The role of ICT for Future Agriculture and the role of Agriculture for Future ICT

SJAAK WOLFERT, CORNÉ KEMPENAAR
Wageningen UR – Agricultural Economics research Institute, P.O.Box 35, 6700 AA Wageningen, NL, Sjaak.wolfert@wur.nl
Wageningen UR - Plant Research International, P.O.Box 616, 6700 AP Wageningen, NL, corne.kempenaar@wur.nl

At the start of the 21st Century we are faced with the emerging problem of global food demand and exceeding the Earth's carrying capacity with the current way of agricultural production. Moreover, the issues of safety, health, quality and sustainability, underpinned by the concept of transparency, have become increasingly important. In many global discussions forums it has been acknowledged that ICT can and will play an important role in meeting these challenges.

Over the past thirty years ICT technologies have been introduced in the agri-food sectors. Important milestones were introduction of computers (1980s), internet, email and mobile phones (1990s), and Global Navigation Satellite Systems (GNSS), wireless communication and social media (last decade). Modern farms make use of one or more of the following ICT: computers with a farm management system to keep track inputs, outputs and economics, weather forecast, early warning and decision support systems for crop management, auto guidance systems for controlled traffic on fields, tractor mounted board computers for steering of sprayers and other machines in a preferred way, and data registration systems to meet legal and chain requirements.

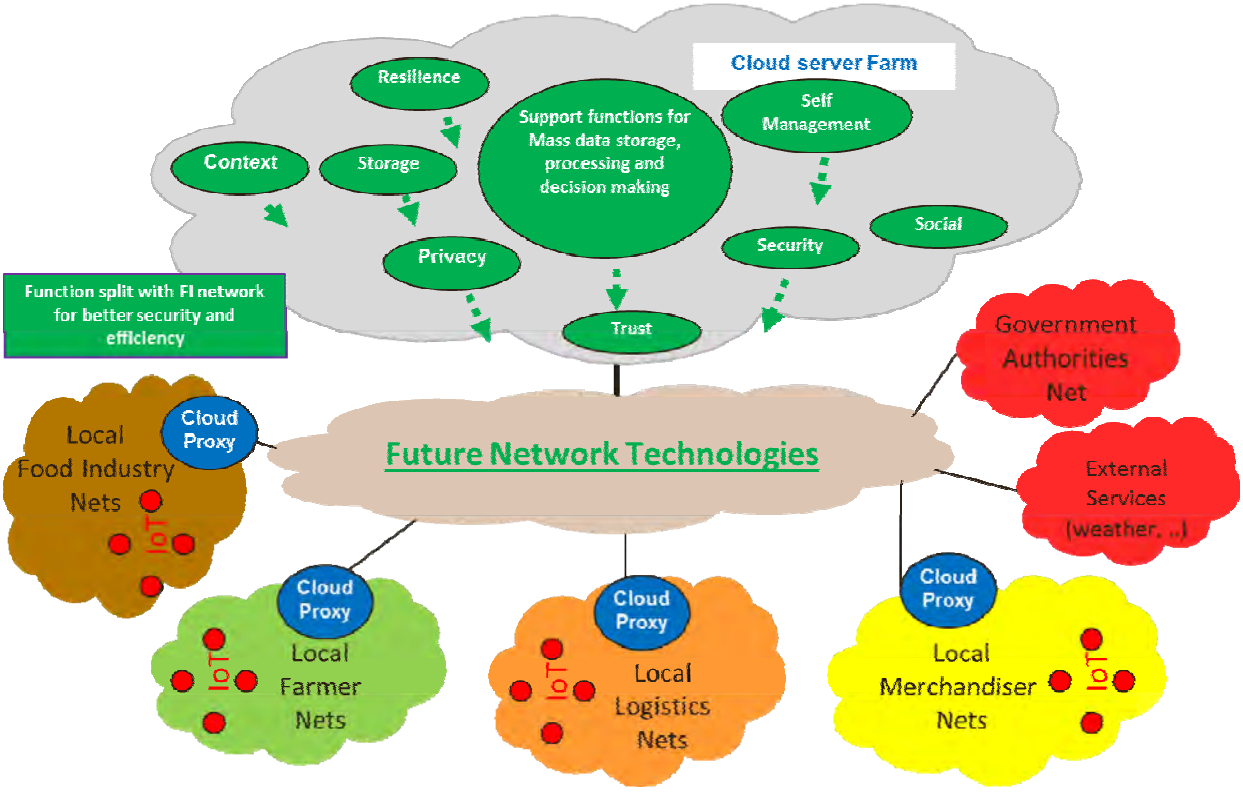
However, the uptake of these solutions has been slow due to a number of important yet unresolved issues. For instance, farmers register a large amount of data. The use of this data is still limited because handling is still far from easy in optimization of crop, farm and chain management. Problems are related with limited standardization, data protection and lack of optimization models. There's still a large potential in stimulating adoption of current ICT, but future ICT technologies even promise more potential gains. At the same time, it is believed that the agri-food sector itself can also play an important role in the development of future ICT.

Precision Agriculture and modern society could play an important roles in accelerating adoption of ICT technologies. Precision Agriculture requires fast and accurate handling and interpretation of GEO-data. Variation in soil and crop conditions are detected by various sensors and translated into sites specific actions. External data bases have to be consulted. Simple web service should facilitate this decision making. Think of digital diagnosis of crop stress and associated crop care advice. Controlled traffic farming and robotics require robust communication and GNSS networks. Society want sustainable food production. This means that farmers and food chains have to proof with data that their production systems are sustainable and risks are minimized (tracking and tracing). So, farm data will be used outside the farm by various other parties with different objectives (supply chain, food chain, governments, logistics, consumers). Social media allow new ways of promotion and sales of farm products.

The objective of this paper is to present the interactive future development of ICT for the agri-food sector. This will be based on several studies and user panel discussions that were carried out in EU-projects such as SmartAgriFood, AgriXchange, ICT-agri and FutureFarm, including a global view. The following issues will be covered in these projects:

- specific characteristics of the agri-food sector relevant for ICT development;
- future ICT needs from agri-food users' perspective;
- future capabilities of ICT to meet future long and short term needs;
- organization of future ICT development in the agri-food sector through private-public cooperation.

The results will be concluded by setting the agenda points for future ICT development for the agri-food sector and an how these can be achieved. Hereafter a depiction of architecture SmartAgriFood (result of a FP7 project of EU).



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The role of Information and Communication Technology (ICT) for Agriculture and vice versa

Introductory lecture on the future of agriculture

Sjaak Wolfert (WUR-LEI) & Corné Kempenaar (WUR-PRI)

IWSC, global café, June 19, 2012

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Content

- Introduction
- Observations and statistics on ICT in agriculture
    - Opportunities and challenges
- Future scenario's
- Concluding remarks

- Aim: to stimulate you on developing ideas on future agriculture -> join the world café at 17.10

Turn **on** your mobile phone

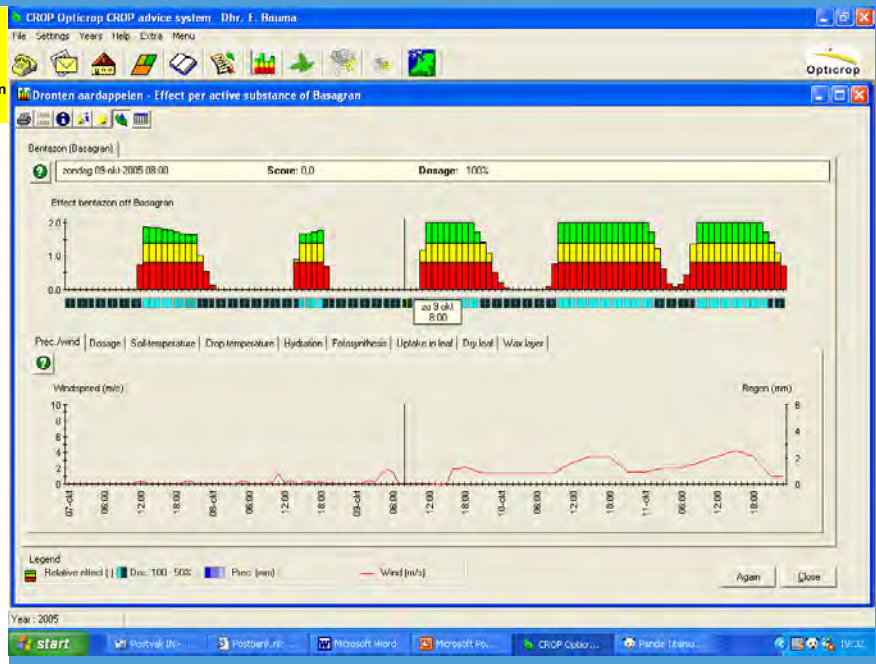
- Multi-tasking is the future?

Some terminology

- Computer use in agriculture
  - Farm Management systems
    - Data registration (inputs, costs, results)
    - Early warning & Decision support systems
  - Board computers
- Internet use in agriculture
- Mobile phones
  - Social media (LinkedIN, Facebook, ...)
- Navigation systems / Robotics

Examples of DSS (www.mlhd.nl, ww.gewis.nl)

Weed species	Herbicides (a.i.)									
	atrazine	bentazone	bentazon + quizalofop	atrazine + bentazone	atrazine + bentazone +nicosulfuron	atrazine + mesotrione	atrazine + mesotrione + nicosulfuron	bromoxynil	isoproturon	bromoxynil +isoproturon
Abutilon theophrasti		+++	+++	+++	+++					
Acalypha australis L.		+	+	+++	+++					
Aethusa cynapium	-	++		-	-			+++		
Alelopecurus aequalis S	++	-	++	++	++	++	++	-	+++	+++
Alopecurus myosuroides	++	-		++	++			-	+++	
Amaranthus retroflexus	++	++	++	+++	+++	++	+++	+		+
Anagallis arvensis		++		+	+			+++		
Apera spica-venti	++	-		+++	+++			-	+++	
Atriplex patula	+	+		+	+			+++		
Avena fatua	+	-		++	++			-	+++	
Bromus Japonicus										
Capsells bursa	++	++		+++	+++	+++	+++	+++	++	+++
Chenopodium album	+++	+	+	+++	+++	+++	+++	++	+	+++
Chrysanthemum segetum	-	++		++	++				++	
Convolvulus arvensis		-		-	+/-	+	+	-		
Cyperus Esculentes		+	++							
Descurania Sophia								++	++	+++
Digitaria ischaemum	-	-		+	+			-	-	
Digitaria sanguinalis	-	-		-	+	+	+	-	-	-
Echinochloa crus-gali	+	-	+++	+	+	++	++	-	-	-
Eclipta Prostrata				+++	+++					
Eleusine indica		-		+	++		++			
Euphorbia helioscopia	+	-		-	-					
Fumaria officinalis	+	-		-	-			-	++	
Galeopsis tetrahit	++	-		++	++			+	++	
Galinsoga parviflora	++	++		+++	+++			++	++	
Galium aparine	-	++		+++	+++			++	-	
Geranium spp.	-	+							-	
Lamium amplexicaule	+++	+/-		++	++				+	
Lamium purpureum	++	-		++	++			+	-	
Matricaria spp.	++	+++		+++	+++			++	+++	
Mercurialis annua	+	-		-	-			++	-	
Myosotis spp.	-	+++		+	+			+	++	
Poa annua	+++	-		+++	+++			-	+++	
Polygonum aviculare	+	+	+	++	++	++	++	++	+	+++
Polygonum Bungeanum										
Polygonum convolvulus	++	++	++	++	++	+++	+++	++	+	++
Polygonum hydropiper	++	+++		+++	+++			+++		
Polygonum lapathifolium	++	++		++	++			++	+	
Polygonum persicaria	++	+++	+++	+++	+++	+++	+++	++	+	++
Portulaca oleracea				+++	+++					
Senecio vulgaris	++	++		++	++			++	++	
Setaria viridis	-	-		+	+	-	+	-		
Sinapis arvensis	++	+++		+++	+++			+++	++	
Solanum nigrum	++	+++	+++	+++	+++	+++	+++	+++	+	+++
Sonchus Brachyotum										
Spergula arvensis	+++	+++		+++	+++				++	
Stellaria media	+++	+++	+++	+++	+++	+++	+++	+	++	++



Weed stage	Weed sensitivity class		
	Very sensitive (+++)	Moderate sensitive (++)	Little sensitive (+)
Seedling	0.1	0.1	0.2
1 leaf	0.1	0.15	0.2
2 leaves	0.2	0.3	0.4
4 leaves	0.3	0.4	0.5
6 leaves	0.6	0.8	1.1

Current situation on modern farms

Service providers

Suppliers

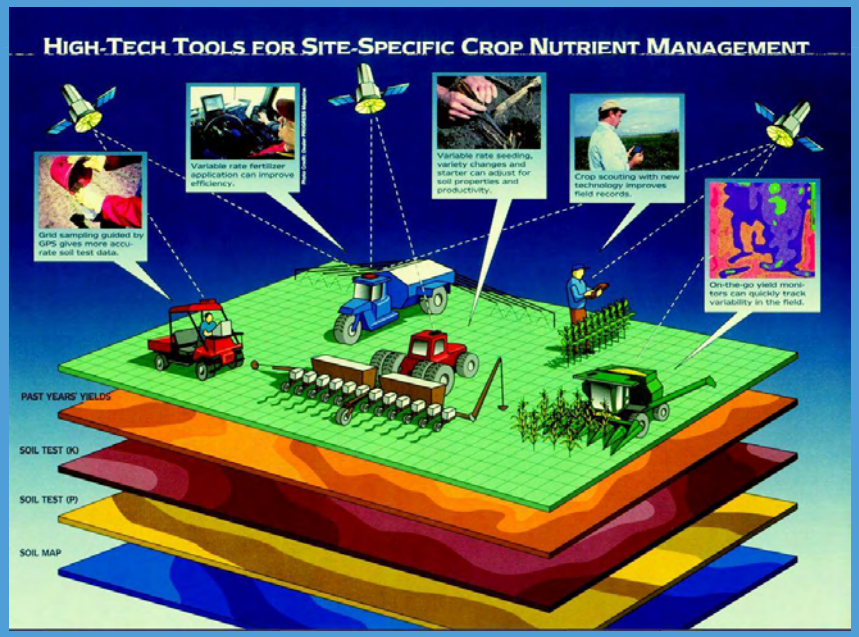
Government

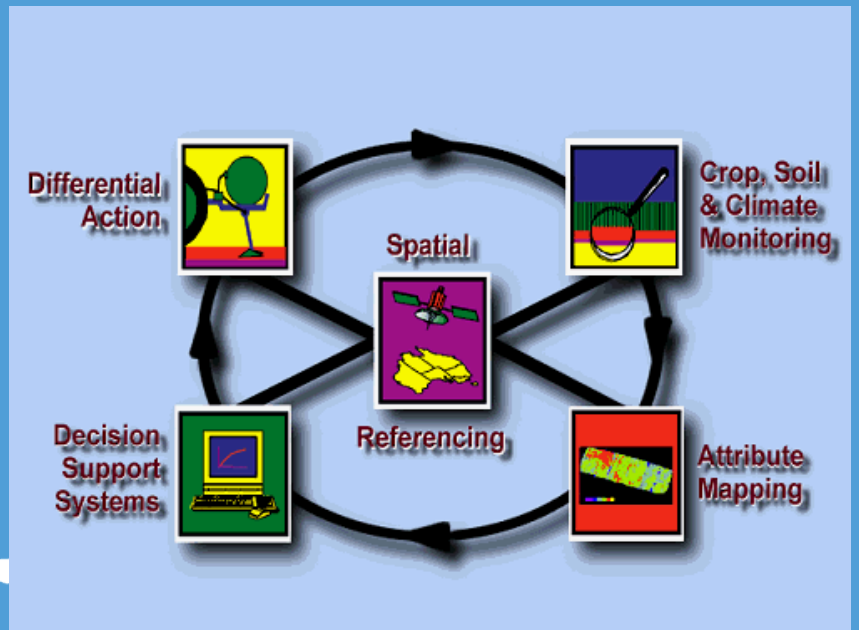
Customers

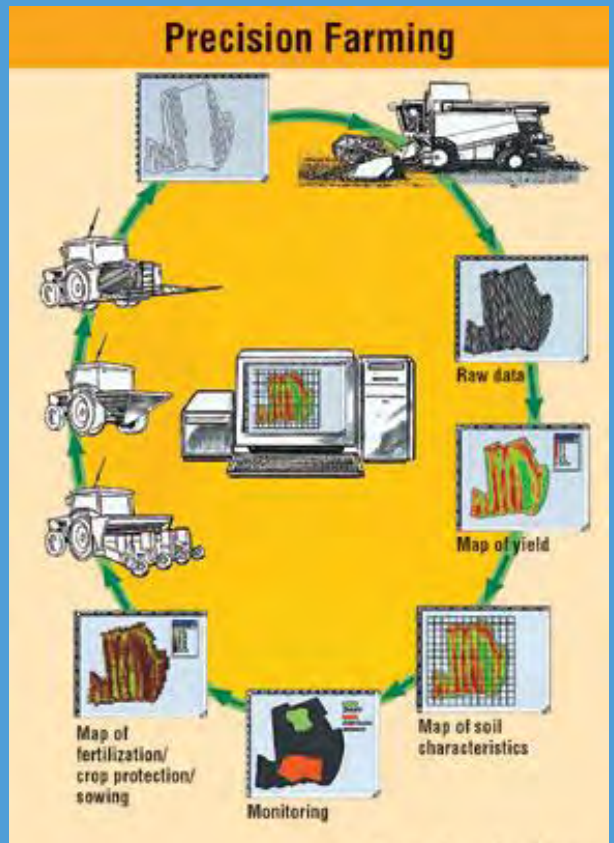
Farm process groups

- Finance
- HRM
- Product management
- Quality assurance

Images of (future) precision agriculture







Potato management cycle (Source: Jacob v.d. Borne)

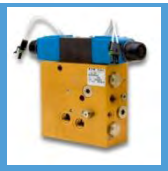
Controlled traffic farming (auto pilot system on tractor and additional machine guidance)

GPS / Galileo / GLONASS, Beidou / GNSS

Displays

Navigation Controller

Steering angle sensor



Hydraulic valve

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Agro robots

- Platforms for crop management

Agro Robots – current projects WUR

- Autonomous sprayers
  - Strawberry
  - Orchards
- Autonomous weed robot ‘Ruud’



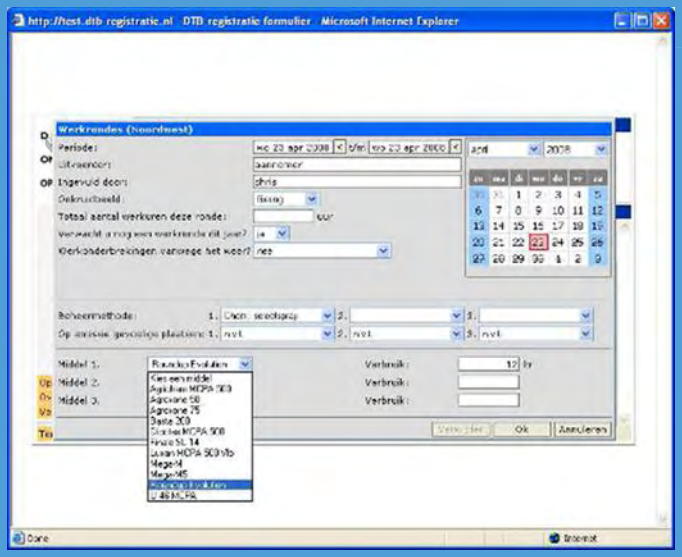


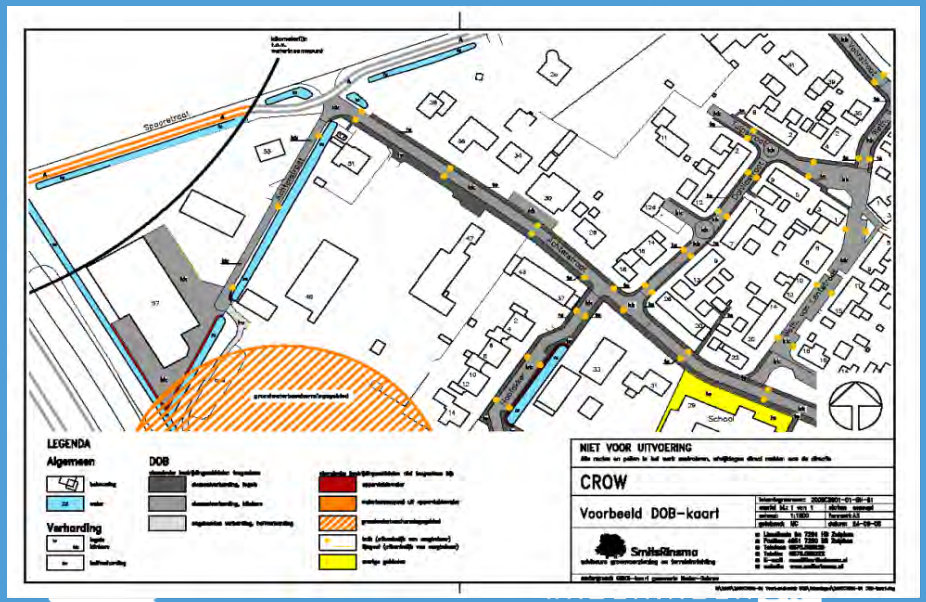
Ground sensors used in crop protection




Related developments in other domain

- Weed control on pavements
- Registration, planning, weather criterion compliance are mandatory





DOB Weerfax

Opgesteld: Maandag 04 apr 2005 05:48
Regio: Veluwe

Duurzaam Onkruid Beheer

Weersverwachting korte termijn:

Datum / Tijd	uur	4 apr 7	10	13	16	19	22	5 apr 1	4	7
Temperatuur 1.50 m.	°C	10	15	17	15	12	9	8	7	6
Temperatuur 0.10 m.	°C	10	15	18	17	12	9	7	6	7
Bladnat	/uur	●●●	○○○	○○○	○○●	●●●	●●●	●●●	●●●	●●●
Neerslag	mm	0	0.1	0.4	1	2	1	1	0.7	0.3
Neerslagkans	%	10	10	20	50	70	60	60	40	10
Windrichting		ZZO	ZZW	ZZW	ZW	ZW	ZW	WZW	WZW	W
Windsnelheid	m/s	2	4	4	4	3	3	2	2	3

Bladnat: ● gewas is nat ○ gewas is droog

Spuitomstandigheden Roundup Evolution:

Datum / Tijd	uur	4 apr 7	10	13	16	19	22	5 apr 1	4	7
Werking		++	+	+	++	+	+	+	++	++
Uitvoering		- -	++	+	-	- -	- -	- -	- -	- -
Dosering (%)		-	70	80	-	-	-	-	-	-

Weersverwachting lange termijn:

Datum		Maa 4 apr	Din 5 apr	Woe 6 apr	Don 7 apr	Vry 8 apr
Weer						
Min-Max Temp. 1.50 m.	°C	7 - 17	5 - 13	4 - 14	6 - 10	4 - 8
Min-Max Temp. 0.10 m.	°C	6 - 18	5 - 14	3 - 14	5 - 11	4 - 8
Bladnat	/3 uur	○●●○○●●	●●●○○○○	●●○○○●●	●●●○○○○	●●●○○○●
Neerslag	mm	4	2	3	5	4
Neerslagkans	%	70	70	70	40	50
Windrichting		ZO - ZW	ZZW - W	Z - ZZW	ZZW - ZW	ZW - NNW
Windsnelheid	m/s	1 - 4	2 - 4	2 - 8	3 - 5	2 - 4

REGIONAAL WEEROVERZICHT
De dag begint zonnig, maar nog voor het middaguur verschijnen de eerste wolkenvelden. Vanmiddag worden dat er steeds meer en in de namiddag vallen soms ook buien. Het wordt ongeveer 19 graden bij een matige wind uit zuidwest. Vanavond en het eerste deel van de nacht blijven soms buien vallen. In de nanacht wordt het droog en klaart het een beetje op. Daarbij koelt het af tot 7 graden.

LANGE TERMIJN VERWACHTING
Dinsdag wordt een droge lentedag met vooral in het noorden en westen van het land veel zon. In het zuiden komen wat meer wolken voor. De wind is west tot zuidwest en matig tot vrij krachtig aan zee, langs de Wadden soms krachtig. Het wordt 11 tot 15 graden. In de nacht naar woensdag neemt de bewolking toe en in de ochtend kan al een bui vallen. Woensdag overdag volgen meer buien. Dat geldt ook voor donderdag en vrijdag. De temperatuur gaat langzaam omlaag naar 8 tot 11 graden op vrijdag. In de nachten daalt het kwik tot zo'n 4 graden op veel plaatsen in het binnenland. Aan zee is het met 6 a 7 graden zachter. De zuidelijke wind trekt woensdag en donderdag flink aan tot vaak krachtig aan zee, soms mogelijk even hard. Vrijdag wordt de wind noordelijk en neemt iets af.

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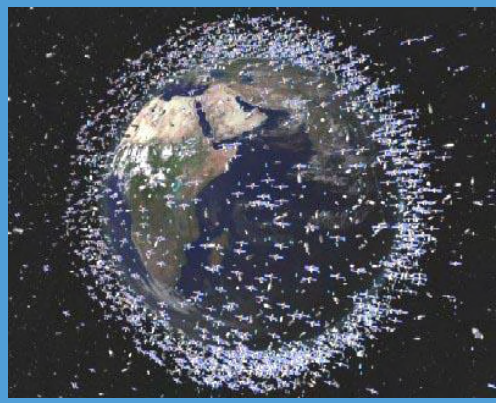
Challenge

- How do we handle the massive amount of availble (sensor) data and use them in a clever way
  - Need of intelligence
- Easy exchange of data between sensors, FMS and external services
- Standardisation
  - ISOBUS (ISO 11783)

State of the art use satellites in PA

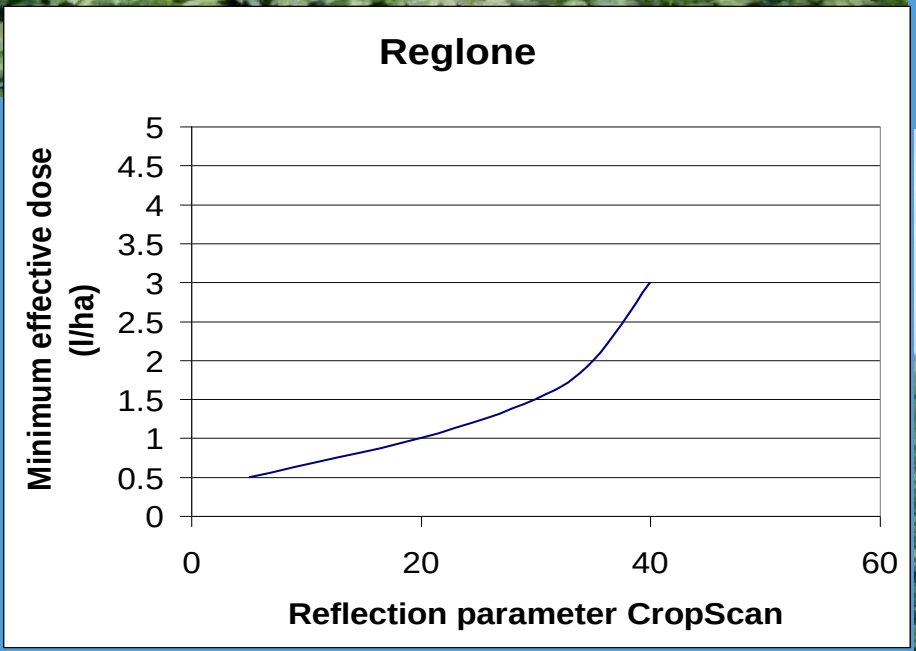
- Many satellites around the world support PA with
  - References for positing systems
  - Qualitative and quantitative crop information
- National satellite database (2012-2015)
- Satellite sensors provide data for
  - Land use monitoring
  - Crop and yield monitoring
  - Optimization of crop management



Variable rate application of pesticides

- Case of potato haulm killing

Ground sensor - VRA (MLHD PHK) 2005



PPO-AGV Proefbedrijf

Eerste tests MLHD online

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W
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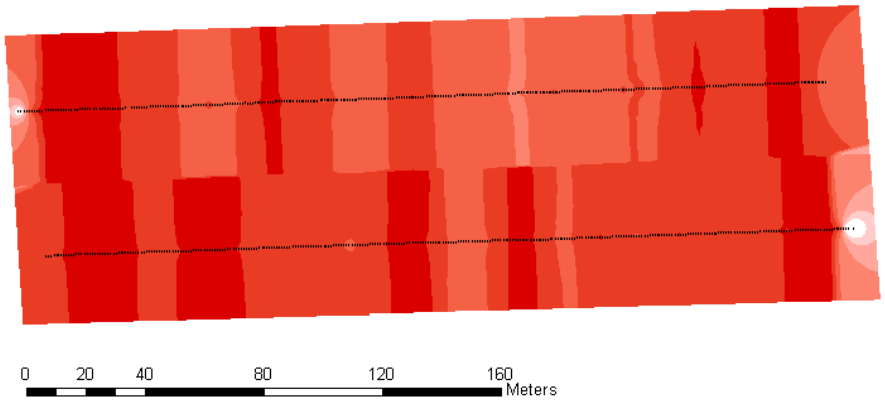
1:1600



Legenda

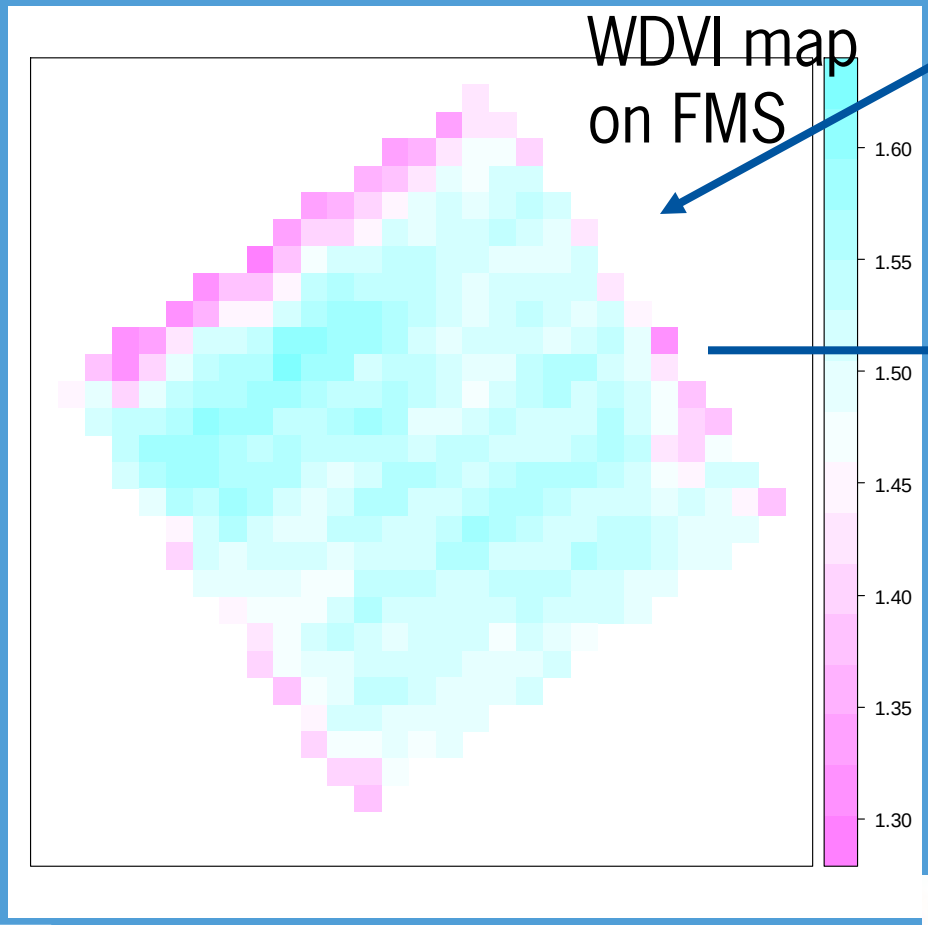
Meetpunten

Interpolatie

Dosering (l/ha)

- 1.50 - 1.75
- 1.76 - 2
- 2.01 - 2.25
- 2.26 - 2.5
- 2.51 - 2.75
- 2.76 - 3.00

Use of remote satellite images in potato haulm killing



Dosing map

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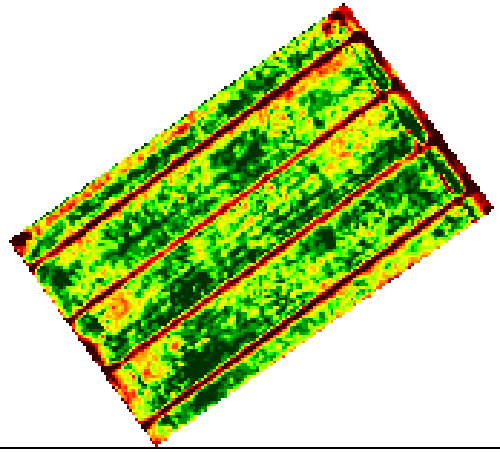
TerraSphere

NIVR



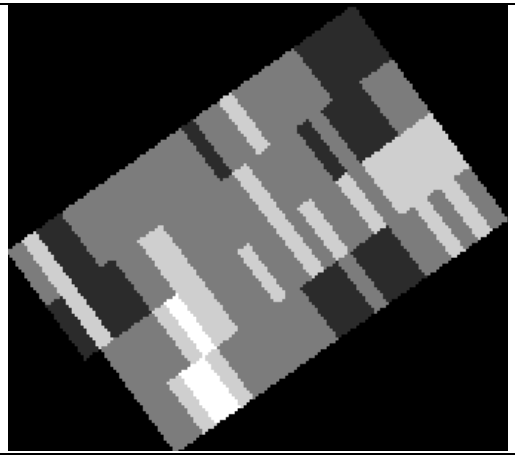
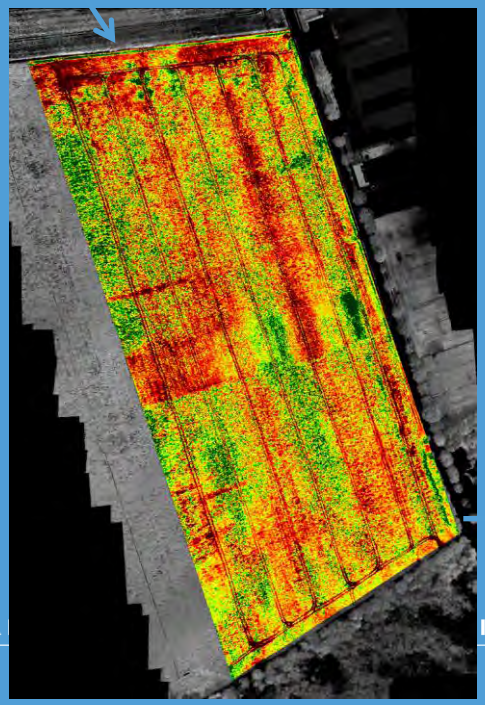
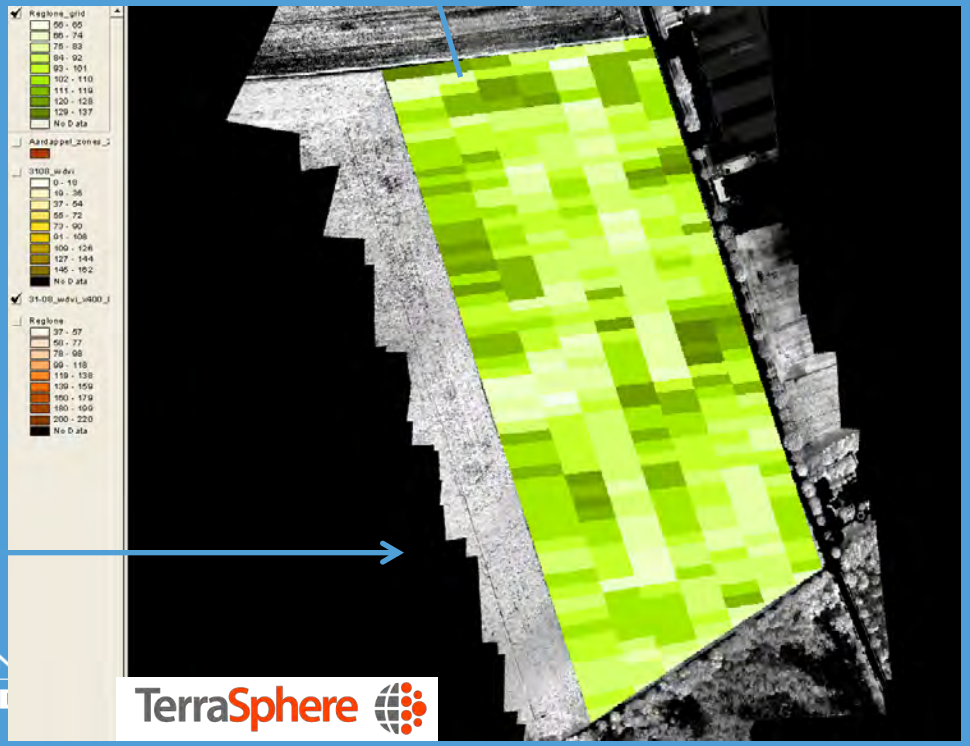


Figure x. Worldview-2 image, 15-08-2011, Flevoland. Test parcel for variable rate application in yellow outline (above). WDVI image of test parcel (lower-left). Reglone dose instruction map (lower-right)

Spray map PHK using UAV biomass map and PHK-algorithm Reglone (sept 2011)

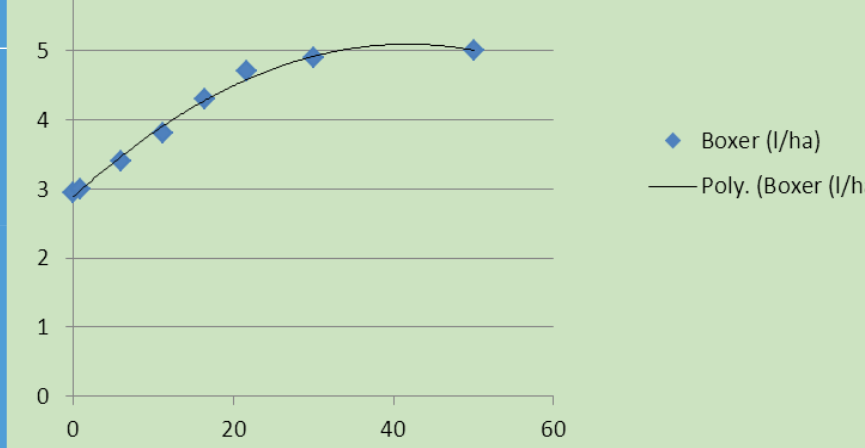




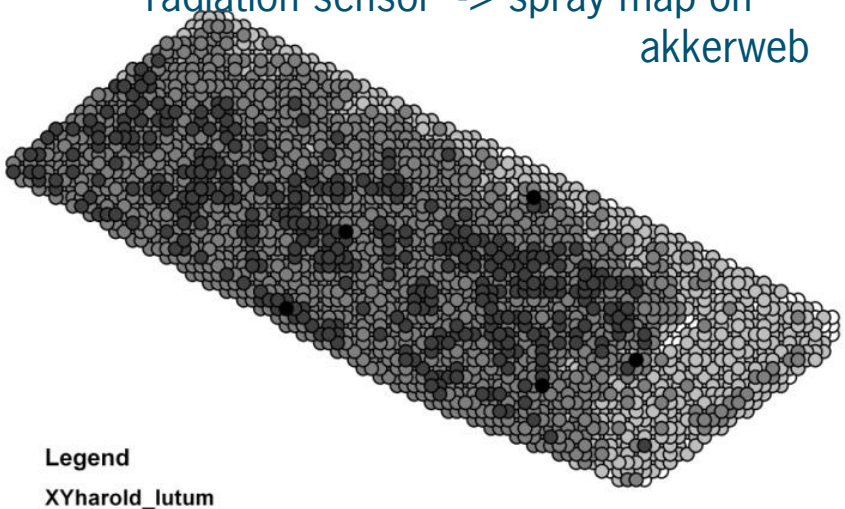
TerraSphere

Standardisation issue

VRA soil herbicides



Lutum map made with gamma radiation sensor -> spray map on akkerweb

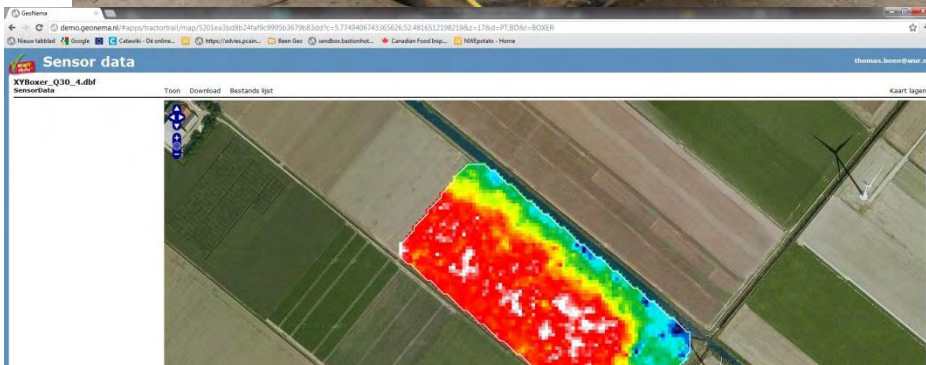


Legend

XYharold_lutum

Lutum

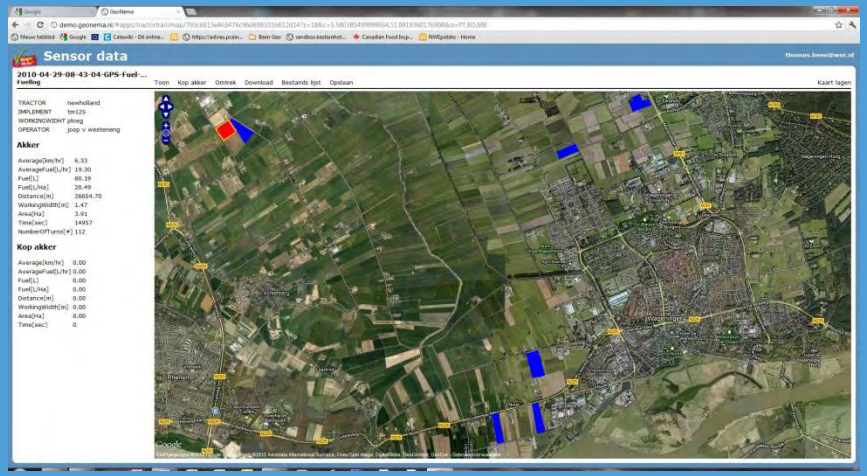
- 6.740000 - 13.738000
- 13.738001 - 20.736000
- 20.736001 - 27.734000
- 27.734001 - 34.732000
- 34.732001 - 41.730000

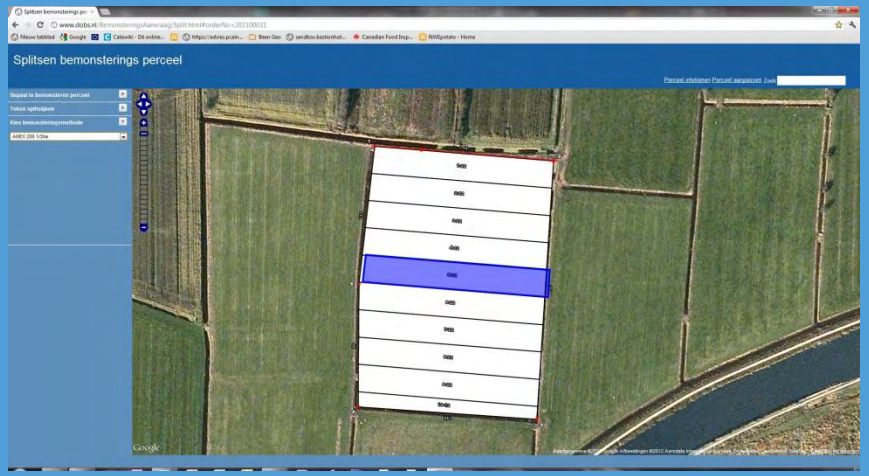


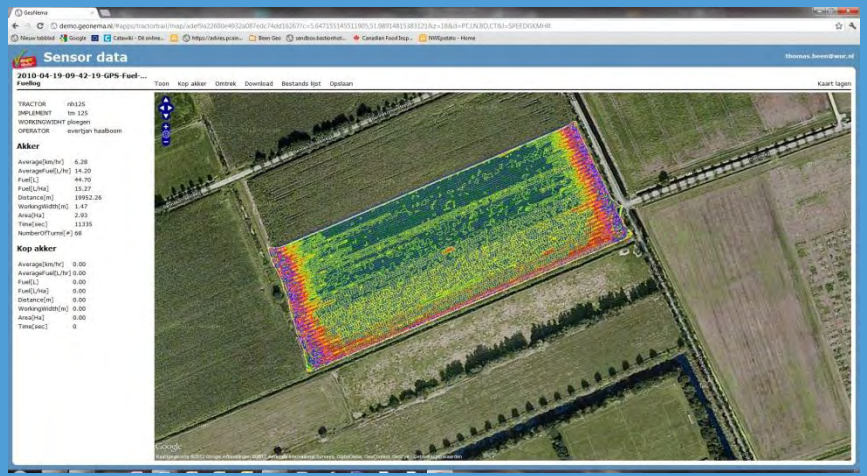
Data infrastructure

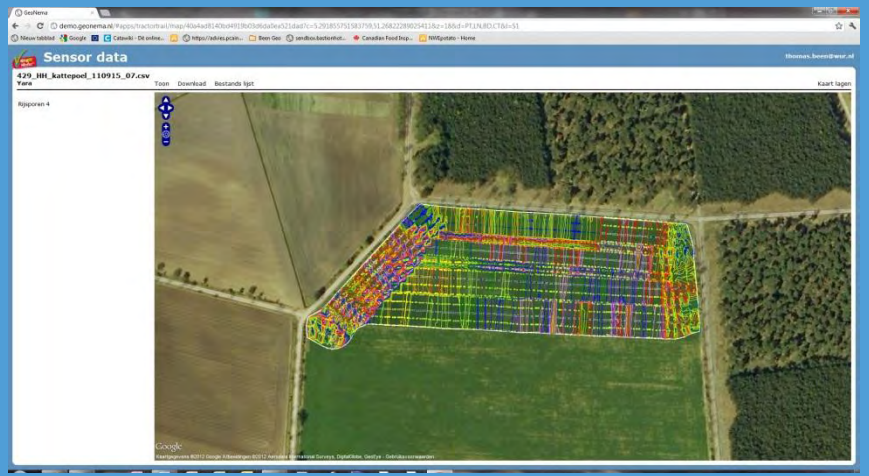
- Internet platform for agriculture
  - On farm communication
    - Between FMS and machines v.v.
  - Communication within food chain
  - Apps
  - Standardisation

Internet Platform Akkerweb







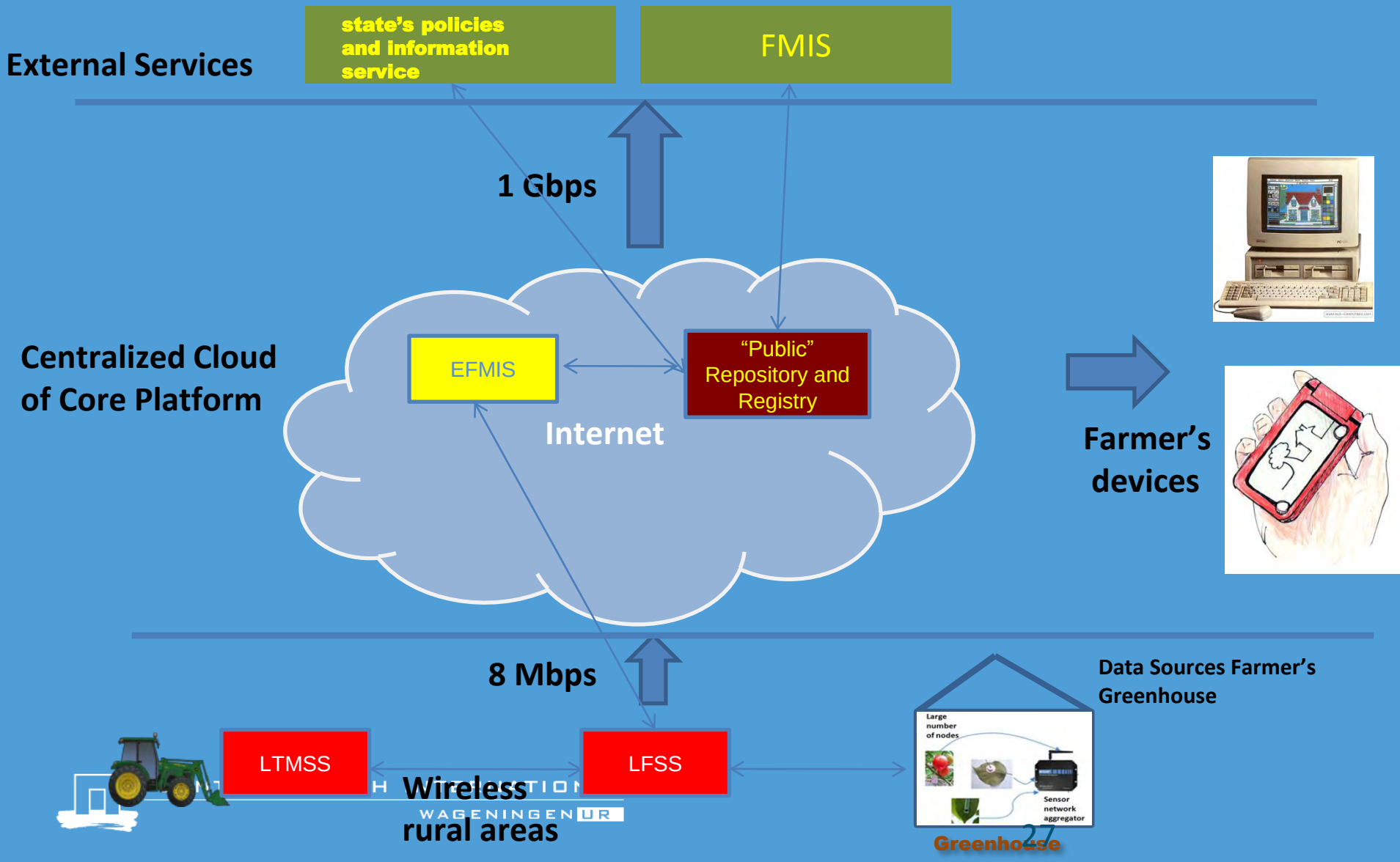


Smart Agri Food (SAF) project

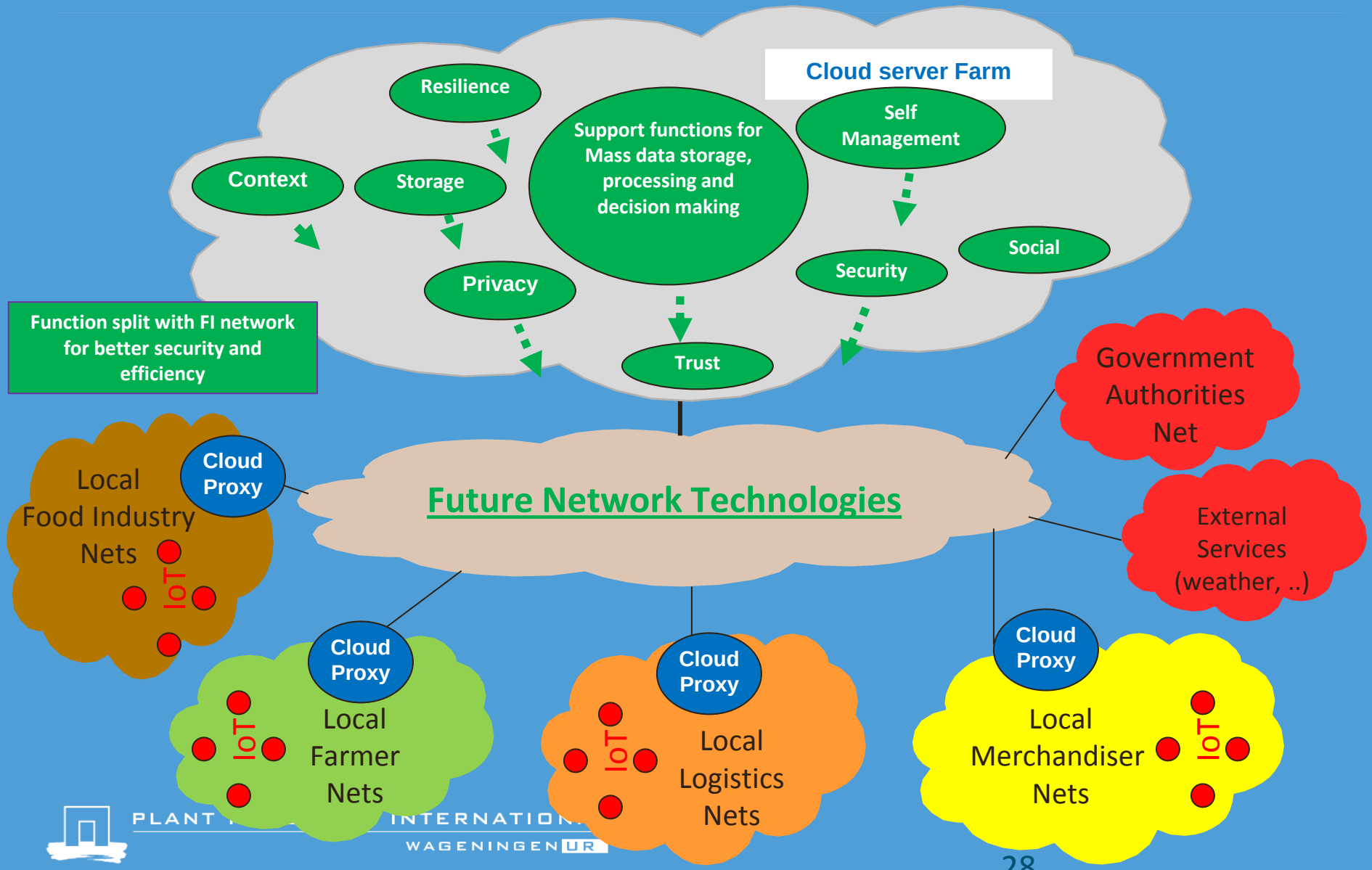
- EU FP7 project in ICT domain
- Some schemes for future internet in agriculture
- Coordinator is Sjaak Wolfert

SAF small scale pilot architecture

FMIS: Farm Management System
EFMIS: Extended FMIS
LTMSS: Local Tractor Mgmt Subsystem
LFSS: Local Farm Mgmt Subsystem



FI-PPP Architecture for SAF (long term)

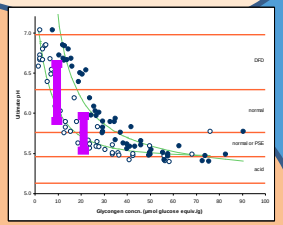


SAF small scale pilot (1/2)

SAF small scale pilot GUI (2/2)

Implementation and Configuration

Intelligence



Connectivity

Dynamic Virtual Representation

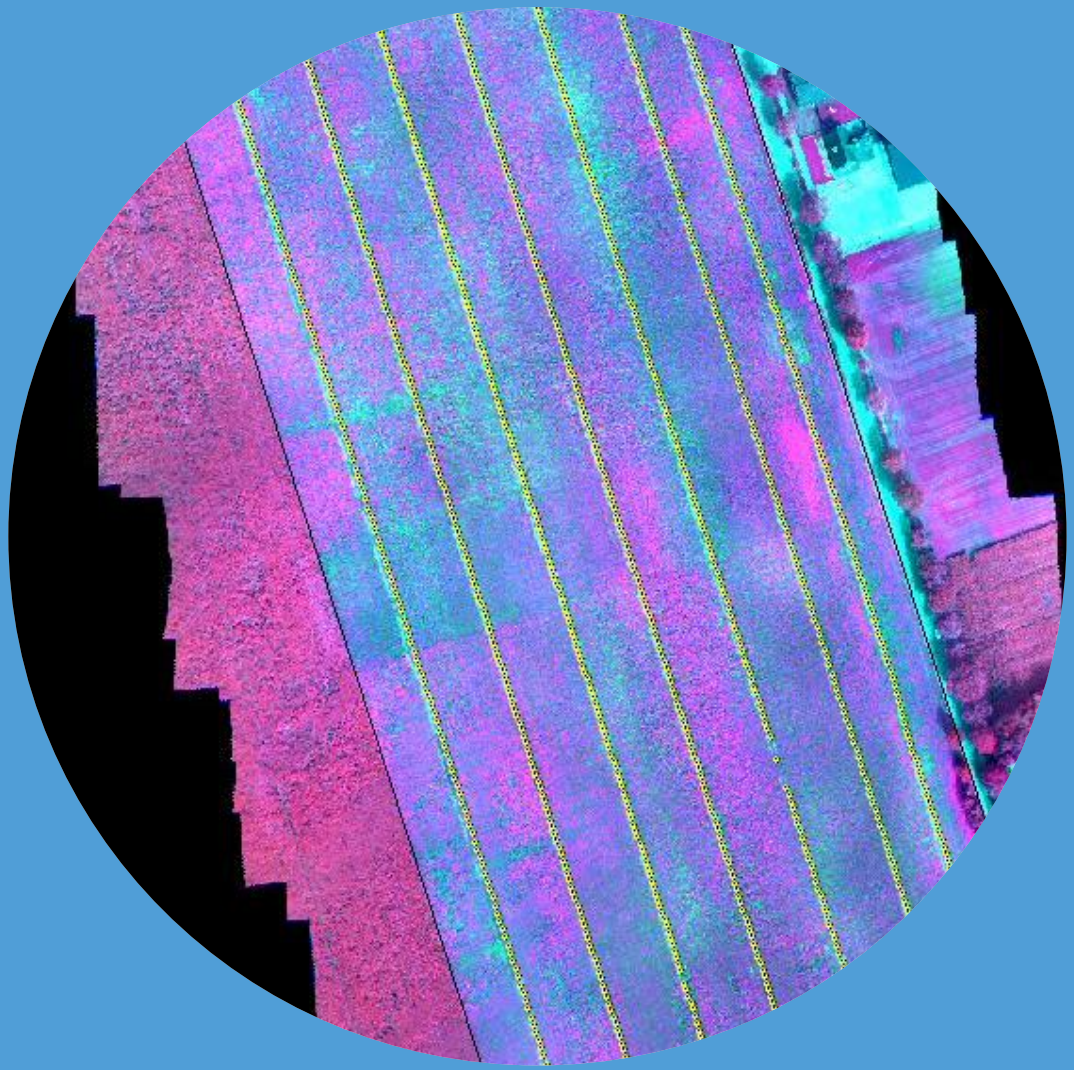
Summary of smart Agri Food (SAF) project

- Exchange of data within food chain
  - Representation of reality
  - Connectivity
  - Intelligence (content (underestimated))
  - Integration
    - Precision Ag, logistics, E-commerce, regulations, food chain network

Conclusion: ICT will play a crucial role in shaping future agriculture

- Intelligence at farm level
  - Excess to databases
    - E.g. nat. satellite data base
    - Open sources and ‘ask your neighbour’
  - Diagnosis, advice
  - PA, Logistics, E-commerce, regulations
- Communication within food chains
  - Tracking and tracing
- Autonomous vehicles/robotis

End of presentation



More info:

corne.kempenaar@wur.nl

+ 31 317 480498