สวทช NSTDA

NAC2023
18th NSTDA Annual Conference
การประชุมวิชาการประจำปี สวทช. ครั้งที่ ๑๘

NAC2023

องค์ความรู้พื้นฐาน ด้าน High throughput phenotyping และการใช้ประโยชน์จาก NSTDA-Plant Phenomics

สำนักงานพัฒนาวิทยาศาสตร์และเทคโนโลยีแห่งชาติ

28-31 มีนาคม 2566

NAC2023
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High-resolution phenotyping for product development in the digital era of agriculture

พูนพิภพ เกษมทรัพย์
มหาวิทยาลัยเกษตรศาสตร์

29 มีนาคม 2566

“There are no low-tech industries,
only low-tech firms”

Professor Michael E. Porter
Institute for Strategy and Competitiveness
Harvard Business School

“Stone age did not end for lack of stones”

the Oil Age will end long before the world runs out of oil

Sheikh Zaki Yamani, former oil minister of Saudi Arabia

เกษตรสมัยใหม่

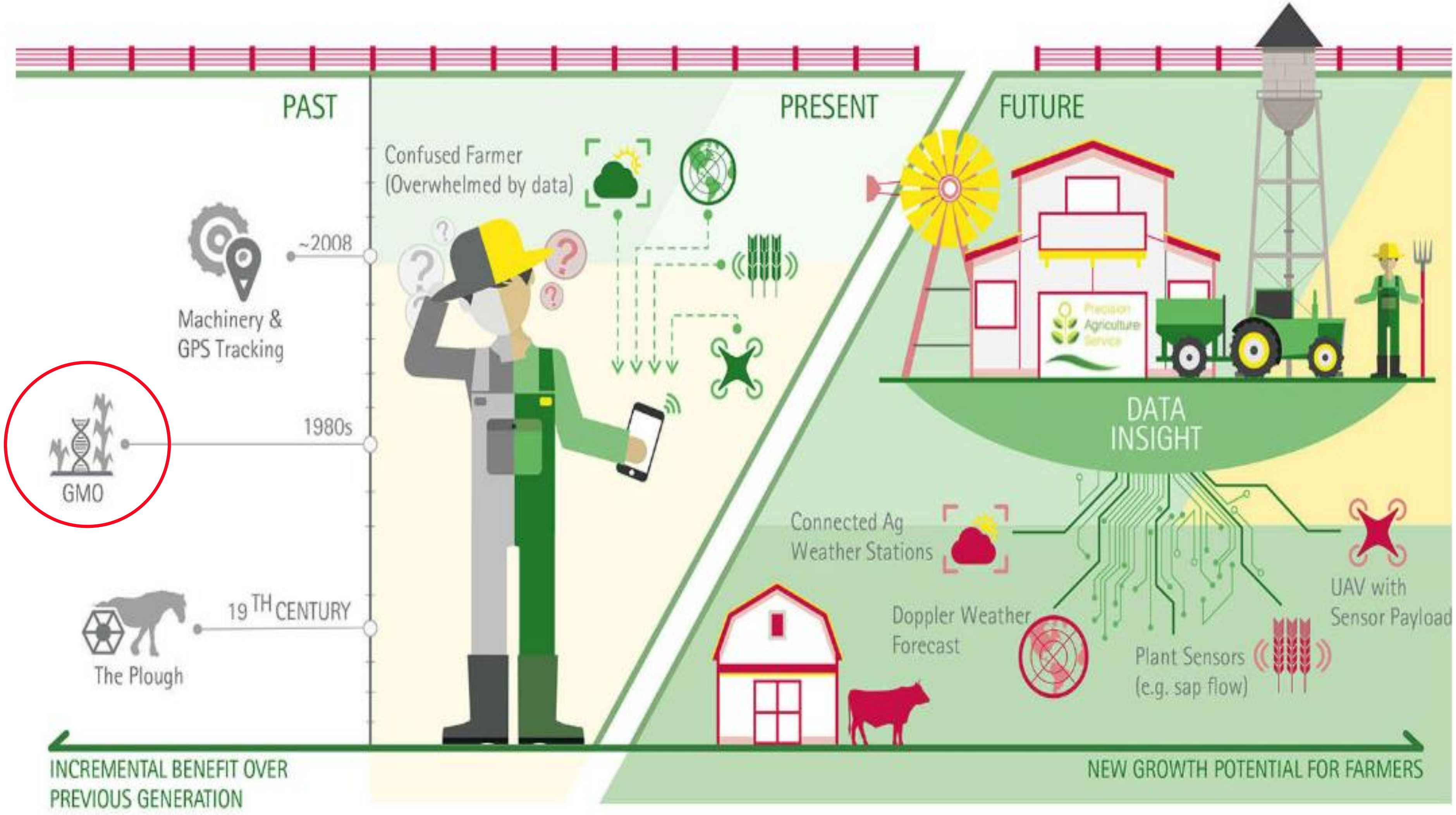
http://breakthrough.unglobalcompact.org/disruptive-technologies/digital-agriculture/

การเกษตรสมัยใหม่

การใช้เทคโนโลยีใหม่และขั้นสูงที่รวมอยู่ในระบบเดียว เพื่อให้เกษตรกรและผู้มีส่วนได้เสียในห่วงโซ่คุณค่าทางการเกษตร พัฒนา&ปรับปรุงทั้งประสิทธิภาพและประสิทธิผล

http://breakthrough.unglobalcompact.org/disruptive-technologies/digital-agriculture/

วิวัฒนาการของการเกษตรสมัยใหม่



www.accenture.com/th-en/insight-accenture-digital-agriculture-solutions

เทคโนโลยีใหม่ และ ขั้นสูง

- ตัวอย่าง ได้แก่
  - เซนเซอร์
  - เครือข่ายสื่อสาร
  - โดรน
  - ปัญญาประดิษฐ์
  - หุ่นยนต์ เครื่องจักรอัจฉริยะ และ อื่น ๆ
  - อุปกรณ์และเครื่องมือที่เชื่อมต่อกับอินเตอร์เน็ต

เก็บข้อมูล
+
บริหารจัดการข้อมูล
+
วิเคราะห์ข้อมูล
+
ให้คำแนะนำ

เทคโนโลยีใหม่และขั้นสูงที่รวมอยู่ในระบบเดียวกัน ให้ข้อมูลที่มีค่า ช่วยให้เกษตรกรสามารถตัดสินใจ และ ดำเนินการ ได้ดีมากขึ้น

ศักยภาพ

- การเกษตรสมัยใหม่ มีศักยภาพที่จะทำให้การเกษตร :
  - ได้ผลผลิตมากขึ้น
  - มีความสม่ำเสมอมากขึ้น (ลดความเสี่ยง)
  - ใช้เวลาและทรัพยากรน้อยลง

+ advantages for farmers

+ wider social benefits

open up new, disruptive opportunities

ปัญหาและอุปสรรค

- การเกษตรสมัยใหม่ มีศักยภาพที่จะเปลี่ยนแปลงการผลิตอาหารให้โลก

แต่ :

- เป็นเรื่องใหม่มาก ๆ
- **แพง**
- รายละเอียดผลตอบแทนในระยะยาว **ยังมีน้อย**

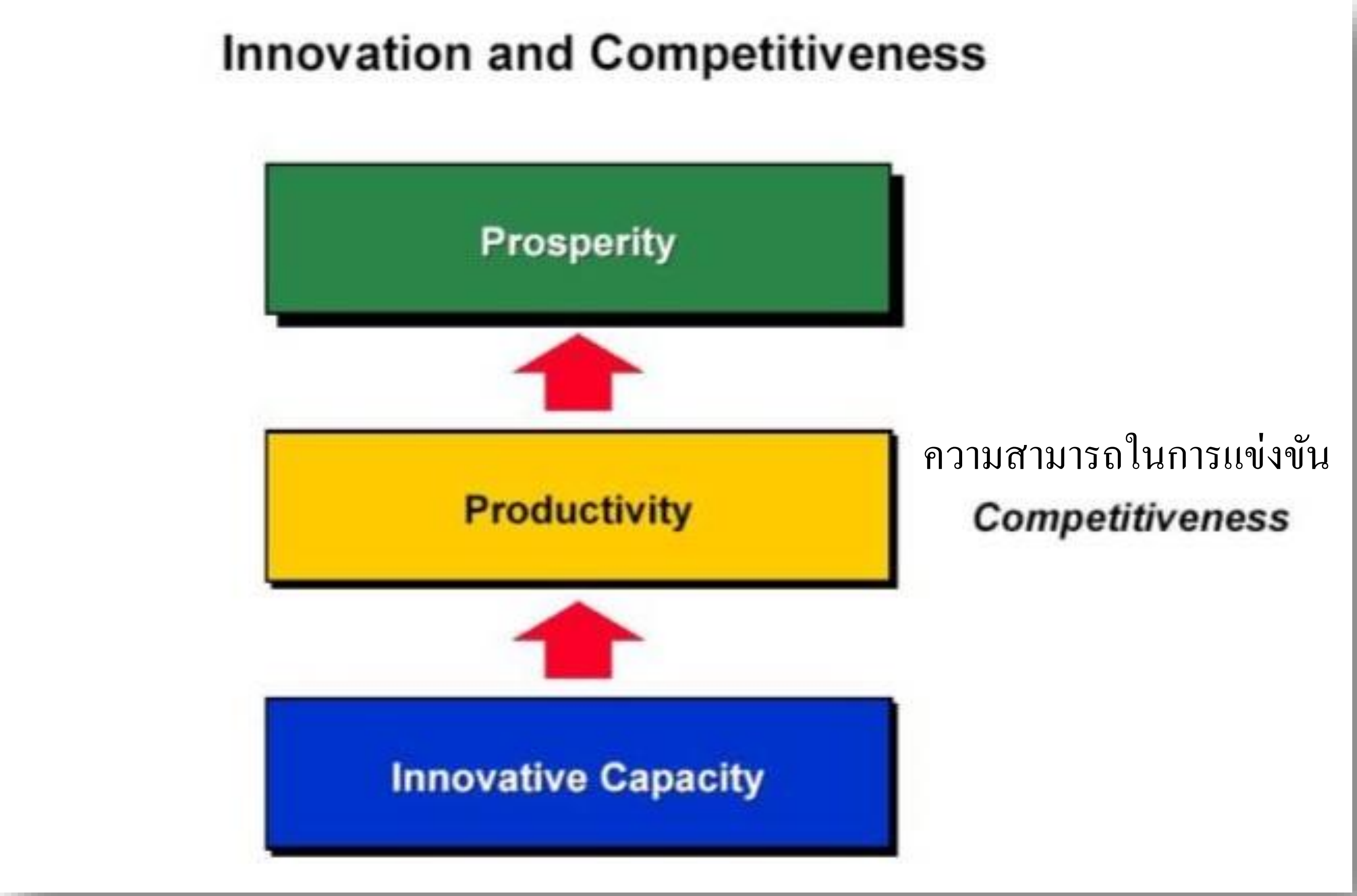
widespread adoption requires *collaboration* and *consensus* across the value chain

IP

Employment impact

Security

Use innovation to increase competitiveness



Professor Michael E. Porter
Institute for Strategy and Competitiveness
Harvard Business School

ความสามารถในการแข่งขัน

Competitiveness is determined by productivity with which a nation uses its human, capital, and resources.

Productivity depends both on the value of products and services (e.g. uniqueness, quality) as well as the efficiency with which they are produced.

Professor Michael E. Porter
Institute for Strategy and Competitiveness
Harvard Business School

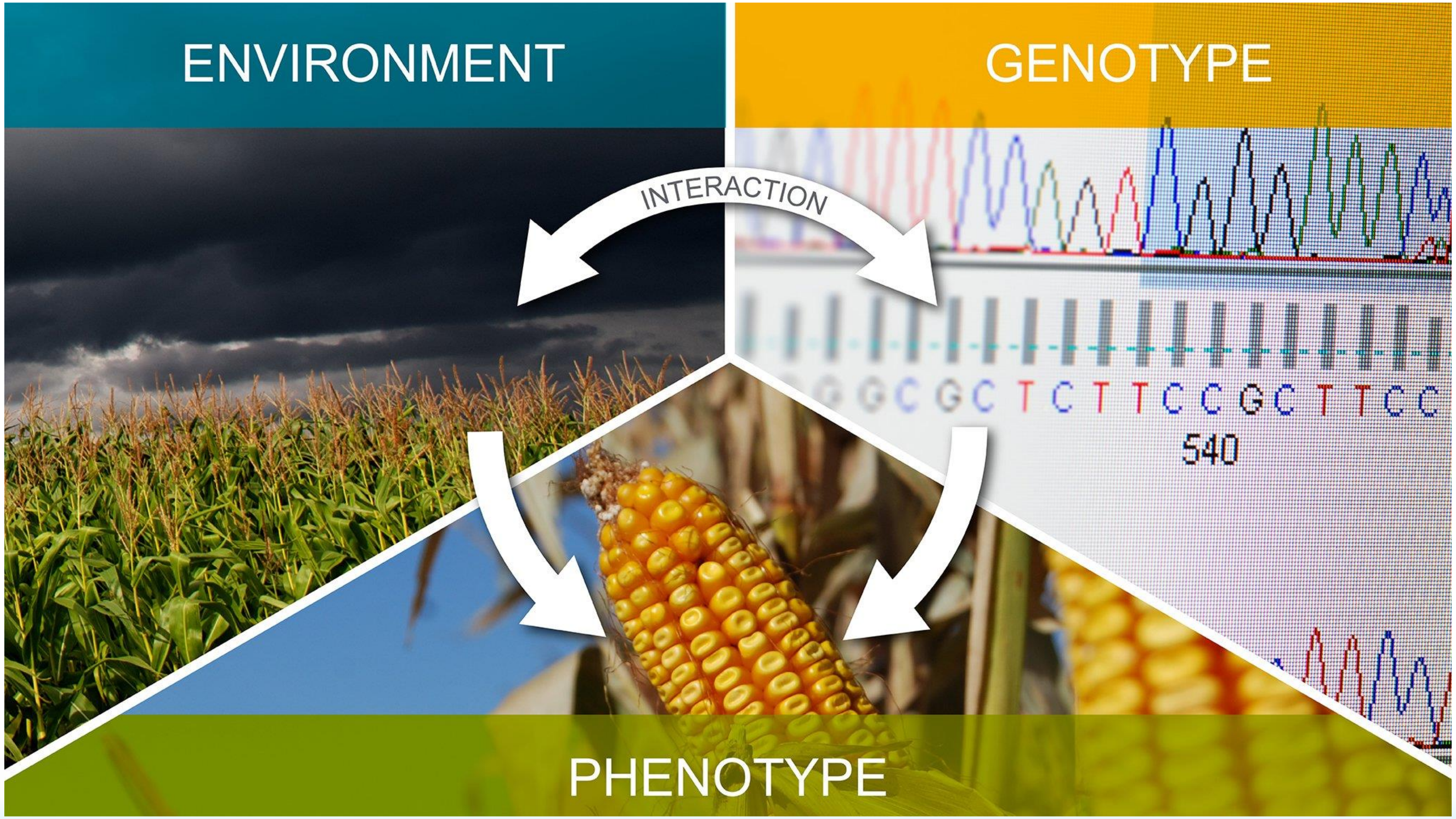
สู้ด้วยเทคโนโลยี และ นวัตกรรม
สร้างความสามารถในการแข่งขัน

- เพิ่มคุณค่าของผลิตภัณฑ์และบริการ
- เพิ่มประสิทธิภาพการผลิต
  - เพิ่มผลผลิต
  - ลดต้นทุน
  - ใช้ทรัพยากรต่างๆ ให้มีประสิทธิภาพมากที่สุด

It's about doing more with less

Sustainable intensification: more yield-less water,fertilizer, pesticides

Plant performance is determined by 3 major factors: genes, environment and the interaction between them (GxE)



ลักษณะปรากฏ หรือ รูปแบบปรากฏ (phenotype)
(กรีก: φαίνω แปลว่า "เปิดเผย, แสดงออก"; กรีก: τύπος แปลว่า "รูปแบบ“)

Advances in High Throughput 3P

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HT3P = high throughput plant phenotyping platform

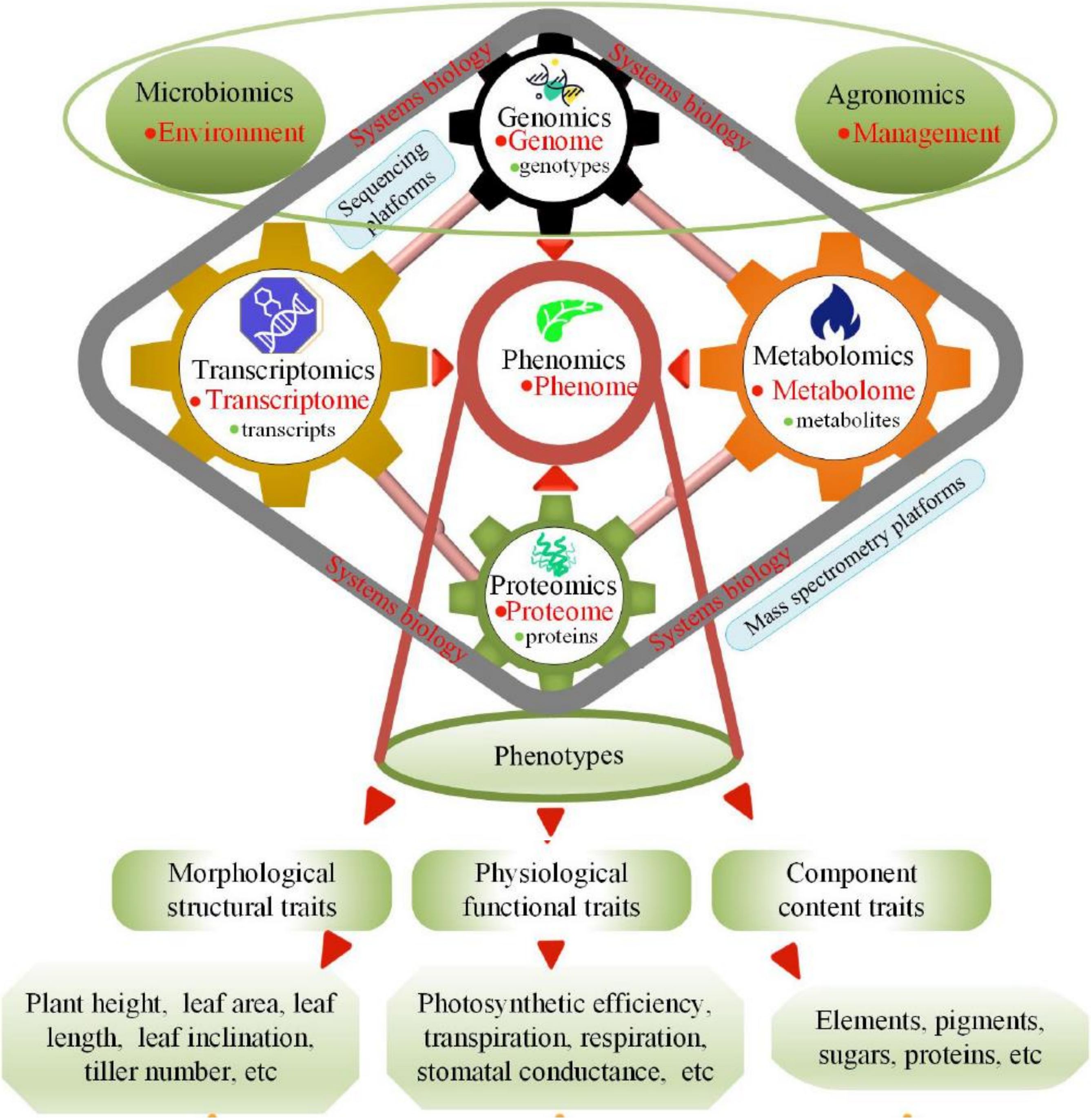
- A broad diversity of sensors enables capturing and quantifying previously undetectable phenotypic traits. Combining the reflectance of different spectra allows for the detection of abiotic stress, such as nitrogen deficiency and frost damage.

- • HTP has the potential to accelerate crop breeding, producing data that can be used to identify varieties with improved traits and higher performance, but there are technical challenges to overcome.

- Deep learning models are effective in plant phenotyping tasks due to their capacity to leverage highly complex and multidimensional data, but their performance is dependent on the quality and diversity of the dataset.

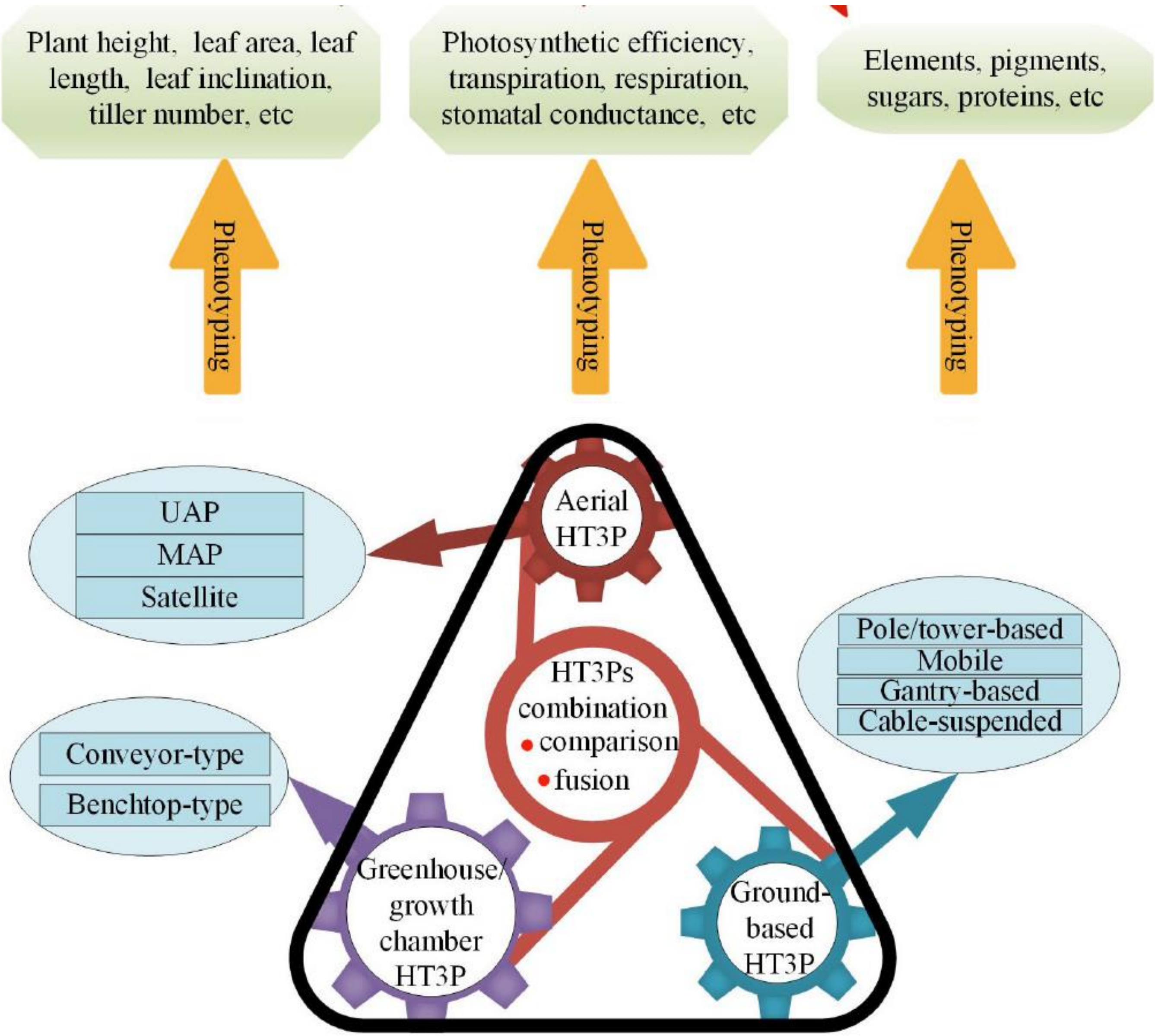
- A large effort is required to facilitate sharing high-quality phenotype datasets because they provide a key resource for developing tools for agronomic trait measurement and crop breeding.

https://academic.oup.com/plphys/article/187/2/699/6310753



- Sequencing platforms employed for researching genotypes and transcripts assist in genomics and transcriptomics
- Mass spectrometry platforms employed for researching proteins, and metabolites promote proteomics and metabolomics
- -omics platforms further progress multi-omics in systems biology.

https://academic.oup.com/plphys/article/187/2/699/6310753



- HT3Ps employed for phenotyping plant phenotypes of

  -genotype,

  - environment, and

  - management

(G×E×M) interactions.

https://academic.oup.com/plphys/article/187/2/699/6310753

HT3P for indoor phenotyping

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

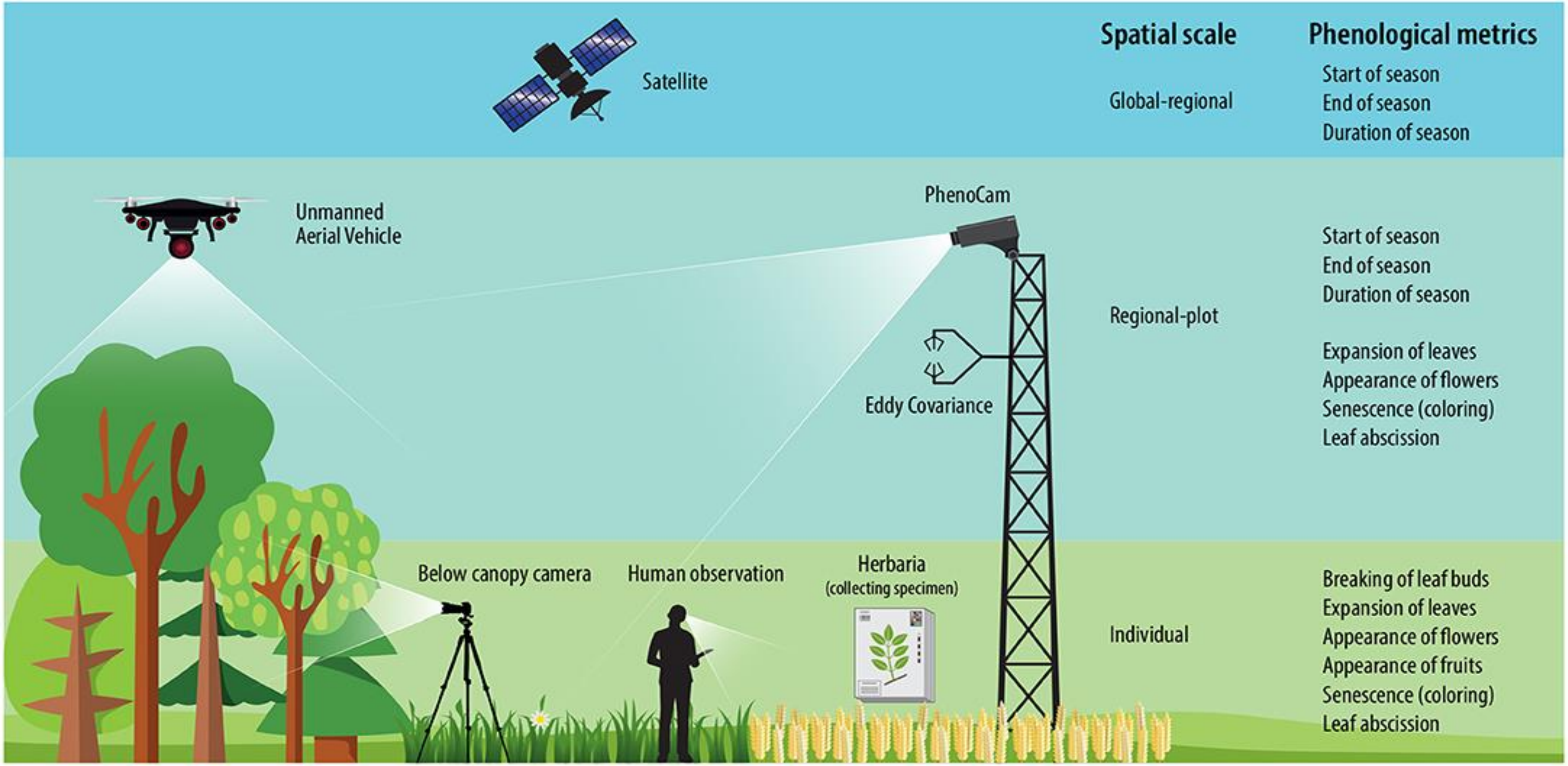
[Beadle HTS Chamber | Agricultural Research Division U of Nebraska-Lincoln]

LemnaTec Scanalyzer 3D high-throughput plant phenotyping facility at the UNL: view of the automated greenhouse (**top-left**); watering station (**top-right**); a plant entering the fluorescent chamber (**bottom-left**); and plants on the conveyor belt heading towards the visible light chamber (**bottom-right**).

Ground-based field HT3P

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

- Both pole-based and tower-basedHT3Ps are easy and low-cost to build and maintain, and are convenient for temporary use and multi-site deployments to form networks.



www.frontiersin.org/articles/10.3389/fpls.2022.805738/full

- The mobile HT3P can move through the field and collect crop phenotypic traits in a semi-automatic or fully automatic manner, including refitted agricultural machinery (tractor, sprayer, or harvester), self-developed mechanical platform (cart or buggy), and commercial automatic platform.

	Description
1	Frame with 1.5 m ground clearance
2	Wheel encoders (∼1-mm accuracy)
3	Real time kinematic GPS (∼2-cm accuracy)
4	Height adjustable boom (max 3 m)
5	Removable light bank
6	Three LiDAR sensors
7	Four RGB stereo cameras
8	Spectrometer/ hyperspectral camera
9	Infra-red thermometers/ infra-red thermal camera
10	Generator and electronics
11	Two wheel drive hydraulic drive system

www.mdpi.com/2073-4395/4/3/349

- As a gantry frame is equipped with a sensor box, and moves along the track and collects crop traits along XYZ directions, it becomes the gantry-based HT3P.

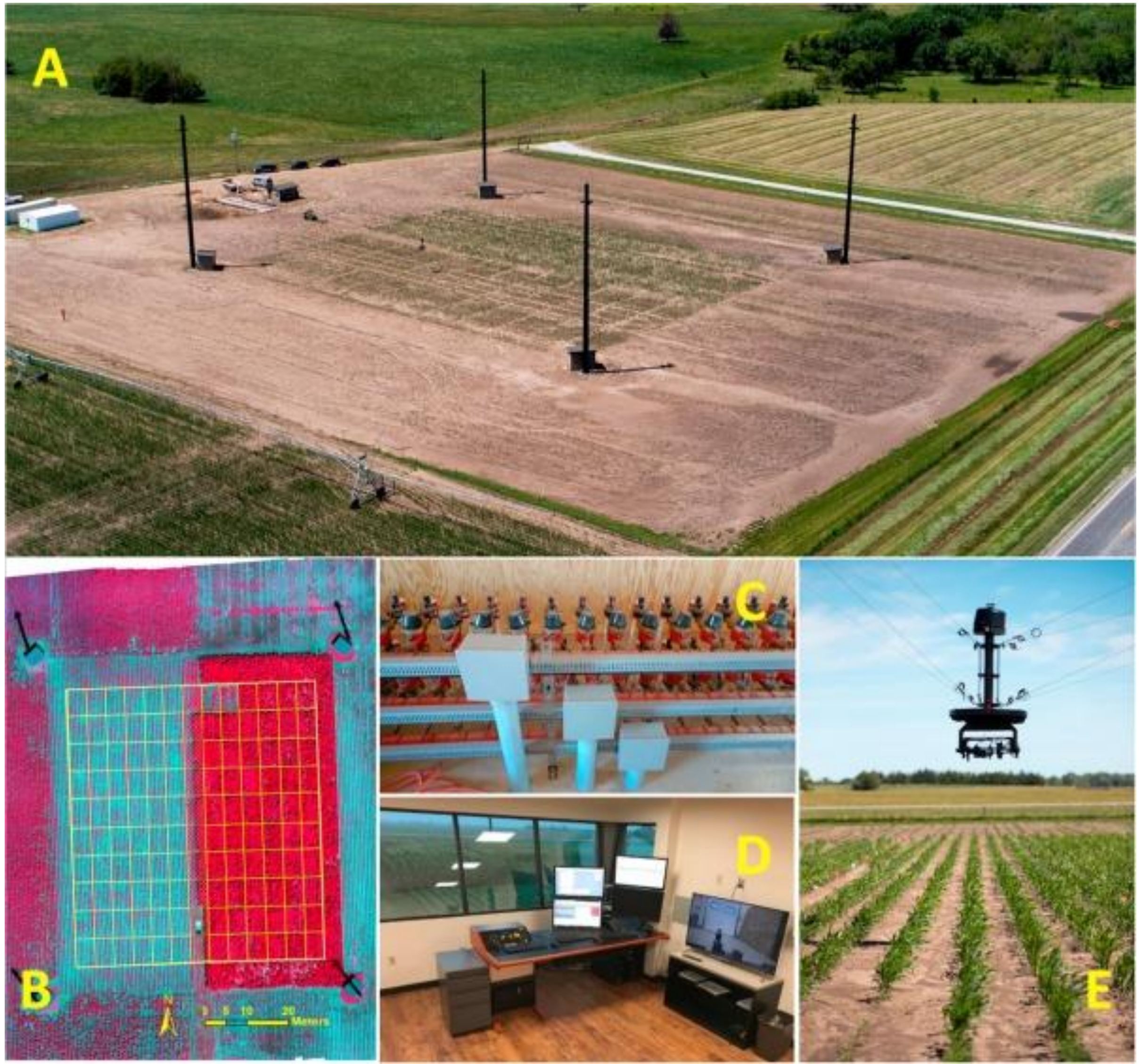
3D Laser Scanners.

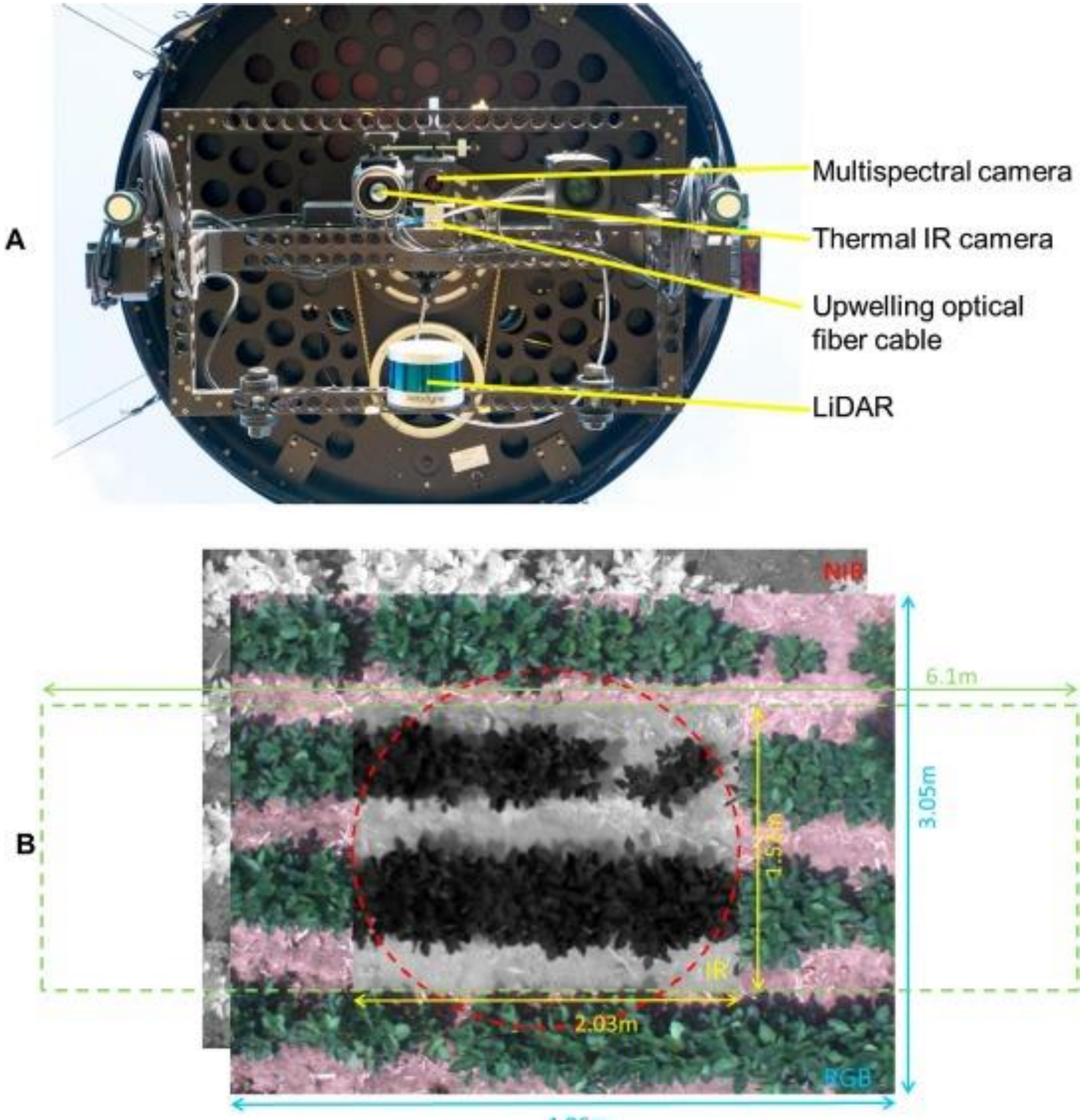
Hyperspectral Imagers.

www.rothamsted.ac.uk/field-scanalyzer/equipment

- A cable-suspended HT3P is mainly composed of sensing system, data acquisition system, mechanical transmission system, and drive system.

www.sciencedirect.com/science/article/pii/S0168169918314170





HT3P type	Advantages	Disadvantages
Pole/tower-based	Low cost; relatively simple structure; flexible movement	Small range; increased distance decreases resolution
Mobile	Semi-automatic or fully automatic; high resolution; expansive; high flexibility.	Affected by weather, soil conditions; soil compaction; mechanical interference; requires some manpower; long boom may cause sensor jittering and blurred images; safety mechanism needed
Gantry-based	Low weather dependency; continuous phenotyping all-day	Expensive; fixed limited area; high maintenance costs
Cable-suspended	Low weather dependency	Expensive; fixed limited area; limited endurance

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

Aerial HT3P

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

Unmanned Aerial Platform (UAP)

In recent years, due to the reduction of Unmanned Aerial Vehicle (UAV) prices and the relaxation of air traffic regulations, the application of UAP in agricultural research has increased

- RGB camera
- Multispectral camera
- Infrared thermal camera

Manned Aerial Platform (MAP)

The MAP is converted from a manned helicopter or fixed-wing aircraft, by mounting to it the phenotype acquisition kit, placed in a cargo pod or directly installed on the step (via a bracket), with a passenger(s) evaluating the images and giving feedback on their quality to the pilot, in real time, *via* a video monitor in the cockpit. The phenotypic equipment used for this entail sensors, GPS unit, gyroscopes and/or inertial measurement units.

Designation	Sensors	Flight altitude (m)	Plants	Traits
Robinson R44 Raven helicopter	Radiometrically-calibrated thermal	60, 90	Wheat	Canopy temperature
Air Tractor AT-402B	RGB	152–3,048	Crop	Pest severity

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

Satellite Platform

Satellites can provide panchromatic imagery, multispectral imagery, or radio detection and ranging (RADAR) data. Panchromatic images of a single-band are displayed as gray-scale images with high resolution but limited spectral information, whereas multispectral images have a rich spectrum yet with relatively low resolution.

Designation	Sensors	Flight altitude (m)	Plants	Traits
GeoEye-1	Multispectral	684 k	Turfgrasses	Nitrogen content
RapidEye	Multispectral	630 k	Wheat	Nitrogen stress
Sentinel-1 and RADARSAT-2	Synthetic aperture radar (SAR)	700, 798 k	Wheat	Crop height, angle of inclination
Fluorescence explorer (FLEX)	Fluorescence Imaging Spectrometer (FLORIS)	814.5 k	Terrestrial vegetation	Photosynthesis

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

HT3P type	Advantages	Disadvantages
UAP	Flexible flight plan; coverage a wide range of field plots; relatively low cost; GPS navigation;	Weather (light, rain, fog, etc.) dependence; limited payload; limited endurance; strict aviation regulation (altitude); flight training
MAP	Flexible payload; rapid coverage of large areas	Expensive; non-repeatable flight route; substantial manpower
Satellite	Coverage a wide range of field plots; relatively low cost	Low resolution; long return period; weather restrictions (except radar)

www.frontiersin.org/articles/10.3389/fbioe.2020.623705/full

Applications in High Throughput 3P

Examples:

- Improving crop productivity
- Developing crops tolerant to abiotic stress
- Pathogen and pest detection in the field
- Quantitative plant morphology (+ ปริมาณสารสำคัญ)

Improving crop productivity

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Plant performance is regulated by (G), (E), (GxE)

- Field HTP can substantially accelerate the breeding process by allowing breeders to predict end-of season traits, such as yield and biomass at early growth stages.
  - A soybean (Glycine max) study, 2,551 genotypes were grown in different locations, and it was observed that yield, plant maturity, and seed size can be predicted at an early stage using Cubist regression because it presented the best result in comparison to Partial Least Squares Regression, Random Forests, Artificial Neural Networks, and Support Vector Regression (Yuan et al., 2019).
- The broad diversity of remote sensors enables capturing different aspects of the plant phenotype.
  - Different combinations of RGB, multispectral, and thermal image data associated with weather and soil have been employed to train deep learning models for crop yield forecasting.
- The models can support differentiating crop performance in relation to environmental regimes.

Developing crops tolerant to abiotic stress

The development of climate resilient crops must consider the effect of combined abiotic stresses.

- Crop water stress
- Salt tolerance
- Frost damage/tolerance

(ECOSTRESS) was launched to measure ET and identify plant stress (Fisher et al., 2020). It provides a higher spatial and temporal resolution ratio (60 m with 1–5 d interval) in comparison to Landsat (>60 m, 16-d interval) or MODIS (>375 m, daily; Anderson et al., 2012).

Tools:

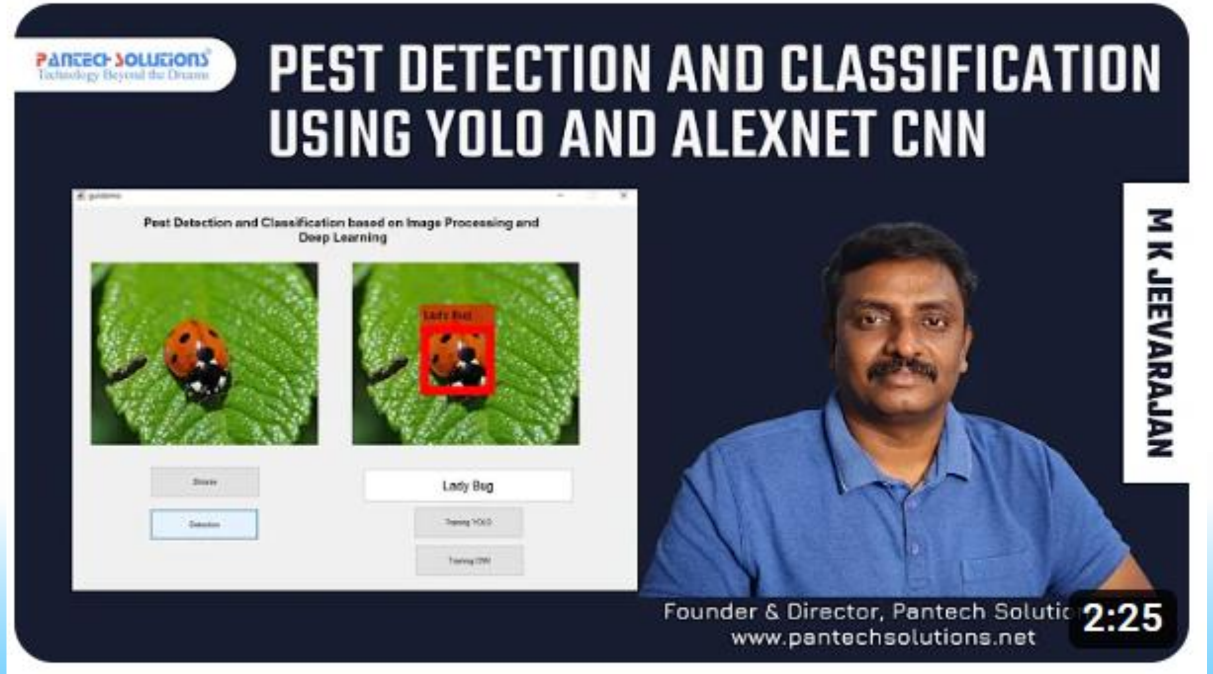
- infrared thermography, multispectral and hyperspectral sensors/images.
- Remotely sensed thermal data collected by satellite platforms allow mapping water resource use through the prediction of ET maps.

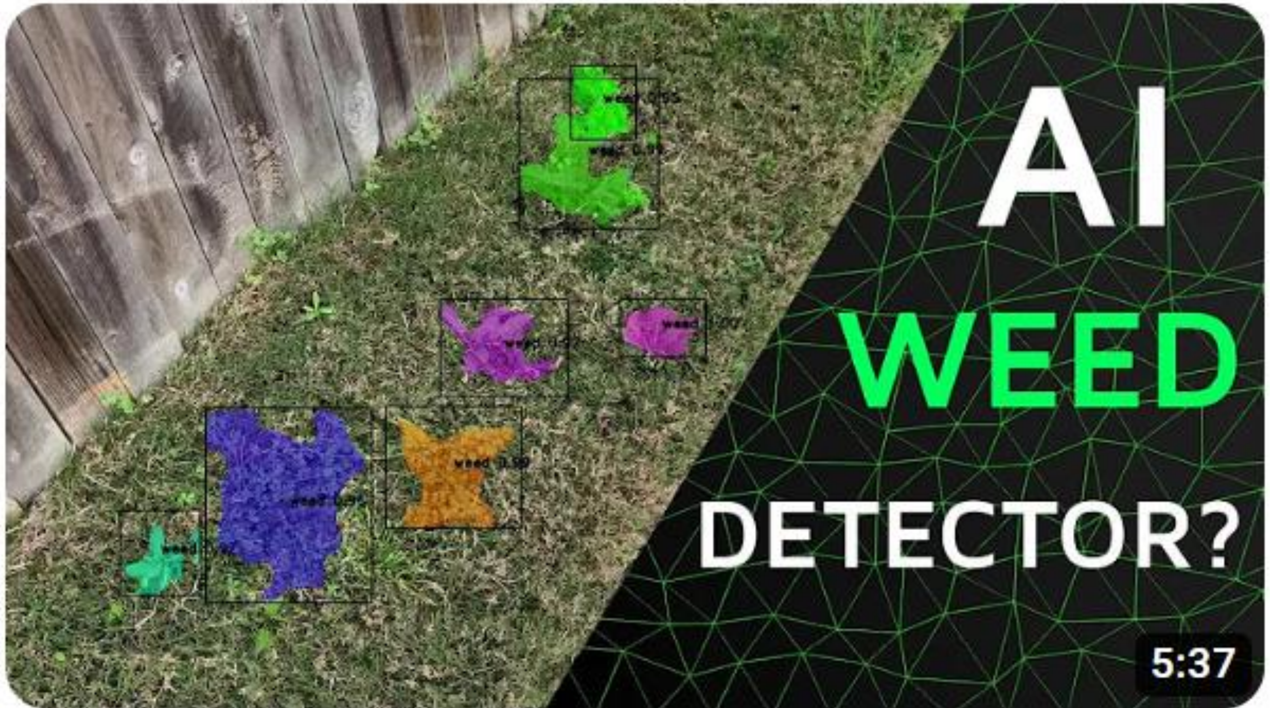
Pathogen and pest detection in the field

Urgent needs to gain greater understanding of the ecological, phenotypic, and molecular basis of the interaction between plant and pathogens.

- Disease diagnosis and severity scoring in collected leaves are available in several species, such as citrus, cassava, and apple.
  - Machine learning models using support vector machines, CNNs, etc.
  - Recent focus on developing models that use UAV-collected images to accelerate disease detection.
- Field HTP is widely applied to the detection and quantification of pests.
  - RGB sensors are used to quantify leaf damage and defoliation.
- Weed detection systems can reduce herbicide application by up to 60% in comparison to broadcast applications.
  - RGB and multispectral images.


ไลน์บอทโรคข้าว (Rice Disease Linebot)
โมบายแอปพลิเคชันเพื่อการวินิจฉัยโรคข้าวโดยใช้การวิเคราะห์ภาพถ่ายและปัญญาประดิษฐ์
Application for rice disease diagnosis using image analysis and artificial intelligence
0:04 / 4:40


PANTECH SOLUTIONS
Technology Beyond the Dreams
PEST DETECTION AND CLASSIFICATION USING YOLO AND ALEXNET CNN
Pest Detection and Classification based on Image Processing and Deep Learning
Lady Bug
M K JEEVARAJAN
Founder & Director, Pantech Solutic
www.pantechsolutions.net
2:25


AI
WEED
DETECTOR?
5:37

Quantitative plant morphology +++

- The description of plant morphological traits (for example, number of leaves, canopy cover, number of flowers, and seeds) provides a foundation to characterize plant phenotypic response, which is directly related to plant developmental stage, yield potential, and overall health.
  - Neural networks and other machine learning models have been published to perform leaf counting, area estimation, folding and plant growth stage classification, stem–leaf segmentation, and seed counting.

Plant health + natural compound

Wish list in HT3P

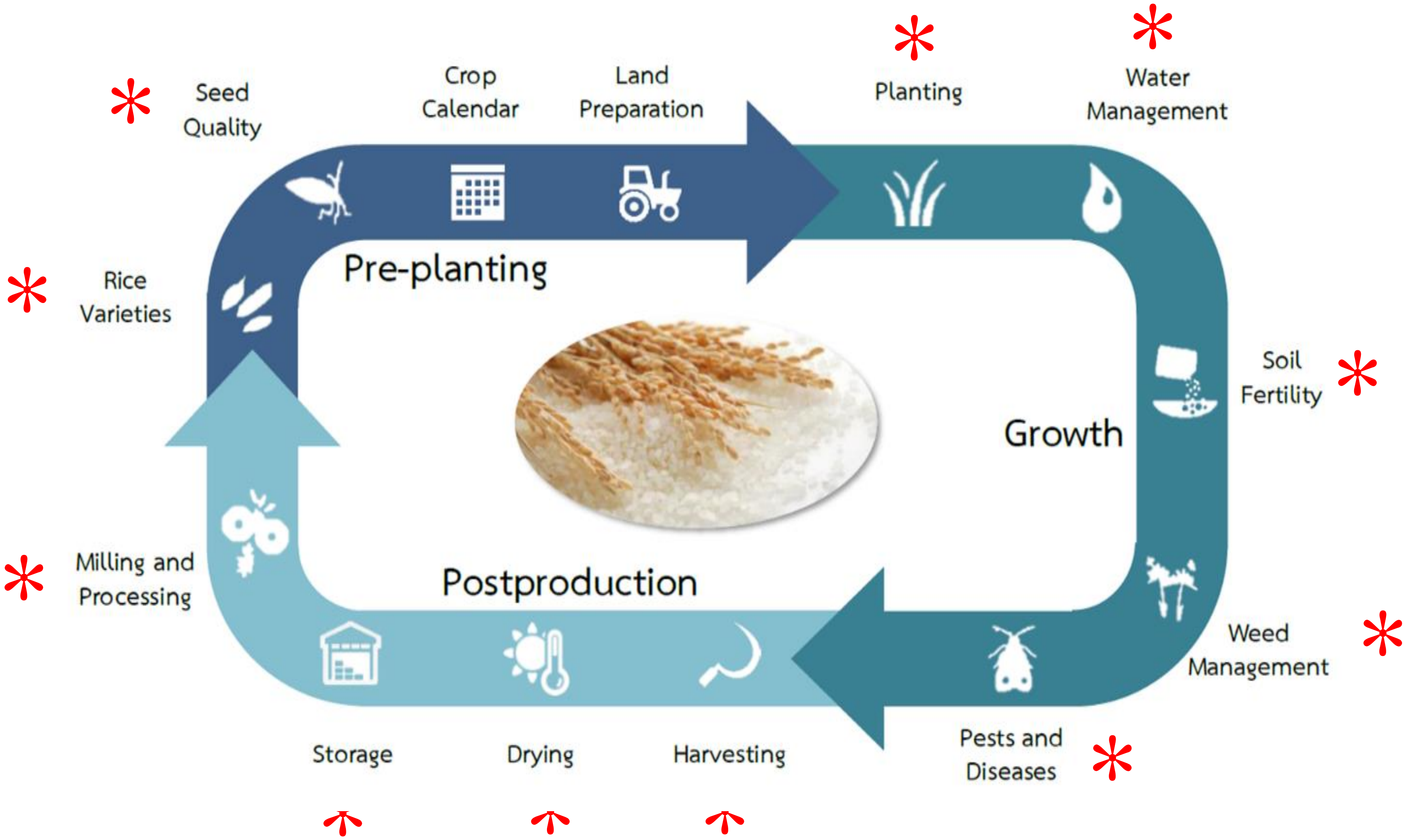
- Smarter farming
  - Need field high throughput/resolution phenotyping.

    \+ Fast processing !
- Climate change adaptation & mitigation research
  - To study the effects of climatic change in crop species requires the datasets in which the combined stresses are observed. These datasets must have a detailed description of the environmental conditions and also, of the genetic data.
  - Need controlled environment facility !

Smart farming ในข้าว

ครอบคลุมทุกองค์ประกอบสำคัญให้ครบถ้วนและเชื่อมโยงสัมพันธ์กัน

* Phenotyping needed



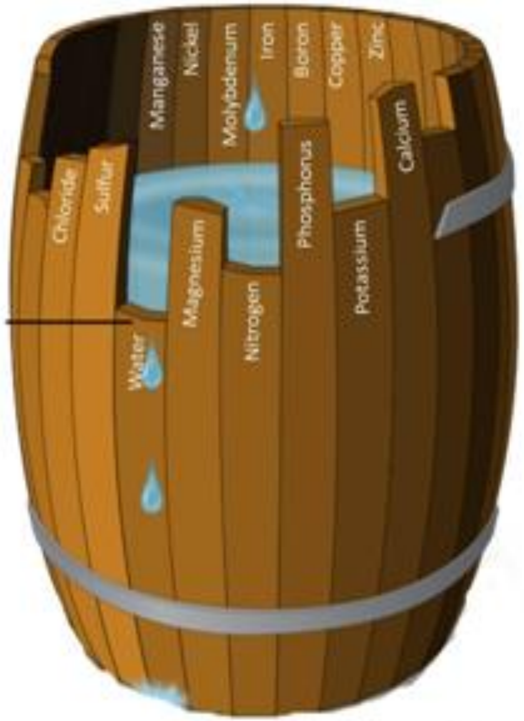
เลือกพัฒนา/ใช้เทคโนโลยี และ นวัตกรรม ใดก่อน

- เพิ่มประสิทธิภาพการผลิต (เพิ่มผลผลิต ลดต้นทุน ใช้ทรัพยากรมีประสิทธิภาพ)

  NOT a single limiting factors or innovations ไม่ได้มีประเด็นเดียว

มีหลายประเด็น

- พันธุ์
- การเขตกรรม
  - ปุ๋ย จัดการศัตรูพืช
- การเก็บเกี่ยว
- แปรรูป
- การตลาด
- อื่นๆ …



-or-

Intelligent Farming & Smart Farming of Tomatoes

Fruit harvesting robots

New Atlas
Apple harvesting robot plucks a piece ...

ABC
Fruit-picking robot technology will be ...

Freethink
New harvesting robots are gentle enough ...

Analytics Insight
Flying Robots Picking Fruits ...

AgriTech Tomorrow
Fruit-Picking Robots And Drones ...

mainichi.jp
Fruit harvesting AI robot dev...

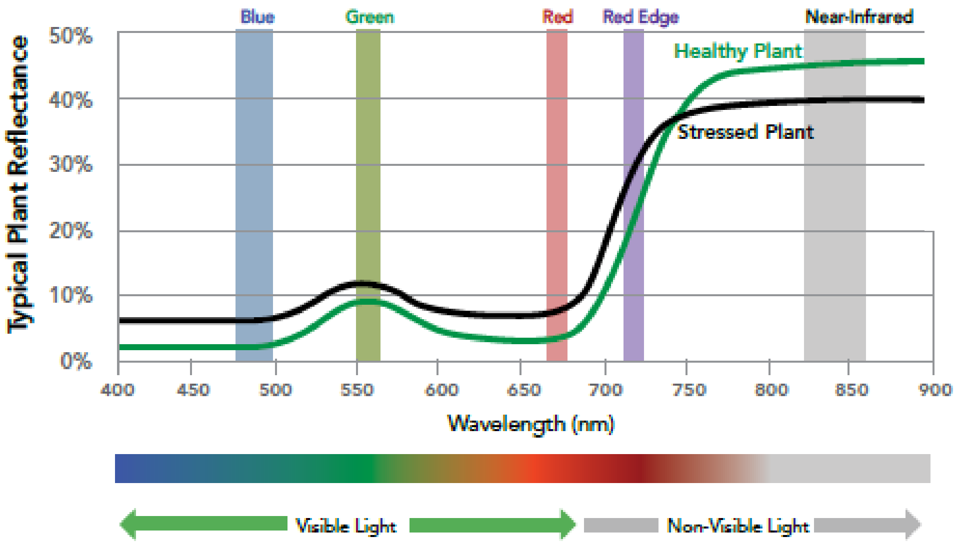
The Robot Report
Abundant Robotics shuts down fruit ...

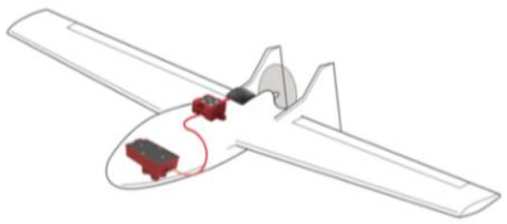
mainichi.jp
Fruit harvesting AI robot ...

RoboticsBiz
agricultural robots for harvesting ...

Multi-spectral sensor

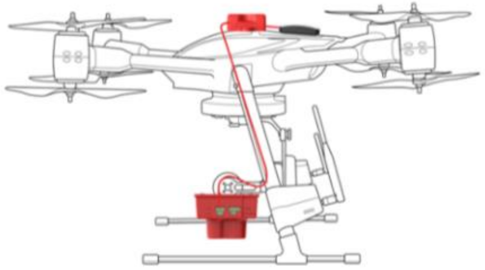
RedEdge™
by MicaSense





NDVI (Normalized Difference Vegetation Index) reveals variability in plant vigor and biomass, often times not visible in standard RGB color imagery.

Advanced vegetation indices like NDRE (Normalized Difference Red Edge) are more sensitive to changes in leaf chlorophyll content and provide information about plant nutrient status.

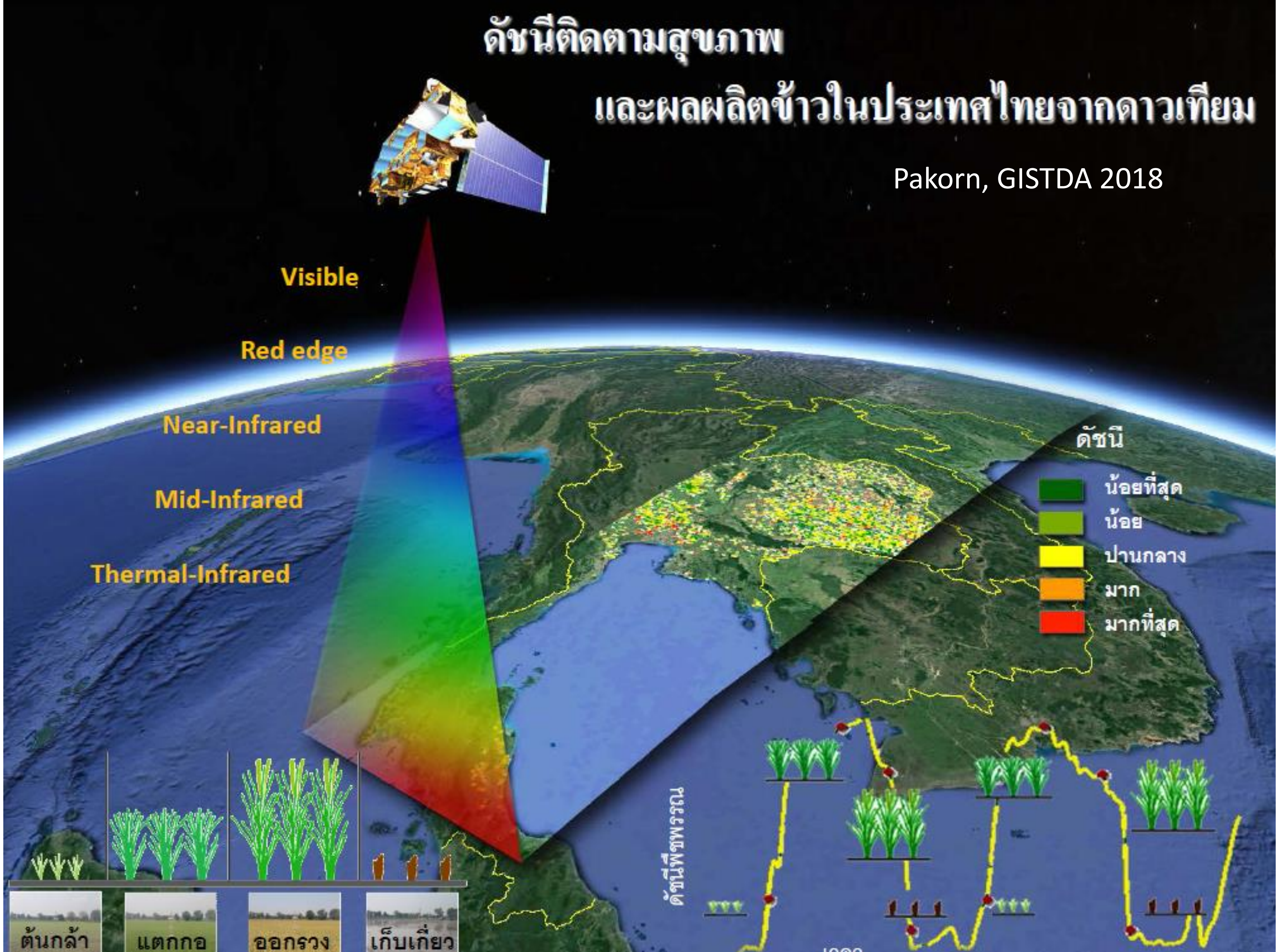


MicaSense

Farmers look above drones as space satellite updates on crop health expand

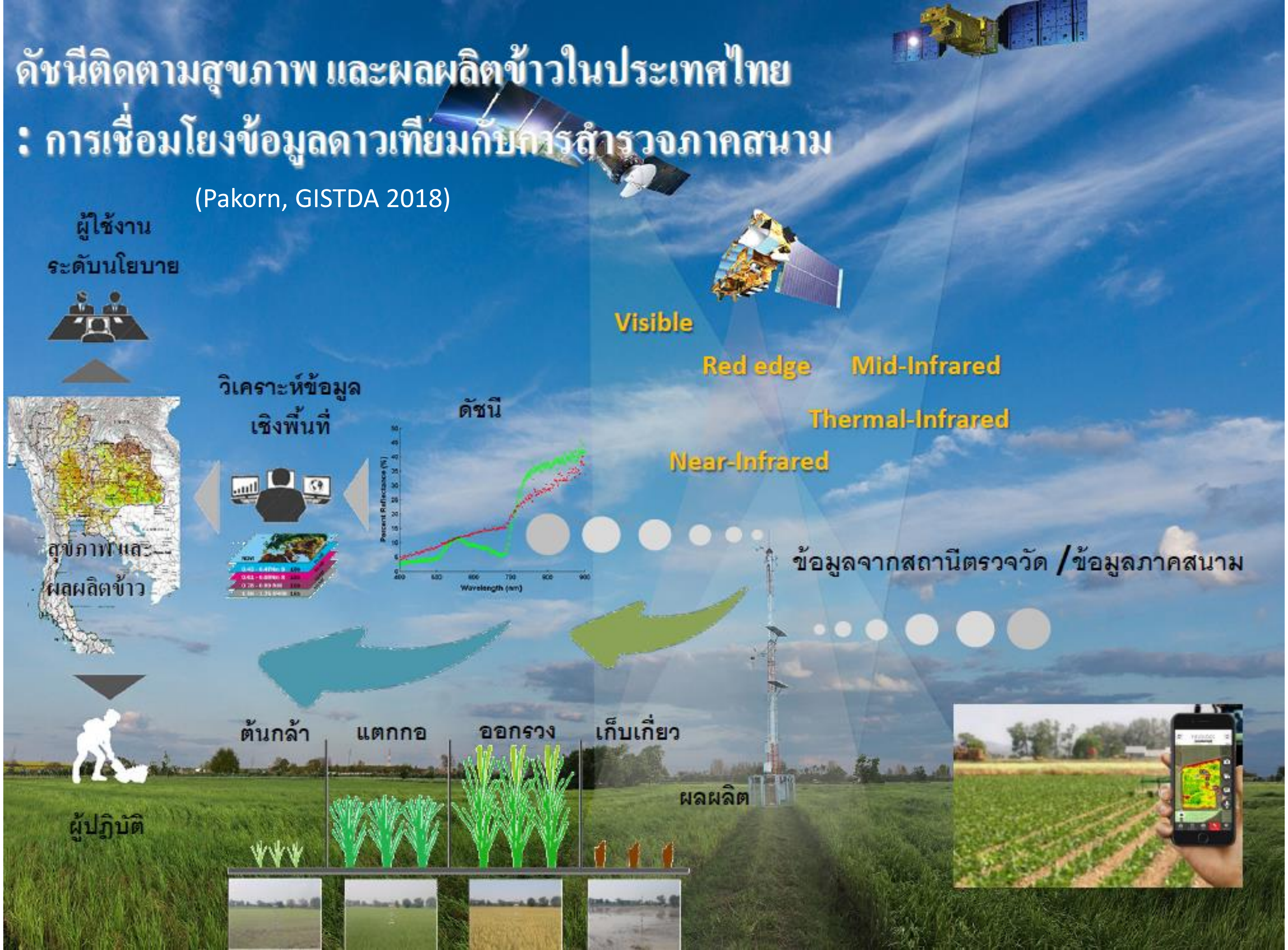
Earth imaging satellites could 'save agriculture,' says Winnipeg-based company

The Canadian Press Posted: Oct 11, 2017 1:40 PM MT | Last Updated: Oct 11, 2017 1:58 PM MT


ดัชนีติดตามสุขภาพ
และผลผลิตข้าวในประเทศไทยจากดาวเทียม
Pakorn, GISTDA 2018
Visible
Red edge
Near-Infrared
Mid-Infrared
Thermal-Infrared
ดัชนี
น้อยที่สุด
น้อย
ปานกลาง
มาก
มากที่สุด
ดัชนีพืชพรรณ
ต้นกล้า
แตกกอ
ออกรวง
เก็บเกี่ยว

ดัชนีติดตามสุขภาพ และผลผลิตข้าวในประเทศไทย : การเชื่อมโยงข้อมูลดาวเทียมกับการสำรวจภาคสนาม

(Pakorn, GISTDA 2018)



Satellite RS … (phenotyping needed)

Allowing better :

- Monitoring
- Managing
- Warning
- Insurance
- …

at larger scale

The benefits of RS technology

- spatial coverage over a large geographic area
- availability during all seasons
- relatively low cost, since some optical images are freely available (*i.e., MODIS, Landsat*)
- efficient analysis
- they provide information in a timely manner
- they are capable of delineating detailed spatial distributions of areas under rice cultivation.

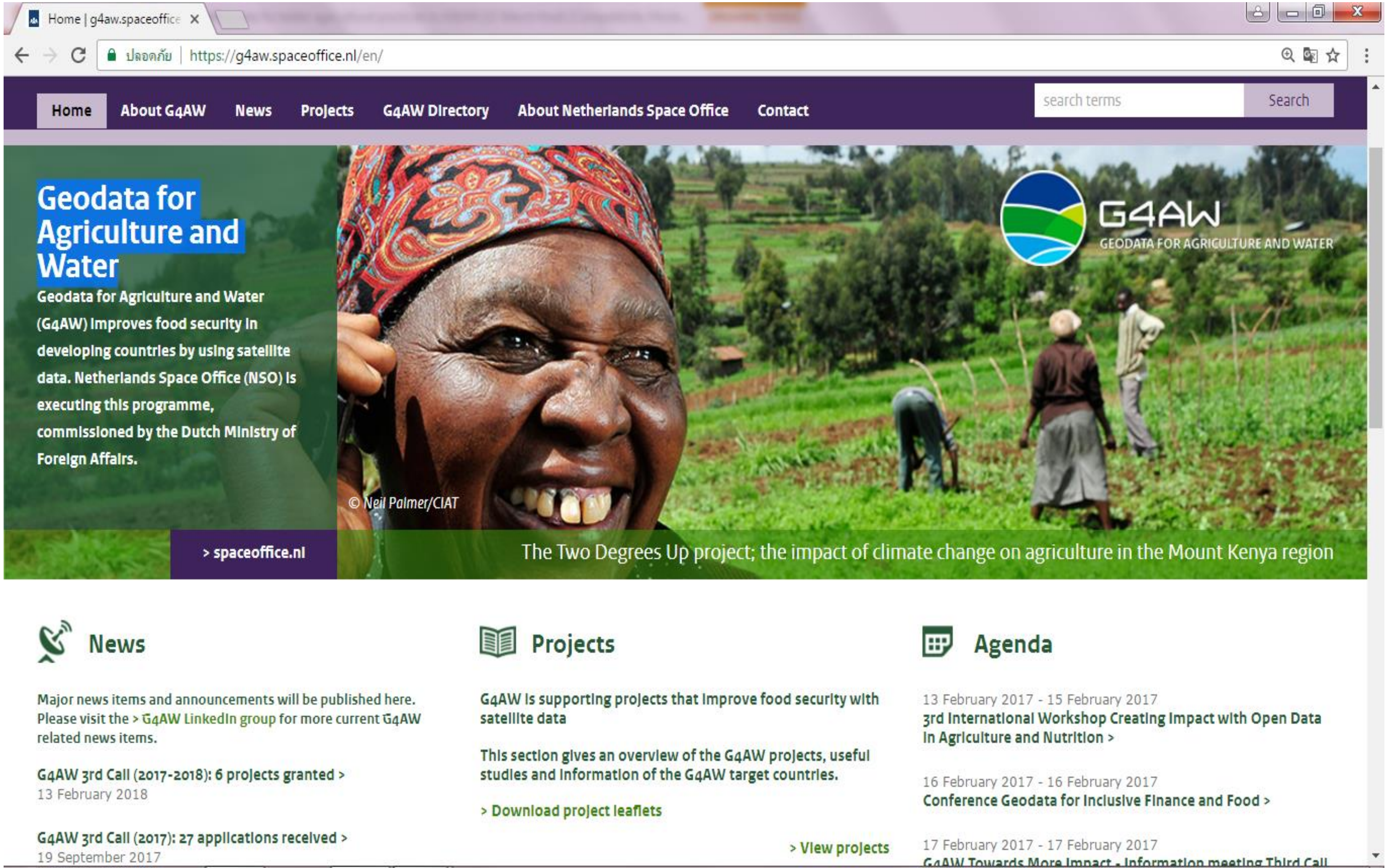
Sensors **2015, 15, 769-791**

Agricultural uses of RS

- Agricultural <u>mapping & surveys</u>
  - Data at different spatial, spectral & temperal resolutions
  - Agricultural and crop assessment
    - **Crop health**
      - monitoring
      - detecting diseases
      - assessing the impacts of severe weather events
    - Change detection
    - Environmental analysis
    - Yield determination
    - Soil analysis …

Allow better management

Decision support system example



When crop growth is non-optimal, farmers will receive alert messages based on near real-time satellite imagery.

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Crop Monitoring Service (CROPMON)

G4AW

Category	Crop advisory service
Region	East Africa
Country	Kenya
Period	2015 - 2018
Targeted end users	farmers in the southwestern part of Kenya producing the crops coffee, maize, grass and sorghum

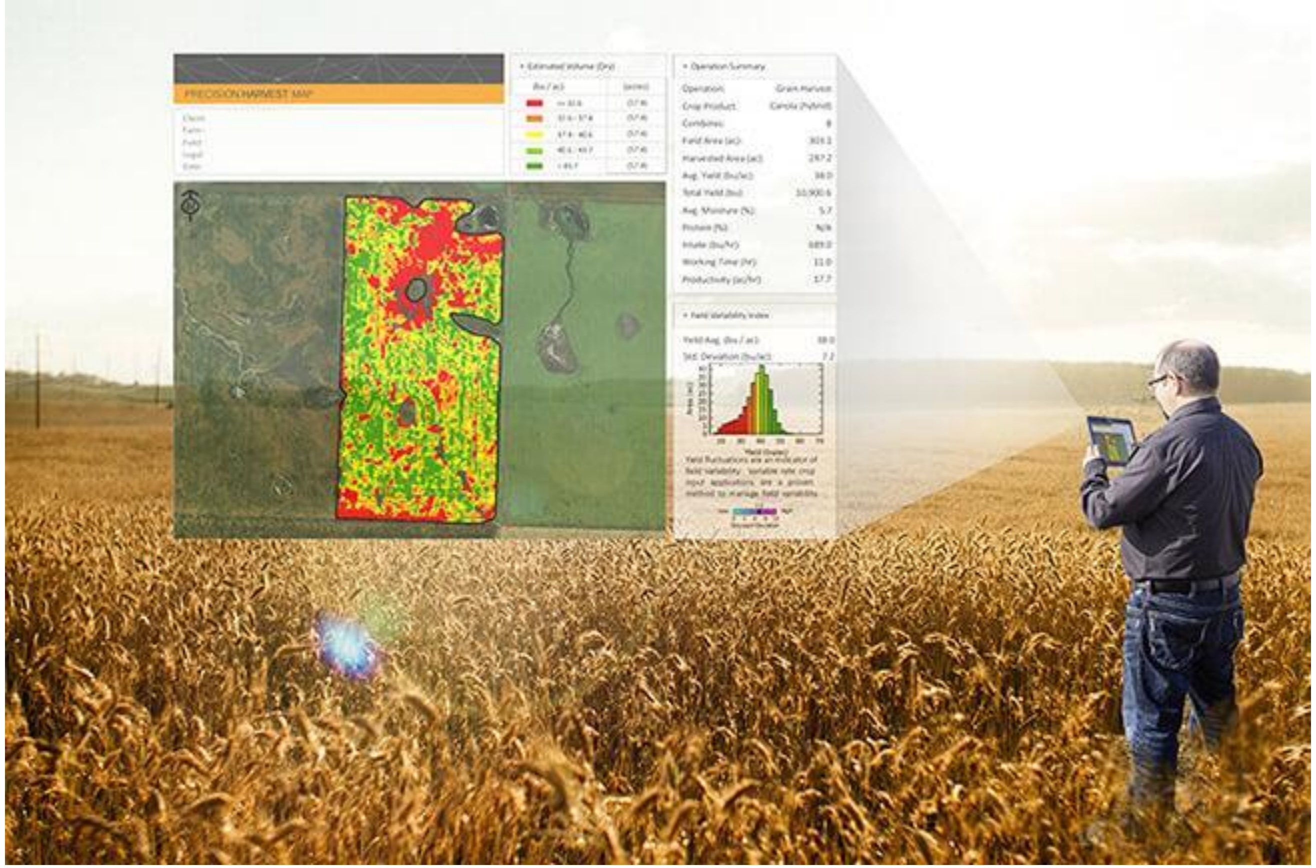
Business proposition

CROPMON provides information services to the farmers on:

- The actual crop condition;
- The most probable crop growth limiting factor (climate, soil fertility, water supply, etc.) when crop development drops;
- And advice how to remedy or reduce the limiting factor by adjusting farm management.

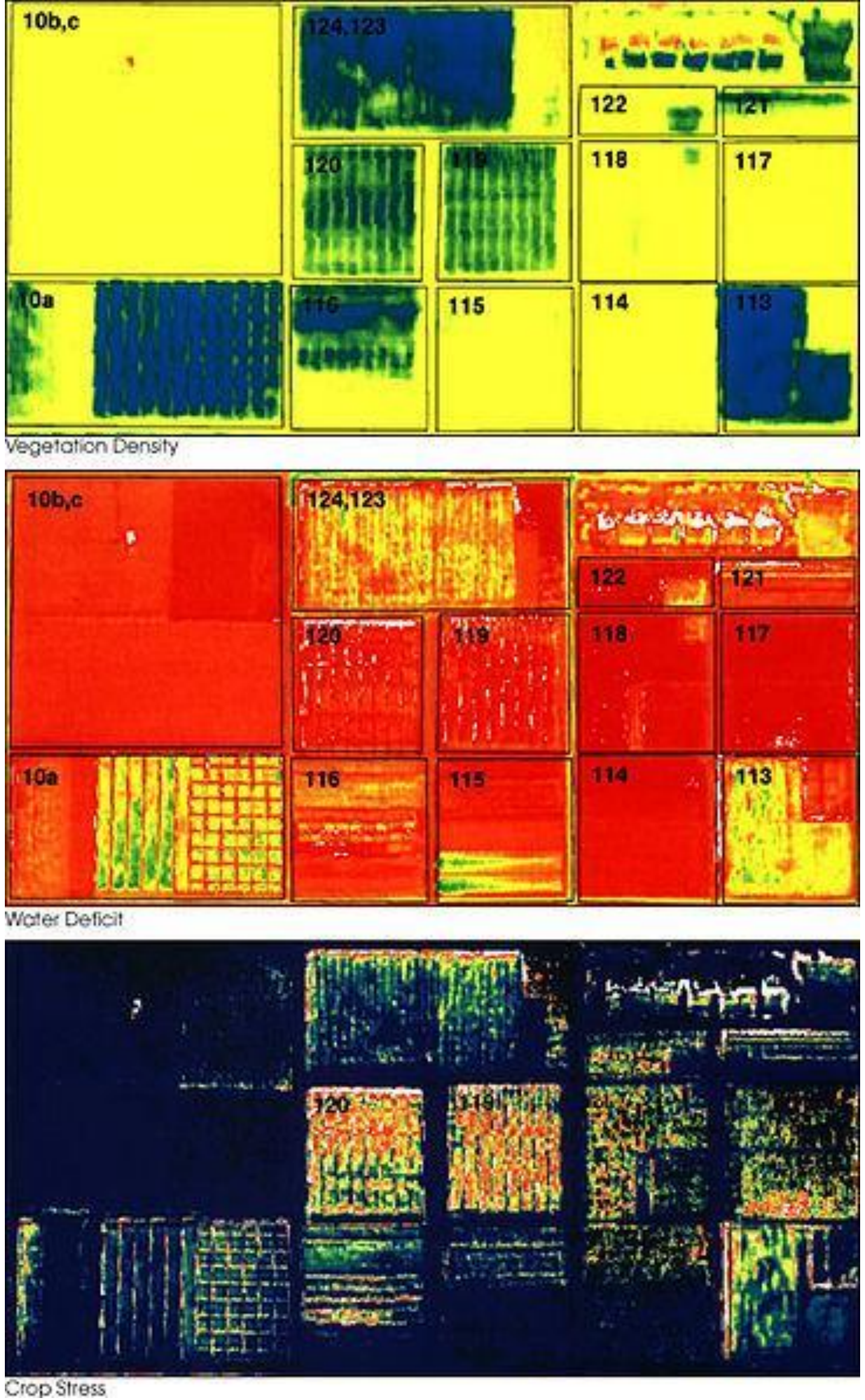
A farmer will pay for the use of the service. The costs per information message received will be in the order of 10-100 KSh (€ 0.10-1,00). In addition, opportunities are explored to sell data to aggregators such as (local) governments, banks, insurance companies, fertilizer industry and agro-dealers.

Satellite farming :



www.mitsui.com/jp/en/innovation/business/science_network/index.html

- Using satellite imagery to monitor crop growth
- Develop accurate prescription maps
- This data is fed into tractors’ on-board systems to apply fertilizer at variable rates.
- The result? The largest possible harvest at the lowest possible cost.



- **vegetation density:** shows the color variations determined by crop density ("Normalized Difference Vegetation Index", or NDVI), where dark blues and greens indicate lush vegetation and reds show areas of bare soil.
- **water deficit:** is a map of water deficit, derived from the Daedalus' reflectance and temperature measurements. Greens and blues indicate wet soil and reds are dry soil.
- **crop stress**: shows where crops are under serious stress, as is particularly the case in Fields 120 and 119 (indicated by red and yellow pixels). These fields were due to be irrigated the following day.

From : NASA Earth Observatory

Precision agriculture: stages and tools

- Precision agriculture is a four-stage process using techniques to observe spatial variability:

1. **Geolocation of data**
2. **Characterizing variability**
3. **Decision-making**
4. **Implementing practices to address variability**

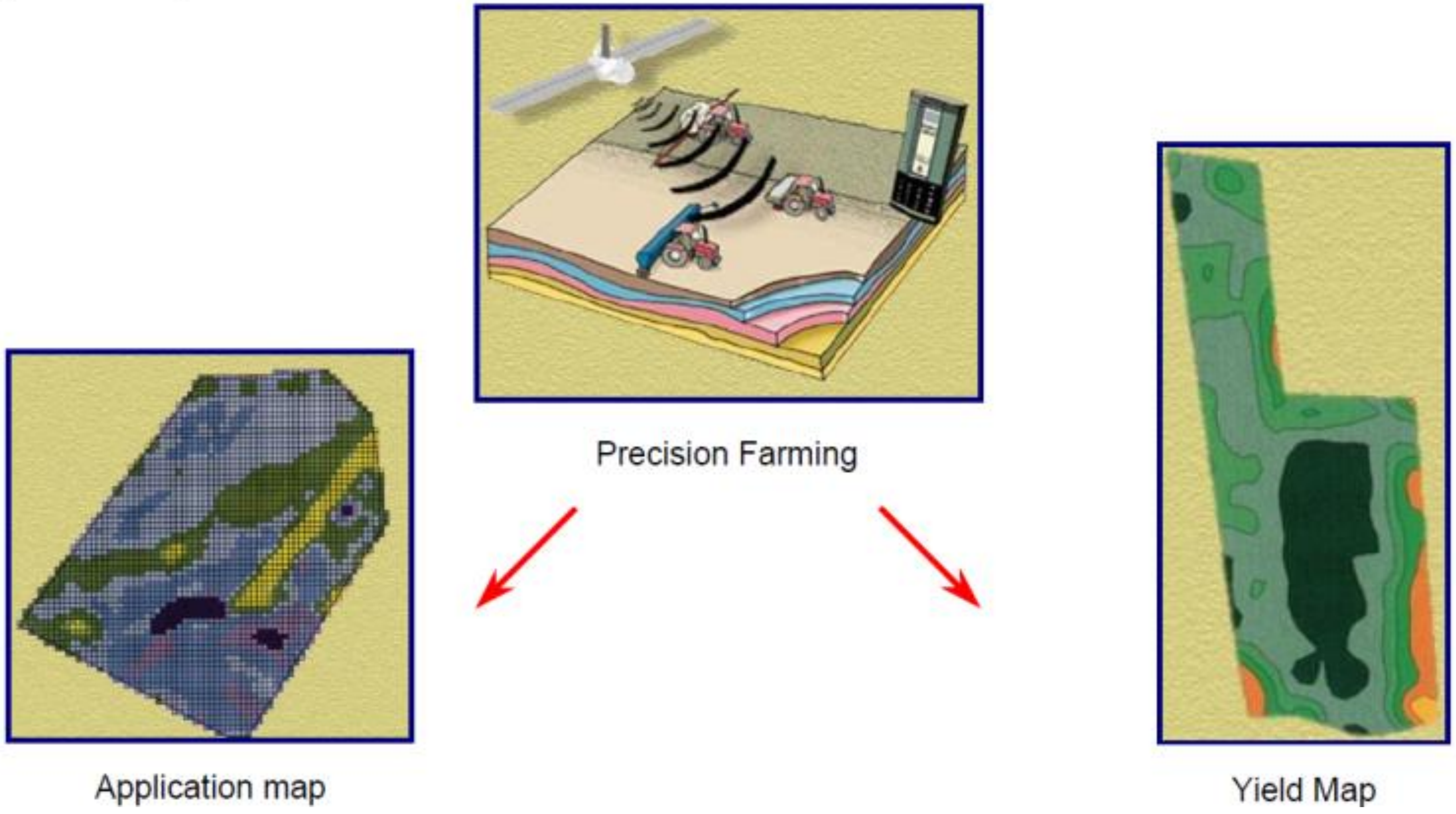
+ high resolution phenotyping

1) Geolocation of data

- Geolocating a field enables the farmer to overlay information gathered from analysis of soils and residual nitrogen, and information on previous crops and soil resistivity
- Geolocation is done in two ways:
  - The field is delineated using an in-vehicle GPS receiver as the farmer drives a tractor around the field
  - The field is delineated on a basemap derived from aerial or satellite imagery.

Using aerial or satellite imagery

Put simply, it turns one 100-hectare field into 100 one-hectare fields to optimise the yield / cost ratio



Basker et al. LH (www.egnos-pro.esa.int)

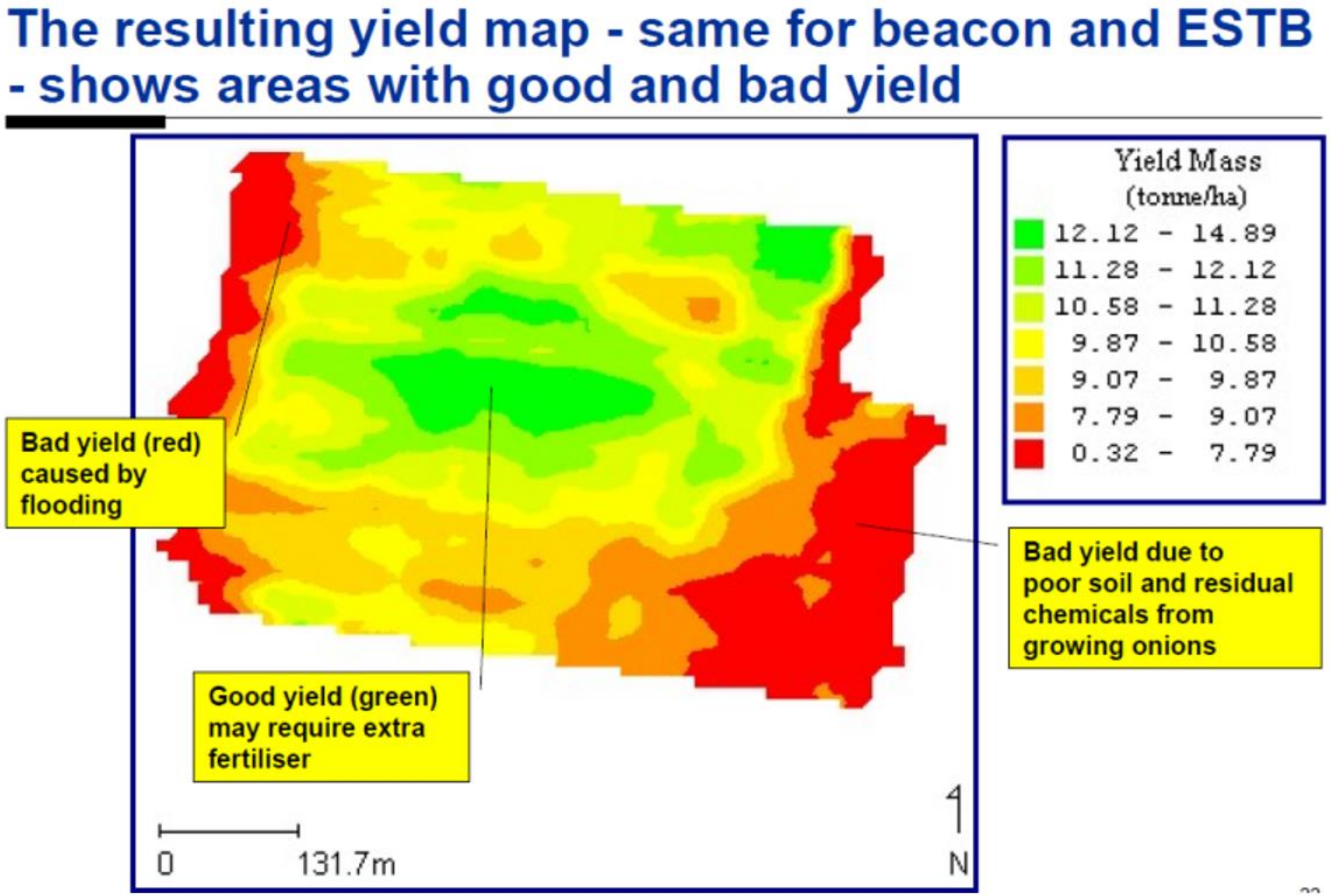
2) Characterizing variability

- Intra and inter-field variability may result from a number of factors. These include:
  - climatic conditions (drought, rain, etc.),
  - soils (texture, depth, nitrogen levels), cropping practices,
  - weeds and disease.
- Point indicators allow them to track a crop’s status,:
  - whether diseases are developing,
  - if the crop is suffering from water stress, nitrogen stress, or lodging, whether it has been damaged by ice and so on.
- This information may come from weather stations and other sensors (soil electrical resistivity, detection with the naked eye, satellite imagery, etc.).

3) Decision-making

- Two strategies to adjust field inputs:
  - Predictive approach: based on analysis of static indicators (soil, resistivity, field history, etc.) during the crop cycle.
  - Control approach: information from static indicators is regularly updated during the crop cycle by:
    - sampling: weighing biomass, measuring leaf chlorophyll content, weighing fruit, etc.
    - remote sensing: measuring parameters like temperature (air/soil), humidity (air/soil/leaf).
    - proxy-detection: in-vehicle sensors measure leaf status; this requires the farmer to drive around the entire field.
    - aerial or satellite remote sensing: multispectral imagery is acquired and processed to derive maps of crop biophysical parameters.
  - Decisions may be based on decision-support models (crop simulation models), + business value and impacts

Yield map



Basker et al. LH (www.egnos-pro.esa.int)

Yara *N-Sensor ALS*

- ALS = *active light source*
- Xenon flash lamps for night work. mounted on the canopy of a John Deere tractor

(DLG field days 2010, Germany)

- This sensor system :
  1. scans the crops roughly 5 to 6 metres left and right of the tractor lane, records the light reflection of the plants as an indicator of their current nitrogen uptake,
  2. translates the measured data (by using a special software) into fertilisation recommendations, which then
  3. are used by the applicator to vary the actually needed amount of fertiliser spread.

www.yara.co.uk

Example application of N-sensor

Optimum sugarcane growth stage for canopy reflectance sensor to predict biomass and nitrogen uptake

using Yara *N-Sensor ALS*

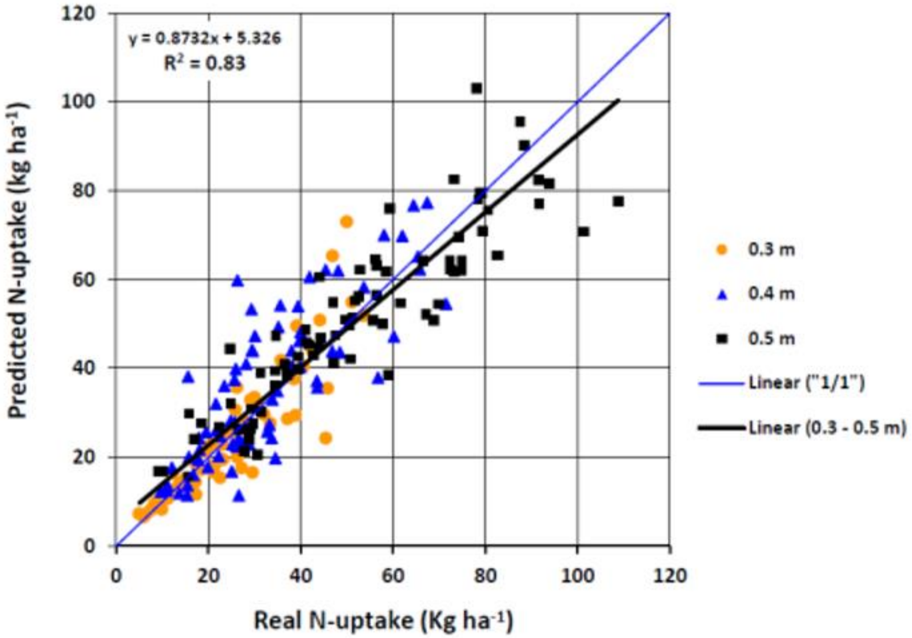


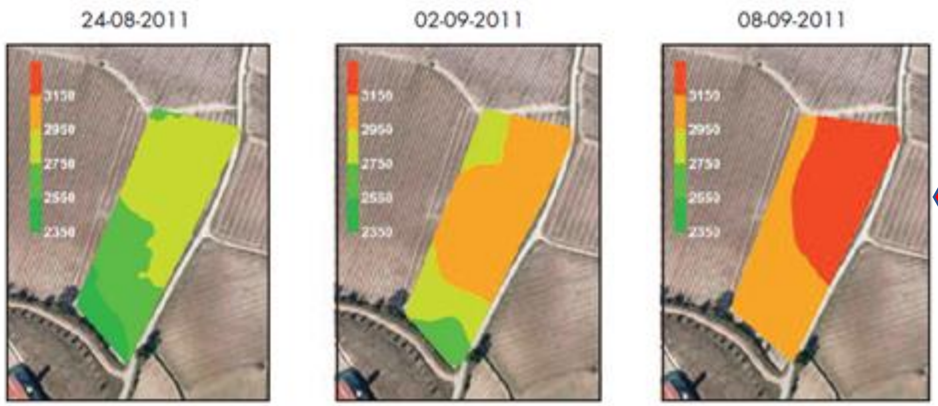
Figure 7: Integration of sugarcane real measured N-uptake compared to sensor predicted N-uptake for the 0.3 to 0.5 meter heights.

G. Portz, L. R. Amaral and J. P. Molin (2012)

Grapevine cluster diagnostic

- These real-time sensors measure the anthocyanin content of dark grape clusters.
- These measurements work out a color index, which allows you to monitor the phenolic maturity of vineyard.

1,200 grape clusters were measured per hectare.



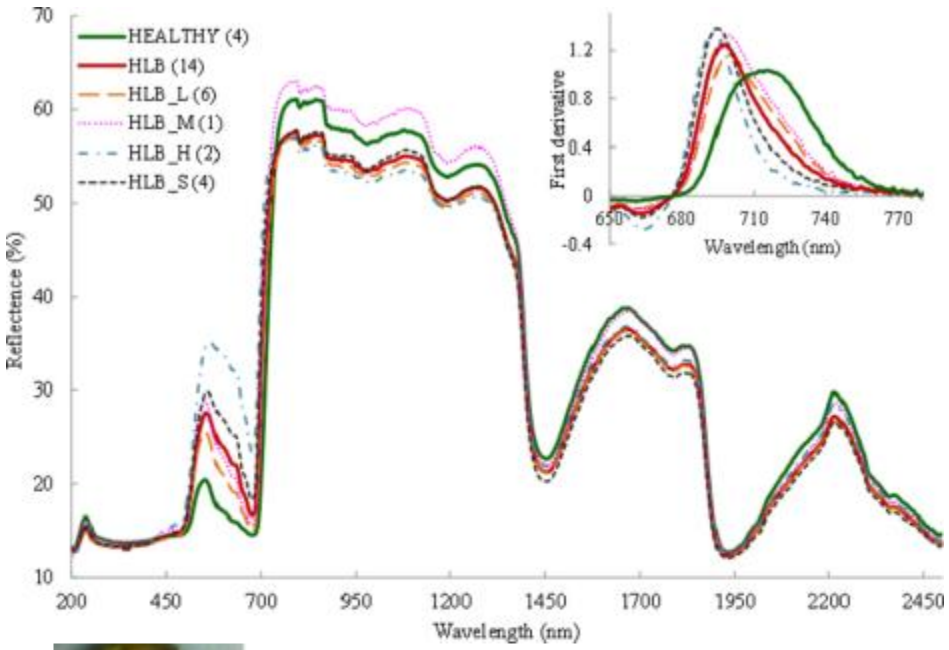
Parcelle de Tempranillo, Domaine de la RIOJA-ALAVESA (LANCIEGO)

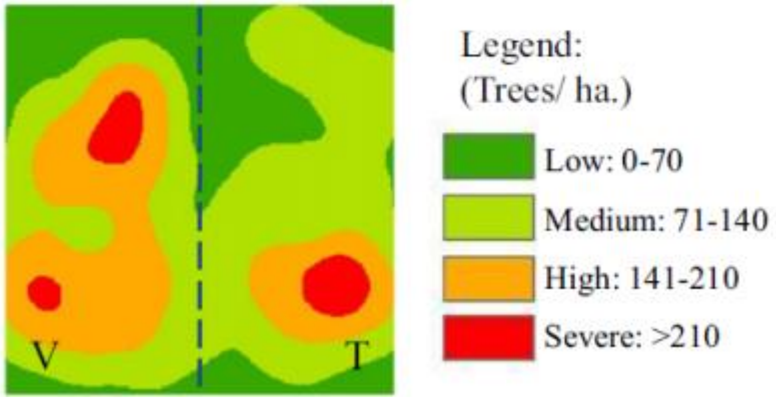
Zoning functions of anthocyanin content :

selective vintage, several areas of homogeneous anthocyanin quality were identified into the same block.

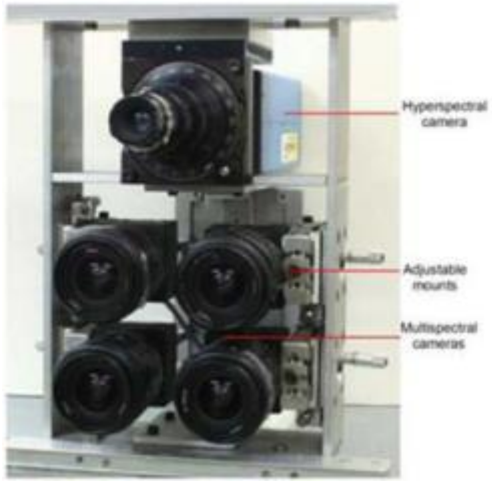
Classification for citrus greening infected trees

- Citrus greening disease (Huanglongbing or HLB)
- Multispectral (MS) and hyperspectral (HS) airborne images of citrus groves in Florida were acquired to detect citrus greening infected trees.



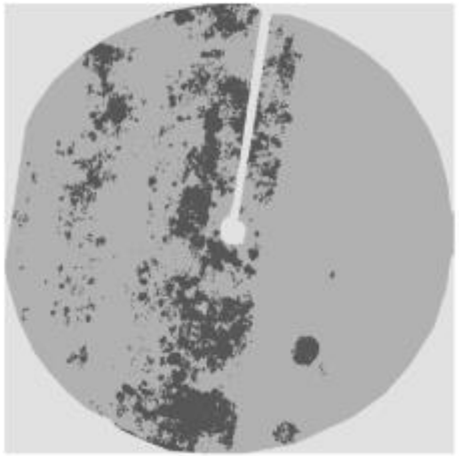


Li et al., 2012.



MAPPING PHYMATOTRICHUM ROOT ROT

- Phymatotrichum root rot is a serious and destructive disease that significantly reduces cotton yield and lowers lint quality.
- Airborne multispectral imagery for detecting and mapping root rot areas in cotton fields for site-specific management of the disease.
- Two-zone classification map :



Yang et al., 2005.

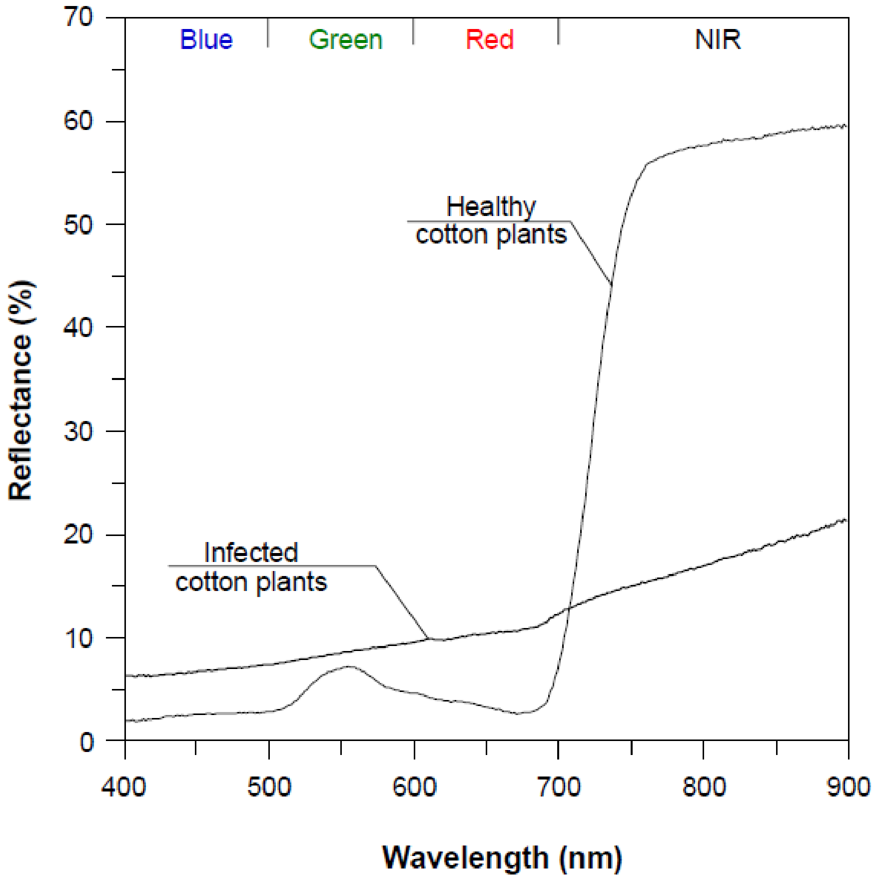
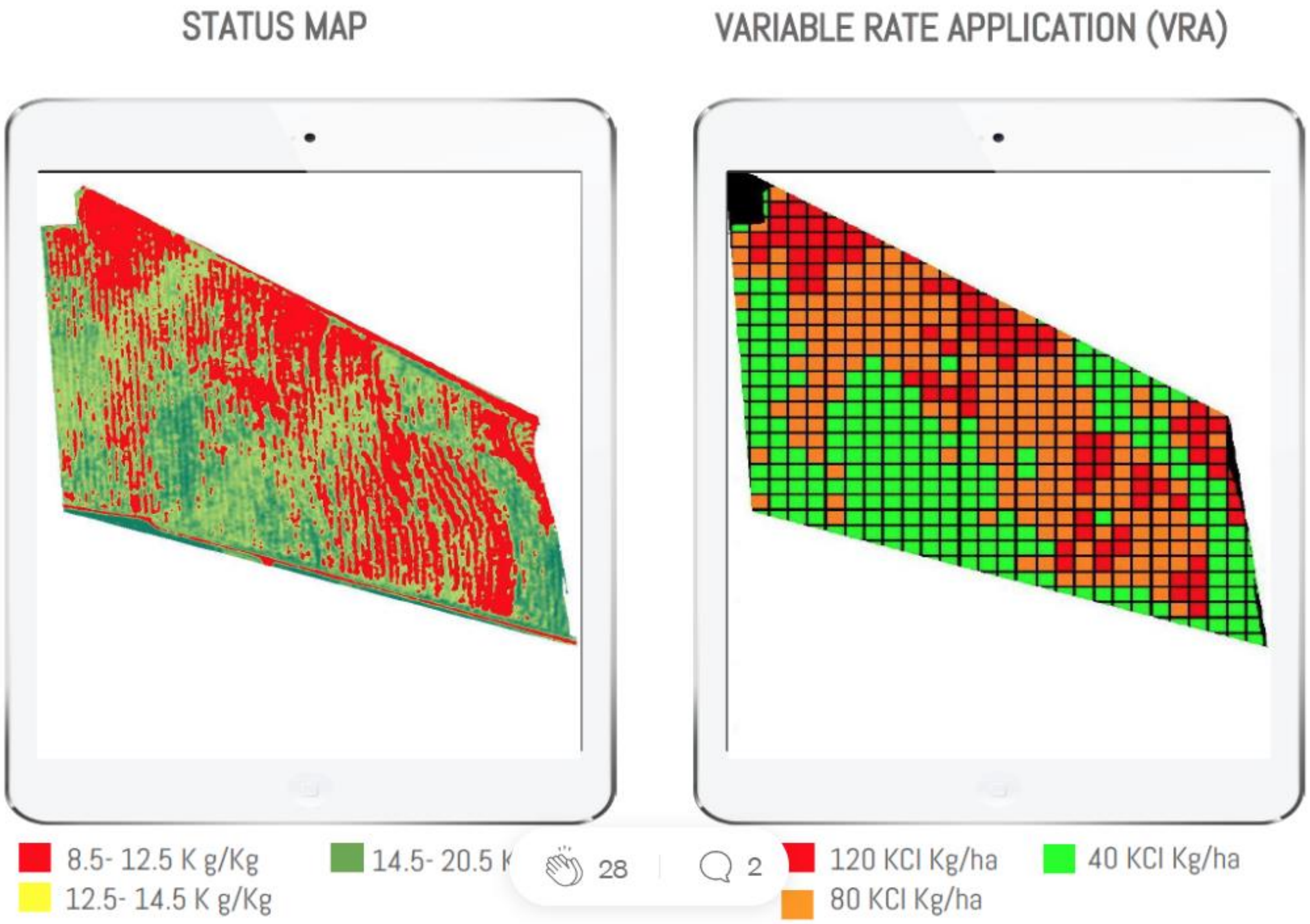


Figure 3. Representative reflectance spectra for healthy cotton plants and severely diseased plants with cotton root rot in the visible (400-700 nm) to NIR (700-900 nm) region of the spectrum.

4) Implementing practices to address variability

- New information and communication technologies (NICT) make field-level crop management more operational and easier to achieve for farmers.
- Application of crop management decisions calls for agricultural equipment that supports variable-rate technology (VRT), for example varying seed density along with variable-rate application (VRA) of nitrogen and phytosanitary products.

VRT



ใช้ปุ๋ยอะไร ?

A Business Case for Opening new Markets using Satellite Data for Smallholder Farmers and Pastoralists in Developing Countries

How 'Space for Food Security' works at the local level

STATUS	Implementation
START DATE	01-Jan-2014
END DATE (PLANNED)	31-Dec-2022
FINANCE	100% of 79,483,445 EUR

Geodata for Agriculture and Water

The G4AW Facility promotes and supports private investments for large scale, demand-driven and satellite-based information services. It provides a platform for partnerships of public organizations, research institutes, private sector operators, NGOs, farmer cooperatives, satellite data/service operators, businesses and transmission operators. For the past three years, the Netherlands Space Office (NSO) has been responsible for executing the Facility and supporting 17 on-going projects.

G4AW GEODATA FOR AGRICULTURE AND WATER

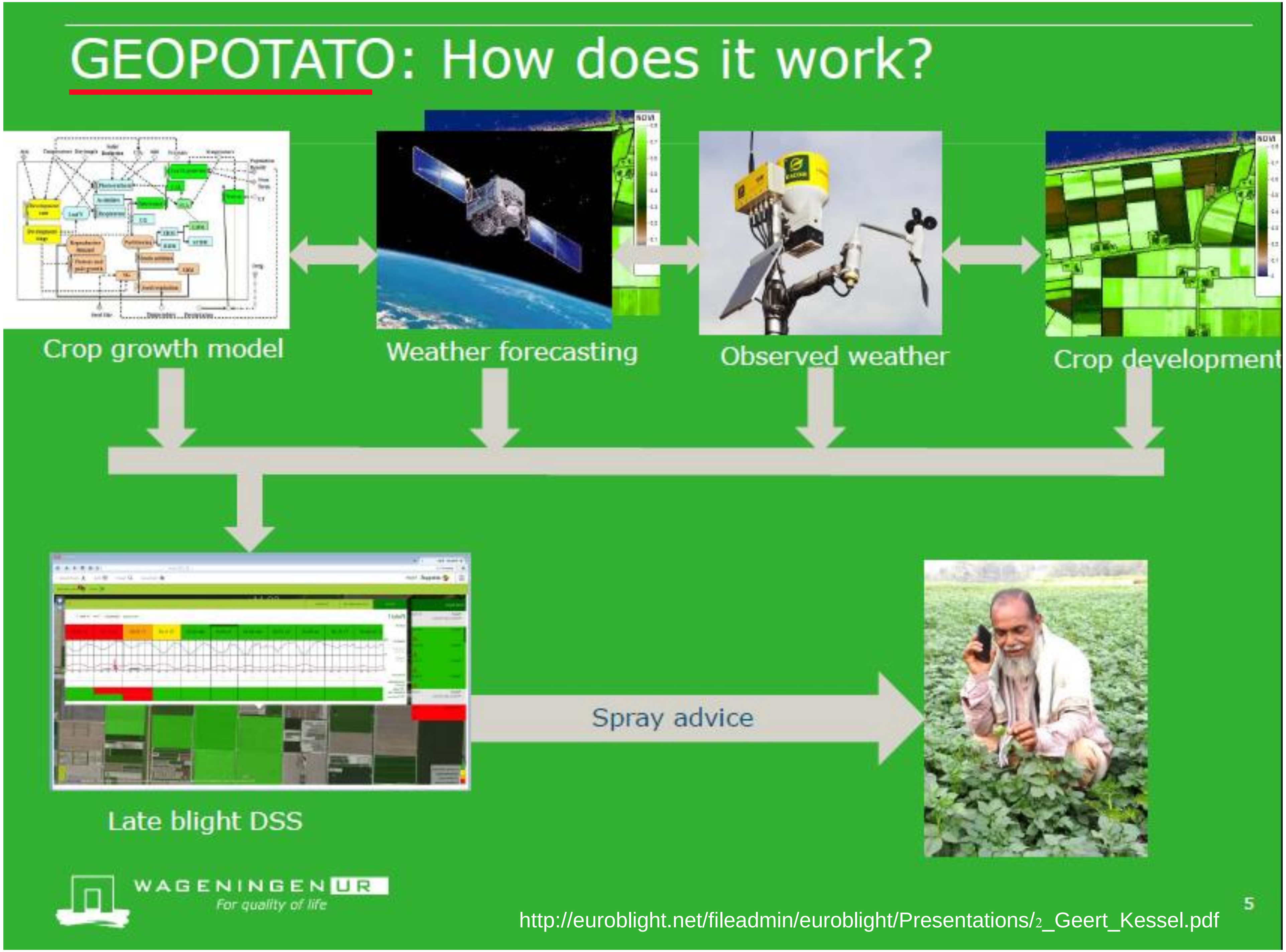
Netherlands Space Office

Warning system

> Geodata to control potato late blight in Bangladesh (GEOPOTATO)

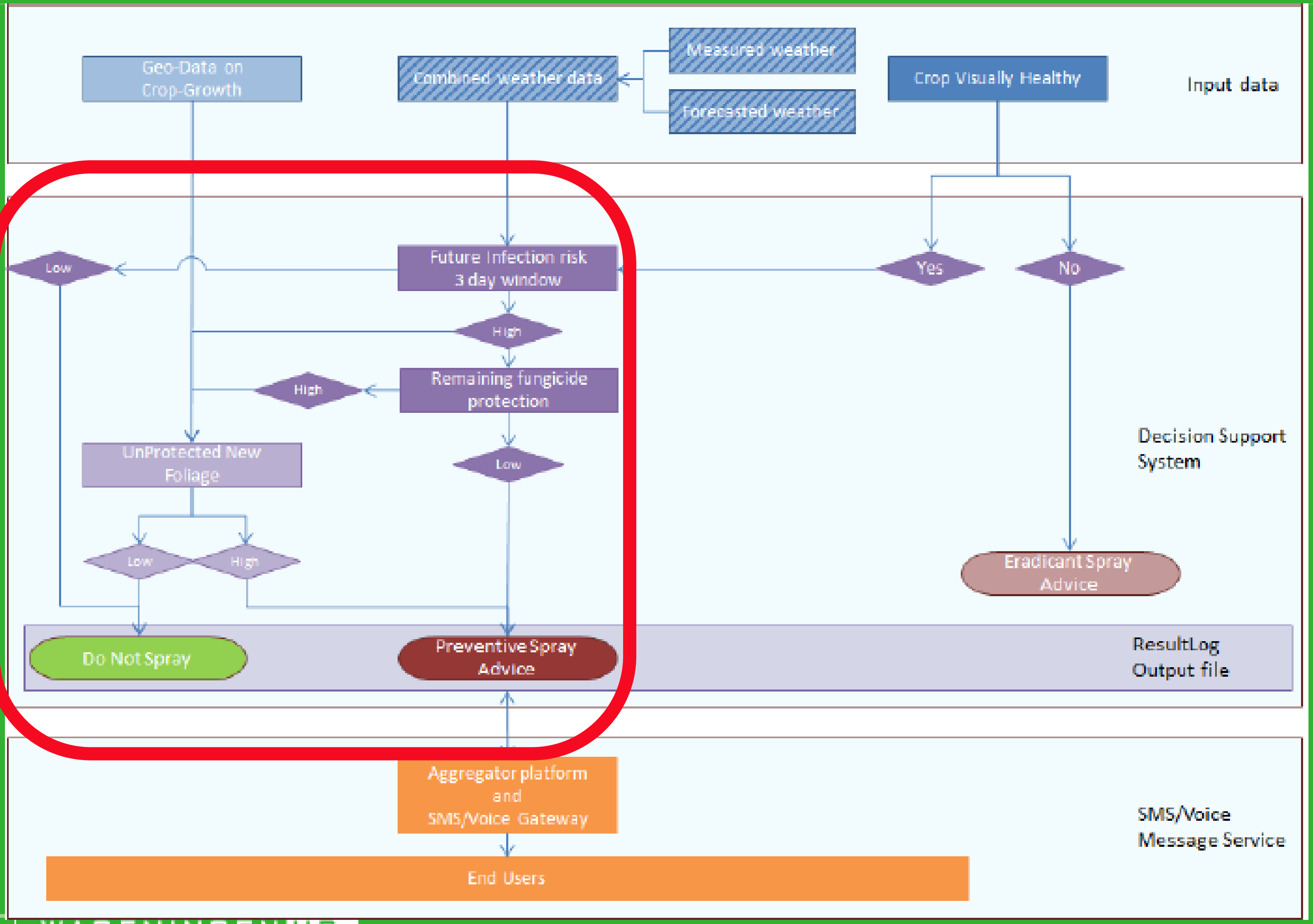
Crop advisory service

GEOPOTATO will develop and implement a decision support service (DSS) in Bangladesh for an optimal control strategy of late blight in potato. Various models using satellite data will continuously measures and forecasts weather and biomass growth of potato crops in relation to the late blight disease cycle. The DSS evaluates this information to provide farmers with preventive spray advice when a late blight infection period is predicted to occur.



http://euroblight.net/fileadmin/euroblight/Presentations/2_Geert_Kessel.pdf

DSS in detail



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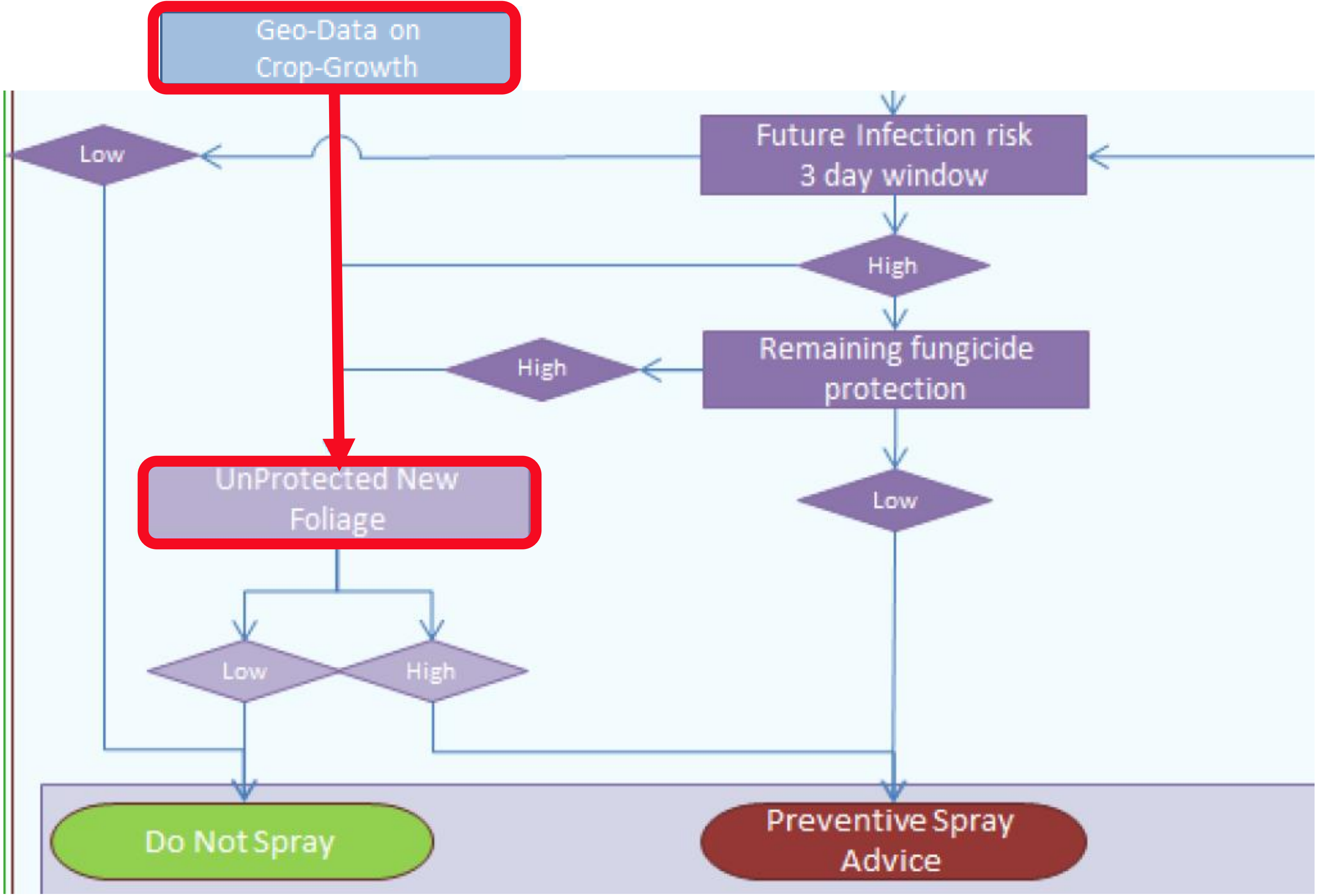
For quality of life

http://euroblight.net/fileadmin/euroblight/Presentations/2_Geert_Kessel.pdf



Geo-Data on Crop-Growth
Low
Future Infection risk 3 day window
High
High
Remaining fungicide protection
UnProtected New Foliage
Low
Low
High
Do Not Spray
Preventive Spray Advice

Data sharing policy issue !!!

doi:10.1093/plphys/kiab301 PLANT PHYSIOLOGY 2021: 187: 699–715

Plant Physiology®

Resources for image-based high-throughput phenotyping in crops and data sharing challenges

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https://academic.oup.com/plphys/article/187/2/699/6310753

Benchmark dataset

Benchmark datasets are often employed as a standardized way to assess a new method’s performance, finding its strengths, and limitations (Lobet, 2017).

1. **intentional**, the dataset must be designed to be employed on specific tasks;
2. **relevant,** the data should be coherent with the event it attempts to describe and have the limitations identified and clearly stated;
3. **representative**, meaning that the dataset covers most cases commonly encountered when performing a task within the defined;
4. **sizable**, the dataset must contain enough examples of each class or target to enable training machine learning and computer vision methods;
5. **reliable**, the data points must be experimentally obtained instead of artificially generated and annotations must be performed by plant;
6. **descriptive**, the dataset must have an extensive description of data collection methodology (sensors, UAV altitude), biological information (species, genotype, growth stage), and experimental conditions (temperature, soil, water availability).

https://academic.oup.com/plphys/article/187/2/699/6310753

Researchers may exploit these datasets either for phenotype comparison or employ them as a benchmark to assess tool performance and to support the development of tools that are better at generalizing between different crops and environments.

Supplemental data

The following materials are available in the online version of this article.

Supplementary Data Set 1. Available image-based HTP datasets for crop yield prediction.

Supplementary Data Set 2. Available image-based HTP datasets for abiotic stress phenotyping

Supplementary Data Set 3. Available image-based HTP datasets for disease and pest detection

Supplementary Data Set 4. Root phenotyping datasets

Supplementary Data Set 5. Other miscellaneous databases that may be useful for applications not discussed in this review.

" Many challenges prevent the research community from efficiently reusing data processing tools and analysis pipelines. "

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“ Those who have the technology will thrive; those who don’t will wither away.”

NAC2023 18th NSTDA Annual Conference การประชุมวิชาการประจำปี สวทช. ครั้งที่ ๑๘

The Future Of Food: Completely Automated Farms Run By Robots

WRITTEN BY: TAYLOR DOBBS   DECEMBER 29, 2015

With automated farming, workers and traditional family farmers will be quickly and easily excessed. The race will be on to completely subsume small farms into giant corporate farms that exercise monopoly control over food production, and advanced technology will drive the whole process. Those who have the technology will thrive; those who don’t will wither away.

GPT
5.5G

Learners inherit the earth;
while the learned find themselves
beautifully equipped to deal with
a world that no longer exists.

Eric Hoffer