



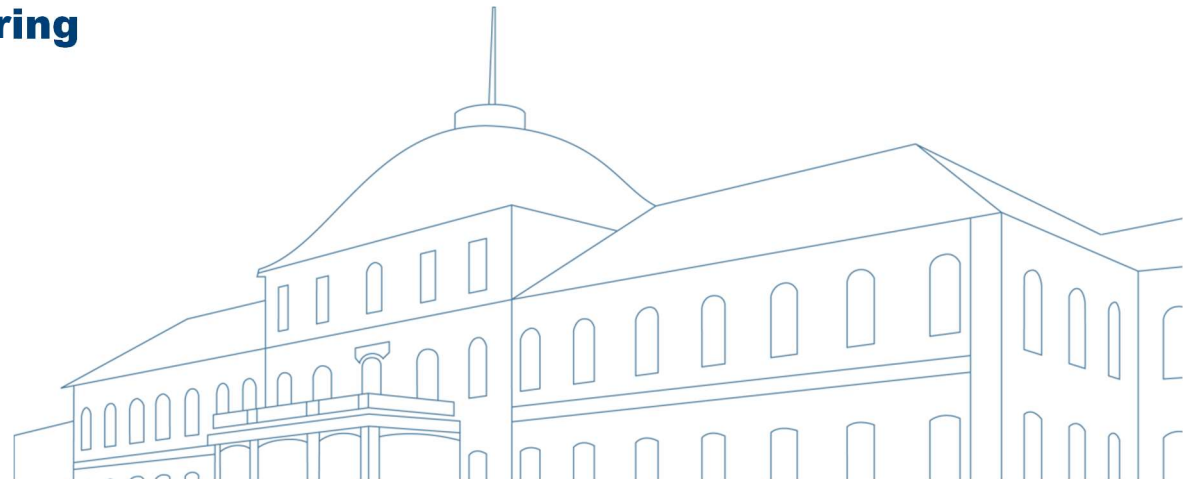
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Agricultural Robots

Mini Public, 3rd June 2019

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Future views?



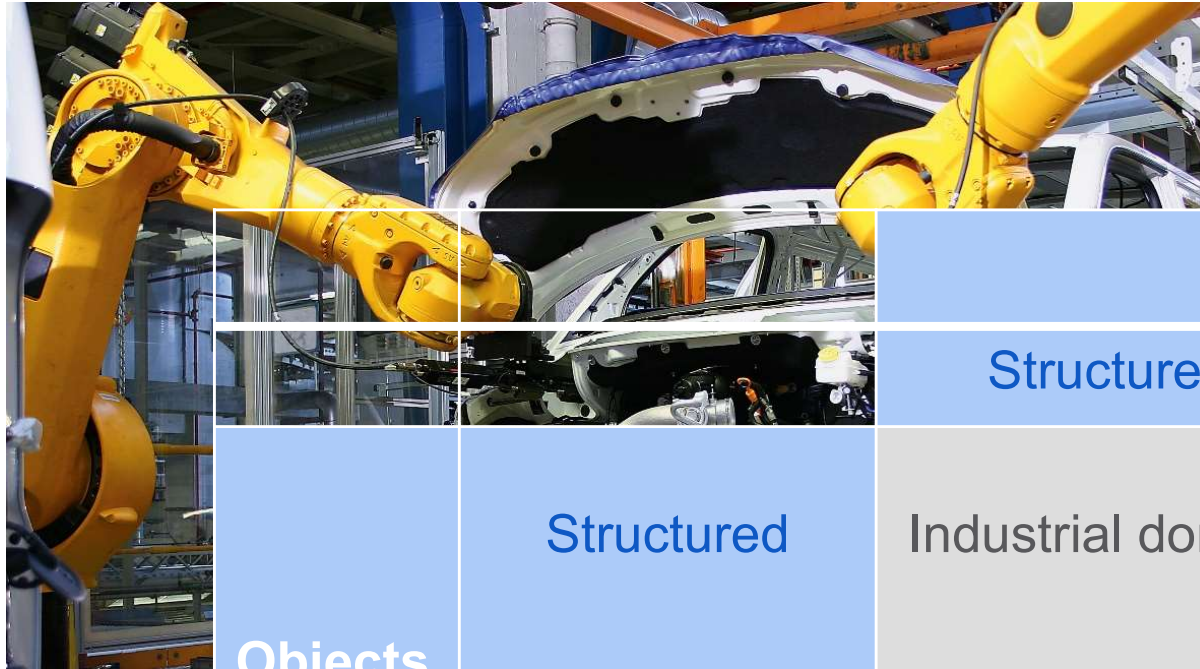
Source: thechinainvestors.com



Outline

- Introduction
- Technical Opportunities
- Expectations
- Risks
- Conclusions

Automation & Robotics Domains (1)



		Environment	
		Structured	Unstructured
Objects	Structured	Industrial domain	Military, Space, Underwater, Mining domain
	Unstructured	Medical domain	Agricultural domain



Source: Bechar & Vigneault 2016

Automation & Robotics Domains (2)



- Industrial domain (industry 4.0)
 - Highly complex, but conditions are constant and easy to control (deterministic)
- Agricultural domain (digital farming)
 - Highly complex and dynamic conditions in time & space (only partly deterministic & highly stochastic)



Source: Bechar & Vigneault 2016

Market prices

?

Investments

?

Climate

?

Fertilization

Soil

?

Nutrients

?

Mechanization

?

Soil moisture

?

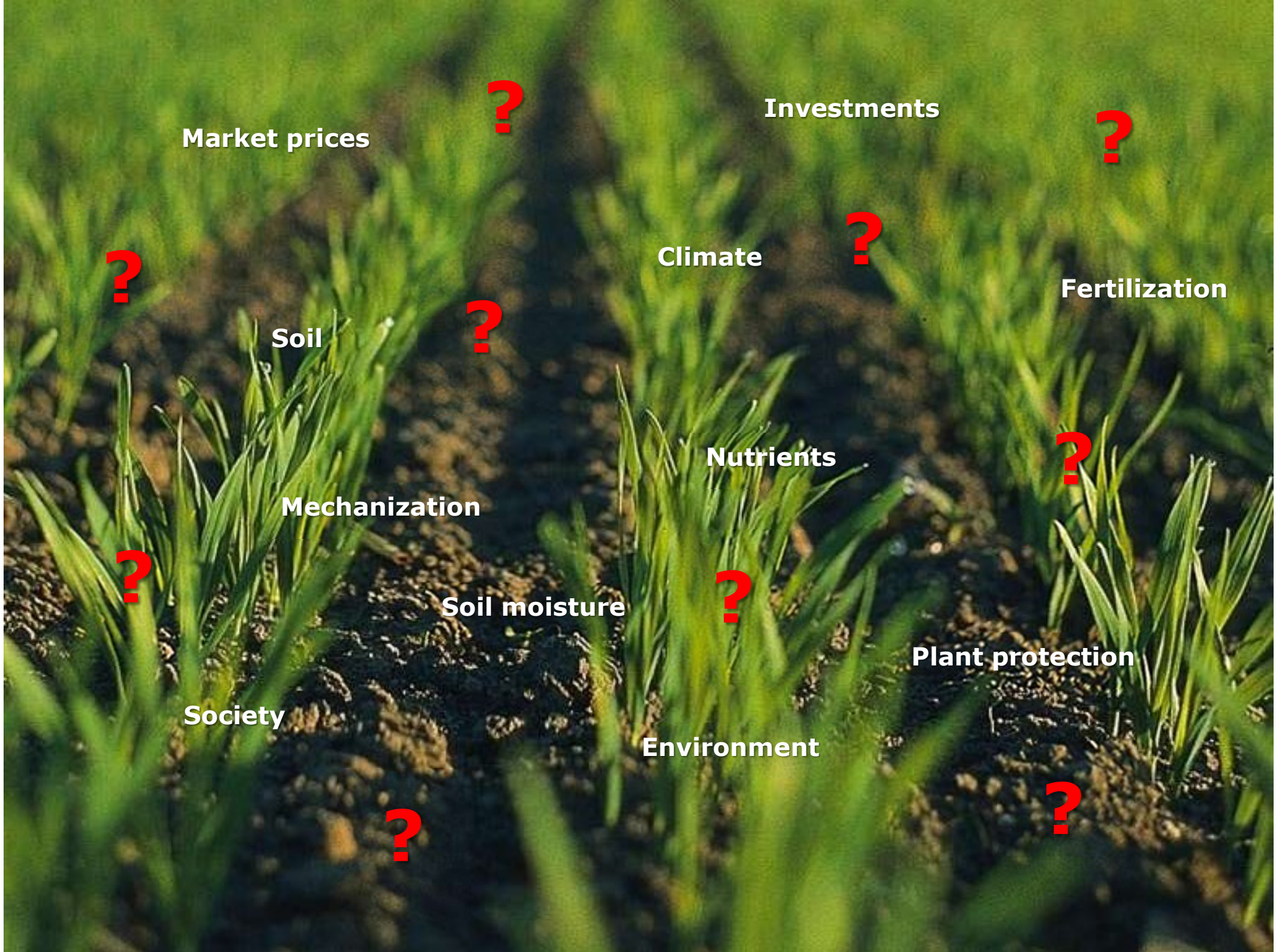
Plant protection

Society

?

Environment

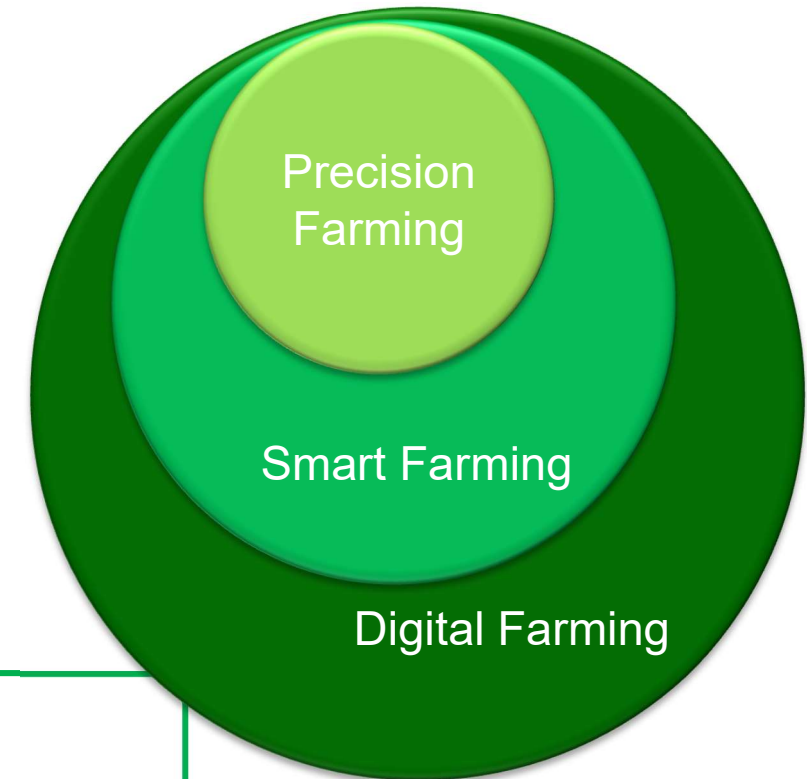
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Definition of Terms

- Precision Farming
 - Site-specific treatment
Map based variable rate applications
 - Automation
Automatic steering, section control & self adapting complex machinery
- Smart Farming
 - Realtime systems
 - Fusion & analysis of information
 - Decision support
- Digital Farming & Farming 4.0
 - Internet of things (M2M)
 - Cloud computing
 - Big-data & AI
 - Robots

**Future System:
Paradigm Shift!**





Top 10 Robotic Applications in the Agricultural Industry

- Nursery Planting
- Crop Seeding
- Crop Monitoring and Analysis
- Fertilizing and Irrigation
- Crop Weeding and Spraying
- Thinning and Pruning
- Autonomous Tractors
- Picking and Harvesting
- Shepherding and Herding
- Milking

Robots - Conventional Size

Source: CNH 2018

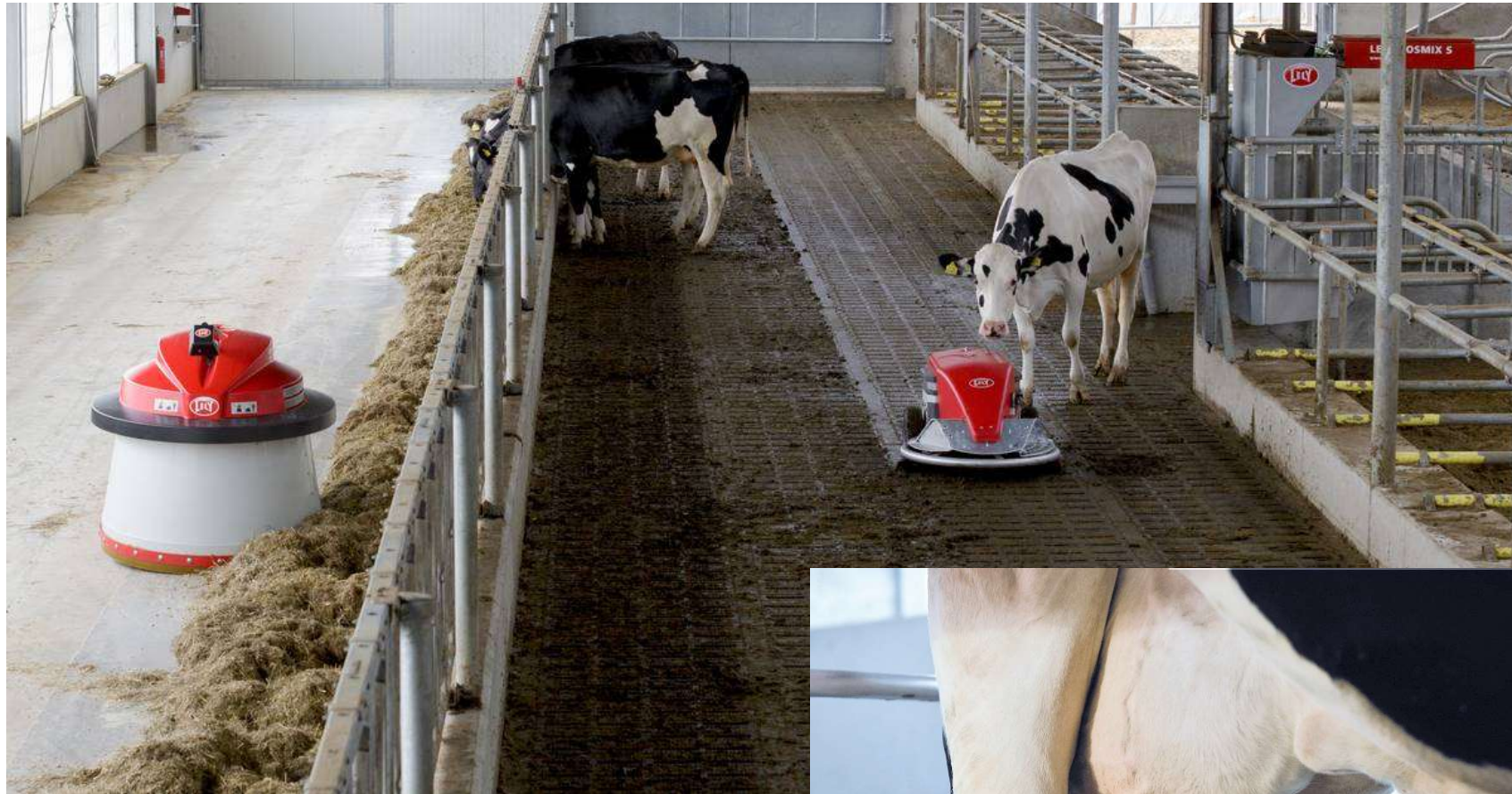


Robots – Small Size

Source: AGCO Fendt 2017



Robots – Animal Husbandry



Fotos: Lely 2019





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Robots – Assisting Humans



Source: Technovelgy.com 2019

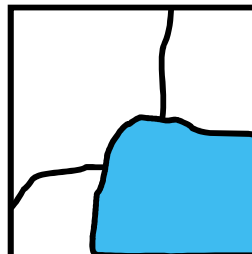
Opportunities (1)

- Conventional or traditional farming



Field
uniform dose rate

- Precision Farming
 - map & soil based



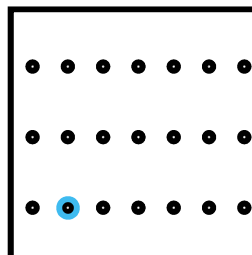
Site specific & offline
variable dose rate

- Smart Farming
 - sensor & crop based



Site specific & real time
variable dose rate

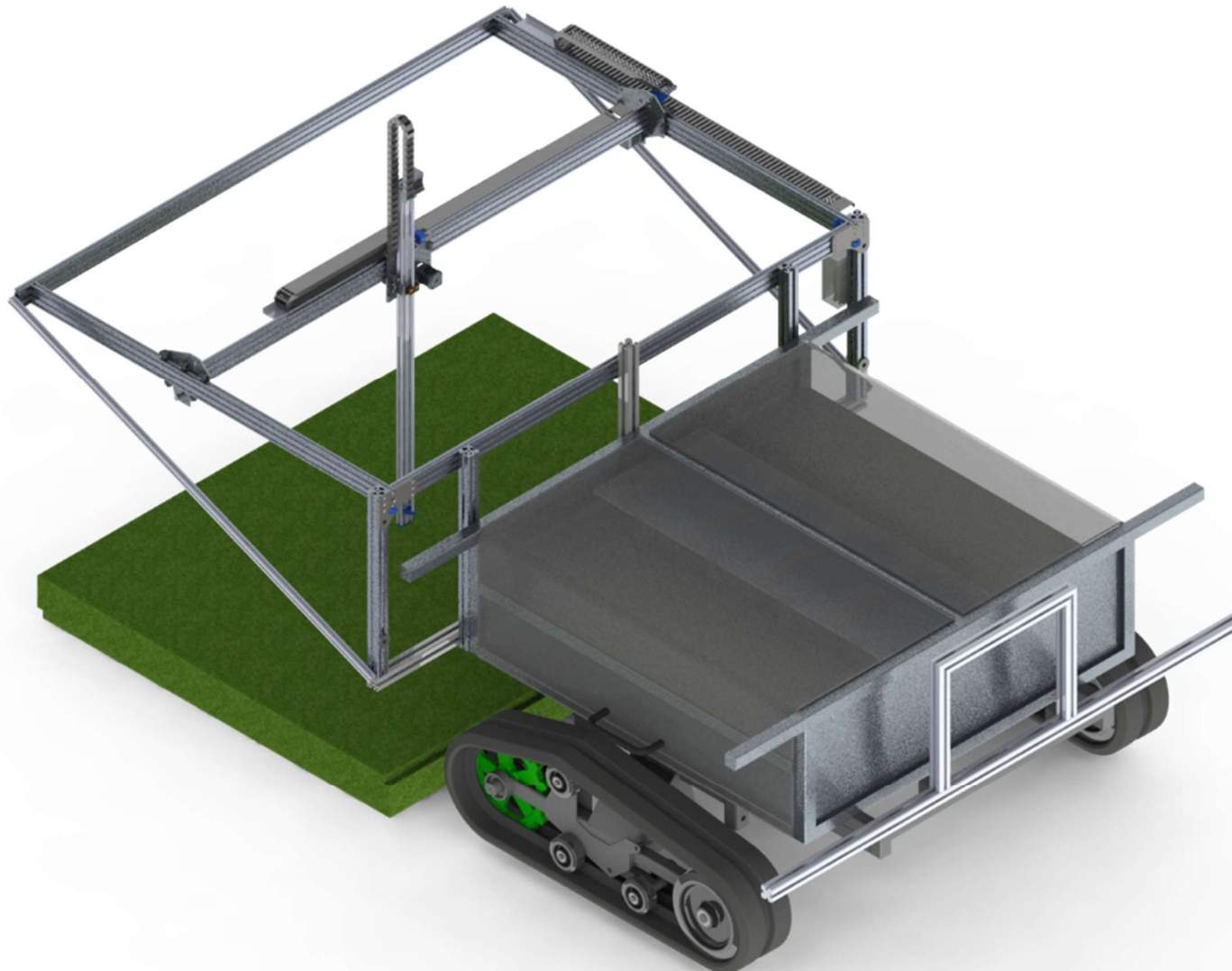
- Digital Farming
 - IT based



Single plant
variable & individual
dose rate

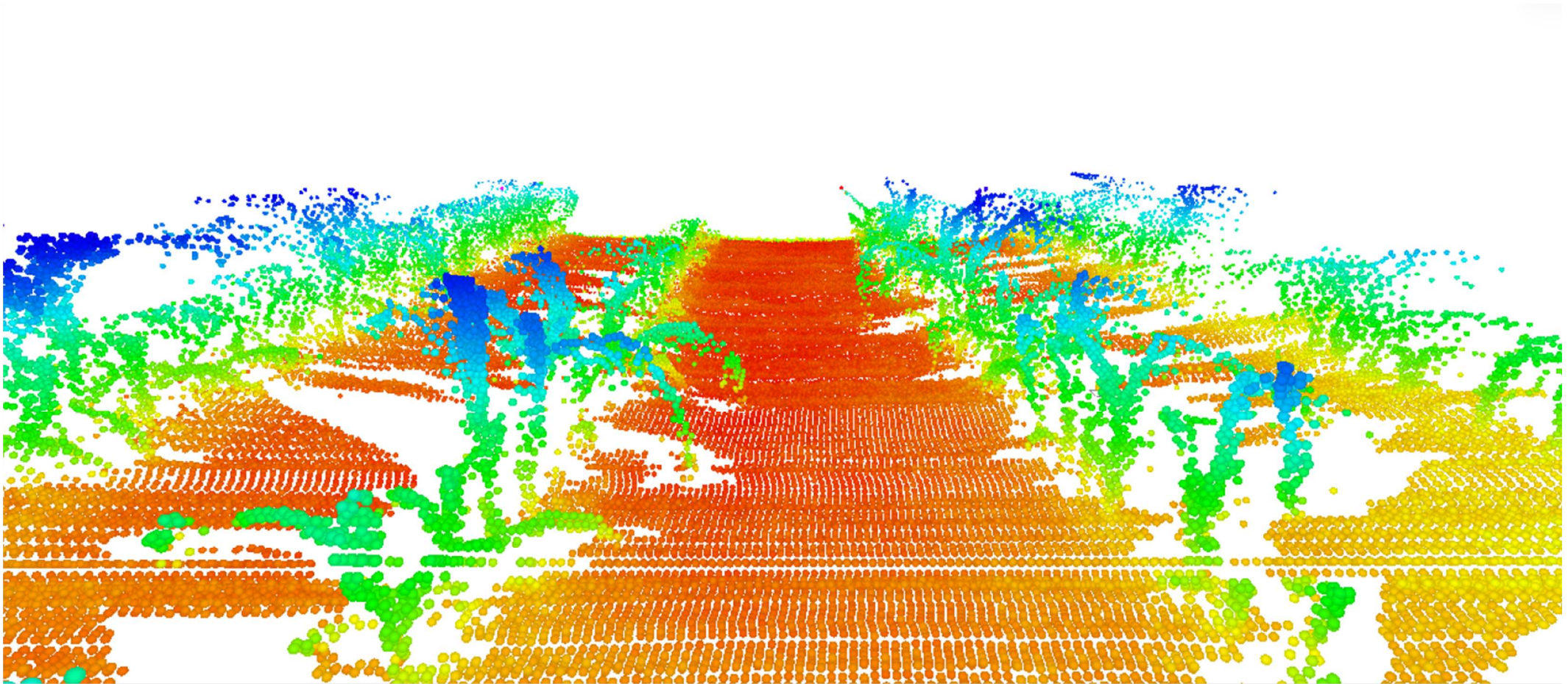
Opportunities (2)

3D – Frame for Mapping and Application



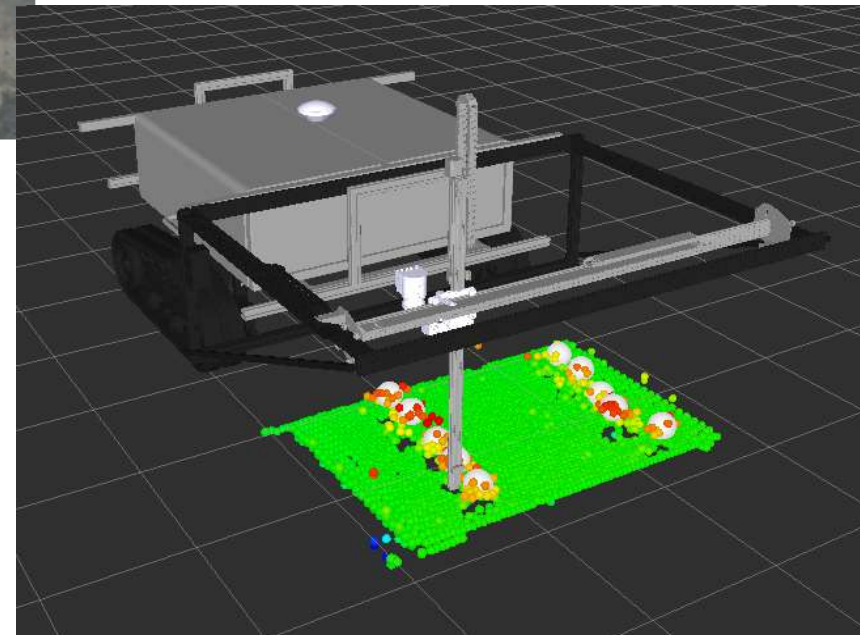
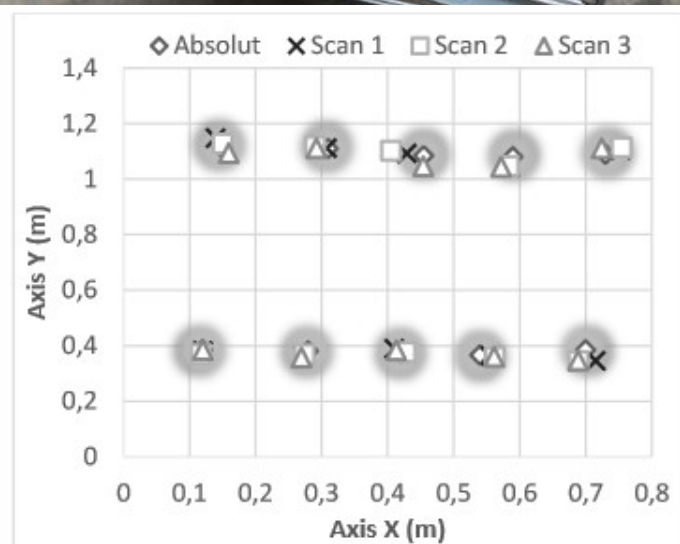
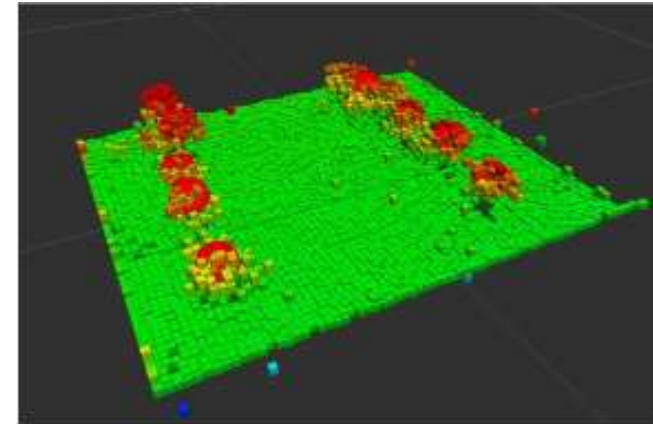
Opportunities (3)

Mapping & reconstruction of maize plants - LIDAR

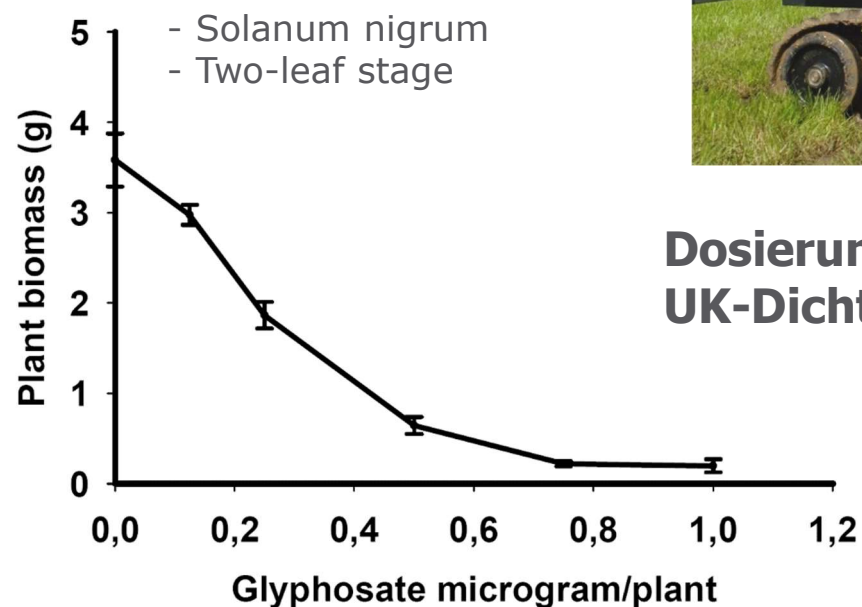


Opportunities (4)

Mapping & reconstruction of plants - SONAR



Opportunities (5) Micro-Sprayer



Dosierung 1 [μg] pro UK-Pflanze
UK-Dichte 100 [pro m^2] =

1 [g/ha]

Source: Soegaard & Lund, 2006

Constraints – Data protection

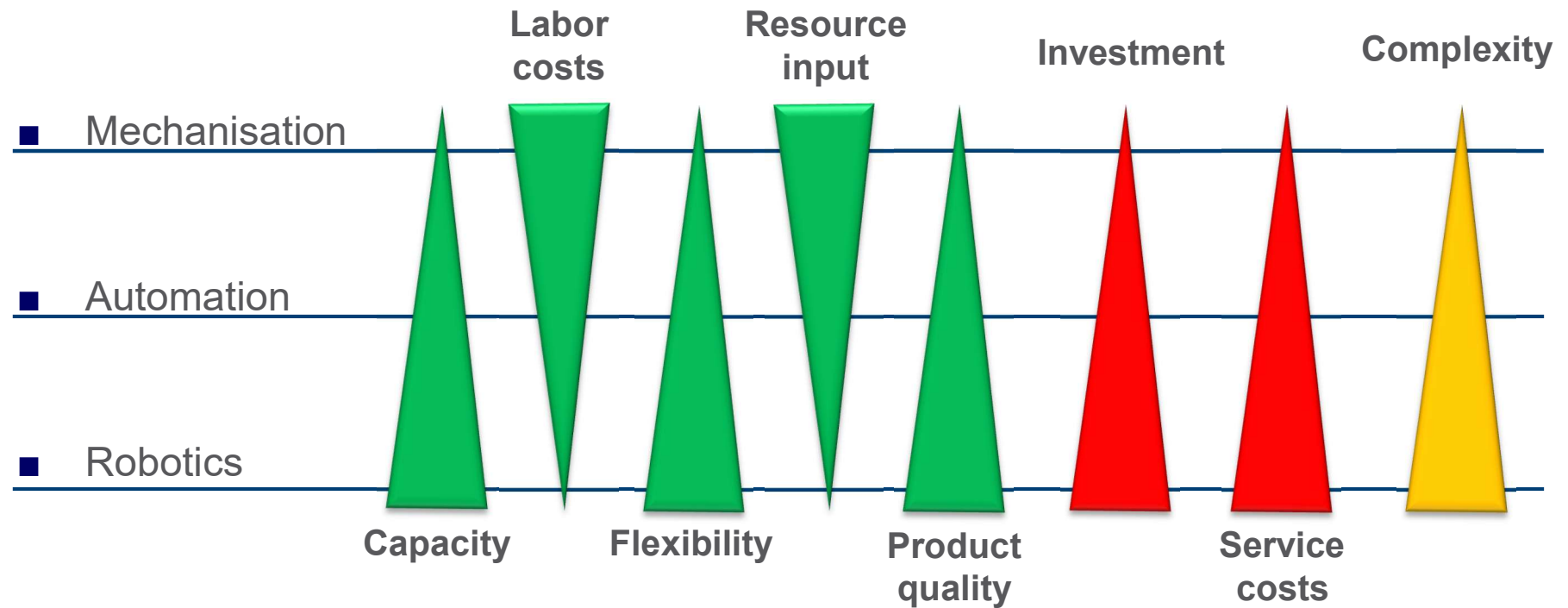
Example for yield logging

- Contractor is combining for the farmer Piepenbrink. The machine has mobile communication to a server of the manufacturer. All data about field, yield, time, mission etc. are logged.
- Who owns the data?
 - The machine manufacturer, machine data are used for diagnostics, servicing and maintenance.
 - The combine operator, personal data (legal regulation)
 - The contractor, it is his machine, hired driver and job
 - The farmer, it's his company secret and his working & business data

Data from agriculture are tradable goods of high value.

Hence, if commercialized the farmer has to agree to it and to have a part!

Conclusion - Opportunities Parameters



Outlook

Conditions of Agricultural Production



Production for the world market; low intensities; low land prices; high automation of subsystems



Appropriate technology; medium and high intensities; low labor costs



High product qualities; high safety and environmental concerns; high labor costs, investments and intensities