

NOI Nature of Innovation Technopark – Bozen

unibz Studium Generale course 12/2023 – 04/2024

Introduction to Smart Agriculture Technologies for Mountain Ecosystems

Giovanni CARABIN
Andreas MANDLER



Introduction to Smart Agriculture Technologies for Mountain Ecosystems

- 00 – Introduction

- Andreas Mandler, PhD
- Giovanni Carabin, PhD
- UNIBZ, Faculty of Agricultural, Environmental and Food Sciences

Timetable

	Date	Time	Title	Lecturer	hrs
1	12.12.	4:30 - 6 pm	Course introduction smart agriculture and smart forestry, *define exact course dates and times	Carabin, Mandler	0,5
			Introduction	Mandler	1h
2	21.12.	4:30 – 6pm	FMIS theory and concepts	Mandler	1,5
3	9.1. 2024	4:30 – 7pm	SA and FMIS technological components 1 - break at 6pm FMIS technological components 2 (sensors, GPS, software, GIS)	Carabin	2,5
4	11.1.	8:30-12:30	Laboratory AFILab A) <u>Sprayer</u> (Lorenzo) <u>Mobile Plattform</u> (Giovanni, Merve)	Carabin, all	4
5	16.1.	4:30 – 7pm	FMIS examples 2 - break at 6pm Show products and exercises	Mandler	2,5
6	18.1.	8:30 – 12:30	Laboratory AFILab B) <u>ByeLab</u> test and exercise	Carabin, all	4
7	22.1.*	5-7pm	BACKUP: e.g. Smart machines in mountain ecosystems General Discussion	Carabin, Mandler	2
8	2.2.		Exam , oral exam 15min	Carabin, Mandler	1

Being able to:

- differentiate between precision farming and smart farming applications
- discover and apply the technological requirements of smart farming
- apply complex system understanding to production process and tools of precision and smart farming applications
- understand technologies and tools offered on the market for complex system evaluation and optimize process efficiency

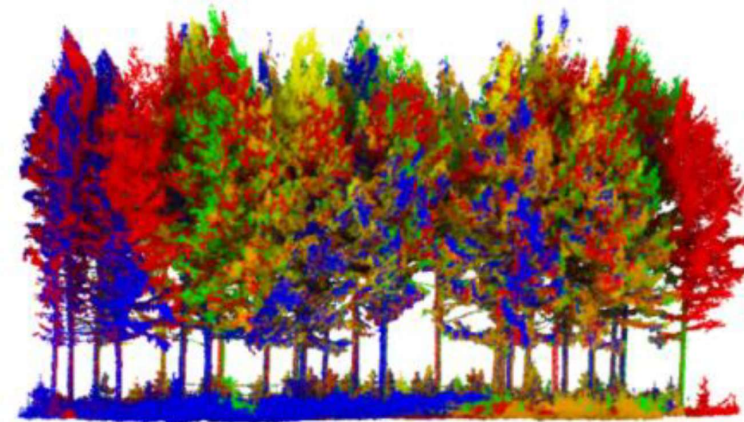
AI4FOREST Project

An Artificial Intelligence approach for Forestry Robotics in Environment Survey and Inspection

The aim of the project is to design and implement an **autonomous sensorized robotic** system capable of **navigating within a forest** to create a **Digital Twin (DT)** of the **under-canopy environment**.

Activity:

1. Provide support for the **setup of the robotic system**, with the different sensors considered, and the acquisition system.
2. Provide support for the **manual survey/census** in the forest.
3. Create a **database** for the DT management.
4. Develop algorithms to **extrapolate information on forest elements** from the acquired data (tree type, tree diameter, tree position, etc.).



AI4FOREST Project

An Artificial Intelligence approach for Forestry Robotics in Environment Survey and Inspection

- Candidature deadline: **9.01.2024** – 12:00
- <https://www.unibz.it/it/home/position-calls/positions-for-academic-staff/6732-meccanica-agraria-prof-mazzetto-fabrizio?group=18>
- For any question contact: giovanni.carabin@unibz.it



Smart Agriculture Technologies for Mountain Ecosystems

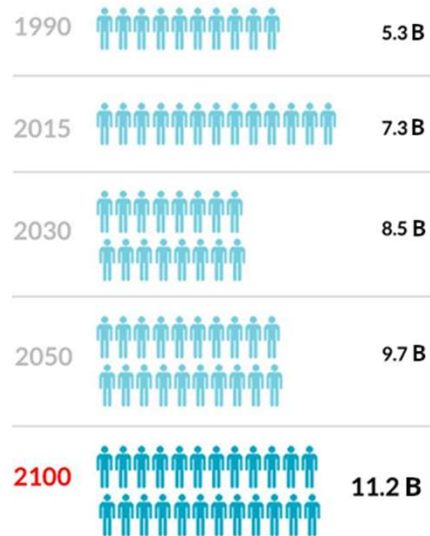
- 01 - Precision Farming & Smart Farming
 - Andreas Mandler, PhD & Giovanni Carabin, PhD
 - UNIBZ, Faculty of Agricultural, Environmental and Food Sciences
 - Research group agricultural engineering
 - andreas.mandler@unibz.it

Introduction

- **Agriculture 1.0** (pre-1900s):
 - Experimentation and innovation in food production and livestock breeding, leading to the development of various **new tools** and **soil management practices** (e.g., crop rotations).
 - Yields increased dramatically but a **large number of human and animal resources** were required.
- **Agriculture 2.0** (post-WW1):
 - The diffusion of combustion engine led to the development of **mechanized farm tools**.
 - The lower dependence on manual and animal labor has been drastically reduced (**from 80% of the population employed in agriculture to less than 5%**) but at the same time productivity has increased.
- **Agriculture 3.0** (1960-70s):
 - Application of the science of chemistry (e.g., **pesticides and fertilizers**) and of **hybridization and genetic modification** of agricultural goods.
 - First green revolution.
 - Yield increment.



Introduction: Global Challenges



○ **Global population growth.**

- Growing demand for food (double the current food production capacity for 2050).
- High quality product (more and more people are looking for healthier foods – no use of herbicides and pesticides).
- Global urbanization “steals” farmland.

○ **Environmental preservation**

- Reduction of chemicals and water waste.
- Food system accounts for the 26% of total global greenhouse gas emissions.

Introduction: Operational Challenges

- Willingness to relieve workers from **operations** considered potentially **dangerous** (e.g., pesticide application).
- **Lack of qualified labor** (profession is not attractive enough for the younger generation).
- Entrepreneurial risks: **High competitiveness** of high-quality products.



Emerging needs...

The agriculture of the third millennium has to face some emerging needs:

- **Economic Sustainability:** making the farm agricultural processes more competitive from an economic standpoint, with relevant **reduction in cost productions**.
- **Ecologic Sustainability:** making the farm agricultural processes more reliable in terms of **environmental impacts**, land conservations and effects on climate change.
- **Product Safety and Quality:** ensuring **safety and quality** of its primary products, of both vegetable and animal origin.
- **Workers' Safety and Satisfaction:** ensuring **adequate living standards** to its workers, both in terms of ergonomics and safety aspects, and of cultural satisfactions for the ways the work is carried out.



Break of slides ...

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Smart Agriculture Technologies for Mountain Ecosystems

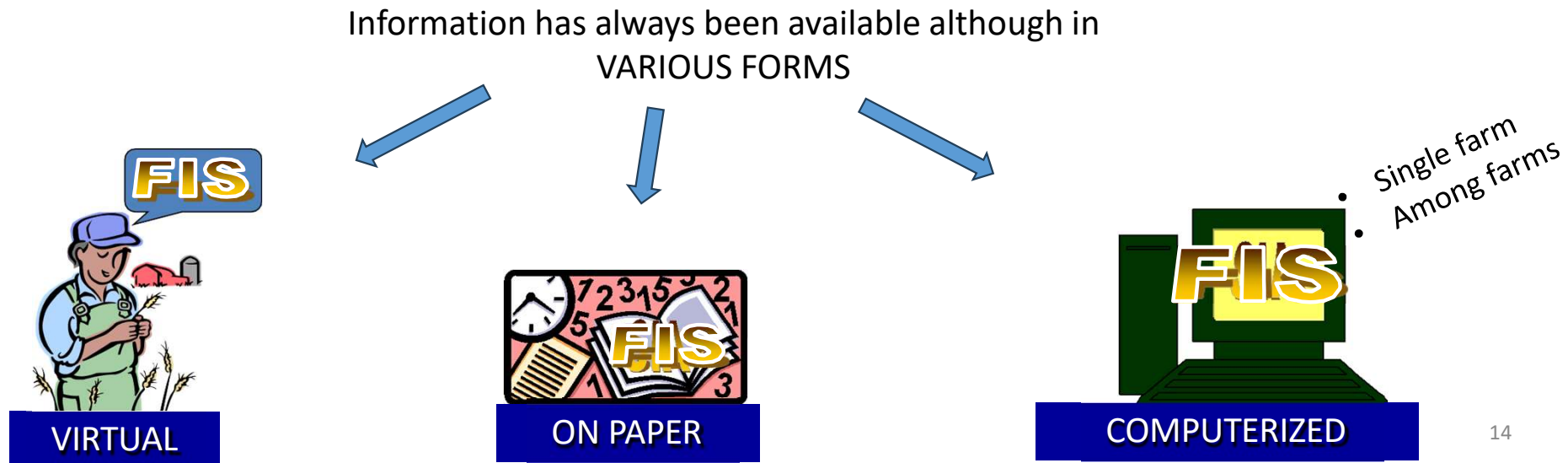
- 02 - Farm Information System (FIS)

- Andreas Mandler, PhD
- UNIBZ, Faculty of Agricultural, Environmental and Food Sciences
- Research group agricultural engineering
- andreas.mandler@unibz.it

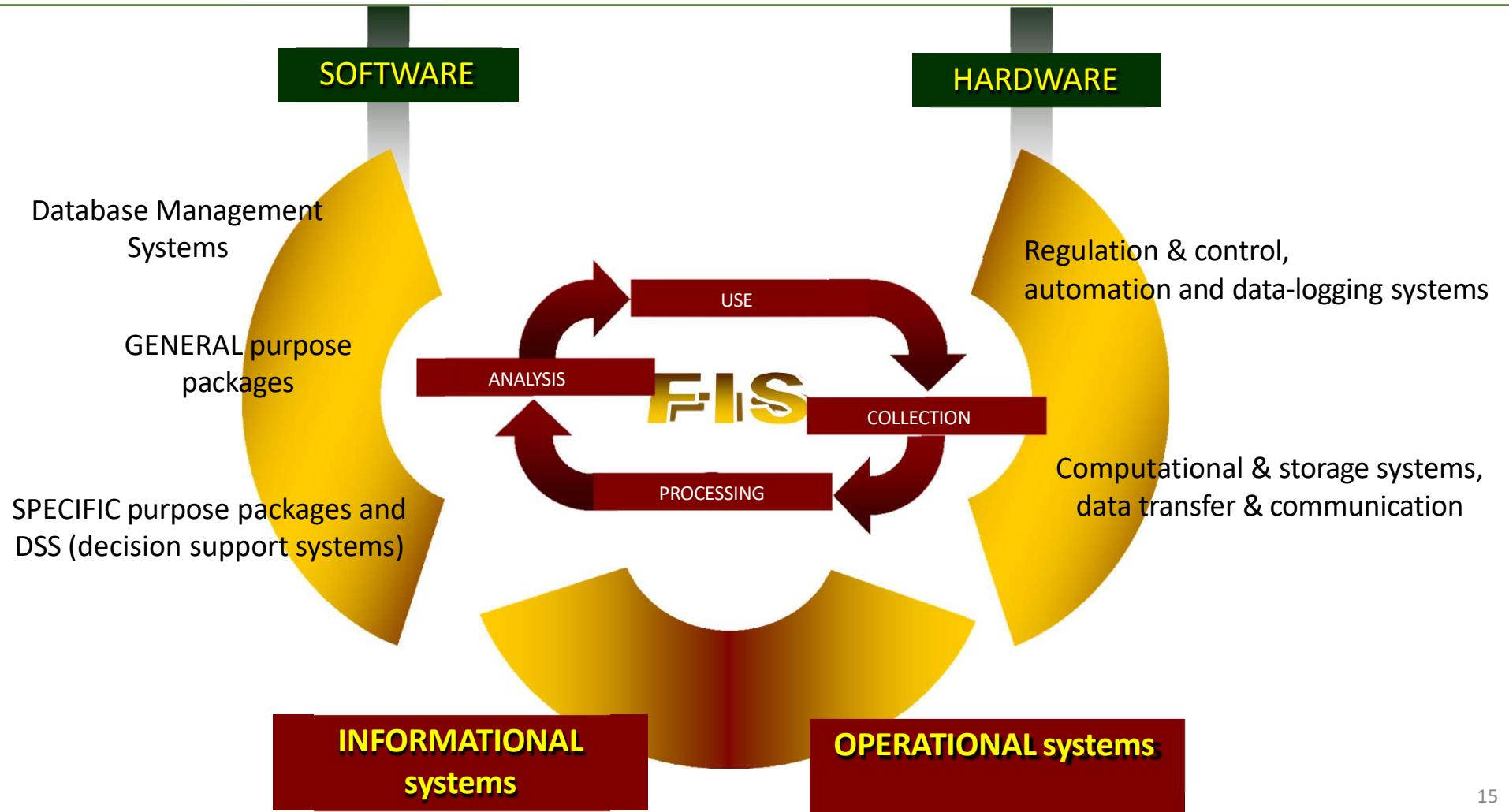
Farm Information System (FIS)

- Precision Farming requires the introduction of a farm information system (FIS) to record, archive and utilize all information.

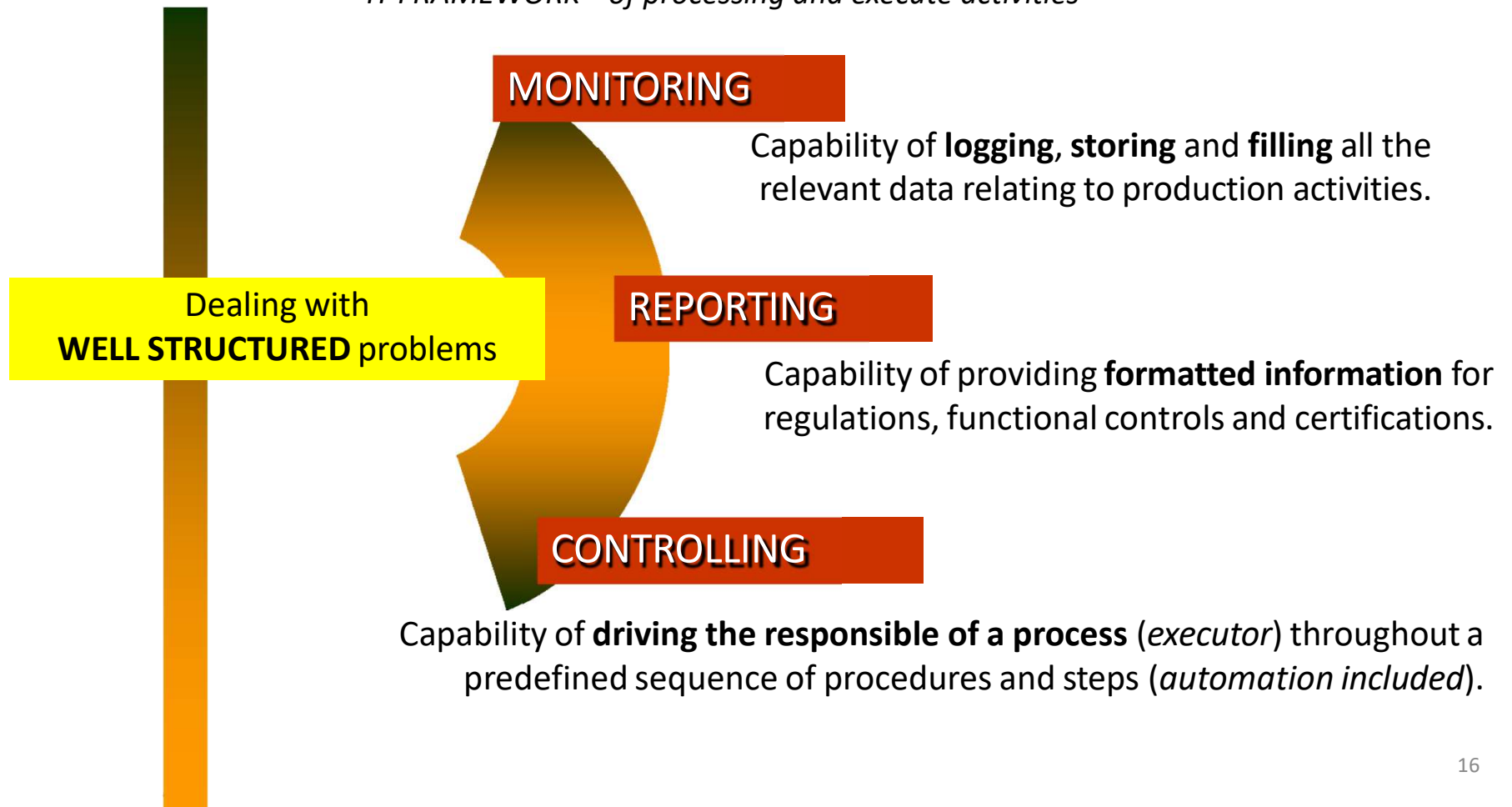
Set of tools with the aim to ensure the **acquisition and the distribution** of information to the people and resources **acting in the enterprise** as soon as the information is **required**.



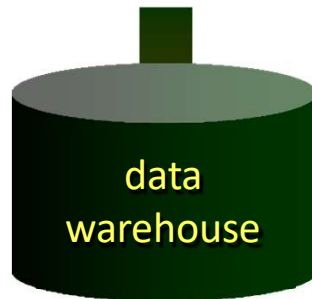
Farm Information System (FIS)



“IT FRAMEWORK” of processing and execute activities



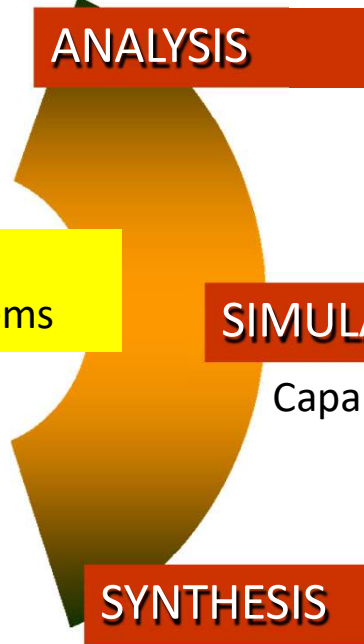
Increasing the ANALYTICAL skills and capability of FARM MANAGEMENT



Dealing with
NOT STRUCTURED problems

*It is impossible to automate **not structured problems** by predefined **standard procedures***

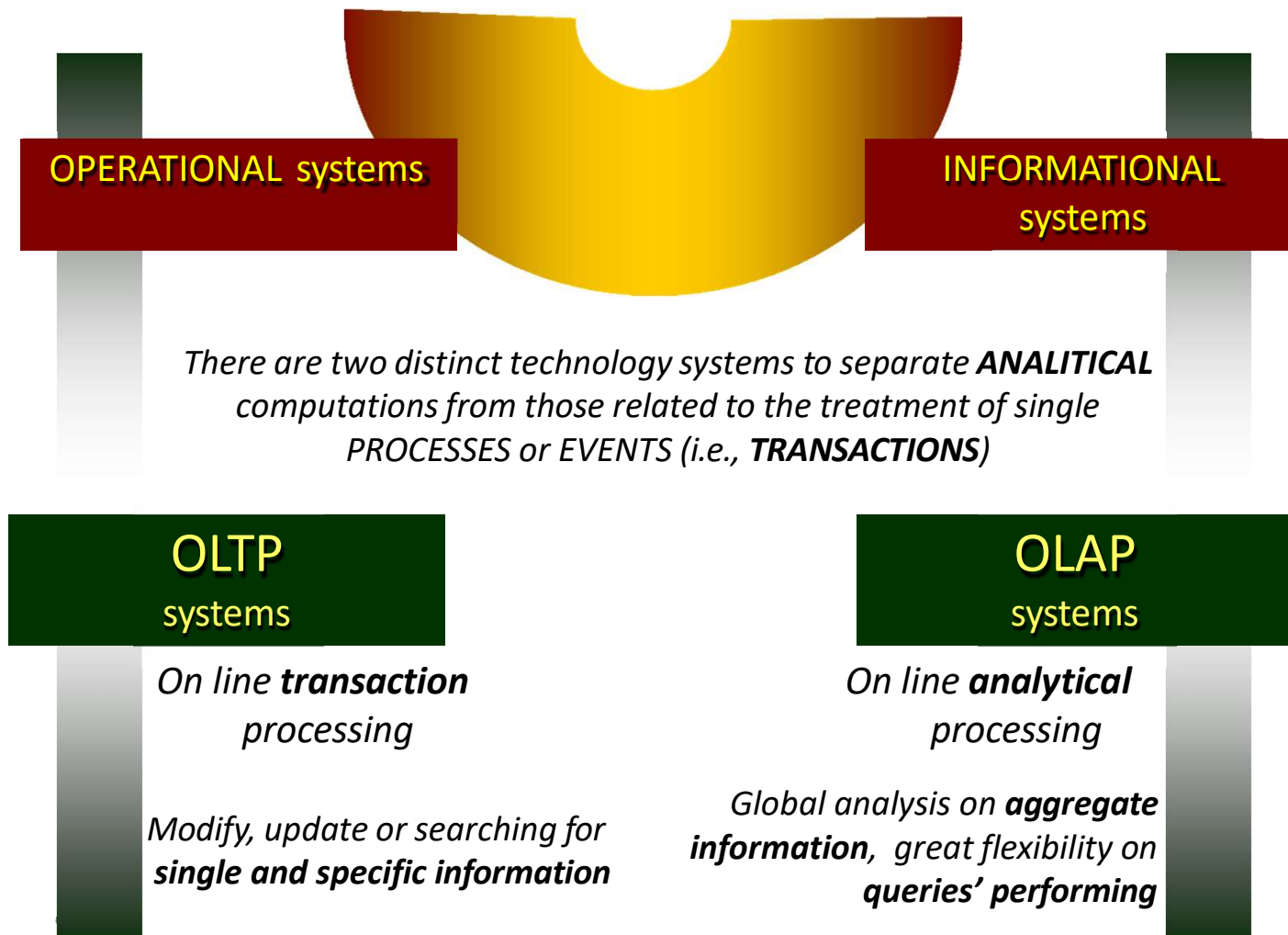
Decisions are highly influenced by subjective viewpoints and experience of each decision maker

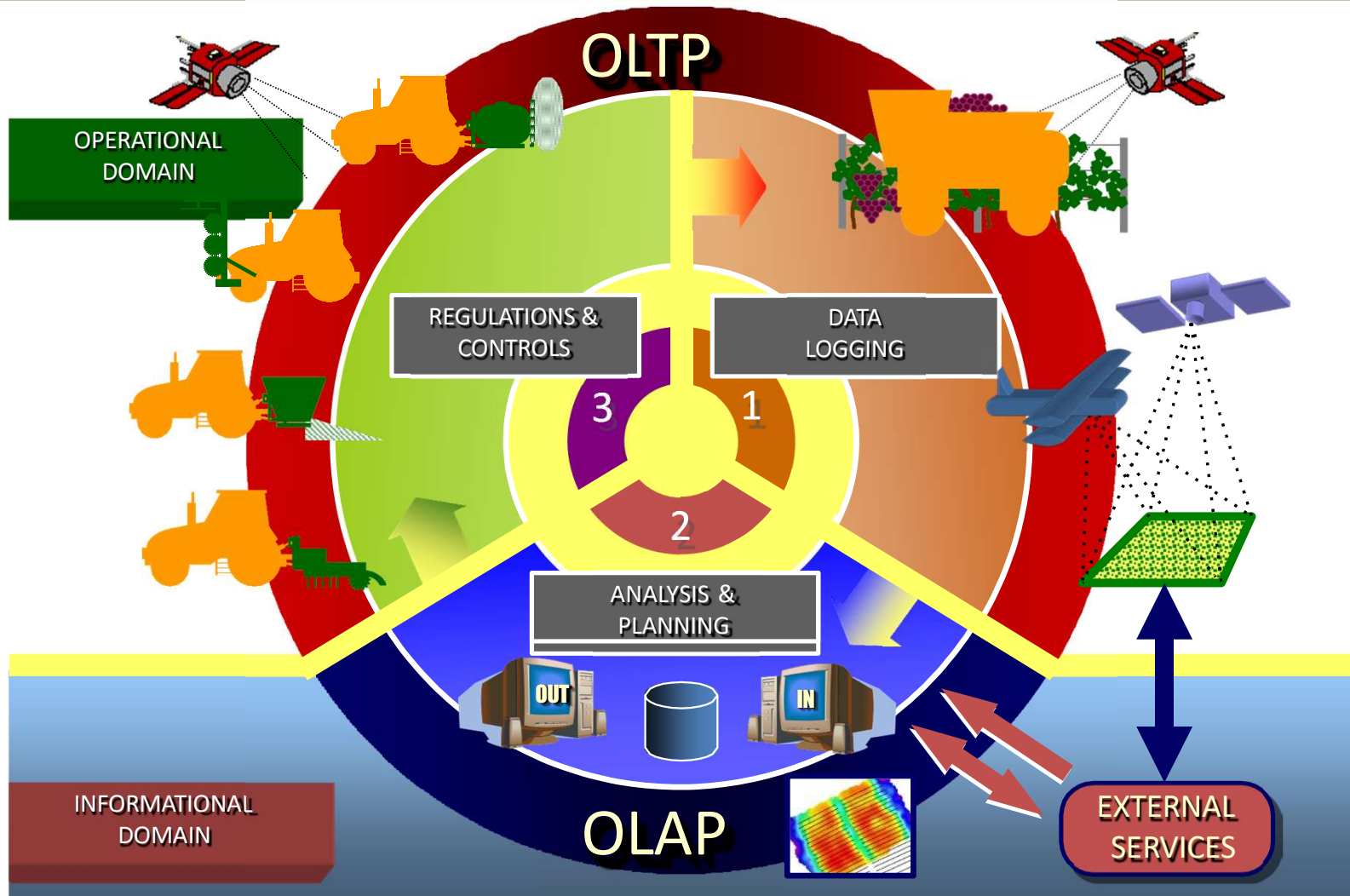


Capability of carrying out (technical and economical) computations throughout highly **interactive** approaches.

Capability of assessing **alternative scenarios** and carrying out comparative evaluations on their performances.

Searching for data aggregations and **correlations**, performing **hystorical data analysis**, providing **prescriptions** for the operational level.





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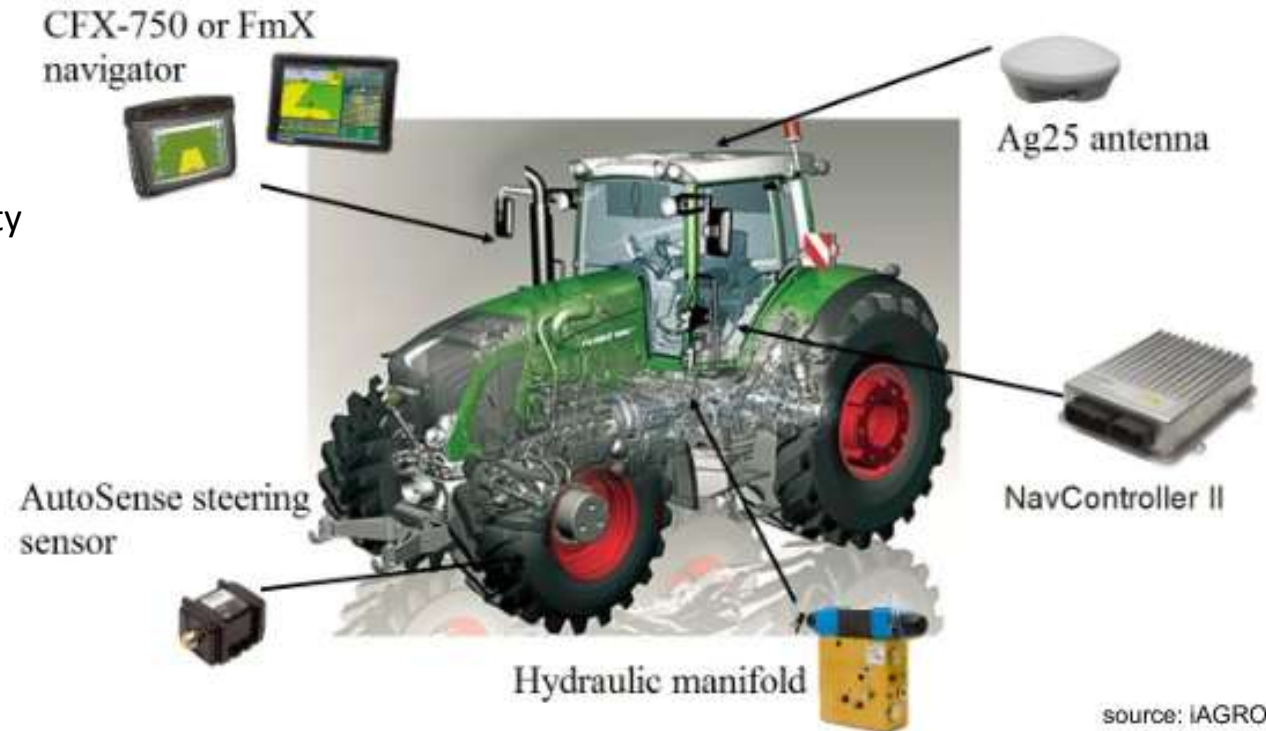
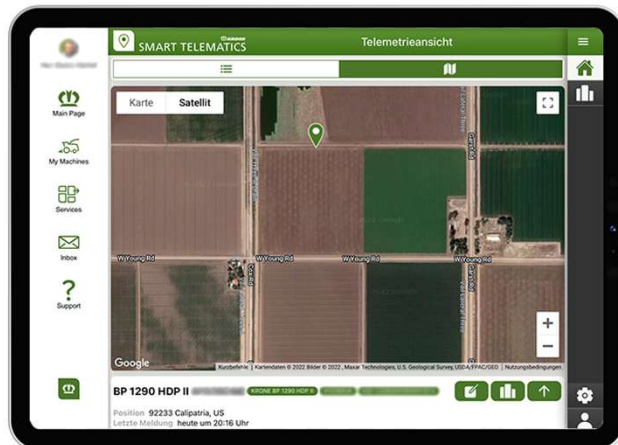
Smart Agriculture Technologies for Mountain Ecosystems

- 02 – Technologies and Farm Information System (FIS), part 2

- Andreas Mandler, PhD
- UNIBZ, Faculty of Agricultural, Environmental and Food Sciences
- Research group agricultural engineering
- andreas.mandler@unibz.it

Overview

- Tractor – Implement relations ISOBUS
- Automatic Guidance Systems (AGS)
- Telemetry
- Functions of a FMIS
- Modularity of Tasks
- Decision Support Systems DSS
- Interconnectivity - Interoperability
- Challenges and future outlook



source: IAGRO 2018



ISOBUS

is an **international standard** (*ISO 11783*)

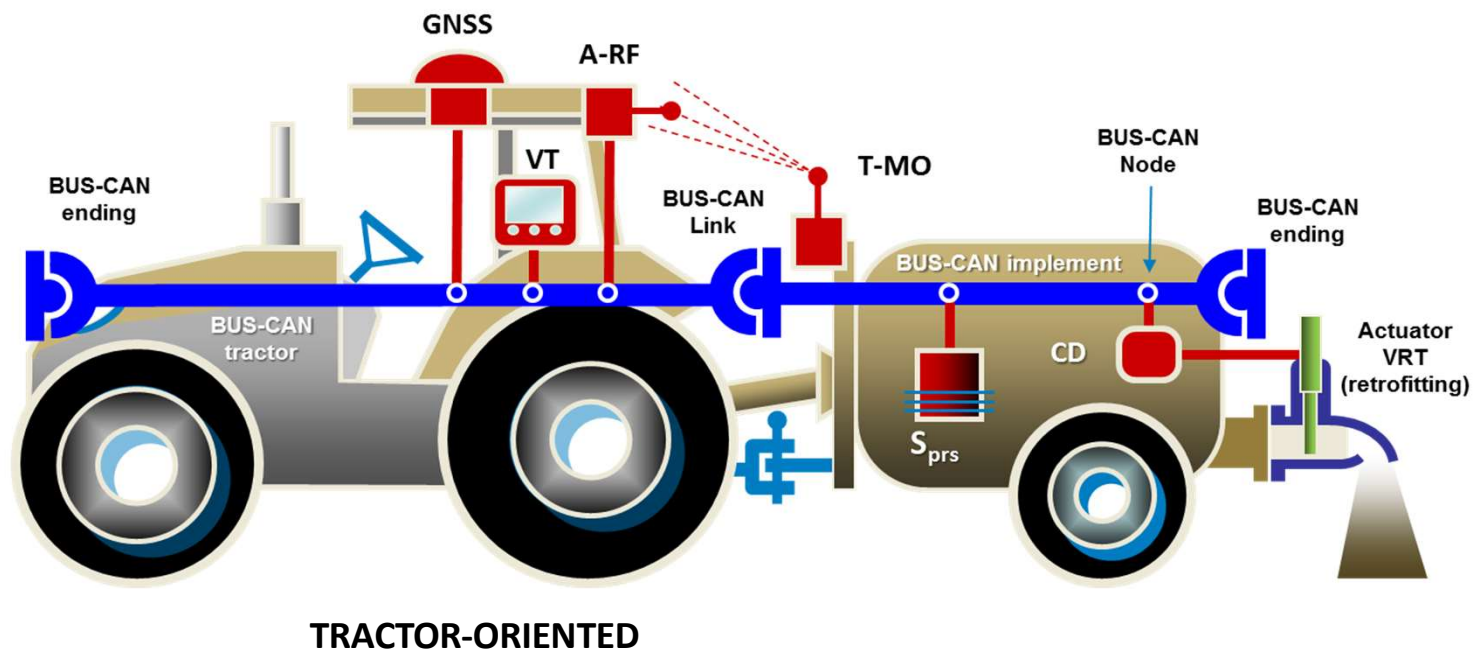
for the

communication between tractor and implement.



- Communication, control and monitoring within and beyond the tractor
- Cross-manufacturer compatibility
- Understand and compare product features & functionalities between different manufacturers

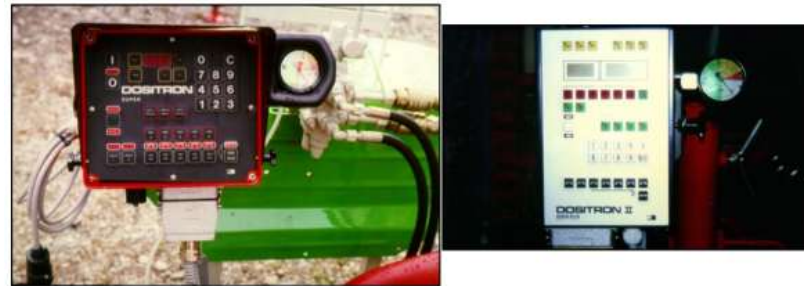
- An increasing level of the technology complexity is possible:



Operational monitoring system with **sensors** installed on both tractor and implement (monitoring the full behaviour of implement and tractor) which communicate via CANbus (Controller Area Network).

ISOBUS examples

Field computers



Sprayer dosing computers, slip-independent dosing of chemicals/ha
Holder (1978)

Proprietary Terminals

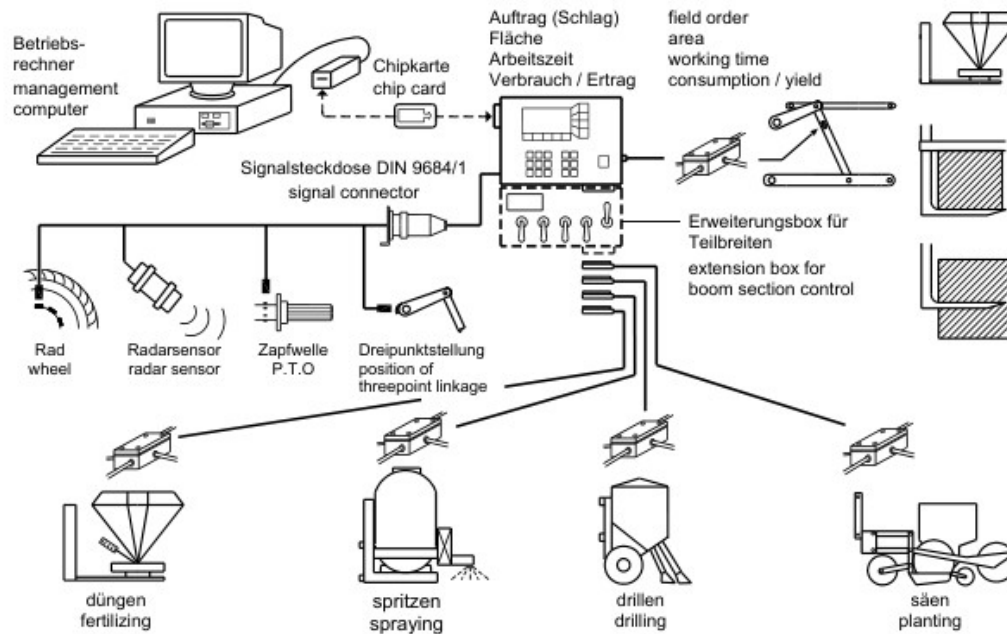


Source: Amazone

→Tractor-Implement combinations of different manufacturers are the rule, not the exception!



The High-time of field computers



Source: Prillinger



Source: AEF



Source: STG



Source: Müller Elektronik

Operational monitoring system with **sensors** installed on both tractor and implement (monitoring the full behaviour of implement and tractor) which communicate via CANbus

Break of slides ...

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Smart Agriculture Technologies for Mountain Ecosystems

- 05 – Technology systems: robotic applications
 - UNIBZ, Faculty of Agricultural, Environmental and Food Sciences
 - Research group agricultural engineering



https://www.youtube.com/watch?v=9E3UjeRK_PI&t=22s

Plowing

- Heavy and powerful machines are required.

Robotti 150D (Agrointelli)

- Autonomous multipurpose vehicle (seeding, weeding, spraying, ridging, mowing, rotovating)
- Four-wheel Steering system
- 106kW diesel engine
- Weight 3000 kg, Size: (L) 2.44m x (W) 3.05m x (H) 2,15m
- PTO, 3 point hitch
- 187 k€

ICS20 (AutoAgri)

- Implement carrier
- Four-wheel Steering system
- Electric or plug-in hybrid
- Weight 2500 kg, Size: (L) 4.1m x (W) 2.4m x (H) 2,26m
- PTO, 3 point hitch
- 230 k€

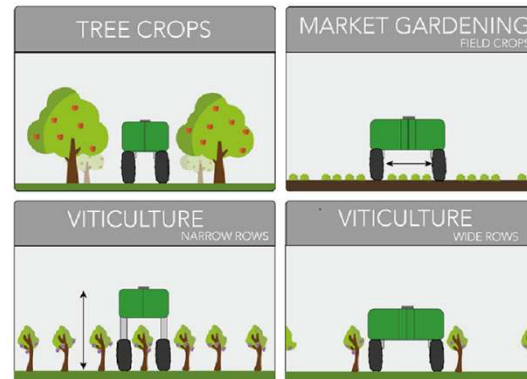
Plowing

Trektor (Sitia)

- Autonomous multipurpose vehicle
- 4 wheels, ackermann steering
- Hybrid (with diesel reload)
- Weight 2930kg
- Size: (L) 3.7m x (W) 1.4m x (H) 2,2m
- PTO, 3 point hitch (cat 2)
- 265 k€

ONE ROBOT... MULTI PURPOSE

The robot TREKTOR can adapt to various types of crops thanks to its variable height and wheelbase.



MANY IMPLEMENTS

TREKTOR works with your existing tools thanks to a standard three-point linkage (cat. 2) and its points of attachment behind and between the wheels.



Plowing

Jo (Näio)

- Autonomous multipurpose vehicle (weeding, seeding, mowing, furrow tracing, carrying)
- Tracks
- Electrical motors
- Weight 850kg
- Size: (L) 2m x (W) 0.6m x (H) 2m
- 100 k€



Plowing

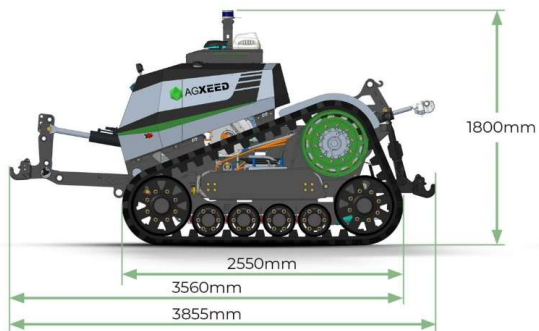
- Concept of heavy-duty autonomous tractor (Case IH Magnum Autonomous Concept, John Deere autonomous 8R).
- Concept of fully electric heavy-duty autonomous tractor (John Deere Autonomous Concept).
- Electric autonomous tractor connected to the grid (John Deere GridCon).



Fertilizing

Agbot (AgXeed)

- Implement carrier
- Tracks (skid steering)
- 115 kW diesel engine
- Weight 6000kg
- Size: (L) 2,55m x (W) 1,8-3m
- PTO, 2 x 3 point hitch (cat 2 and 3)
- 250 k€



Sowing

- Lighter systems make it possible to avoid soil compaction (i.e., this affect the soil resistance and porosity, the rate of water infiltration and aeration).

FarmDroid (FD20)

- Fully automatic sowing and weeding
- Weight: 900kg
- 50 k€

Xaver Sowing Robot (Fendt)

- Small robot with a weight of 150kg.
- Larger field -> multiple robots (swarm system).
- Reduction of investment and power costs.
- Minimisation of failure risks (i.e., redundant robot).
- Complex management.



Sowing



Robotti (Agrointelli) plants potatoes

Sowing

Aeroseeder AS30

- Seeding of cover crops
- Payload 18kg
- Time flight 3.5min (10 min charge time)
- 50 ha/day
- 12 k€



Break of slides ...

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