Precision Farming in South Africa

Louis Ehlers

FERTASA Soil Fertility & Plant Nutrition Symposium

CSIR, Pretoria

22 August 2019

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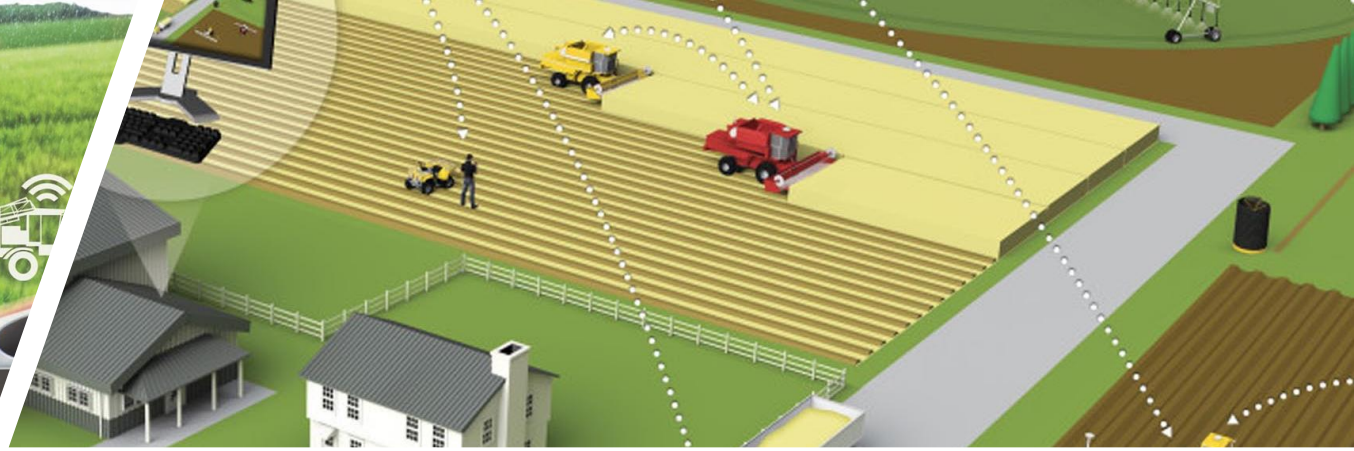

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Precision Farming

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Definition

“Precision farming is the application of technology and agronomic principles to manage spatial and temporal variation associated within all aspects of production with the aim to improve crop performance and environmental quality”.

McGraw-Hill Dictionary of Scientific & Technical Terms

Precision Farming:

- Is an approach to farm management;
- Uses Information Technology (IT);
- Ensures that the crops and soil receive exactly what they need for optimal productivity and health.

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Aim of Precision Farming

The goals in Precision Farming:

- Profitability
- Sustainability

- **Precision Farming relies upon:**
  - Specialised equipment
  - Specialised software
  - IT services

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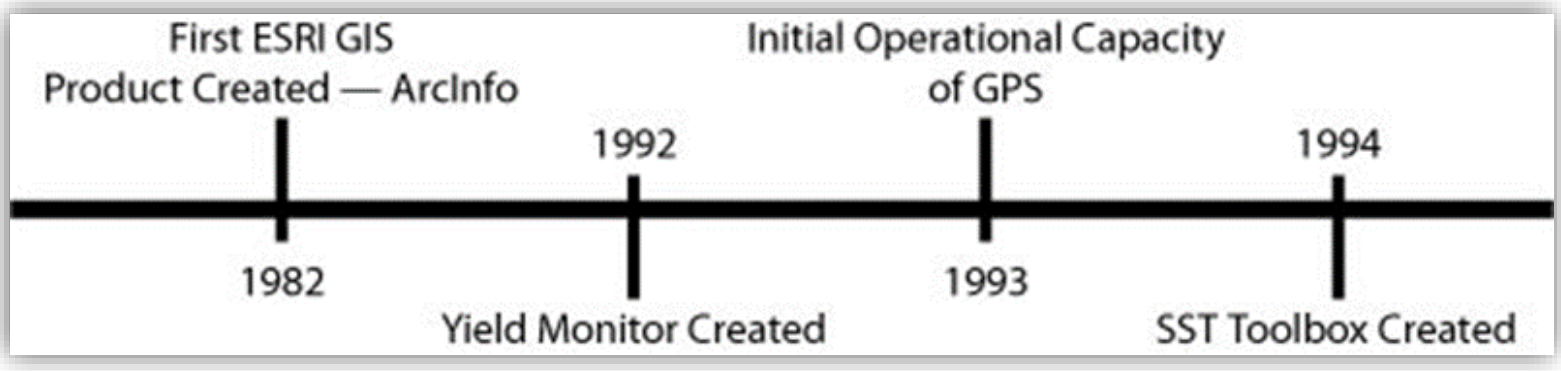
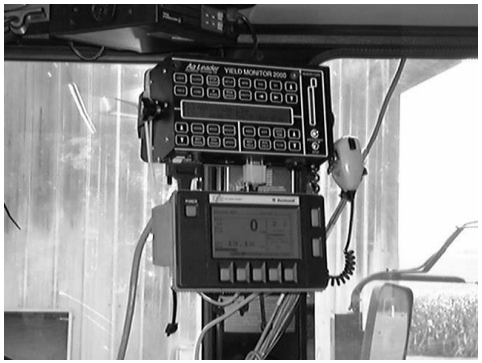
History of Precision Farming





Ref: www.delmarlearning.com

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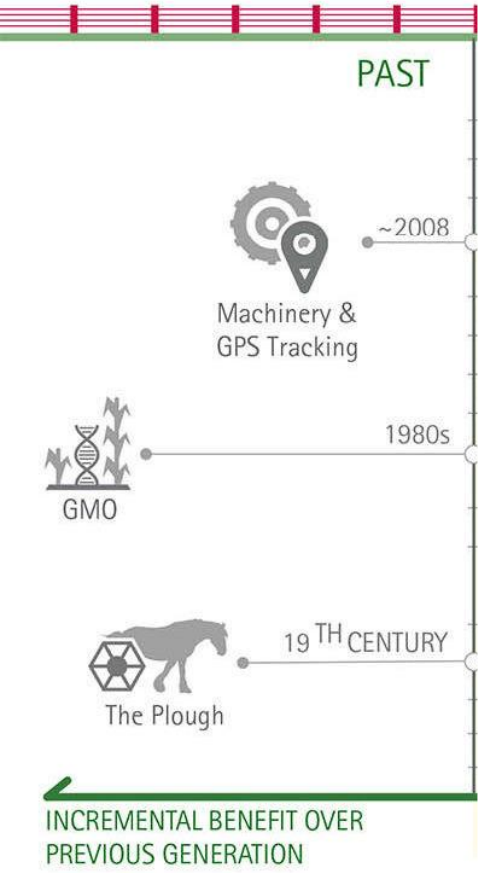
History of Precision Farming in South Africa



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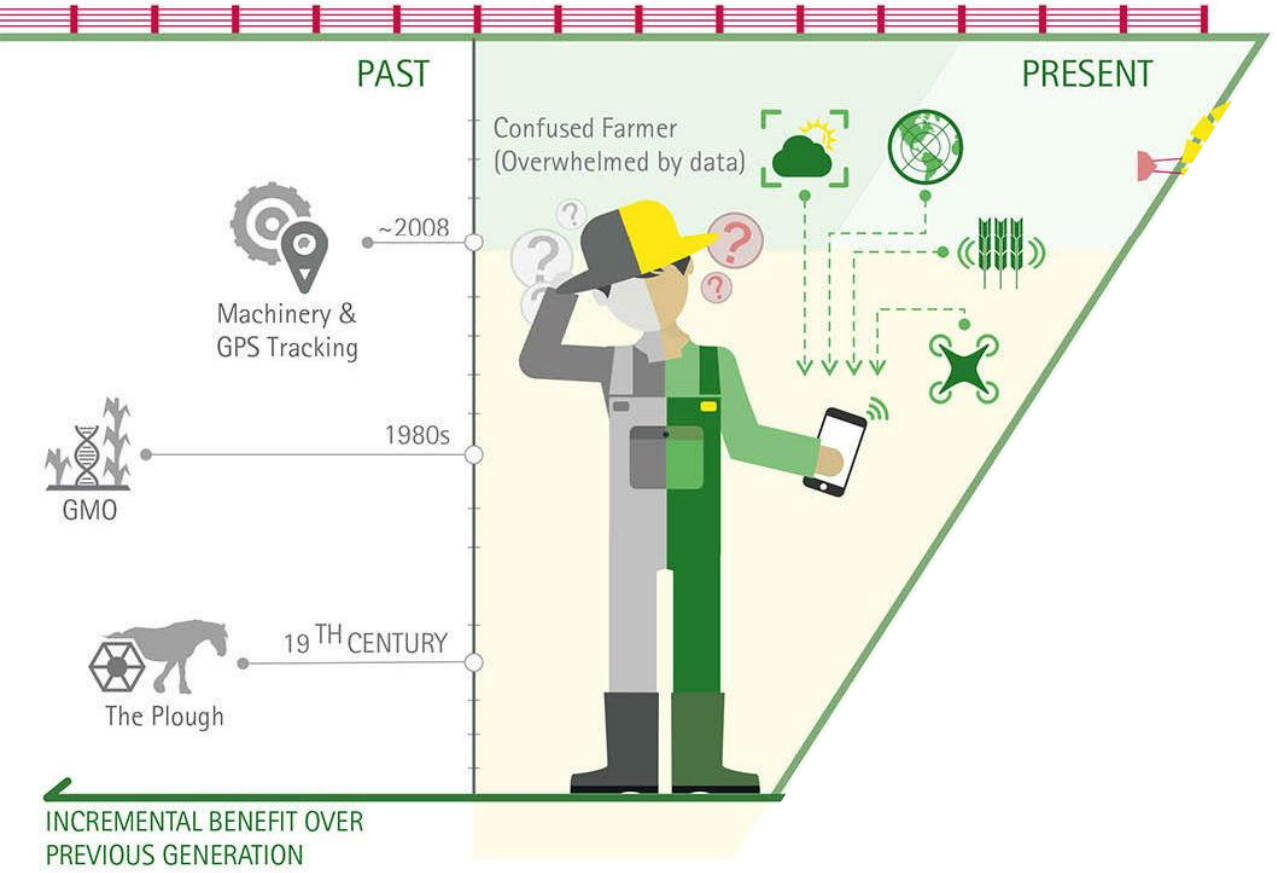
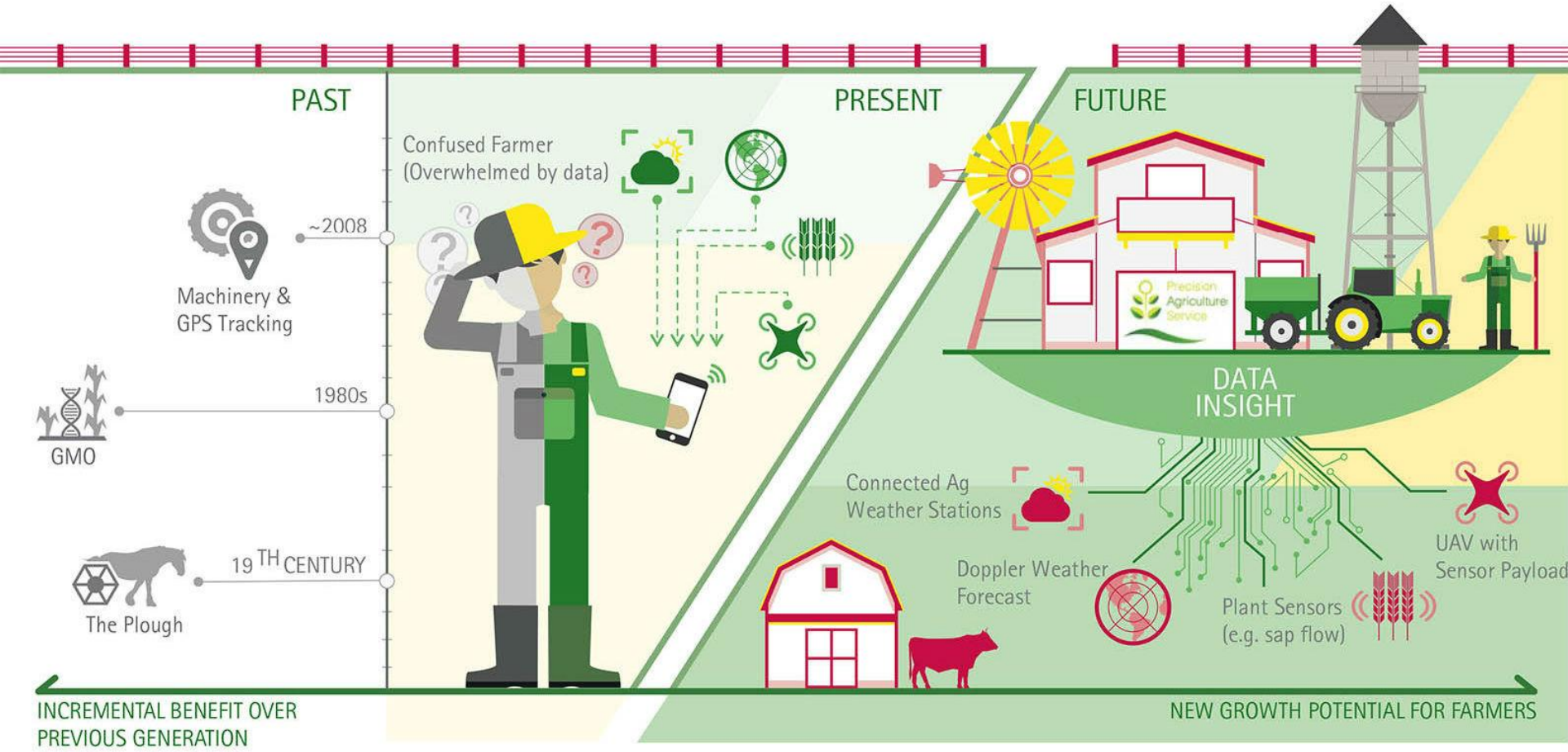
History of Precision Farming

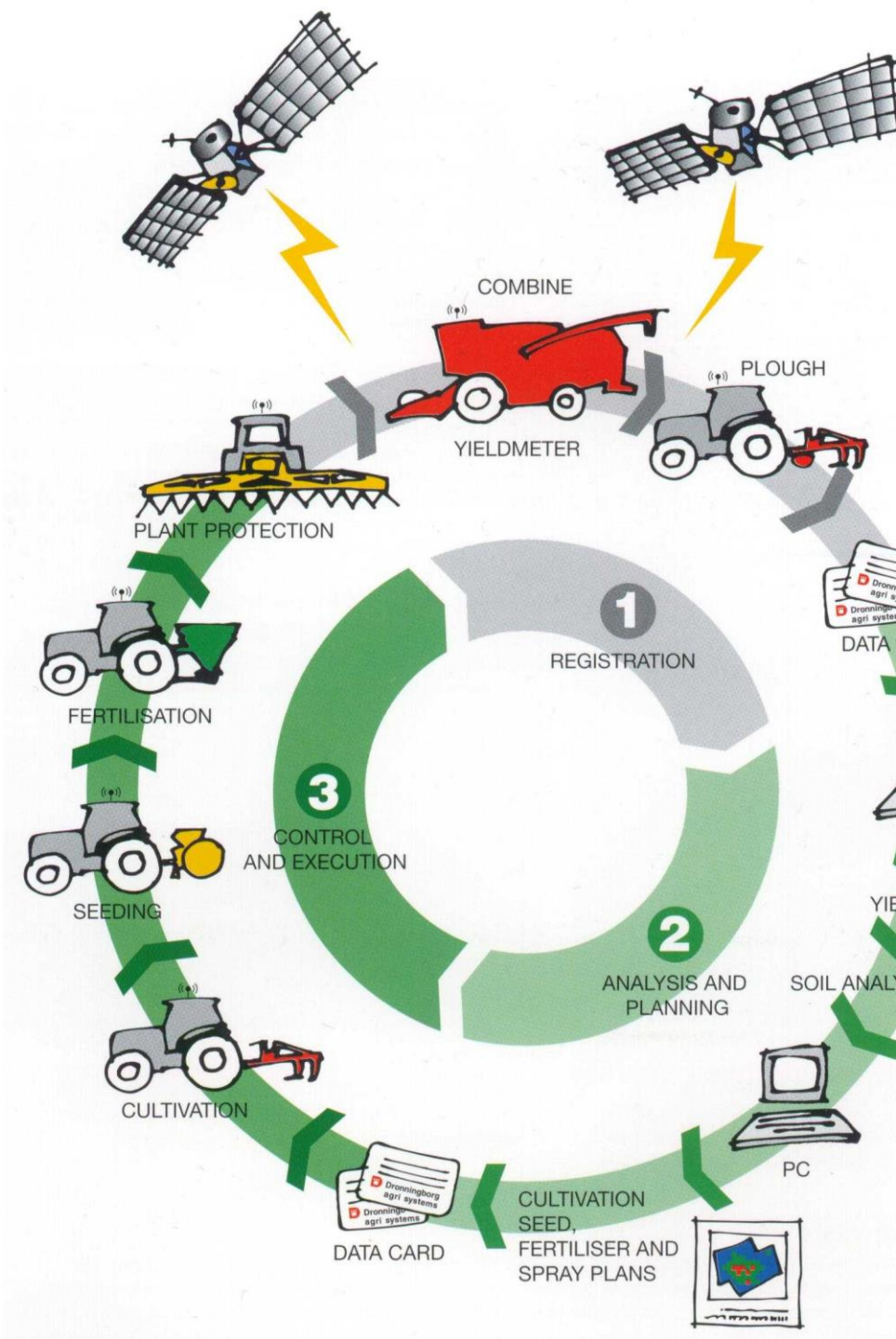


History of Precision Farming



Components of Precision Farming

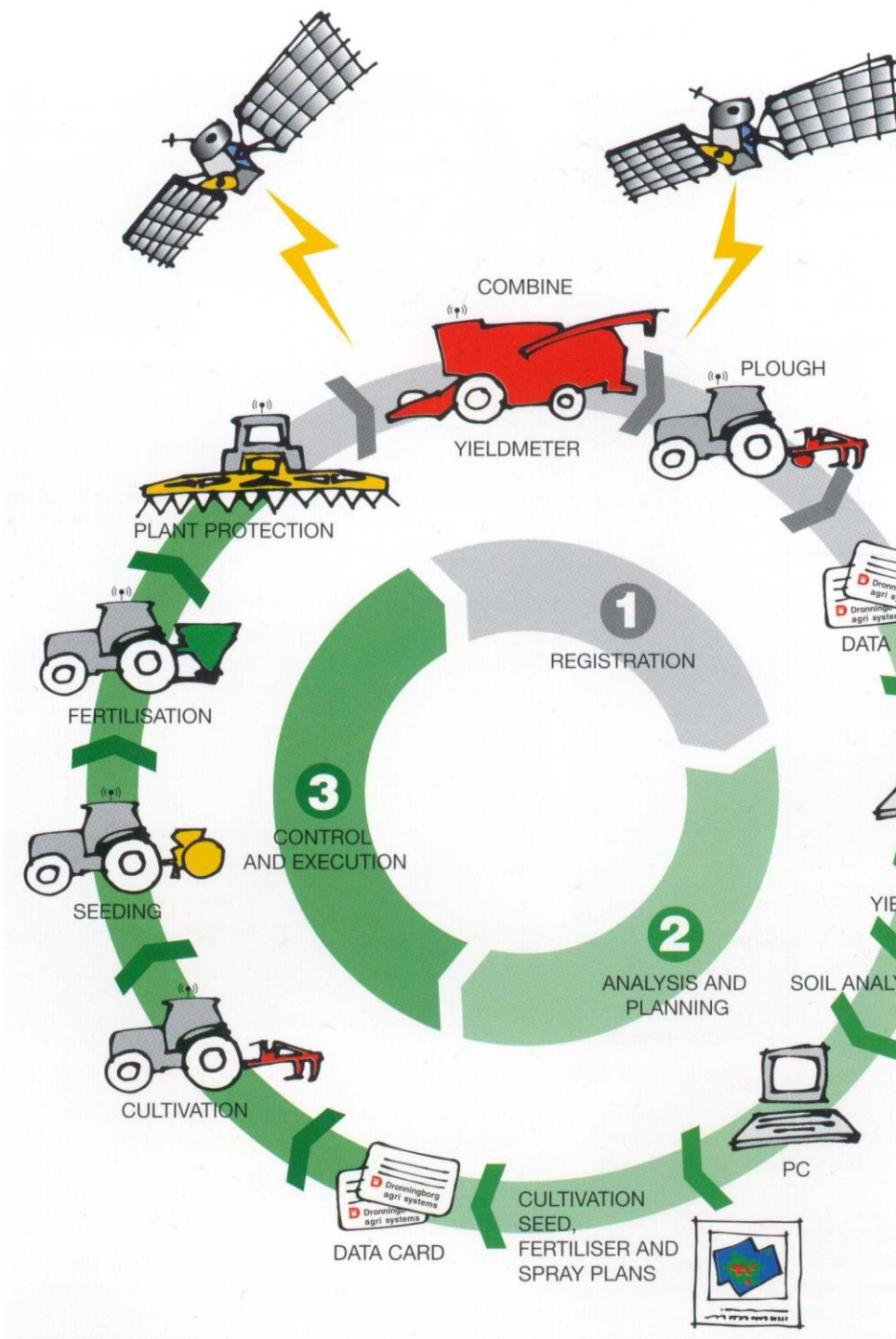
1. **Information (database)**
   - **Soil** (texture, structure, moisture, nutrients, etc.)
   - **Crop** (plant population, nutrient status, stress, weeds, insect or fungal infestation, yield, etc.)
   - **Climate** (temperature, humidity, rainfall, wind velocity, etc.)
2. **Technology**
   - Global Positioning System (GPS) receivers
   - Differential Global Positioning System (DGPS)
   - Geographic Information Systems (GIS)
   - Remote and Proximal Sensing
   - Variable Rate Technology (VRT)



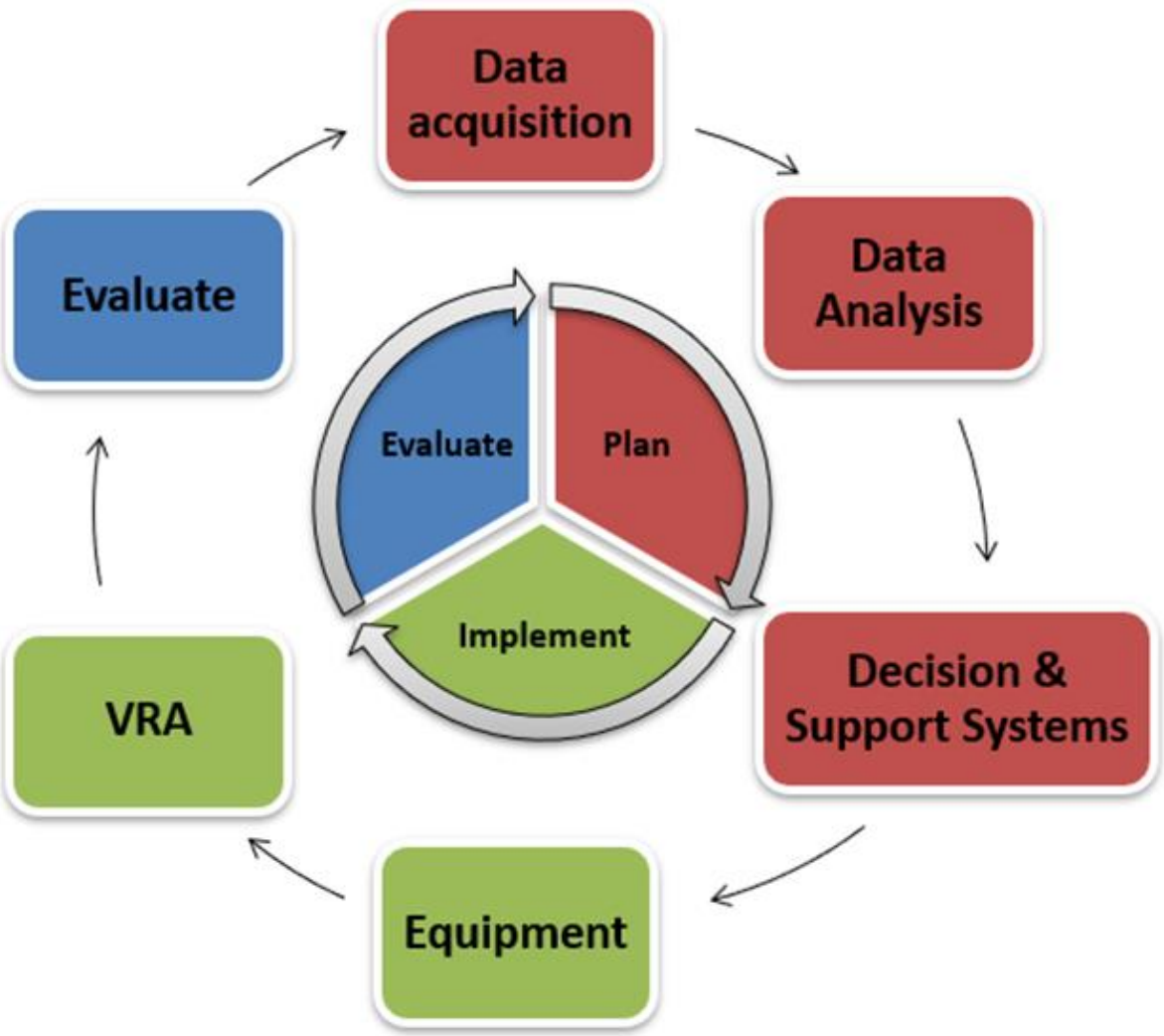
Components of Precision Farming

3. Management

- Information Management
- Decision Support System (DSS)
- Service Providers



The Precision Farming Cycle



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Data Acquisition

Planning Phase

- **Detailed Soil Surveys**
  - Soil physical properties.
- **Grid Sampling**
  - Soil chemical properties.
  - Varies from 0.25 to 4 ha per sampling point.
- **Smart Sampling (Zone Sampling)**
  - Fewer samples are taken in zones that produce constant high yields.
  - More samples are taken in zones with low or non-constant yields (problem areas).
- **Continuous Data Sampling**
  - Sensors and monitors available for in-situ and real-time measurement of soil, crop, climate and equipment variables.

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Data Analysis

Planning Phase

- In-depth analysis, evaluation and interpretation of all data collected.
- Data sets can be large and complex.
- Agricultural Specific Geographic Information Systems (GIS) can be used to analyse and manage these complex data sets.
- This process is known as Geoprocessing.
- Provides the necessary tools to execute numerous GIS commands.
- GIS further enable users to analyse and interpret information stored in different data layers simultaneously.

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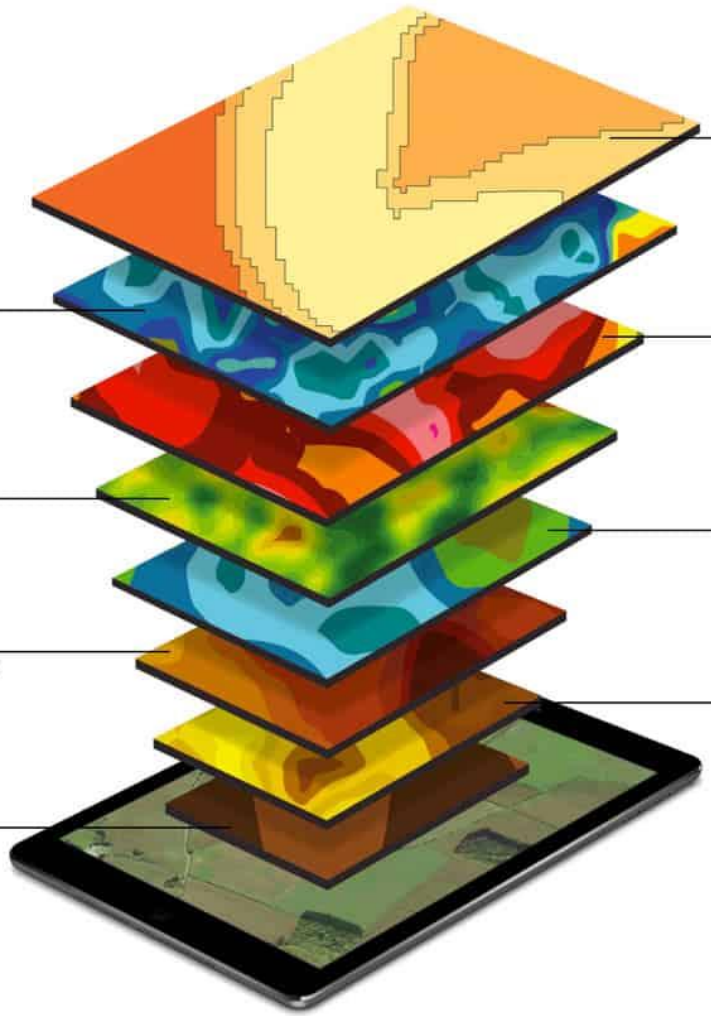
Agricultural Specific Geographic Information Systems (GIS)



Application plan

Generated using Multi-Dimensional Analysis for an unrivalled level of agronomic accuracy

Yield Mapping

Use these in isolation to calculate offtake or combine using Multi-Dimensional Analysis to see the year-on-year field performance

NDVI

Manipulate fertiliser programme using a snapshot of the crop condition

Yield potential

Create these to optimise nutrient management planning

Soil analysis

Take account of soil analysis results to achieve economic optimum crop yields

Weeds

Effective weed management strategies can reduce costs, maintain yields and minimise the risk of resistance

Pests

Target inputs to appropriately manage pest burden

Soil texture

An essential element in determining nutriment management planning and crop establishment

Decision Making

Planning Phase

- Most important component in the Precision Farming Cycle.
- Data is useless if it is not used to pursue a specific goal or to address a specific problem or shortcoming.
- Three types of decisions:
  - Strategic or long-term decisions (10 years).
  - Tactical or medium-term decisions (2 – 5 years).
  - Operational or real-time decisions (daily).
- Only successful if supported by Information Technology and the Decision Support System (DSS).

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Decision Support System

- Specific actions such as variable rate application of inputs such as lime, seed and fertilizer.
- Advanced support systems are only developed and maintained by a limited number of companies, making it expensive.

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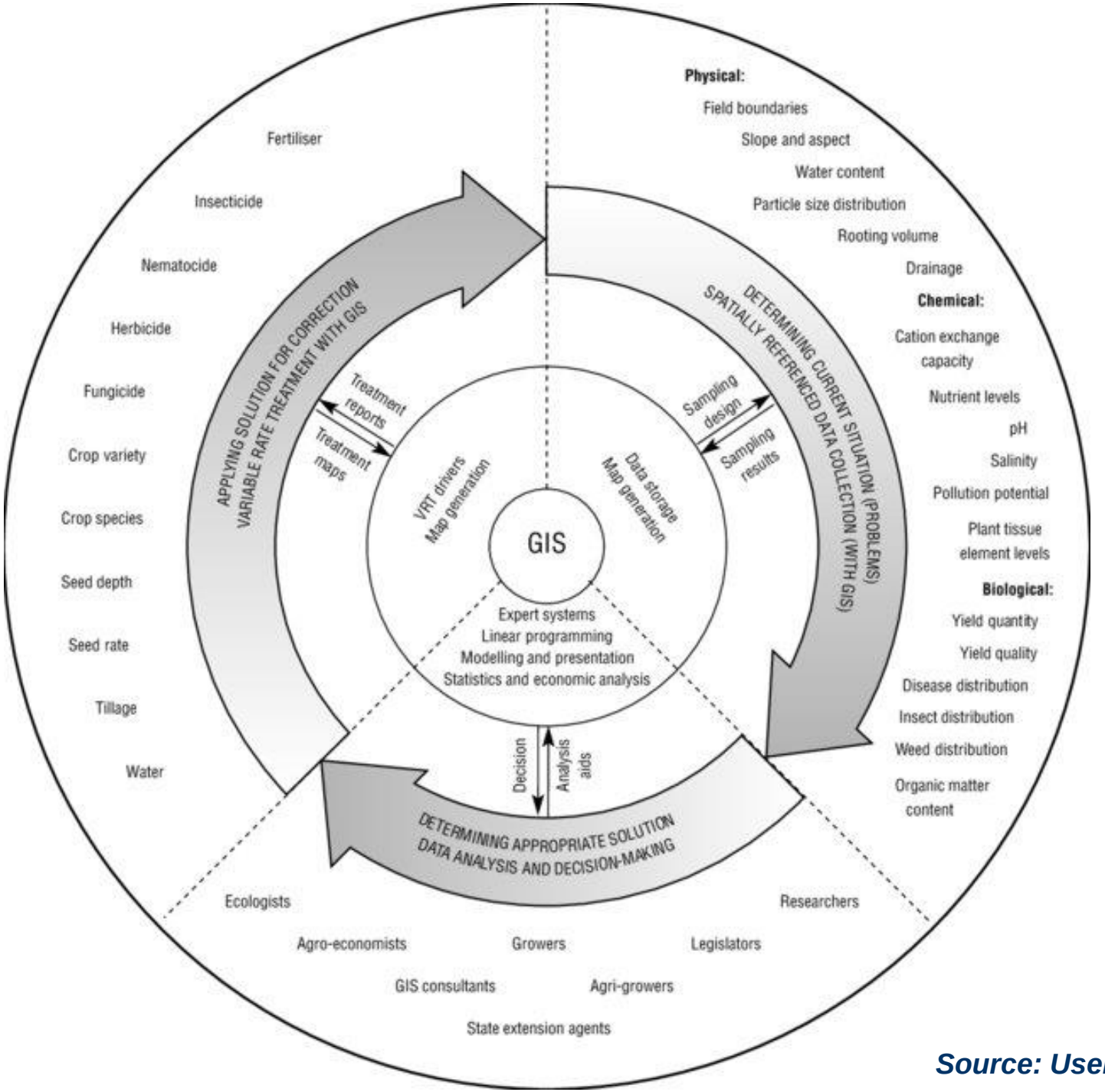
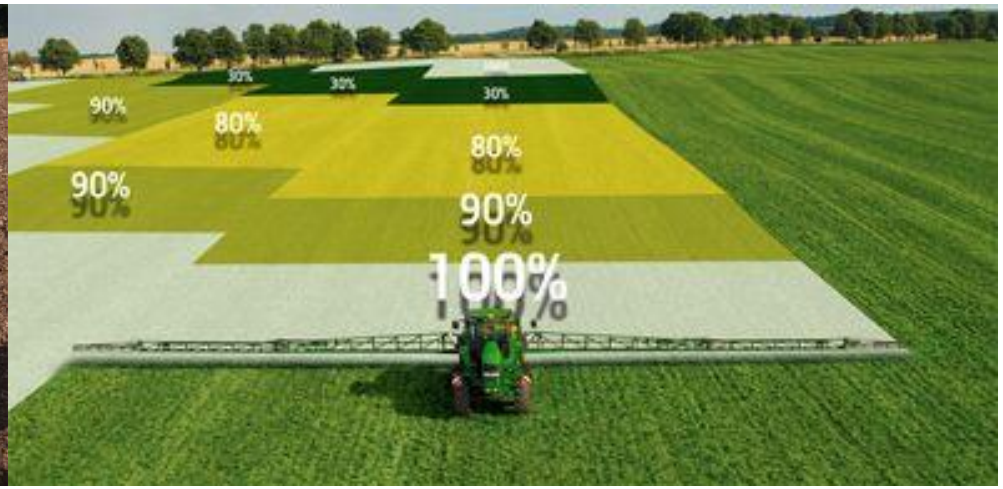


Source: Usery et al., 1995

Implementing Phase

- Variable Rate Application (VRA) is the most common form.
- Other forms include:
  - ❑ Variable depth (example tillage or seeding)
  - ❑ Variable composition or concentration (herbicides or pesticides)
  - ❑ Variable time of application.



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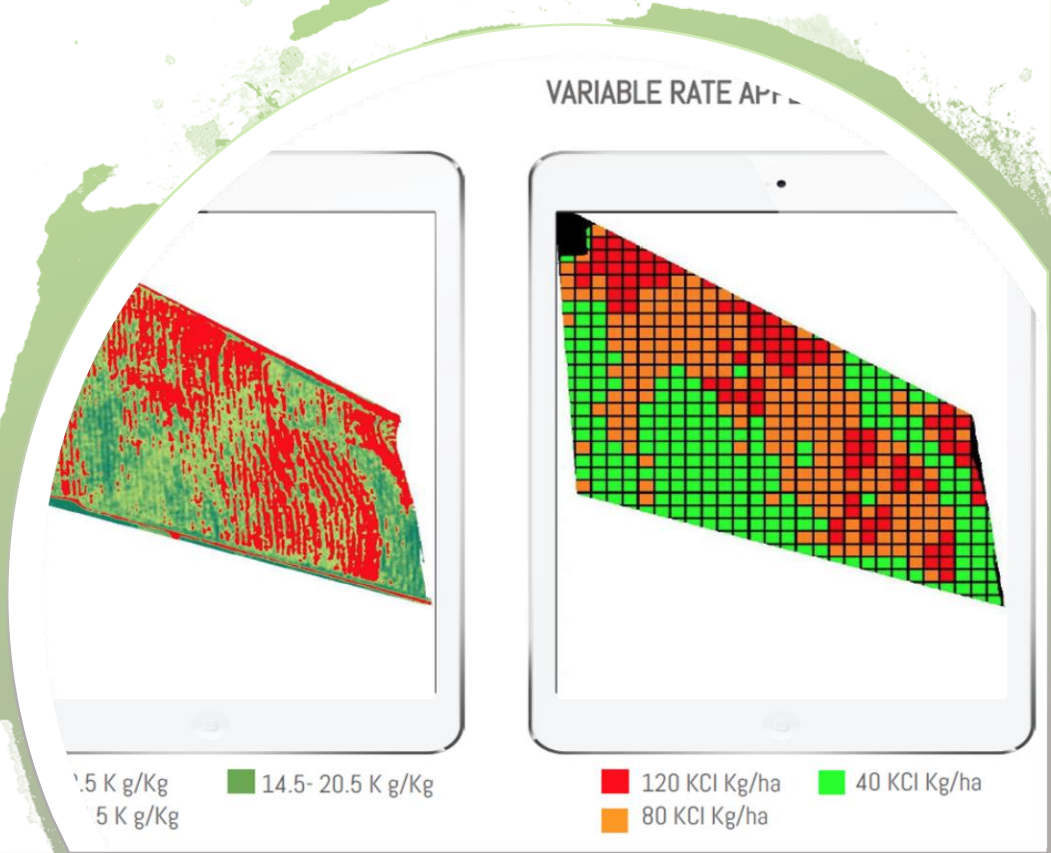
Implementing Phase

Two approaches towards VA:

- **Map-based** variable application (application rate is controlled according to the electronic prescription map derived from the GIS database.
- **Sensor-based** variable application according to real-time data from sensors mounted on the implement or applicator.



Implementing Phase

- Advances in technology drives the exponential development of precision farming equipment:
  - ❑ Big Data
  - ❑ Machine Learning
  - ❑ Artificial Intelligence (AI)
  - ❑ Robotics
- The biggest obstacle to using this technology is the lack of expertise on where and to what extent inputs should be applied variably.

Evaluation Phase

- Results of all decisions taken during the Implementation Phase should be evaluated.
- Most critical aspects to be evaluated:
  - Yield
  - Quality
  - Profit

Evaluation Phase

- Measure of the effectiveness with which inputs (nutrients and water) and resources (soil health) have been used.
- Guidelines for management decisions to be taken again during the next crop's planning phase.
- Simulation, regression and correlation analyses are examples of methods that can be used to determine the economic efficiency of the precision farming system.

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Advantages of the Precision Farming System

Advantages
Identify and manage problem areas (specific issues)
Increase the effectiveness of inputs and resources
Increase profit per unit area
Support applications for financing and crop insurance
More effective utilisation of equipment and manpower
Effective record keeping system
Improve management skills (confidence)
Improve the sustainability of agribusinesses

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Disadvantages of the Precision Farming System

Disadvantages
High capital outlay for equipment
Relatively high cost for soil surveys and analysis
Not an instant solution (may take several years to collect enough data to successfully manage the system)
Software is not always compatible, especially when upgrading to a new system
A high level of knowledge, computer skills and management inputs are required
Lack of support, R&D experts

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State of the Industry

- Precision Farming has made the transition from being an academic research topic to a highly beneficial practice in agriculture.
- By the end of 2030, precision farming is touted to become the most influential trend in agriculture, surpassing other advancements.
- Precision Farming Market (2018 - 2023) report by Mordor Intelligence
  - More farms than ever are using Precision Farming technologies
  - 70 - 80% of new equipment contain some form of precision farming capability.

Adoption Rate (%) of Precision Farming Technologies (Global)

PF Technology	USA	Western Canada	Australia	England	Europe
• Yield Monitors	50	84	*n/a*	*n/a*	*n/a*
• Yield Mapping	> 30	81	*n/a*	11	*n/a*
• VRA	20	48	11-35	16	30
• GPS Guidance	45-50	98	90	22	65
• Auto steer	45-50	79	90	*n/a*	61
Source	***USDA ERS Report 2016***	***Steele, 2017***	***Robertson et al., 2016***	***Scientific Foresight Study, 2016***	***Holland et al. 2013***

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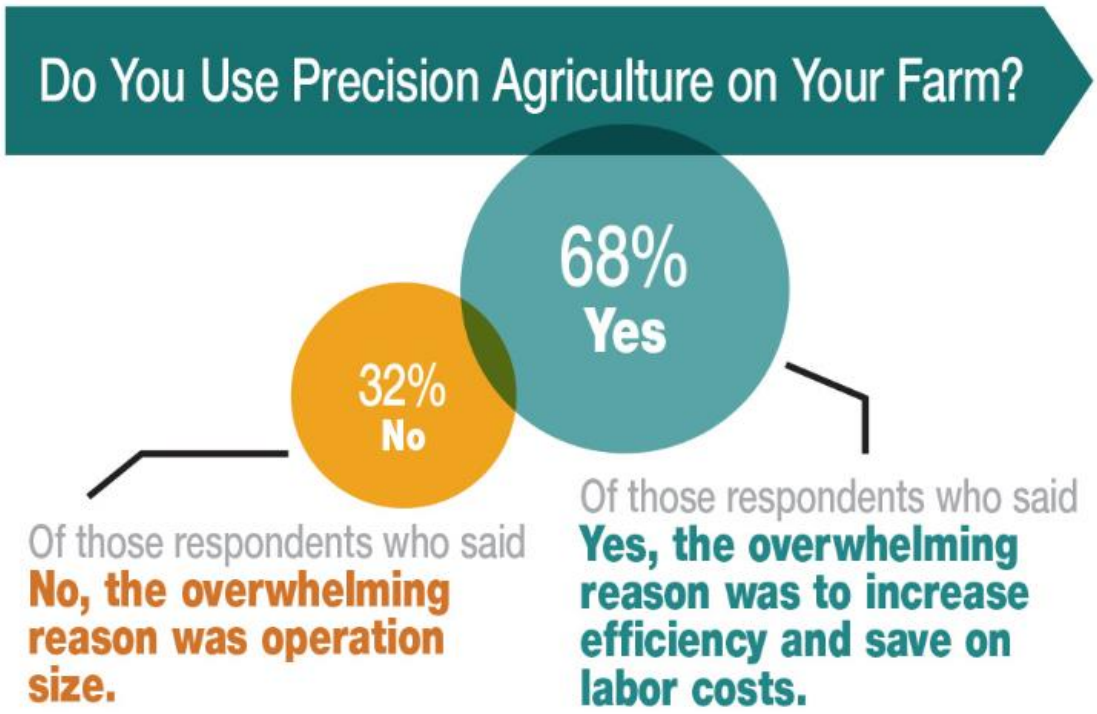

- Adoption was found to be high in areas where labor costs are high and land costs are relatively inexpensive.
- In some cases, farmers were found to be expecting a quick return on investment, which remained largely elusive.
- Farmers are on the lookout for easily accessible information to lower the amount of time spent on management.

Reasons Not Adopting

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Feedback from respondents:

- Dup Haarhoff (GWK)
- Luks Odendaal (Technifarm)
- Martiens du Plessis (NWK)
- Thomas Strydom (Sion Agri)
- Kobus van Zyl (Omnia Fertilizer)

South African Industry Survey 2019

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South African Industry Survey 2019

Feedback covered:

- 1361 clients
- 731 000 ha (Irrigation and Dryland)
- 6 Provinces
- Crops
  - Maize, sunflower, soya, groundnut, lucerne and cotton
  - Potato and onion
  - Pecan, citrus and grapes
  - Wheat, barley and oats

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Adoption Rate (%) of Precision Farming Technologies (South Africa)

PF Technology	Northern Cape	Western & Southern Cape	North West	Eastern FS	Western FS	Mpumalanga
• **Yield monitors**	80	60	25	80	95	70
• **Yield mapping**	50	30	<10	80	95	70
• **GPS Guidance Systems**	60	90	<3	80	100	70
• **GPS Auto-steer**	40	70	40	80	100	60
• **VRA - Lime or Gypsum**	5	90	45	100	84	100
• **VRA - Fertilizer**	30	40	<5	30	40	15
• **VRA - Seed**	1	5	<2	30	12	15
Source	***Haarhoff, 2019***	***Odendaal, 2019***	***Du Plessis, 2019***	***Strydom, 2019***	***Van Zyl, 2019***	***Strydom, 2019***

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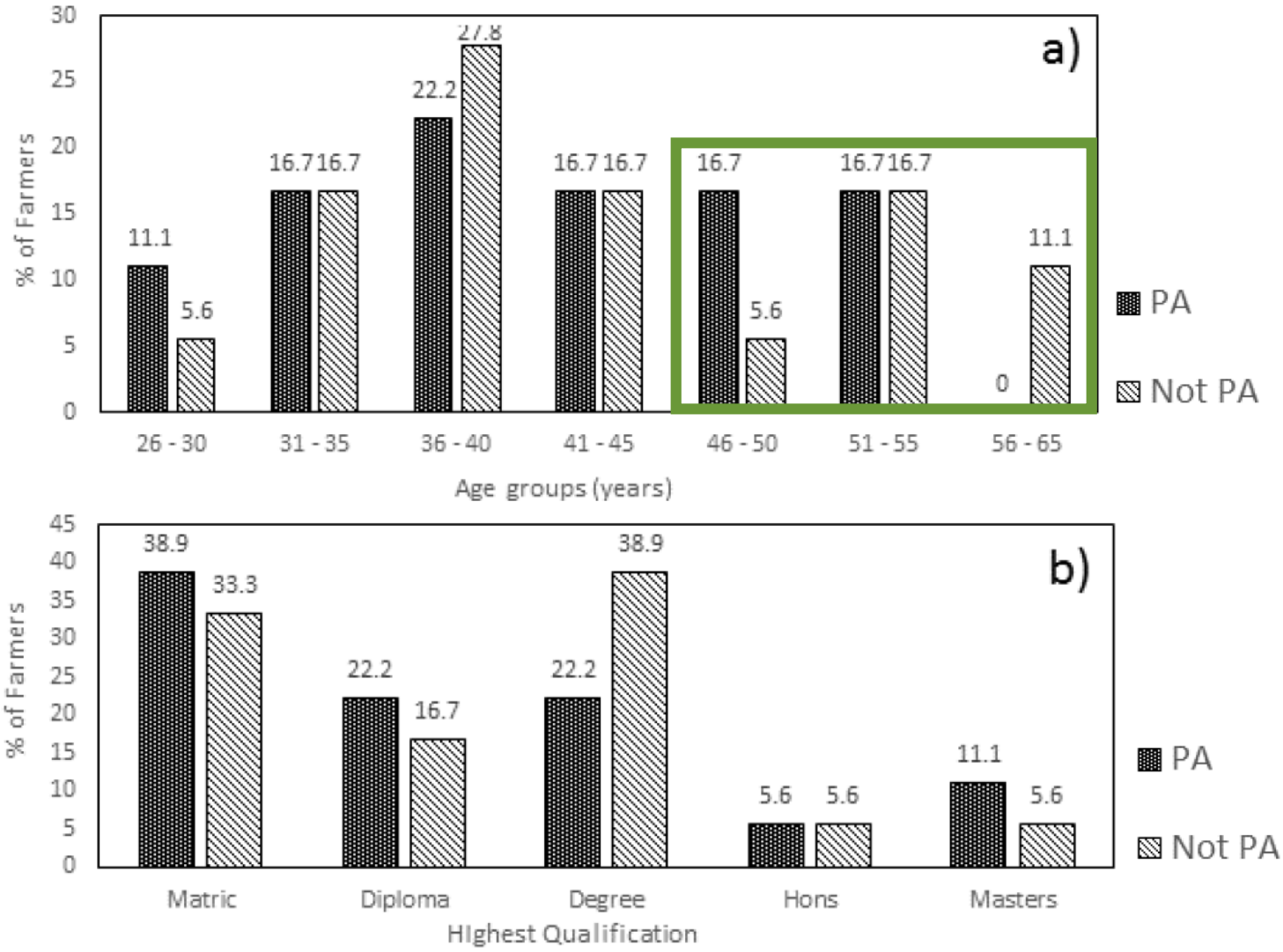
Impact of Age and Qualification on Adoption of Precision Farming



Source: Jacobs, et al., 2018

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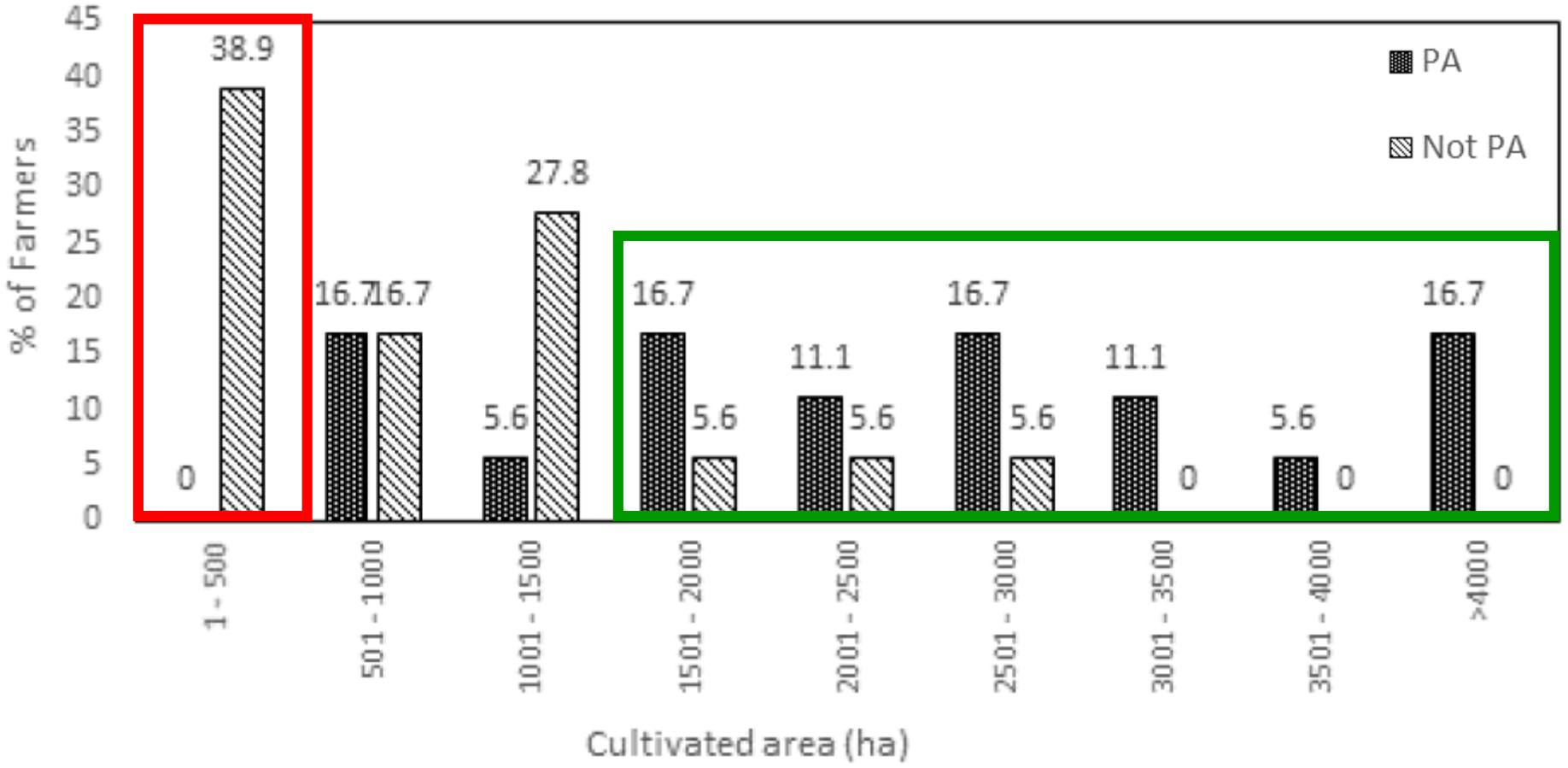
Impact of Cultivated Area on Adoption of Precision Farming



Source: Jacobs, et al., 2018

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Factors Limiting Adoption of Precision Agriculture Technologies

Factor	PA (%)	Not PA (%)
Costs	55.6	66.7
Technology (computer literacy)	16.7	0
Fear of change	16.7	0
Lack of support	5.6	0
Questions yield improvement	5.6	0
Fields are relatively uniform	0	11.1
Unavailability of financing	0	5.6
Management issues	16.7	5.6
Believe it is not worth the effort	0	5.6
Rented fields	0	5.6
Cultivated area is too small	0	11.1

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Conclusion

Potential improvements to the Precision Farming system:

- Thorough advice on operational aspects of precision agriculture
- Servicing of equipment and conversion of equipment can be improved
- More technical advisors are needed
- Training programs and courses for labourers
- Computer software should be simplified and translated to the farmers' first language, mostly Afrikaans
- More uniformity between organisations on how to amend nutrient deficiencies
- More research on optimal levels of different nutrients in different areas are required
- Theoretical predictions of yield potentials can be improved upon.

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Thank you for staying awake!

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