SUSTAINABLE CROP MANAGEMENT

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The Future of Crop Protection: data-driven precision IPM

from vision to execution

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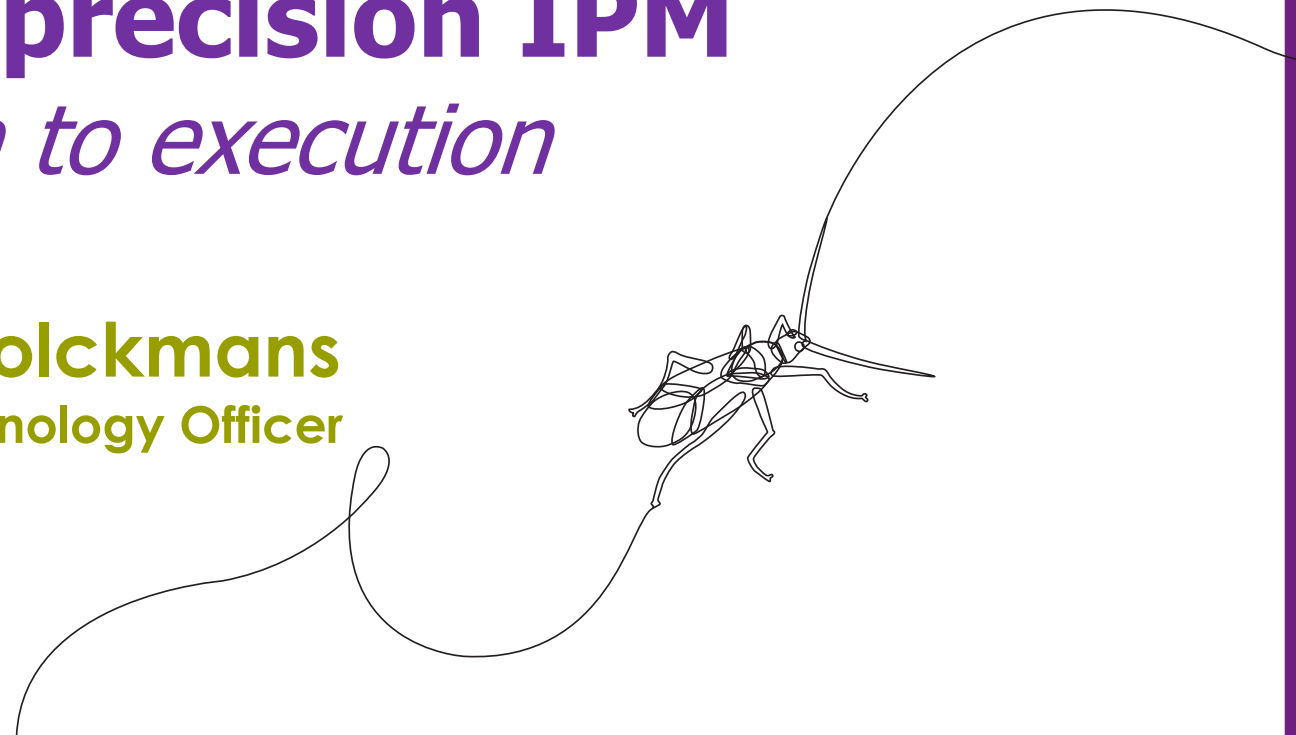


Patterns in (Greenhouse) Production

- High concentration of **buying power** in a small number of retailers (oligopsony)
- **Shorter value chains** ("cut out the middle man"): driven by cost and quality considerations
- Retailers want to deal with as **few suppliers** as possible:
  1. Entire category
  2. All-year-round
  3. Always entire volume (reliability)
  4. Top quality: (1) cosmetic quality, (2) taste, (3) residue poor/free, (4) carbon neutral
  5. Best price
- **<u>Fewer</u>** but **<u>larger</u>**, **<u>multisite</u>** growers
  - Change of ownership structure: corporate farming
  - Increasing complexity and risk → **data-driven growing**
- Labour shortage, quality and cost → **robotization**

} "***The Autonomous Greenhouse***"

- Carbon footprint + Energy cost → Δ climate management (e.g. closed greenhouse, vertical agriculture, …)

Data Is Transforming How Growers Operate

The grower's challenge: **continuously steering** the plants for maximum production through dynamic **climate management** (T, RH, [CO_2], light), **fertigation management** (irrigation, pH, EC, fertiliser mix, …) and **crop management** (leaf picking, lowering plants, cluster pruning, …) and all the **interactions** between them, while keeping **energy cost** and **labor cost** under control → very complex interactions ⇒ **top sport !!!**

Today	❖ Visual inspection. ❖ Grower's experience. ❖ Input from a trusted advisor, such as a sales rep, who has access to otherwise inaccessible information and knowledge. ❖ Supplier product information.
In the (very) near future	❑ **Data-enabled decision making** based on: ✓ real-time data collection (sensors, camera's, computer vision, digitization, IoT, drones, autonomous vehicles, …), ✓ advanced data analytics, artificial intelligence, algorithms (descriptive, diagnostic, predictive and prescriptive analytics), ✓ sharing of best practices via digital farming applications and platforms. ❑ **Automated execution** of farm tasks → robotization

Source: adapted from BCG analysis

Prevention

Host Plant Resistance

- ✓ Resistant Varieties
- ✓ Plant Defence System: SAR, ISR, vaccination, endophytes

Cultural Methods

- ✓ Soil Life
- ✓ Crop Rotation
- ✓ Cropping Systems

Semiochemicals

- ✓ Mating Disruption

Physical Control

- ✓ Exclusion (e.g. netting)

Biological Control

- ✓ Conservation Biocontrol
- ✓ Seasonal Inoculative BC (Predator-in-first)

Scouting

Data Collection

- ✓ Human Eye
- ✓ Sensors & Camera's

Decision Support Systems

- ✓ Descriptive Analytics
- ✓ Diagnostic Analytics
- ✓ Predictive Analytics
- ✓ Prescriptive Analytics

Integrated
Pest & Disease
Management

Intervention

Physical Control

- ✓ Trapping (color, light, pheromone)
- ✓ Clipping, Roughing
- ✓ UVc

Biological Control

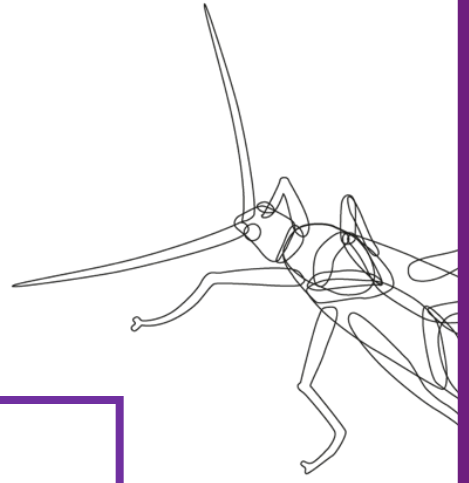
- ✓ Inundative Releases
- ✓ Biopesticides
- ✓ Sterile Male Technique

Chemical Control

- ✓ Only as a last resort !
- ✓ Selective Pesticides
- ✓ Precision Application
- ✓ Pesticide Resistance Mngt.
- ✓ Residue Management

Providing IPM Advice

Challenges & Opportunities



Data Collection & Recording

Detecting – Identifying – Quantifying – Mapping

1. Scouting labour
2. Timely detection
3. Data quality

Decision Support

Analysing - Learning - Deciding

1. Access to greenhouses:
   - ✓ PepMV, ToBrRFV,
   - ✓ Covid-19
   - ✓ remote areas
2. Confidence & Decision quality
3. Training new IPM technicians
4. Efficiency

Action

Applying – Recording

1. Application labour
2. Spot treatments
3. Crop Protection Cost

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Data-driven Precision IPM
WHAT ?

1. **Data collection & recording** (identity, location, severity of diseases, pest & beneficials)
   1) **Human eye**
      a) Mobile Scouting App → Biobest/Ecoation CropScanner 2.0
      b) Vehicle Mounted → Ecoation OKO
   2) **Sensors and Camera's** (RGB, thermal, hyper/multi-spectral, …)
      a) Direct observation of pests (vision, image recognition, wing beat, e-nose)
         a) On plants (underside leaves)
         b) In flight → PATS-C
      b) Indirect observation: plant stress (2-step approach) → Ecoation Plant Health Sensor
      c) Trap Counts (vision, image recognition) → Trap-Scanner, Trap-Eye (PATS)
   3) **High-resolution climate sensors** (T, RH, [CO2], light intensity, …) → Ecoation OKO

   ⇒ Autonomous Vehicles → Bogaerts Greenhouse Logistics
2. Decision Support
3. Action

2-step approach
for Crop Observations

No information
about beneficials !

Entire Plant Population

Plant Stress Sensors
1. Detecting & Mapping

OR

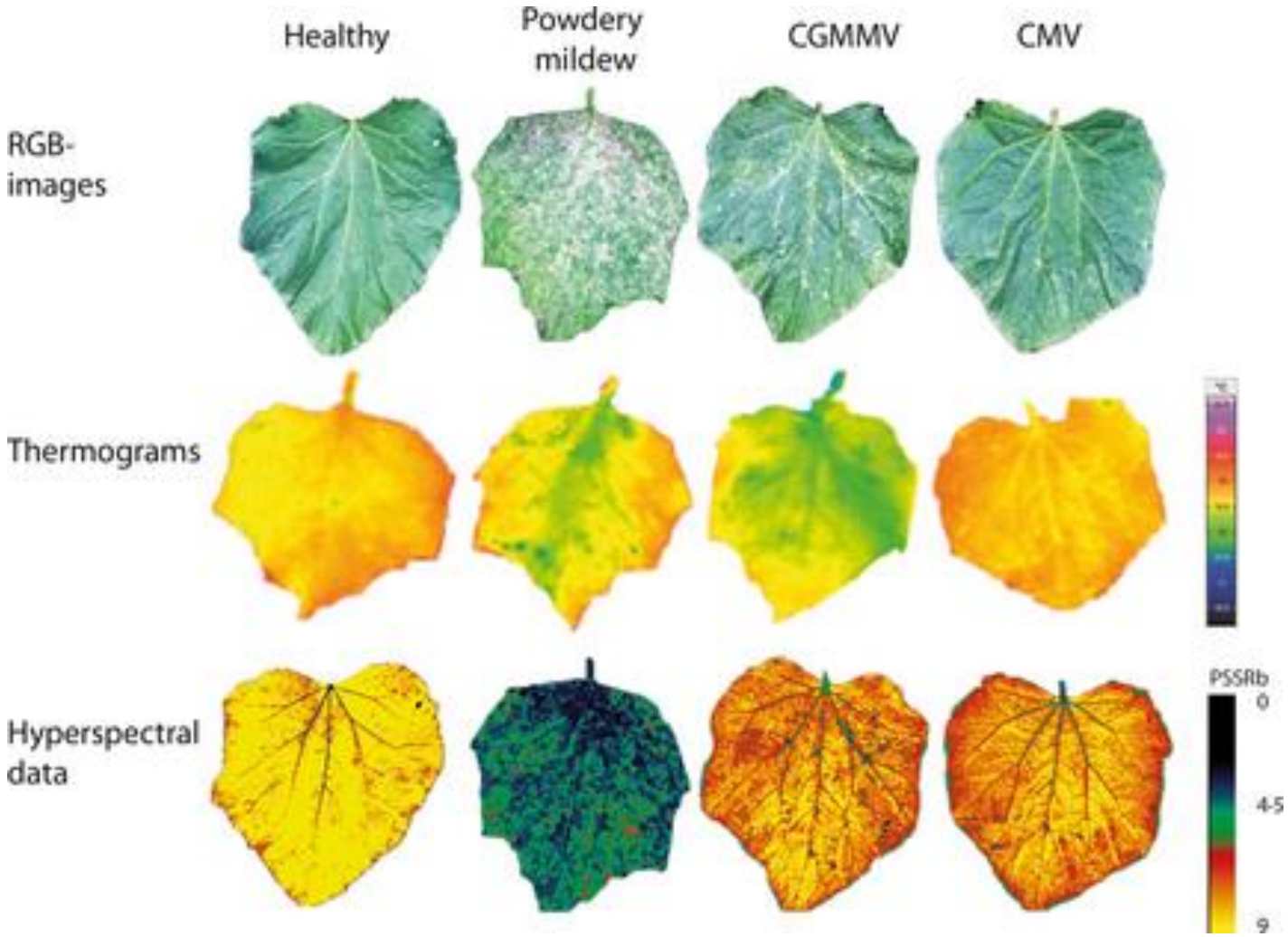
Visual Observation
and Scouting App

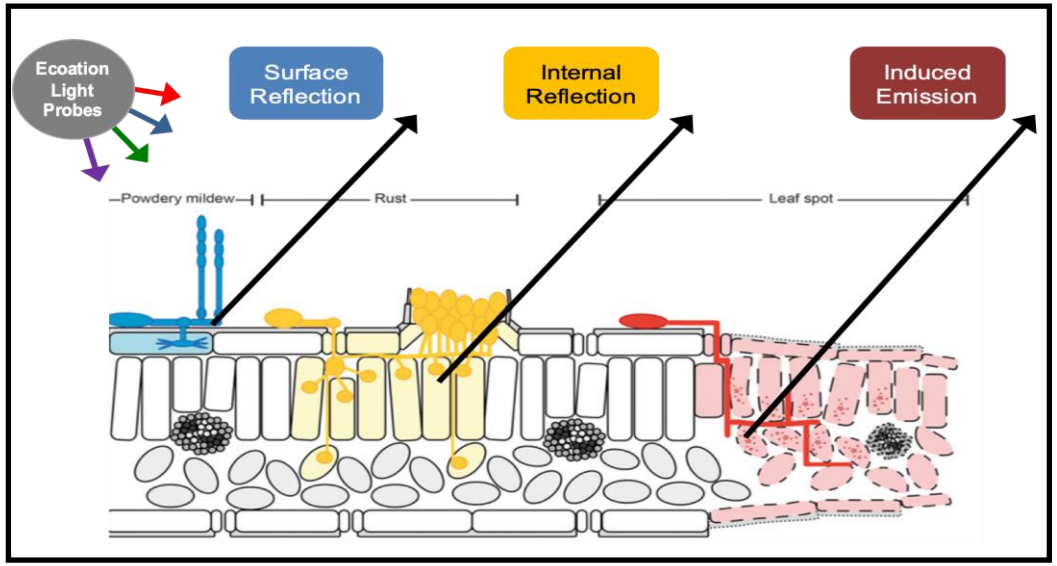
HR Camera
Image Recognition

2. Identifying & Quantifying
Sampling part of the Entire Plant Population

Including information
about beneficials

Beyond the visible





C. A. Berdugo, R. Zito, S. Paulus, and A.-K. Mahlein, “Fusion of sensor data for the detection and differentiation of plant diseases in cucumber,”

Plant Health Sensor

Decision Support System

a new paradigm for technical advice

Predictive
What will likely happen ?

Data

Descriptive
What happened ?
What is happening ?

Prescriptive
What should/could be done about it ?

Actions

Diagnostic
What caused it ?
Why does it happen ?

ecoation

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Data-driven Precision IPM
WHAT ?

1. **Data collection & recording** (identity, location, severity of pest & beneficials)
2. **Decision Support** (DSS)
3. **Action**
    1) Broadcast and/or Precision Application ("spot treatments") of:
        1) Beneficial Insects & Mites
        2) Biopesticides
        3) Selective Chemical Pesticides
    2) UV_C robot

    $\Rightarrow$ Autonomous Vehicles

Data-driven Precision IPM
WHY ?

1. Reduce production **costs** (labor cost+ availability of skilled labour)
   1) Scouting labour (2-step approach)
   2) (Precision) application of beneficials and (bio)pesticides
   3) Crop Protection Costs
2. Maximize **crop yield** and **quality** (Precision IPM)
   1) Even better IPM advice with less risk (PepMV, ToBrFV, …) through remote advice
   2) Less negative impact from pests and diseases on crop yield and quality
      a) Earlier detection, allowing earlier intervention
      b) Optimal (precision) interventions (DSS) (product, rate, timing, frequency, location)
   3) Less negative impact from pesticide treatments on crop yield→ confidence through data !
   4) Better oversight, task management and control of work quality (large, multisite operations)
   5) Reduce/Eliminate pesticide residues (residue-free)
      a) Meet legal and extra-legal requirements ('license to supply')
      b) Ultimately provide residue-free produce

Thank you !

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