

Precision Agriculture Technologies in Europe: achievements and challenges

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What is precision agriculture?

What is Precision Agriculture?

- Basic definition: “*It is a farming management concept based on observing, measuring and responding to inter- and intra-field variability in crops*”.
- Precision agriculture make use of **different technologies** to ensure that crops and soil receive exactly what they need for optimum health and productivity.

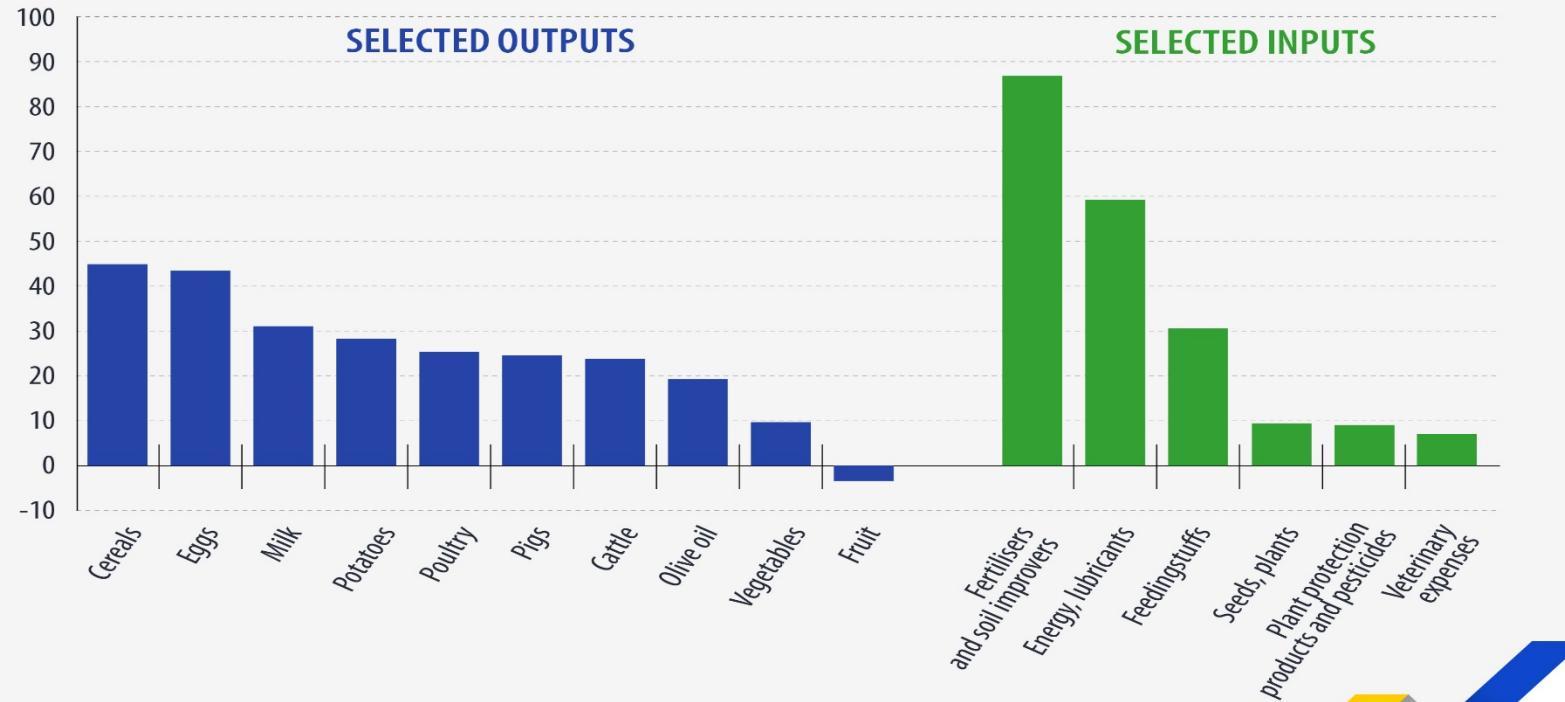
Why is Precision Agriculture increasingly used in Europe?

- Stricter environmental regulations
- Increased availability of technologies
- Etc.
- Main reason in 2022: big increase in inputs price

Precision Agriculture in Europe

Developments of output and input price indices

(% change, 2021-2022, EU estimates)





*What are the most used precision
farming technologies in Europe?*

Most common Precision Agriculture Technologies in Europe:

- Automatic Guidance
- Section control
- Variable rate seeding/fertilizing/spraying
- Monitoring crops with satellites and UAVs
- Yield monitors in harvesters → Yield maps

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Automatic Guidance

Auto-steer systems for tractor guidance



Current Status:

- RTK agricultural guidance systems (± 2 cm of precision)
- Steering control unit
- Steering axle and steering wheel sensors
- 100% take rate on premium tractors (25-66% of total market across European countries)
- Treatments without overlapping or leaving gaps.

Most common Precision Agriculture Technologies in Europe

Visual automatic guidance in self-propelled machines



Image: Agroguia.es

Main features:

- RTK agricultural guidance
- Treatments without overlapping or leaving gaps,
- Simplicity of use.
- Marks the treated areas, the untreated areas and the overlapped areas.
- Drawing of straight parallel lines.
- Measures plot area, distance between two points, speed and treated area.

Most common Precision Agriculture Technologies in Europe

Artificial vision for automatic guidance

- Emission of a laser beam that detects the edge of the harvested area.
- Steering control.
- Combine harvester



Images: Claas

Most common Precision Agriculture Technologies in Europe

Artificial vision for automatic guidance

- Detection of forage string
- Forage harvester with pick-up



Images: Claas

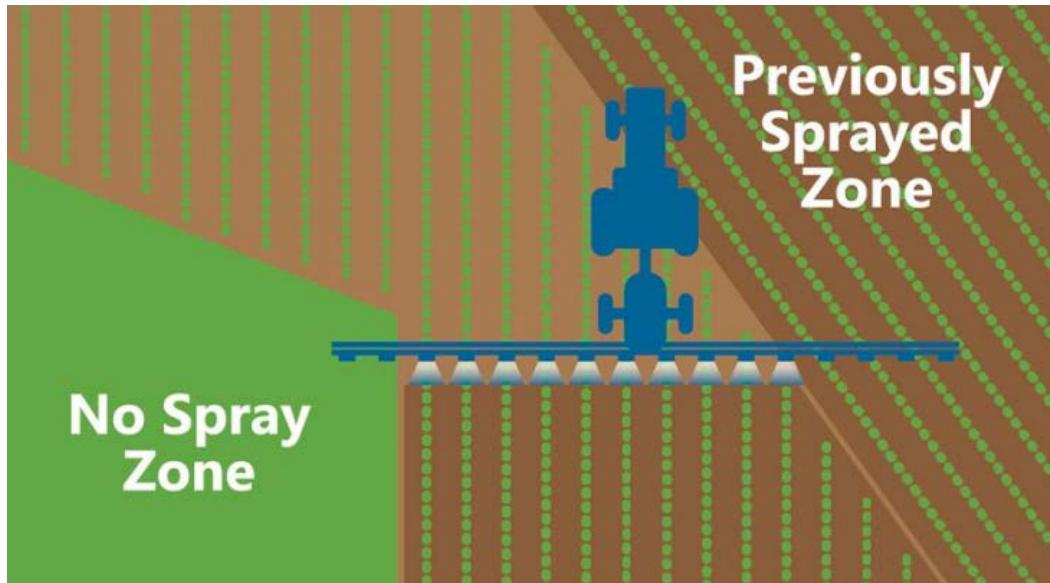
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Section control

Most common Precision Agriculture Technologies in Europe



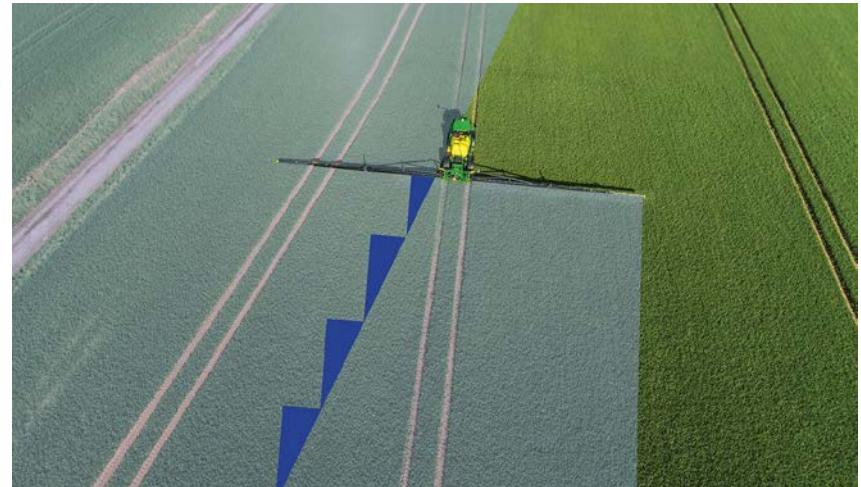
Section control

- It improves placement of agricultural inputs by automatically turning implement sections on and off.
- By reducing product application overlap, Section Control decreases the total amount of product used in the field.
- It reduces the stress and the fatigue of the farmer

Most common Precision Agriculture Technologies in Europe

Section control

- The ISOBUS system uses the task controller for opening and closing sections .



Spraying with section control

Most common Precision Agriculture Technologies in Europe

Section control

- The ISOBUS system uses the task controller for opening and closing sections .



Seeding results with section control

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Monitoring crops with satellites and UAVs

Most common Precision Agriculture Technologies in Europe

Satellite and drones



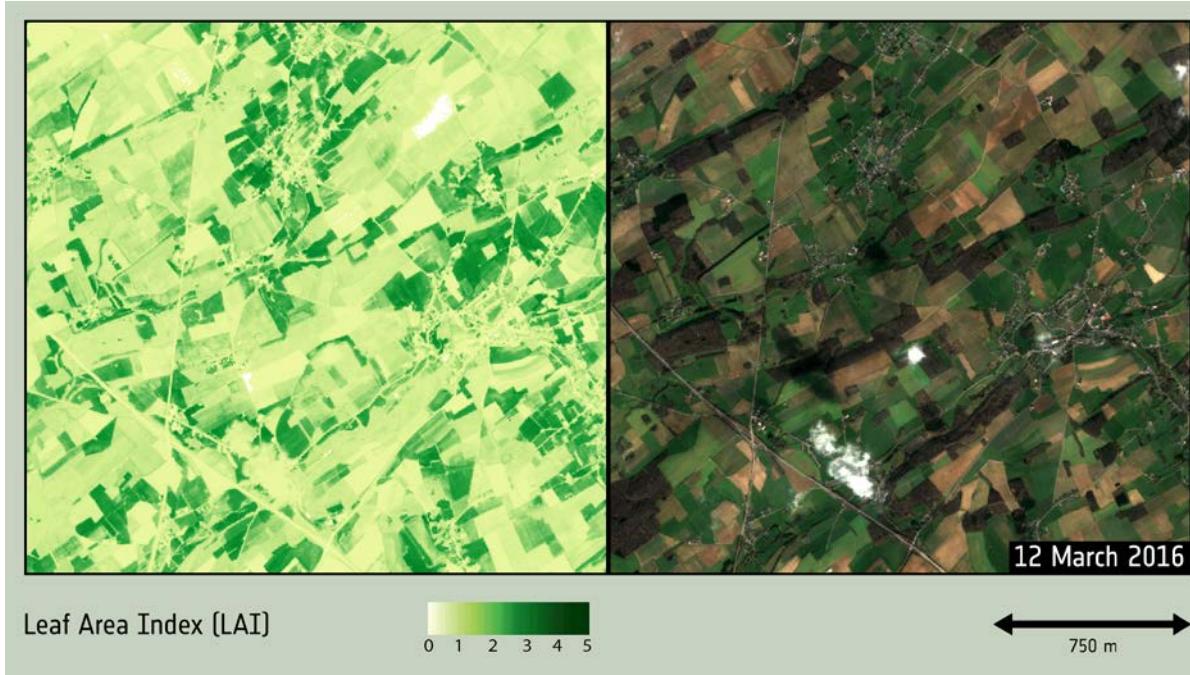
Sentinel 2-A satellite



UAV (drone or RPAS)

Most common Precision Agriculture Technologies in Europe

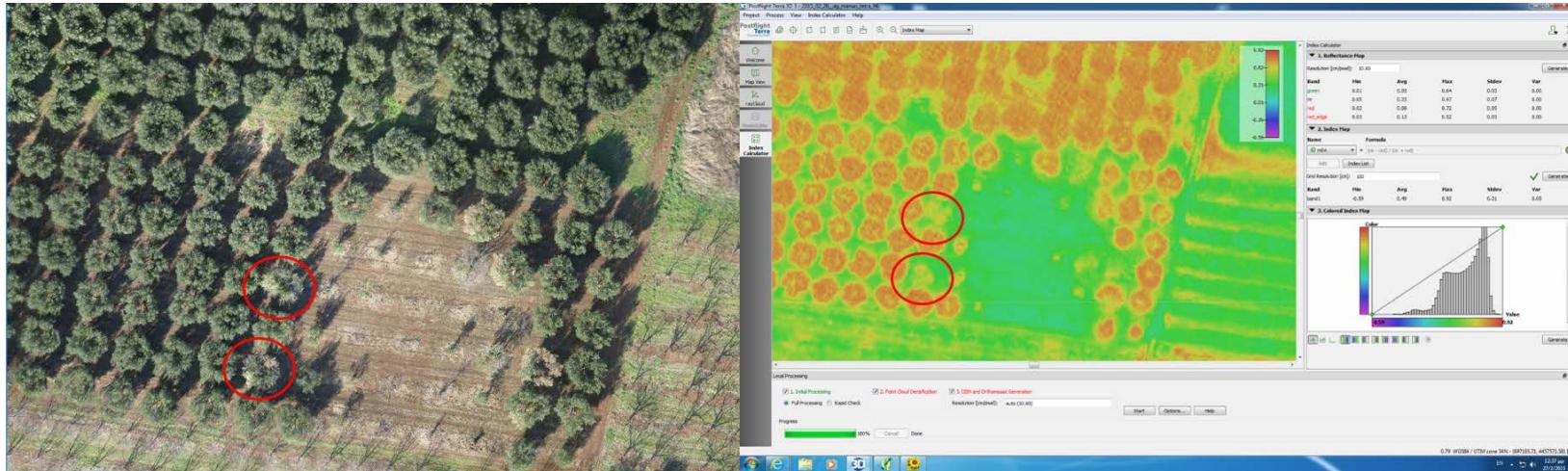
Example of cereal crop monitoring by Satellite (Sentinel 2 mission)



Monitoring crop growth (Leaf Area Index) in Belgium

Most common Precision Agriculture Technologies in Europe

Example of specialty crop monitoring by UAVs



Fungus disease detection (*Verticilium*) in olive trees. Source: Ecodevelopment Agro

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*Yield monitors in harvesters →
Yield maps*

Most common Precision Agriculture Technologies in Europe

Yield monitors in harvesters → Yield maps

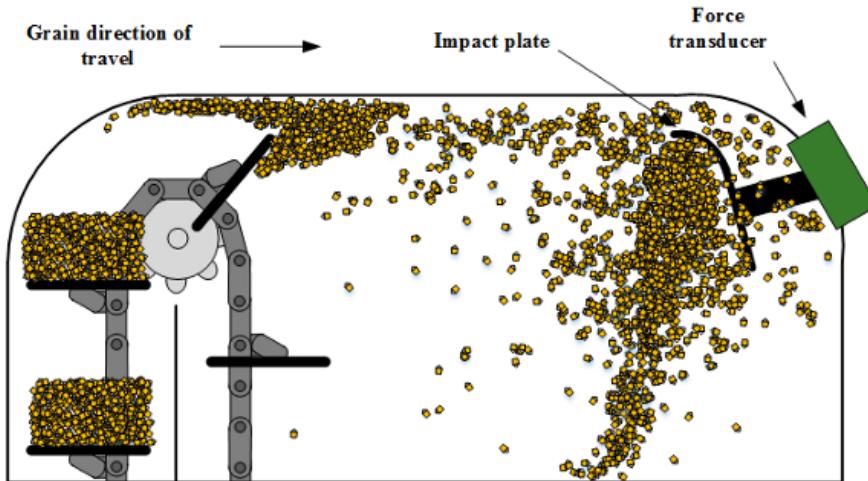


Combine harvester. Image: New Holland



Forage harvester. Claas Jaguar

Most common Precision Agriculture Technologies in Europe

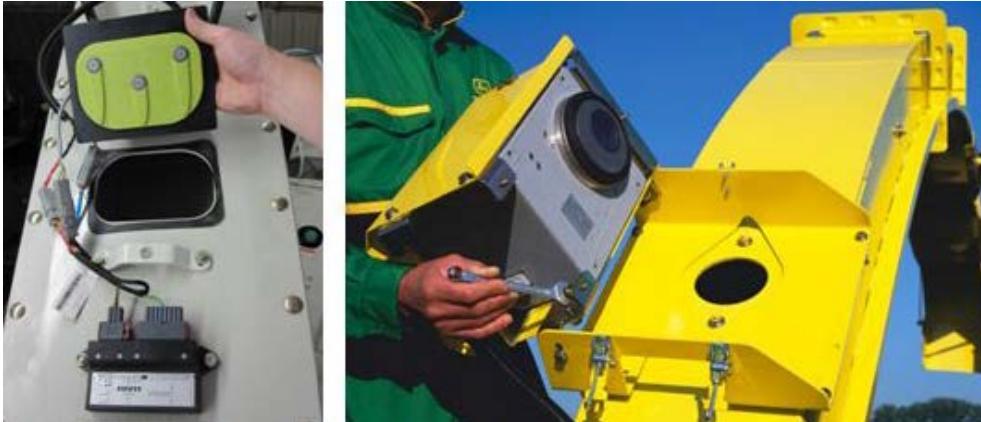


Ag Leader mass flow sensor for combine
harvesters

Yield monitors → Yield maps

- Measures:
 - Harvested grain
 - Moisture content
 - Protein content
 - Starch content
- Coupled with global navigation satellite systems
- Creation of yield maps

Most common Precision Agriculture Technologies in Europe



Capacitance and NIR sensors in forage harvesters

Yield monitors → Yield maps

- Measures in forage harvesters:
 - Harvested forage
 - Moisture content
- New generation of NIR sensors measures also crude fat, crude fibre, crude ash, protein and sugar contents
- Coupled with global navigation satellite systems
- Creation of yield maps

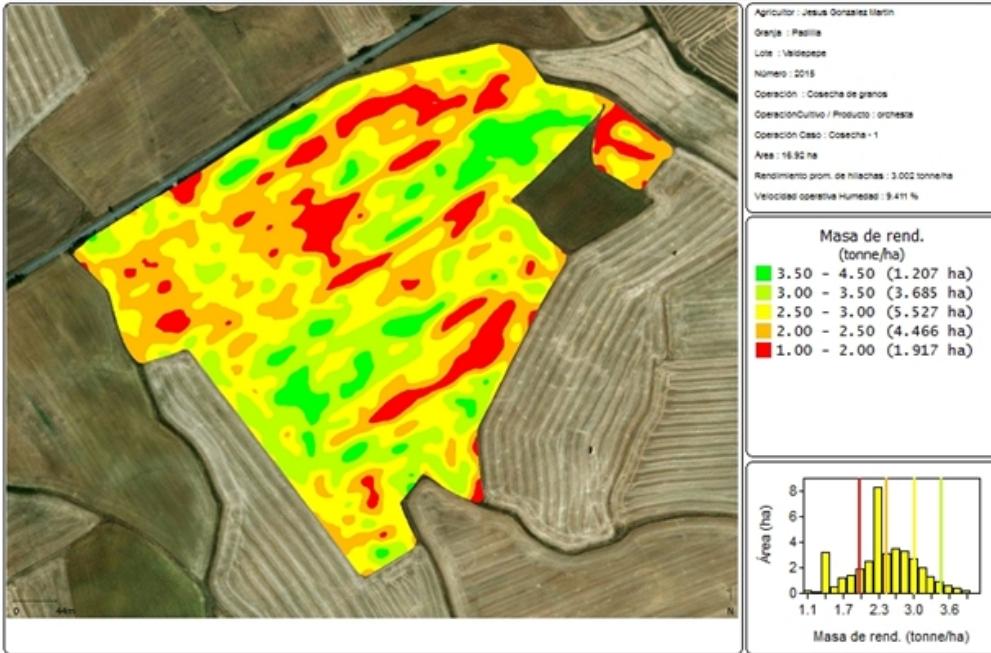
Most common Precision Agriculture Technologies in Europe

Yield monitors in harvesters → Yield maps



Forage harvester. Claas Jaguar

Most common Precision Agriculture Technologies in Europe



Yield map of a barley field in Spain

Yield monitors → Yield maps

- Current Status:
 - The harvesters take measures every 5 seconds
 - 40% take rate on premium combines (15-45% of total market across countries in Europe)

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- Variable rate seeding/fertilizing/spraying





*Variable rate control for
seeding/fertilizing/spraying*

Most common Precision Agriculture Technologies in Europe



Sub-area specific seeding. Image: Asa-Lift Denmark

Variable rate application

- Site-specific management
- For seeding, fertilizing or spraying
- Based on prescription maps
- Current status:
 - 75% take rate on premium implements/tractors (25-66% of total market across countries)

Most common Precision Agriculture Technologies in Europe



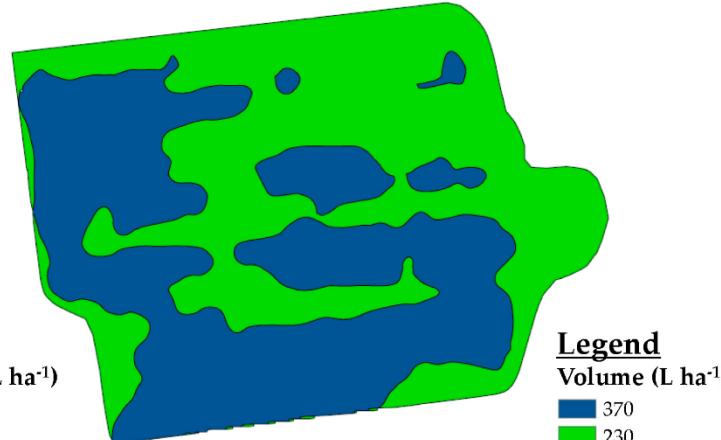
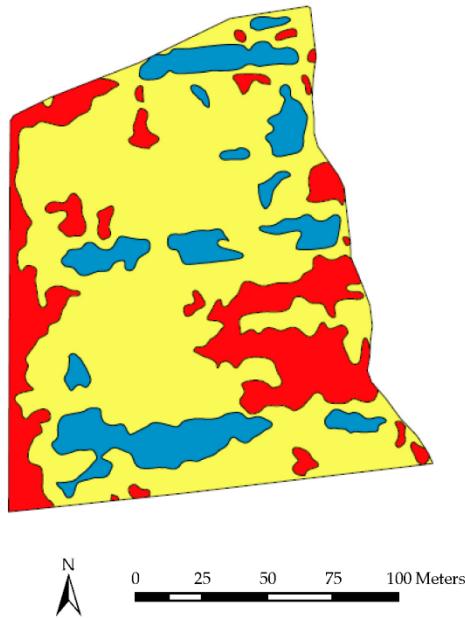
Sub-area specific fertilizing. Maschio Gaspardo

Variable rate application

- Site-specific management
- For seeding, fertilizing or spraying
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- Current status:
 - 75% take rate on premium implements/tractors (25-66% of total market across countries)

Most common Precision Agriculture Technologies in Europe

Prescription Map-Based Variable Rate Application of Pesticides



Campos et al., 2020. Examples of prescription maps used in the field tests in Spanish vineyards. Left: Chardonnay. Right: Merlot.

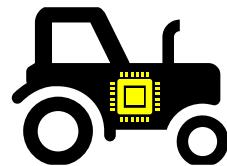
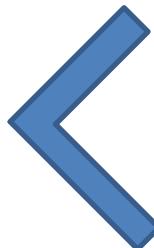
Conclusion



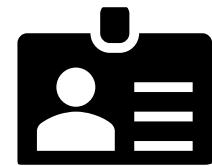
Normal
Machine



Advanced
Operator



Intelligent
Machine



Normal
Operator



*And what are the least used
precision farming technologies in
Europe?*

Least used precision agriculture technologies in Europe:

- Wireless Sensor Networks. In-field IOT
- See and fertilize/spray
- Drone spraying
- In-field robotics

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Wireless Sensor Networks. In-field IOT

Least used Precision Agriculture Technologies in Europe

Wireless Sensor Networks. In-field IOT (Internet of Things)



Image: Plantae system

- Provides real time information
- Wireless communication: short range and long range
- Common data provided:
 - Humidity control at different depths.
 - Ambient and subsoil temperatures.
 - Soil conductivity.
 - Flowmeter to control the irrigation system.

Least used Precision Agriculture Technologies in Europe



In-field IOT (Internet of Things)

Application examples:

1. Humidity and temperature sensors / probes in hydroponic crops.
2. Sensors and probes in drip irrigation.
3. Sensors and probes in the nursery to optimize irrigation
4. Flowmeter installed in the pipe

Images: Plantae system

In-field IOT

Why small % of farmers is using this technology?

Challenges

- Many farmers do not know about it.
- Some farmers do not appreciate the benefits.
- The need for investment is a barrier.
- Most of farmers do not have the necessary digital skills to use it.

Least used precision agriculture technologies in Europe:

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See & Fertilize/Spray

Least used Precision Agriculture Technologies in Europe

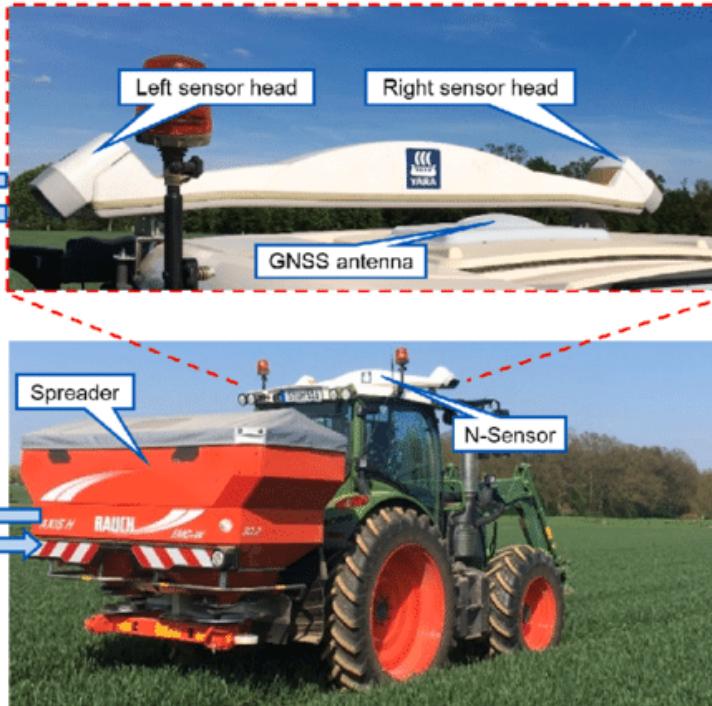
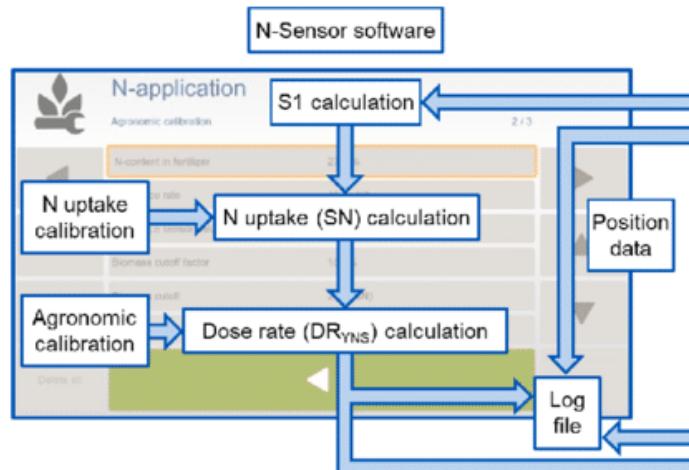
See & fertilize example



Yara N Sensor

- It determines the crop nitrogen status by measuring the light reflectance properties of crop canopies and to enable variable-rate fertilization “on-the-go”.

Least used Precision agriculture Technologies in Europe



Heiß, Andreas & Paraforos, Dimitrios S. & Sharipov, Galibjon & Griepentrog, Hans W.. (2021). Modeling and simulation of a multi-parametric fuzzy expert system for variable rate nitrogen application. Computers and Electronics in Agriculture. 182. 106008. 10.1016/j.compag.2021.106008.

Least used Precision Agriculture Technologies in Europe

See & spray example



John Deere's See & Spray system

- It uses computer vision and advanced technology to Target Spray weeds and significantly reduce the herbicide use by applying only what it needs.

See & Spray/fertilize

Challenges

- High upfront costs.
- Low margin of the agricultural industry.
- See & fertilize is more frequent in Germany, Denmark and Netherlands, but is very rare in Spain or Italy.
- See & spray is almost new at commercial level. Few farmers know this technology.

Least used precision agriculture technologies in Europe:

- Wireless Sensor Networks. In-field IOT
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Drone Spraying

Drone Spraying

Advantages:

- It treats locally and it increases efficiency dropping less plant protection products.
- Does not compact the soil neither lowers production.
- It applies without drift and in a faster way than any other technology.
- It lowers the emissions of old machinery works and costs.



Least used Precision Agriculture Technologies in Europe

Drone Spraying

- Why is it rarely used in Europe?



Challenges in Drone Spraying

Regulatory issues:

- EU envisions a 50% decrease in agricultural chemical use by 2030.
- Since 2009 aerial spraying is prohibited in European Union, with some exceptions.
- It is envisaged that the revision of the above-mentioned directive will consider the use of drones more specifically.

Least used precision agriculture technologies in Europe:

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In-field robotics

Least used Precision Agriculture Technologies in Europe

New generation of commercial agricultural robots



Farmdroid for seeding and weeding
horticultural crops



Naio robot for weeding vineyards



*Why the low adoption of robotics
in the European farms?*

In-field robotics

Challenges

- High upfront costs.
- Low margin of the agricultural industry.
- Insufficient trust from farmers.
- Lack of geographical availability due to the lack of the coverage of 3G, 4G, and beyond.

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