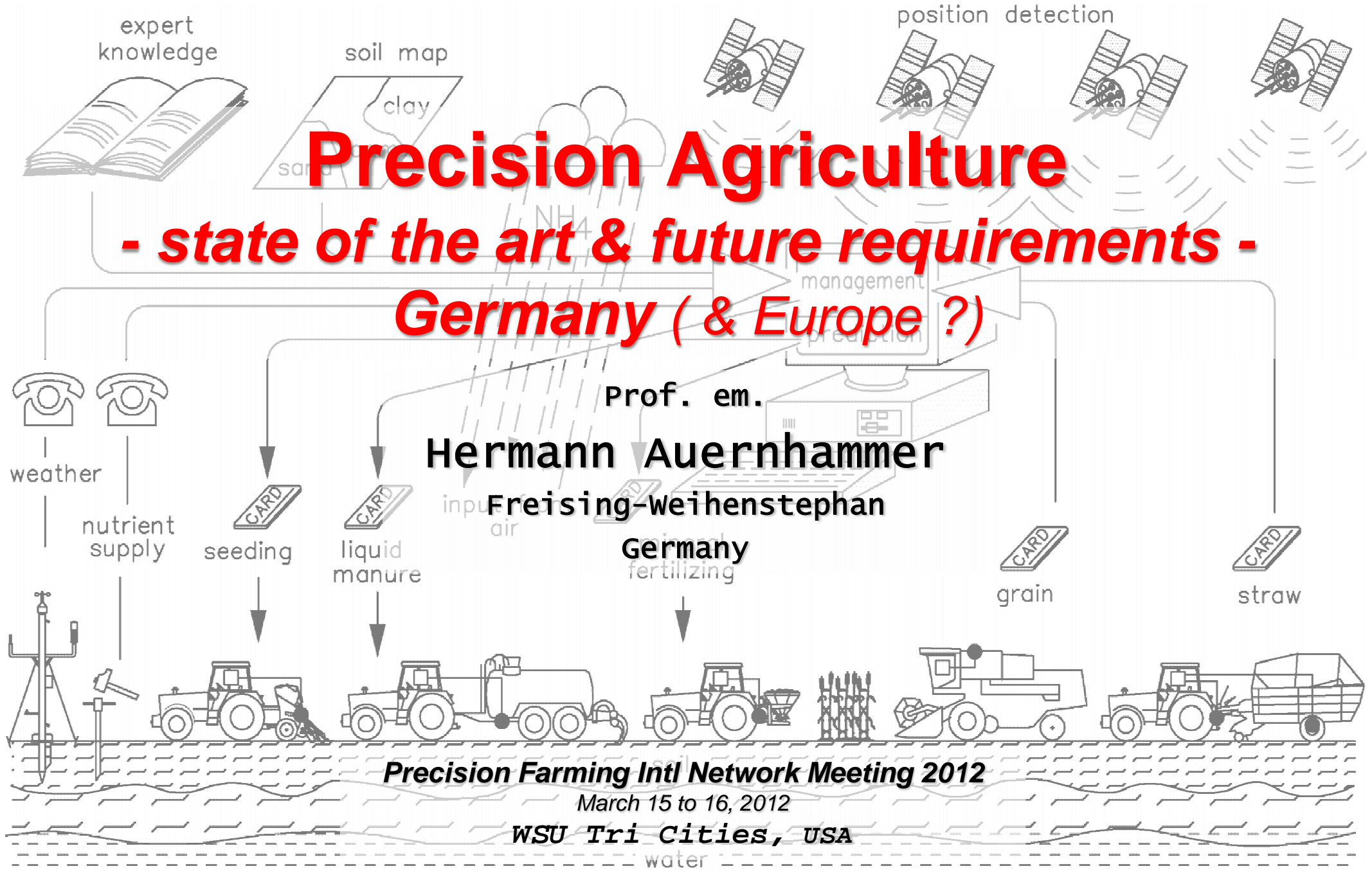


# Precision Agriculture

## - state of the art & future requirements - Germany ( & Europe ? )



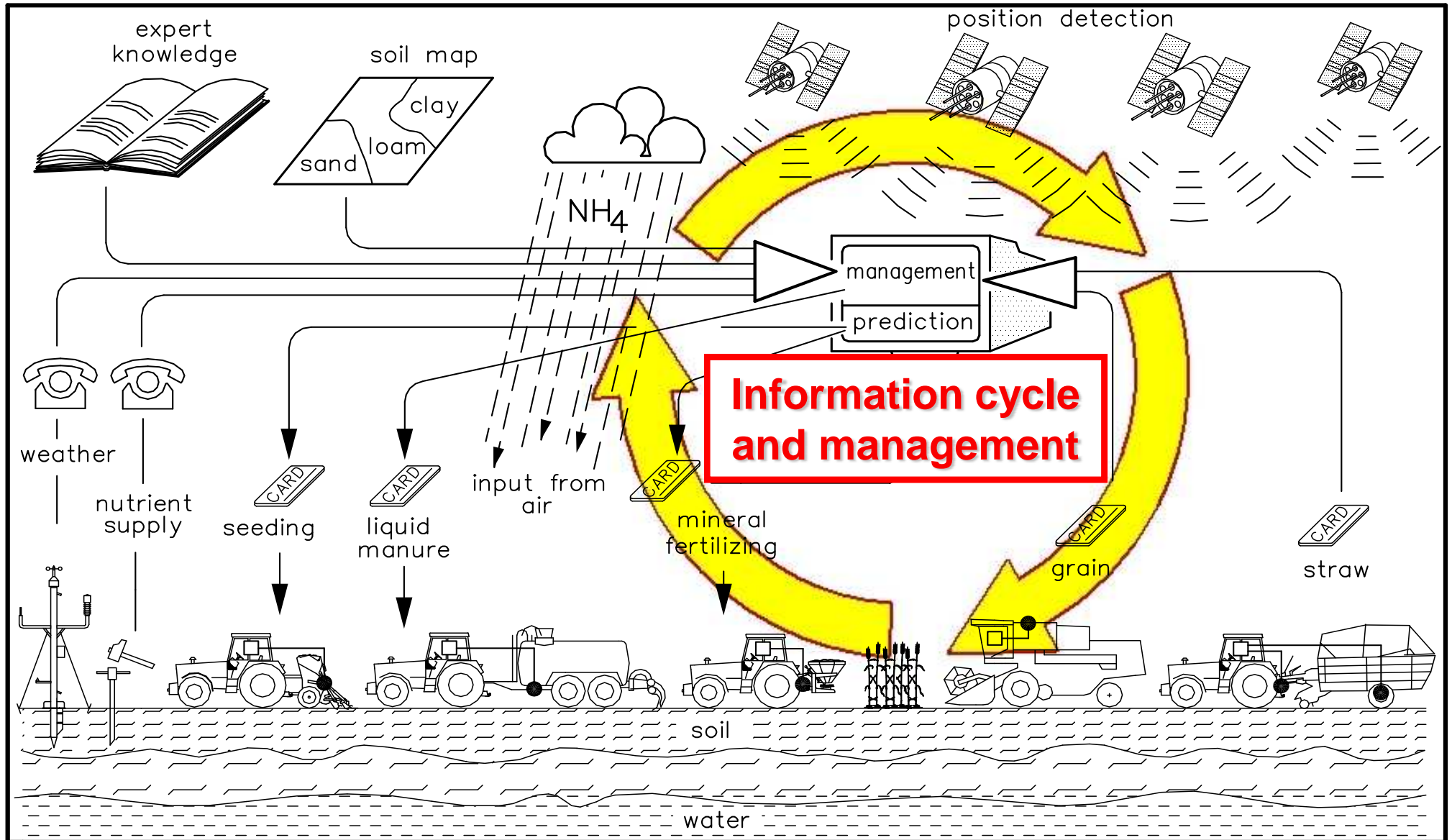
Prof. em.  
**Hermann Auernhammer**  
Freising-Weihenstephan  
Germany

**Precision Farming Intl Network Meeting 2012**

March 15 to 16, 2012

WSU Tri Cities, USA

# Precision Farming 1991 – brain to information driven



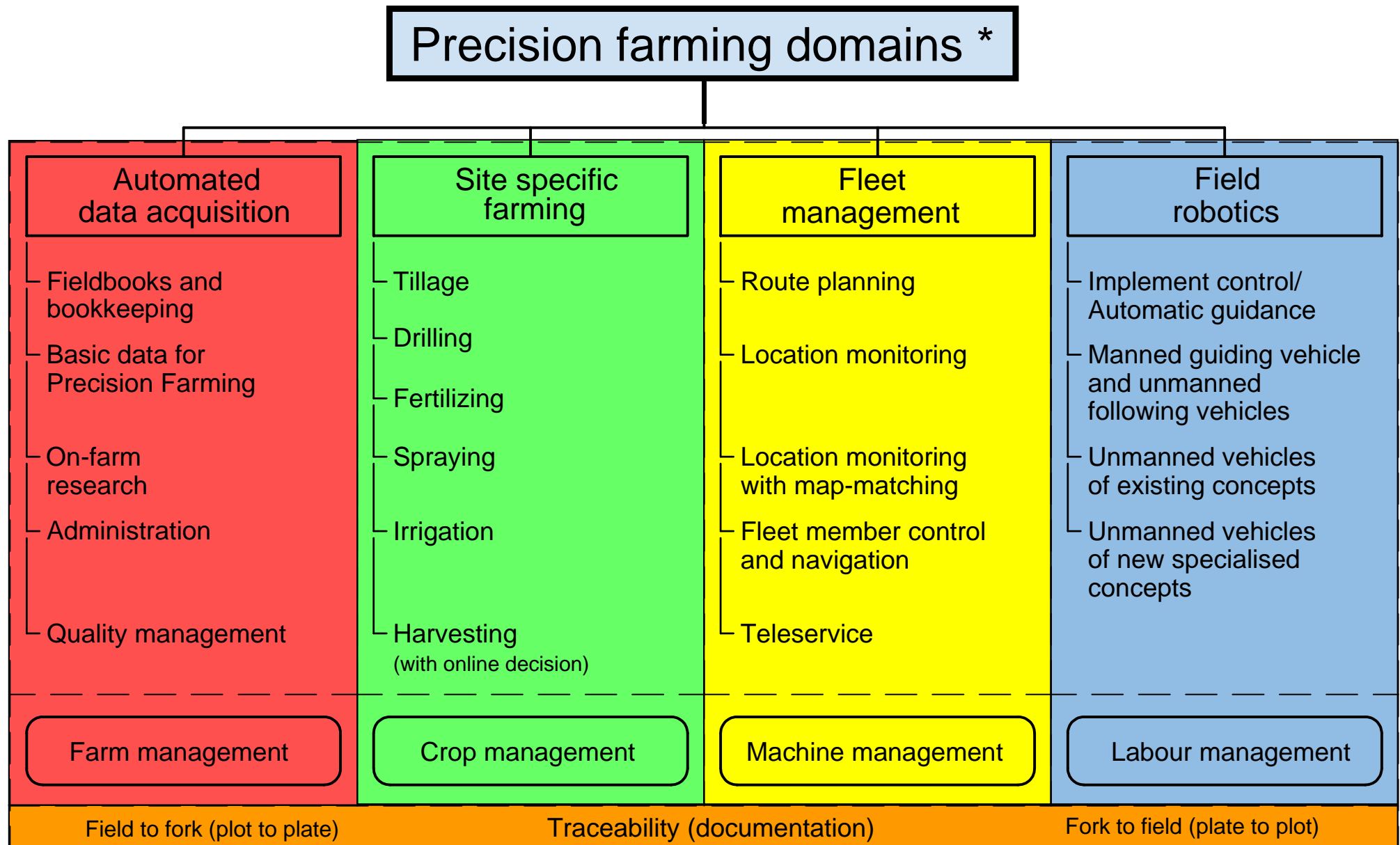
Automated Agriculture in the 21<sup>st</sup> Century, St. Joseph (USA) 1991, pp. 494-402

Auernhammer

Electronics in a closed loop system  
 "Technology for environmental-oriented fertilizing"

LANDTECHNIK  
 WEIHENSTEPHAN  
 Ke 912 223

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



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

# Farms and ownership in Germany (& Europe)

Criteria	Item	Germany (2007)	Europe_27 (2007)
Farms	No. of farms (> 5 ha)	286,920	4,055,610
	Average farm size [ha]	58.3	39.0
Ownership	Private operations by #	266,880	3,782,680
	Share of private operations by #	93.0	93.3
	Average farm size [ha]	42.6	28.7
	Share of cultivated area	68.0	68.6
	Others by #	20,040	272,930
	Share of others by #	7.0	6.7
	Average farm size [ha]	267.0	181.8
	Share of cultivated area	32.0	31.4

Source: [http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search\\_database](http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database); download 2012-24-02

# Farm employment and management

Criteria	Item	Private operations	Others
Labor	Family laborers	Mainly	None
	Permanent employees	Sometimes	Less
	Seasonal employees	Seldom	Mainly
Mechanization	Tillage & Seeding	Own	Own
	Fertilizing	Own	Own / Contractor
	Plant protection	Own	Own / Contractor
	Harvesting	Contractor / Machinery corporation	Contractor
	Transportation	Own	Own + Contractor
Management	Style	By experience & tradition	Cost - Benefit relation
	Data management	Field records (book keeping when required by law <sup>1)</sup> )	Professional <sup>2)</sup>
	Subsidies (around 400 €/ha * a)	By cultivated area (besides fertilization still no environment friendly sound terms and conditions <sup>3)</sup> )	

1) Taxation only if profit > 50,000 €/a

2) Taxation of profit

3) Max. 170 kg/ha of nitrogen by farm gate balance

# PA management today

Criteria	Item	Private operations	Others
Management	Style	By experience & tradition	Cost - Benefit relation
	Data management	Field records (book keeping as required by law <sup>1)</sup> )	Professional <sup>2)</sup>
	Subsidies (around 400 €/ha * a)	By cultivated area (besides fertilization still no environment friendly sound terms and conditions <sup>3)</sup> )	
PA practices	Tillage & Seeding	Tramlines (electronically controlled)	Tramlines (guidance systems)
	Fertilizing	Tramlines (x) + multi purpose controllers + Experience ( ±10% y) (variable rate control)	Tramlines (x) + multi purpose controllers + radar sensors (y) (highest precision in uniformity)
	Plant protection	Tramlines (x) + multi purpose controllers + manual section control (y) + residual amount control	Tramlines (x) + multi purpose controllers + manual/DGPS section control (y) + residual amount control
	Harvesting	--- / (local yield measurement)	guidance systems (edge control, DGPS) / {local yield measurement}
	Transportation	---	---

1) Taxation only if profit > 50,000 €/a

2) Taxation of profits

3) Max. 170 kg/ha of nitrogen by farm gate balance

# Restrictions

PA-Activity	Item	Private operations	Others
Farm	Data gathering	Manual systems and/or proprietary systems only	
	Data storage & backup	No standardized systems, no automation	
	Management software	Desktop solutions only	
		<i>To less education/knowledge</i>	<i>No overall-farm solution</i>
Crop	Soil sensing	Batch systems only, several "schools of doing the right way"	
	Growth sensing & monitoring	Expensive, no standardized systems (delicate calibration)	
		<i>Not adjusted to small fields</i>	<i>Restricted to few crops</i>
	Seeding & Application	No standard for mapping and standardized fusion Imprecise and susceptible spin spreaders	
	<i>Not adjusted to small fields</i>	<i>Restricted to few crops</i>	
	Harvesting	Extra costs, no standard	Use of proprietary standards
Fleet	Monitoring	No need	First manufacturer specific solutions only
	Automation		
	Logistics		
Labor	Guidance systems	<b>No restriction</b>	
	Automation	No need	Specific solutions only
	Field robots	Not adopted to farm specific needs	



# Solutions and improvements

PA-Activity	Item	Private operations	Others
Farm	Data gathering	ISOBUS extension, automation, web services	
	Data storage & backup	Standards, web services	
	Management software	Web services & desktop solutions	
		<i>Education &amp; training</i>	<i>Overall-farm (SAP) solutions</i>
Crop	Soil sensing	Batch & on-the-go systems, proofed "schools (advices)"	
	Crop sensing & monitoring	Multi-platform systems with self calibration	
	Seeding & Application	Standards for mapping and fusion, precise applicators	
	Harvesting	<i>Manual in-field adjustment</i>	<i>Adjusted to all crops</i>
		Yield mapping standards, pre-harvesting yield detection	
Fleet	Monitoring	No need	Integrated systems including farmers, contractors, manufacturers and dealers
	Automation		
	Logistics		
Labor	Guidance systems	Headland management systems, obstacle avoidance	
	Automation	No need	Specified solutions
	Field robots	Specified solutions	



# Progress small-scale farming (field sizes from 1 to 10 ha)

PA-Activity	Item	Short term	Medium term	Long term
<b>Farm</b>	Data gathering	Extended ISOBUS	Process data delivery	Include stock data
	Data storage & backup	Web services	Warehouse functions (handling of historic data)	
	Management software	Web services		
<b>Crop</b>	Soil	On-the-go systems	In-soil web systems NPK	Ongoing moisture sensing
	Growth	Web Services on-demand	Web services by exception	
	Seeding & Application	ISOBUS sensor fusion	Prooved application rules	Single plant application
	Harvesting	Yield mapping standard	On-the-go quality segregation	Low-soil pressure tech. (CTS, contour)
<b>Fleet</b>	Monitoring	Obstacle map-matching		
	Automation			
	Logistics	Automatic process data delivery	Soil moisture based work sequence service	
<b>Labor</b>	Guidance	Headland management	Obstacle avoidance	Driver observation
	Automation	Look ahead sensors	Path planning	
	Field robots		Weeding	Fungi & insects

# Progress large scale farming (field sizes greater ~ 10 ha)

PA-Activity	Item	Short term	Medium term	Long term
Farm	Data gathering	Extended ISOBUS	Stock data gathering	AI material sensors
	Data storage & backup	Web services, farm own systems	Warehouse functions (handling of historic data)	Best climate related mining/prediction
	Management software	Web services & desktop solutions	Overall-farm (SAP) solutions	Anyone/anywhere information
Crop	Soil	On-the-go systems	In-soil web systems NPK	Ongoing moisture sensing
	Growth	Web Services on-demand	Web services by exception	Strip/spot need/exception
	Seeding & Application	ISOBUS sensor fusion	Prooved application rules	Single plant application
	Harvesting	Leader-follower systems	Low-soil pressure tech. (CTS, contour)	On-the-go quality segregation
Fleet	Monitoring	Set-point monitoring and adjustment		
	Automation	Obstacle map-matching	Parallism assistance	
	Logistics	Automatic process data delivery	Preventative service	Pre-harvesting yield detection
Labor	Guidance	Smart headland management	Obstacle avoidance	Driver observation
	Automation	Look ahead sensors		
	Field robots	Scouting robots	Fungi & insect control	Weeding ?

# Progress organic farming (& micro-scale farming, field sizes less ~ 1 ha)

PA-Activity	Item	Short term	Medium term	Long term
Farm	Data gathering <b>traceability</b>	Extended ISOBUS	Process data delivery	Stock data gathering
	Data storage & backup	Web services	Warehouse functions (handling of historic data)	
	Management software	Web services	Chain management	
Crop	Soil	On-the-go systems including organic matter	In-soil web systems NPKoM	Ongoing moisture sensing
	Growth	Web Services on-demand & environment sensors	Web services by exception	
	Seeding & Application	ISOBUS sensor fusion focused on organic matter	Prooved application rules	Single plant application
	Harvesting	On-the-go quality segregation	Low-soil pressure tech (CTS, contour, transborder)	Single plant harvesting
Fleet	Monitoring	Obstacle map-matching		
	Automation			
	Logistics	Automatic process data delivery	Soil moisture based work sequence service	
Labor	Guidance	Controlled traffic systems	Obstacle avoidance	Driver observation
	Automation	Look ahead sensors		
	Field robots	Weeding	Fungi & insect control	