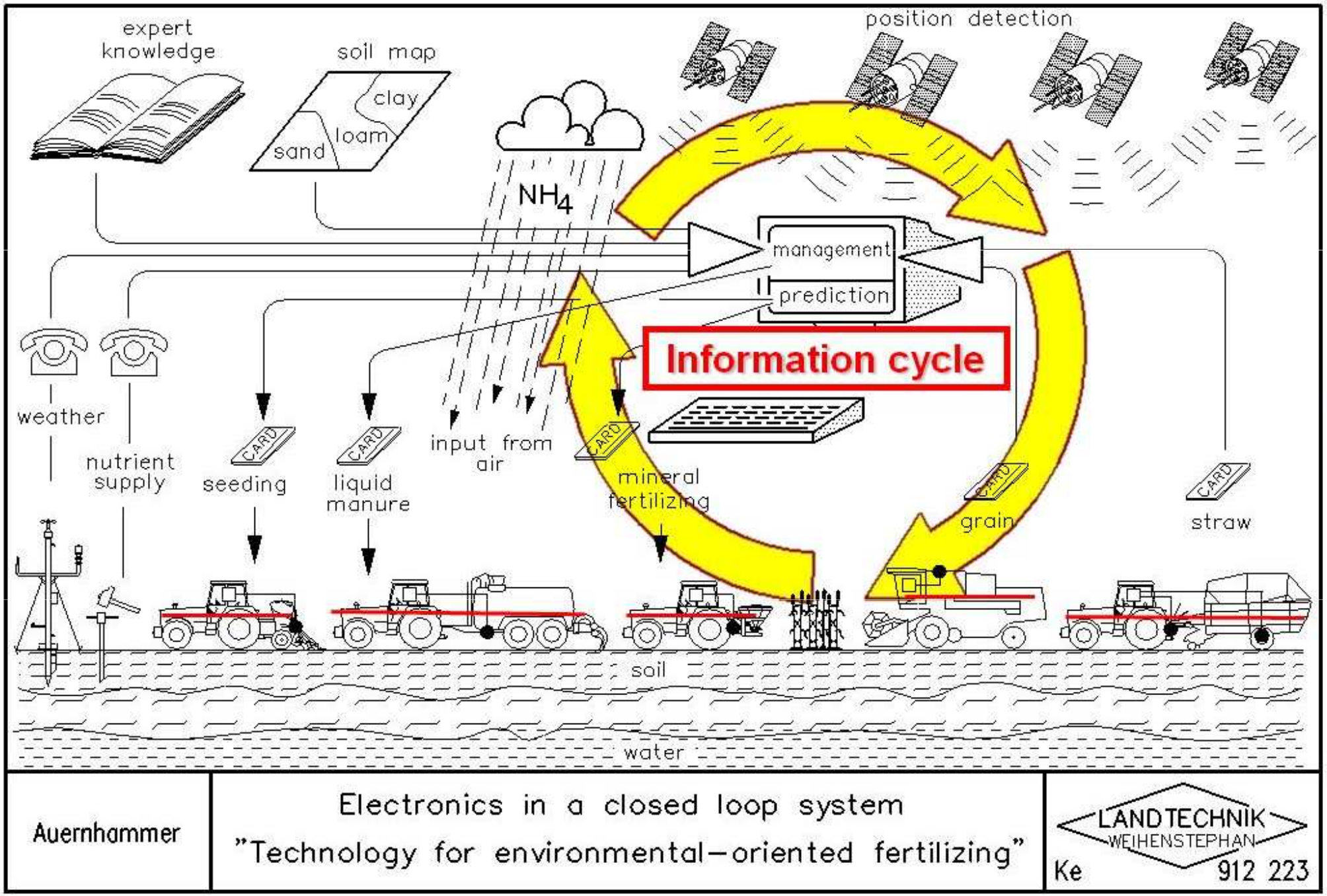
Electronic tractor implement communication

- The European **LBS-standardization** ($D_{leading\ group}$, NL, DK, F, GB) started 1987
- A very early decision to use **CAN with ECU's and a "Virtual Terminal"** and also to have a connection to the On-Farm management computer
- Standardisation was **finished in 1997**
- Besides the LBS-standardization the **ISOBUS-standardization** was initiated by the "LBS-standardization group" in 1990



See also: Auernhammer, H. ,1989, Auernhammer, H. and Frisch, J., 1993; DIN 9684

Precision Farming 1991 – brain to information driven



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

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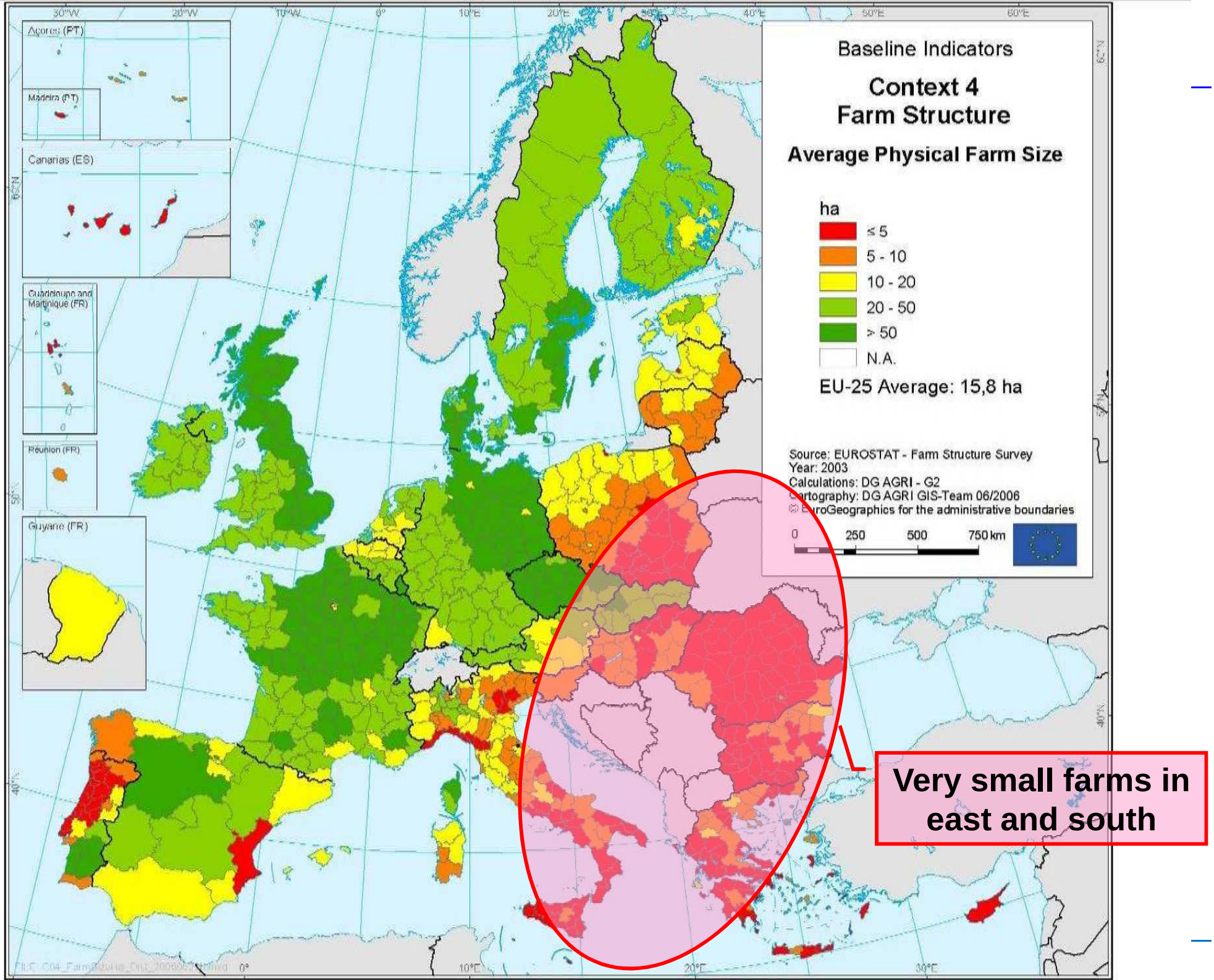
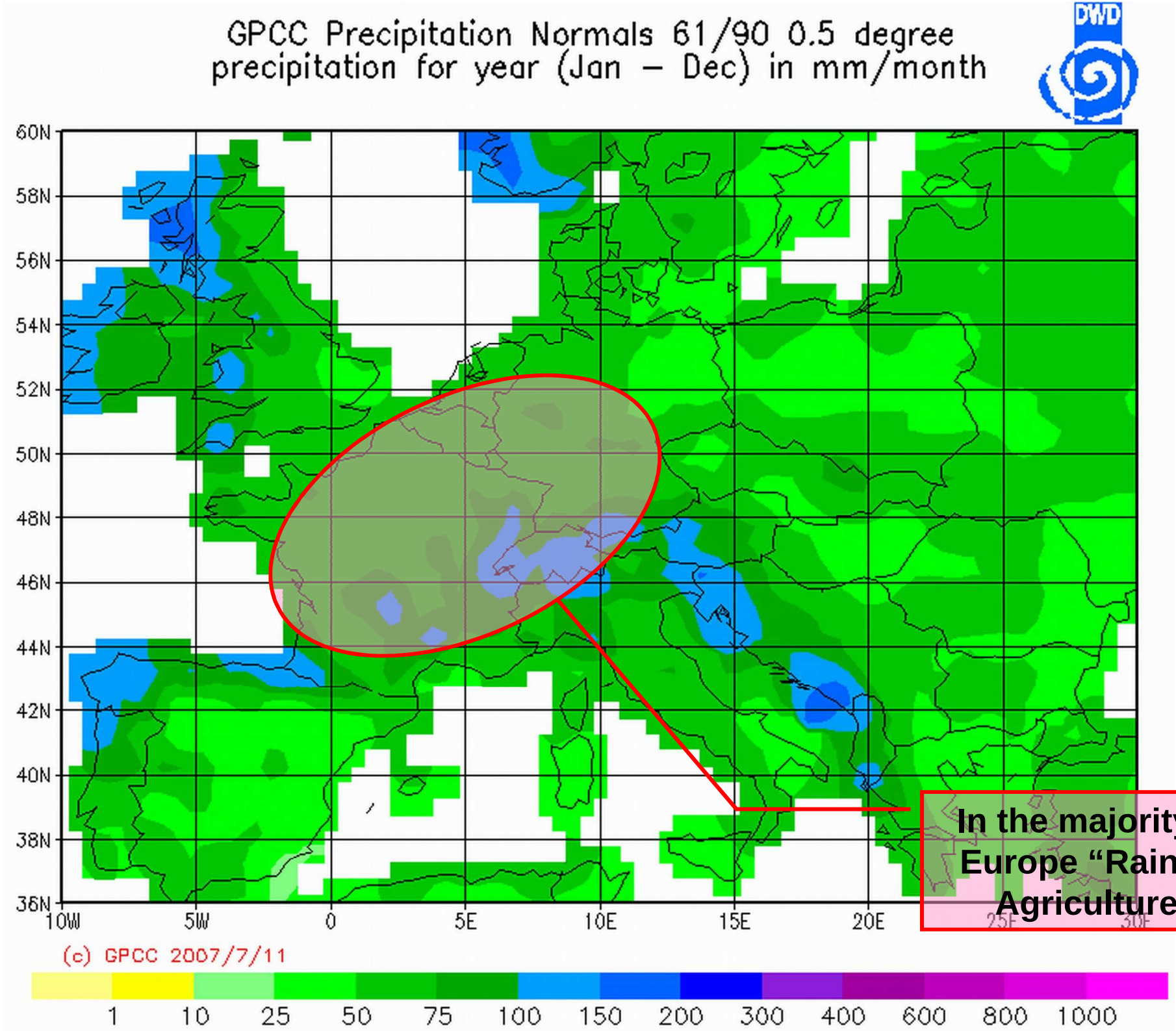
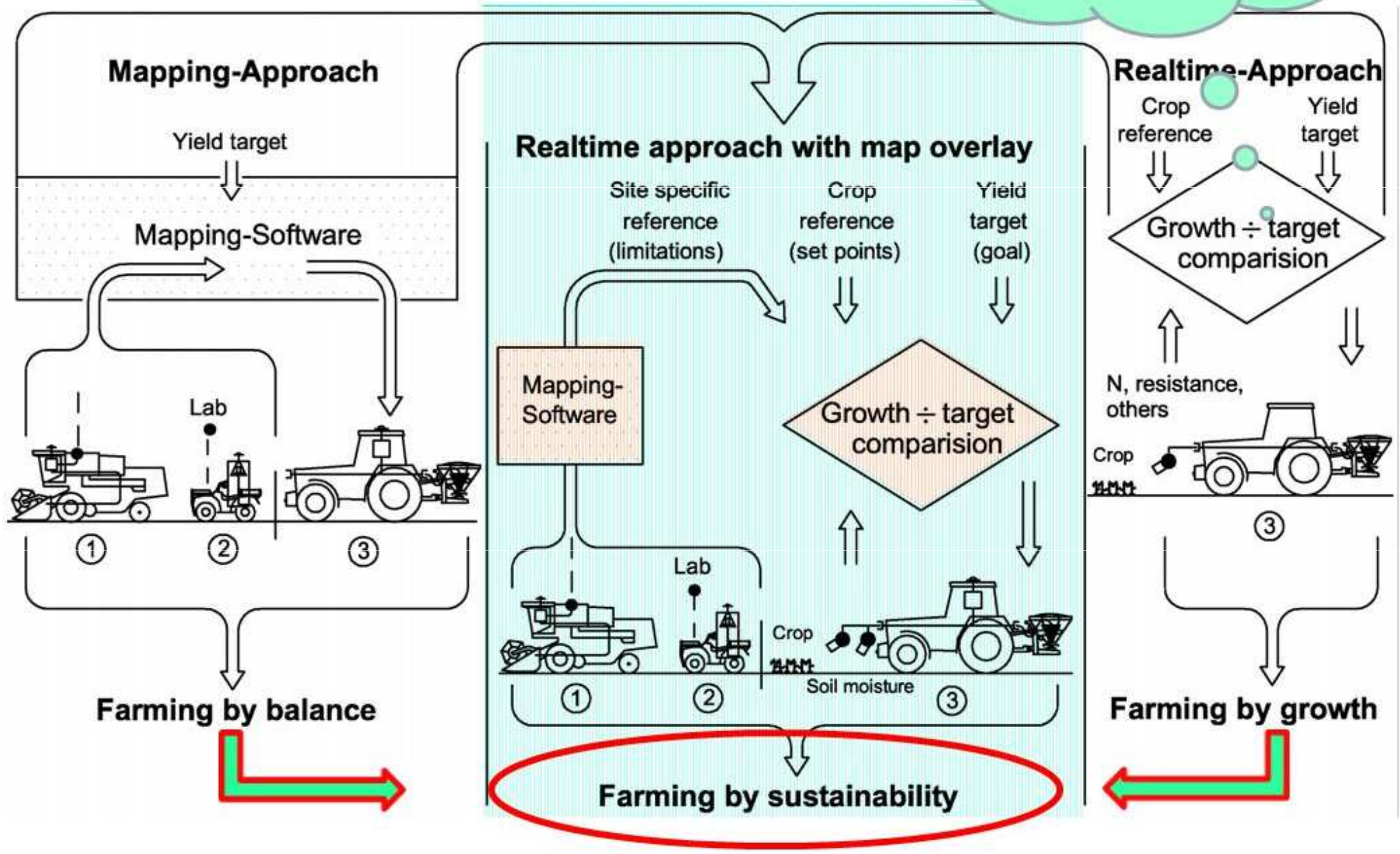

Baseline Indicators
Context 4
Farm Structure
Average Physical Farm Size
ha
≤ 5
5 - 10
10 - 20
20 - 50
> 50
N.A.
EU-25 Average: 15,8 ha
Source: EUROSTAT - Farm Structure Survey
Year: 2003
Calculations: DG AGRI - G2
Cartography: DG AGRI GIS-Team 06/2006
© EuroGeographics for the administrative boundaries
0 250 500 750 km
Açores (PT)
Madeira (PT)
Canarias (ES)
Guadeloupe and Martinique (FR)
Réunion (FR)
Guyane (FR)
Very small farms in east and south


GPCC Precipitation Normals 61/90 0.5 degree
precipitation for year (Jan – Dec) in mm/month
DWD
60N
58N
56N
54N
52N
50N
48N
46N
44N
42N
40N
38N
36N
10W
5W
0
5E
10E
15E
20E
25E
30E
(c) GPCC 2007/7/11
1
10
25
50
75
100
150
200
300
400
600
800
1000
In the majority of Europe “Rainfed Agriculture”

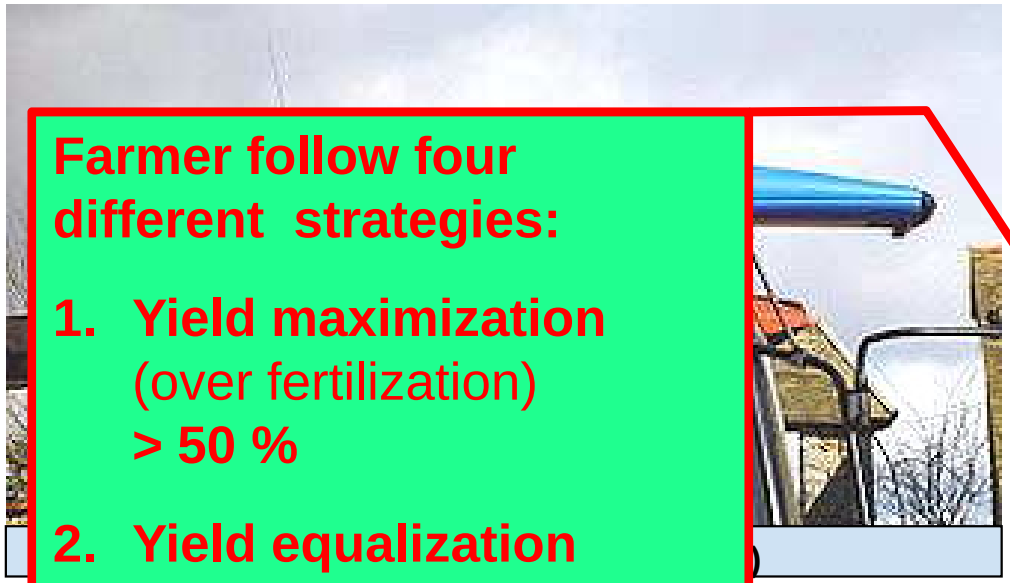
Yield in Europe means N-fertilization

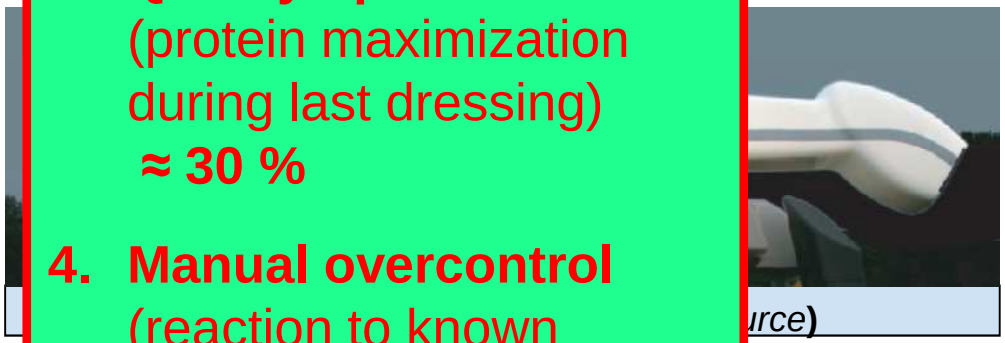
Farmer know and do this !

Three scientific approaches:



NIR Sensor (example YARA N-Sensor)





Farmer follow four different strategies:

1. **Yield maximization** (over fertilization) **> 50 %**
2. **Yield equalization** (harvest maximization) **≈ 10 %**
3. **Quality optimization** (protein maximization during last dressing) **≈ 30 %**
4. **Manual overcontrol** (reaction to known {visible}soil properties) **< 5 %**

*More than **1,000 systems** in use worldwide:*

- *about **1,000 systems** used in **Europe**,*
- *out of them about **500 systems** used in **Germany**,*
- *average field capacity per system around **4.000 ha**,*
- *standard procedure applies **more nitrogen** on part fields with **lower biomass**,*
- *for last dressing application may be changed to the **opposite control strategy**,*
- *systems almost used for **nitrogen fertilisation only.***

(by Agri Con 10/2010)

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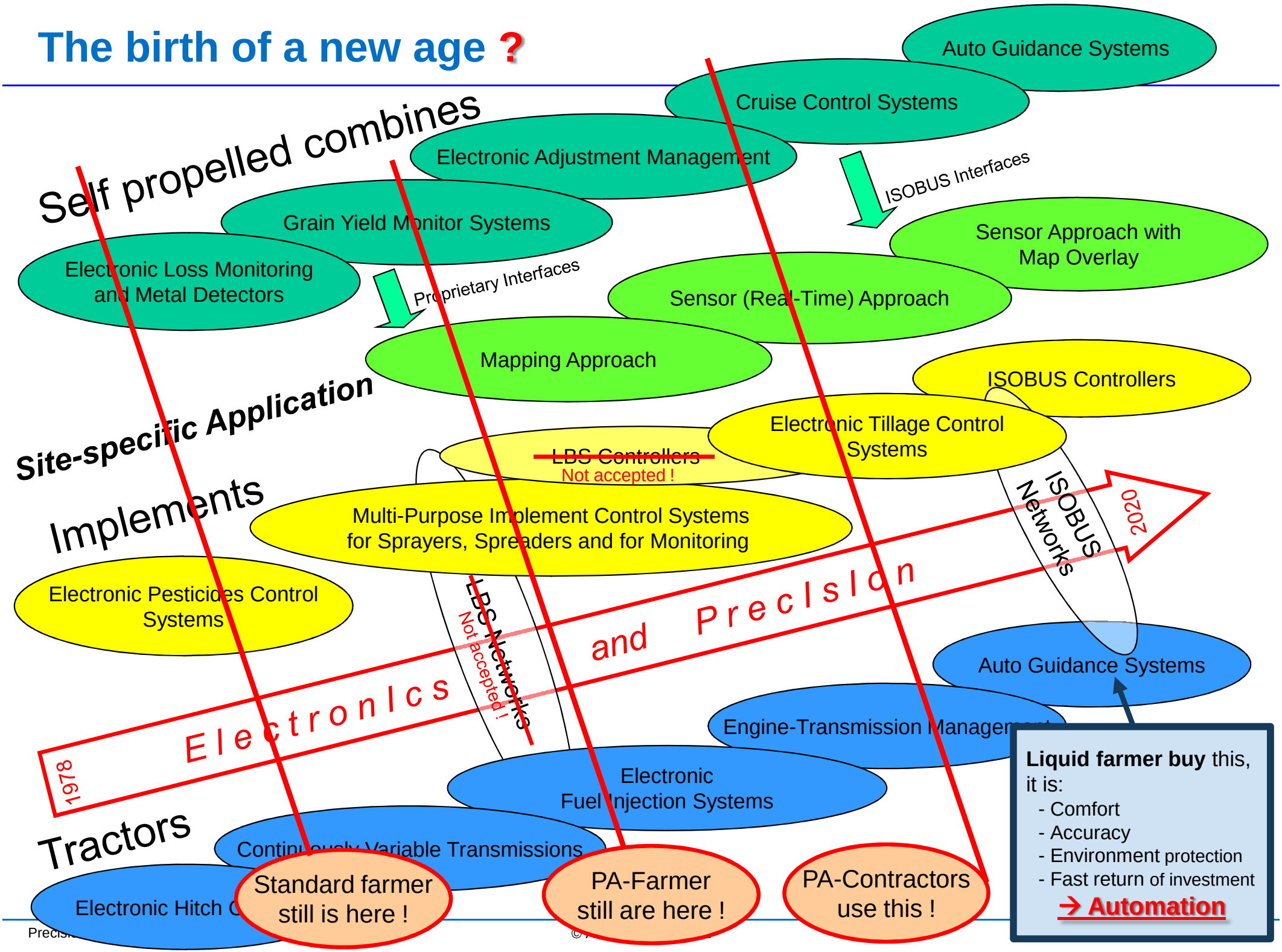
The birth of a new age ?



Precision Farming 1st decade 2000 – Auto guidance

Auto guidance

- **Different solutions** came up to improve the work and to remove high workload from the driver
- **Laser guidance** for combines
- **RTK-Auto guidance** for parallel working with no overlapping and work time extension also to night times, fog, dust, others
- **Auto turning** at headland with headland management systems

See also: de Baerdemaeker, J., R. Delcroix, and P. Lindemans. 1985; Searcy, S. W., J. K. Schueller, Y. H. Bae, S. C. Borgelt, and B. A. Stout. 1989)

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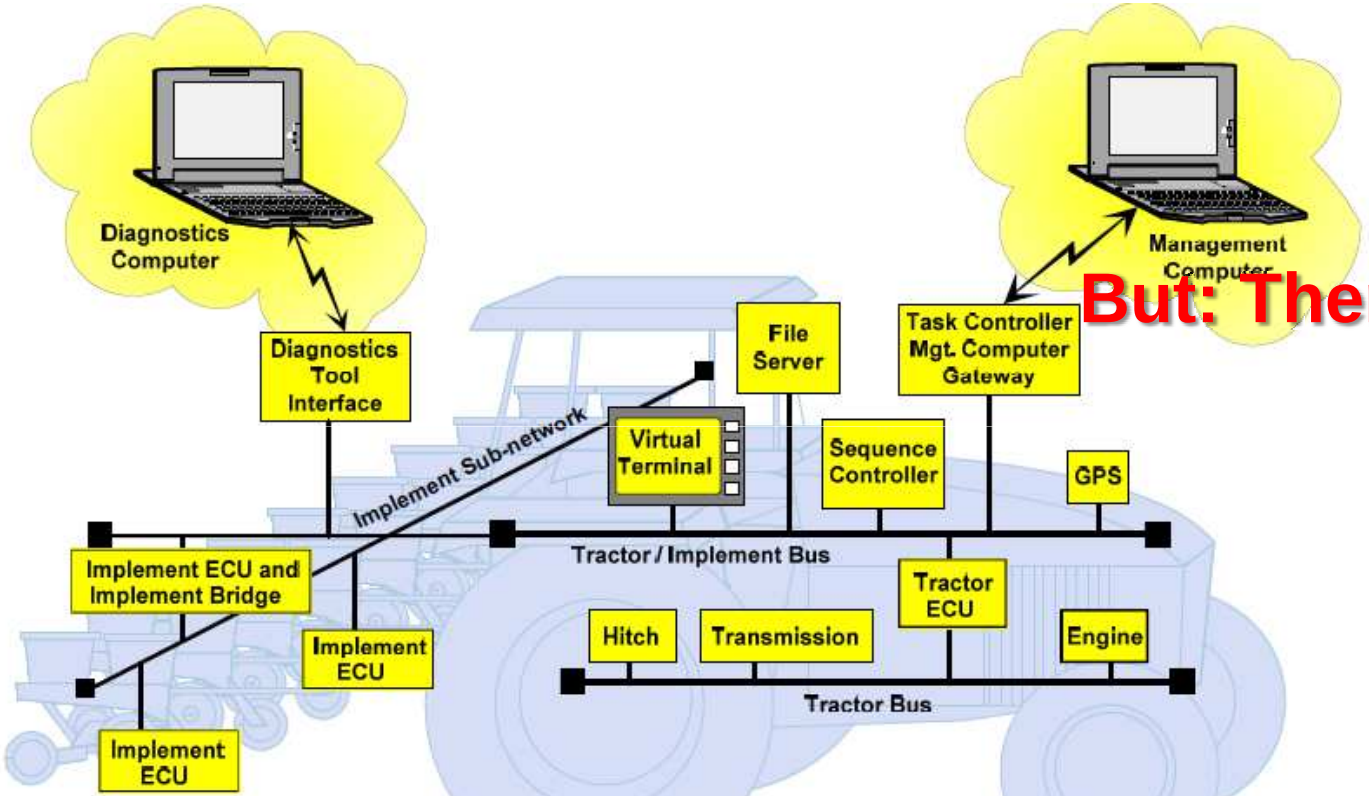
Precision Farming 1st decade 2000 – Communication & diagnostics

ISOBUS

- The standard (beginning in 1990) is **still under development**, extension and revision
- Many **well-sounding announcements** during the last two decades were given (and forgotten)
- Bilateral **proprietary solutions** came up and reduced the believe of the farmers into this “future technology”

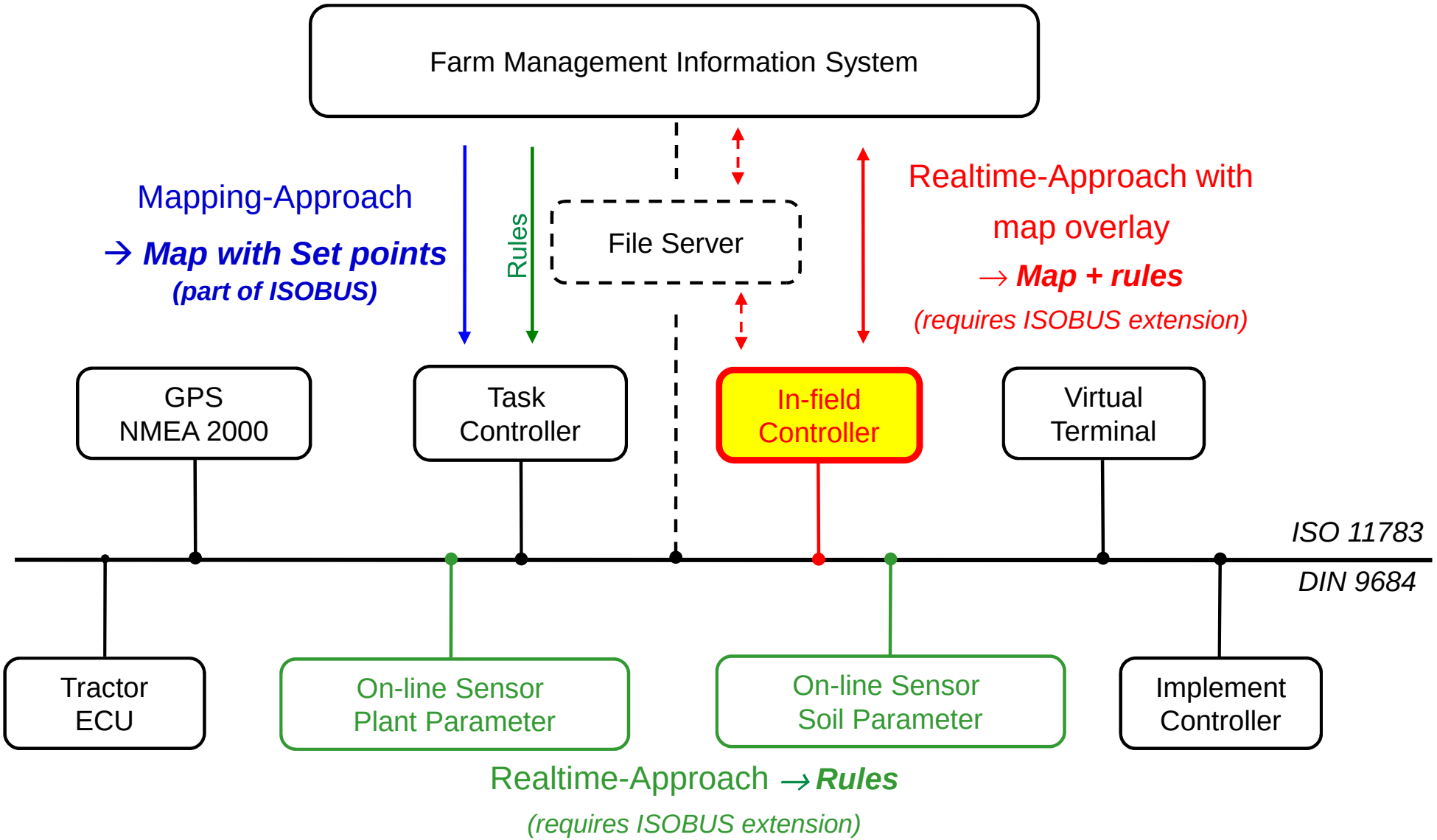


But: There is no alternative !

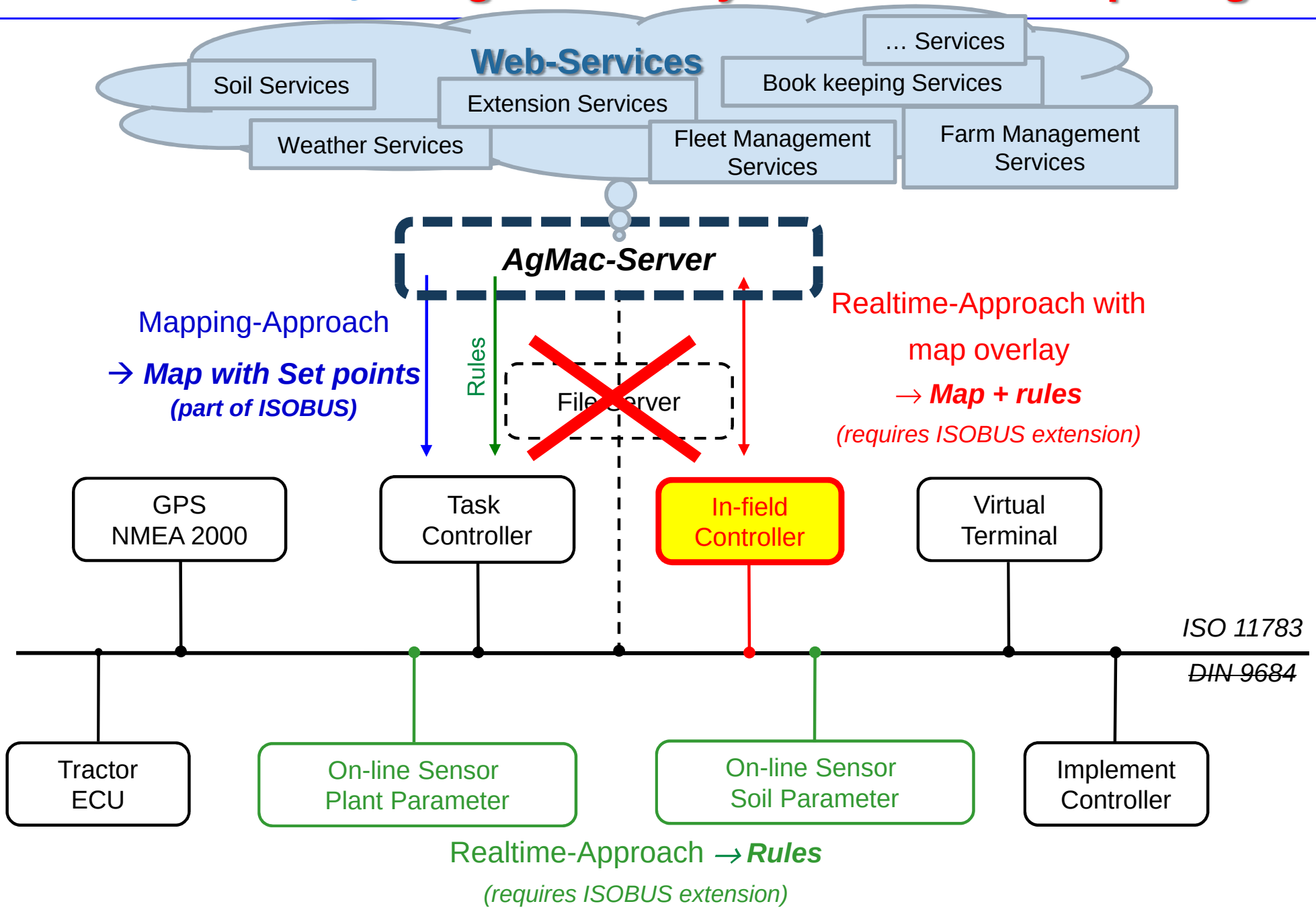
Source: Stone, M. L. (2011). ISO 11783 Part 10 Task controller and management information system data interchange. ASABE AET. http://shieldedpair.net/downloads/ISO%2011783%20Part%2010.pdf

ISOBUS - On-the-go implement control with sensor fusion

Required ISOBUS extension “In-field Controller” (by OSTERMEIER 2005)



Precision Farming – "Ag-Machinery and Cloud Computing"



Low power automation – small robots

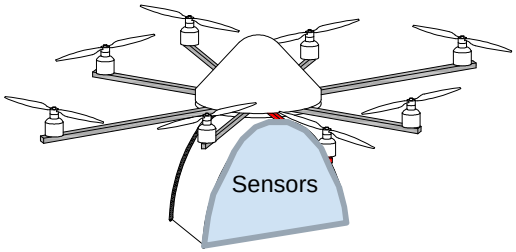
Are we able to harvest with this technology from 50 up to 180 t/ha in a limited time span?

→ *N o !!!*

Source: Blackmore, S.: A specification for an autonomous mechanisation system. Guangzhou (China) 2008

Mini-Robot – the two types of tomorrow and after tomorrow ?

In the air
(at a virtual rope)



Intelligent platform type

- Highest maneu
- Lowest soil co
- Self-contained

Specified to:

- Permanent mo
- Cognitive abilit plants
- Mechanical/ph
- Chemical plan

Wise only, if

- **Restricted area**
- **Enough time for finishing**
- **Specific tasks**
- **High value crops**
- **Selective harvesting**
- **…**

Simple (stupid) ones like

- Vacuum cleaners
- Lawn mowers

→ Lets work them twice or even more times at the same spot, its only important that it does everything in a certain time and went back to the maintenance station !

Systematic of Agricultural Robotics (Auernhammer 2009)

Robotics in Agricultural Farms

Medium & Large – Robots (2015) *

Are working as half or fully autonomous **machine systems** at scalable productivity

Technology available

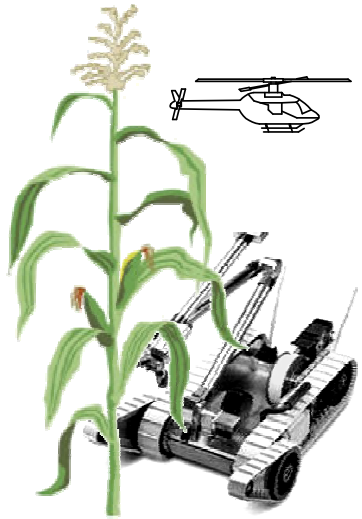
First applications as leader-follower systems in research (e.g. FENDT Guide)

Mini – Robots (2015)

Are working **around** plants from seed to harvest or in front of heavy self driven units

Singular solutions exist

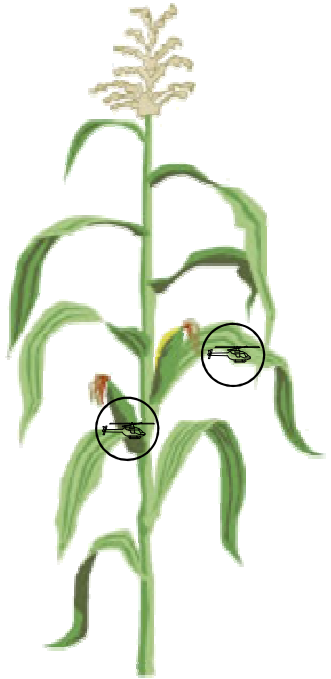
Handling of large masses in short time is limited



Micro – Robots (2020)

Are working **at** the plant to improve health and growth

First ideas and applications known



Nano – Robots (2030)

Are working **within** the plant to improve health

Future vision

* Expected to be at farm level

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Questionnaire on Precision Agriculture 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 %*	

With other words: PA will go on in Europe !!!

Thank you for your attention !