International Meeting on Land Cover and Land Use Changes 2019 | Universiti Teknologi Malaysia (UTM) & National Aeronautics and Space Administration (NASA), USA | Johor Bahru, Johor | July 23, 2019

(Invited Talk)

Is Precision Agriculture the Game Changer in Malaysia?

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MPOCC
MALAYSIAN PALM OIL CERTIFICATION COUNCIL

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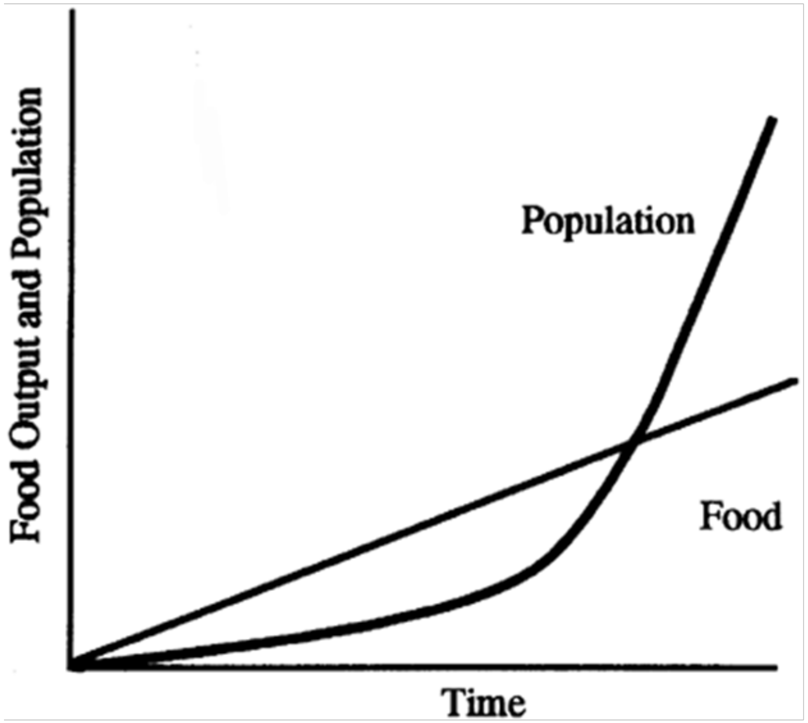
BERILMU BERBAKTI

Was Thomas Malthus correct?



Human population will increase in a geometric ratio (exponential) while food production (for human subsistence) will increase in an arithmetic ratio (linear)

- Essay on the Principle of Population (1798)

Today, after more than 200 years …

Agriculture is being challenged on two fronts:

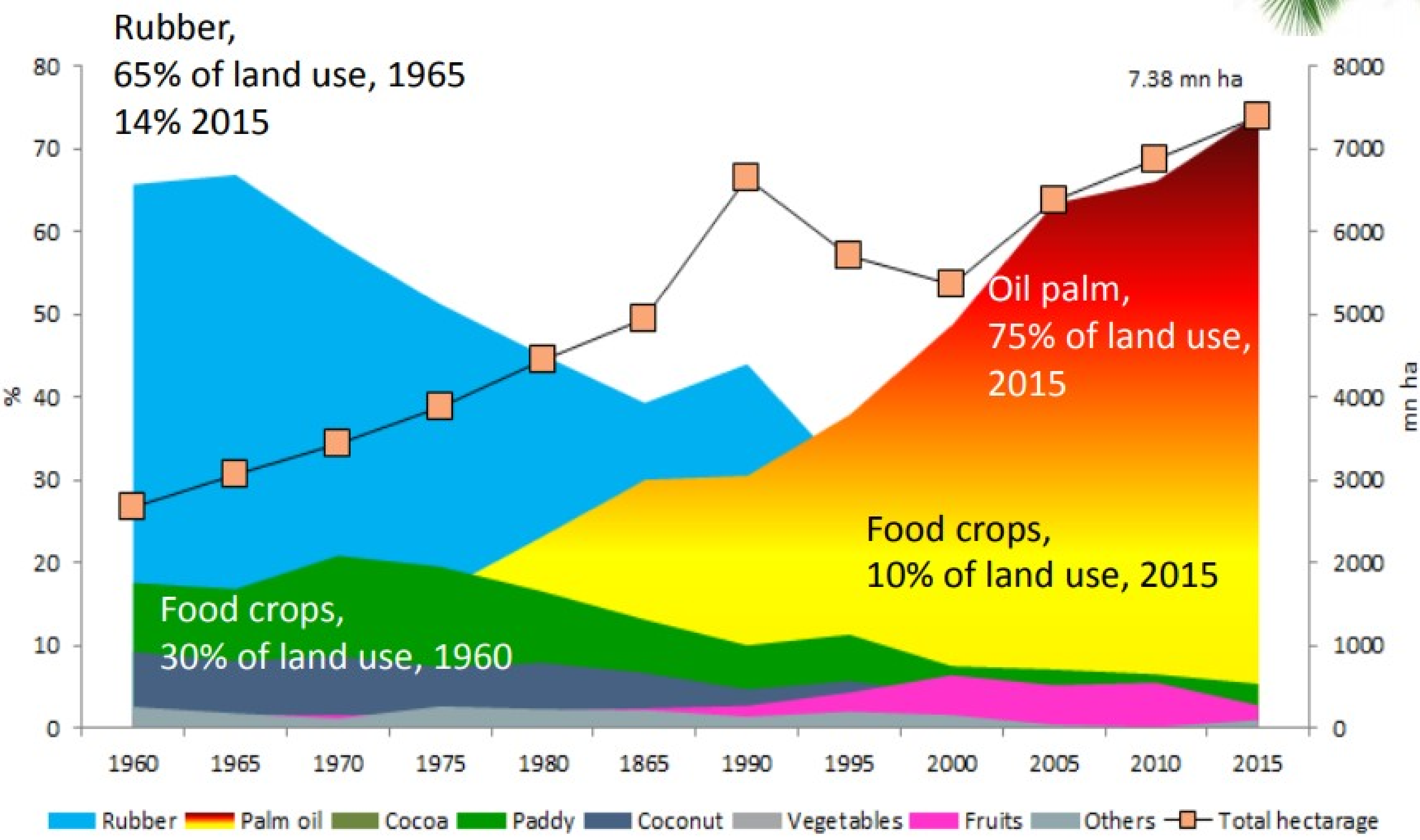
Demand

- Food security
- Population growth
- Growing pressure from biofuels
- Changing consumption patterns

Supply

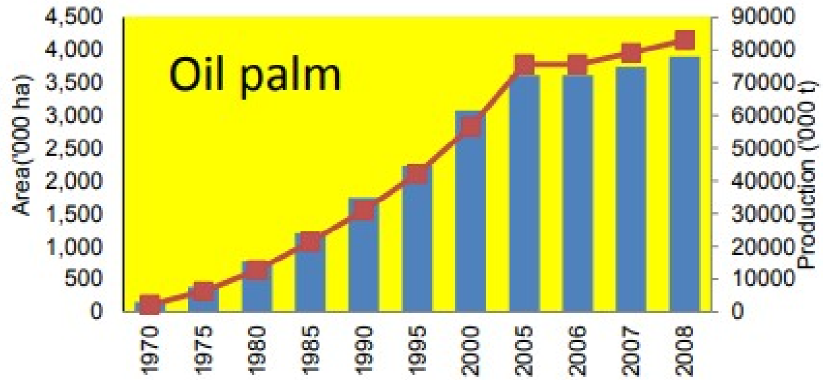
- Limited availability of land, water, mineral inputs and skilled labor
- Climate change
- Pre-harvest and post-harvest losses

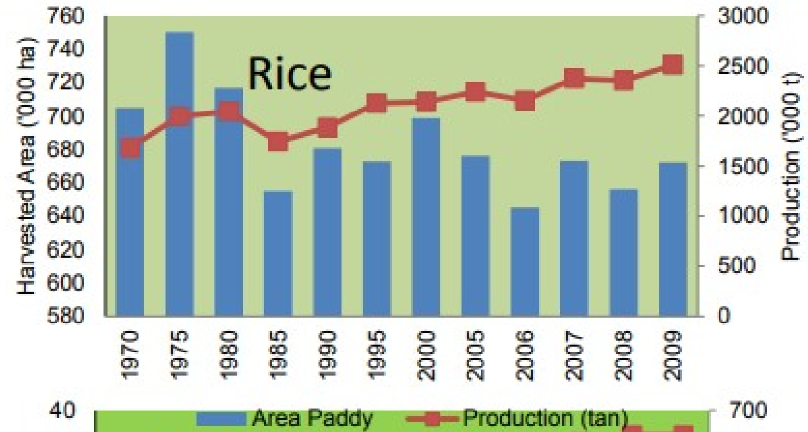
Dominant shift towards monoculture (Fatimah, 2018)

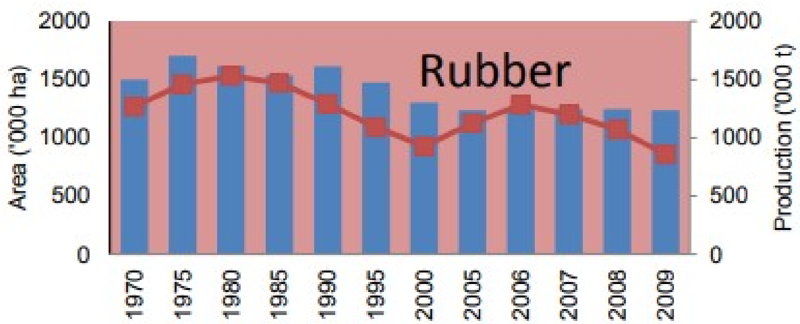


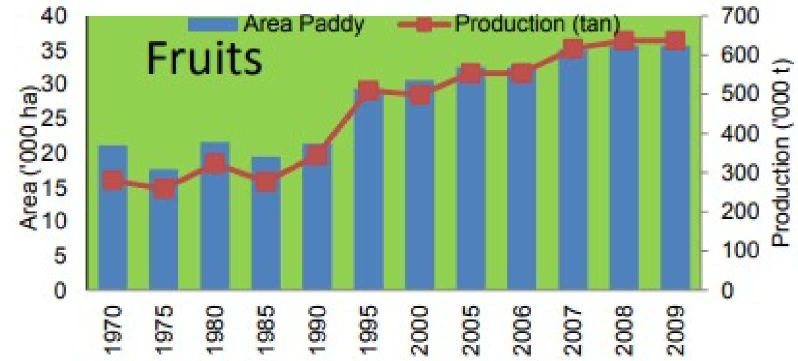
Malaysia: Land use by crops (%) and total hectarage (mn ha), 1960-2015

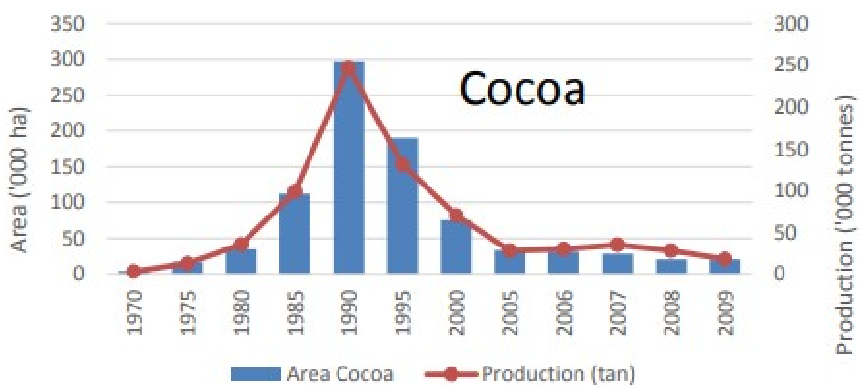
Industrial crops are susceptible to cycles, demand for food is ever increasing (Fatimah, 2018)

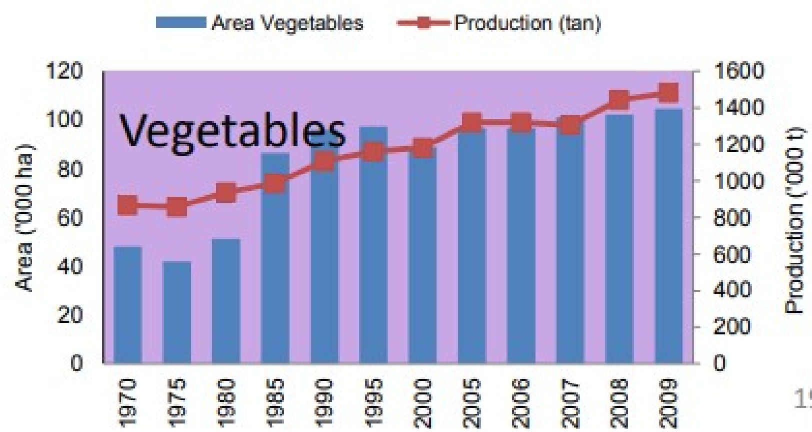




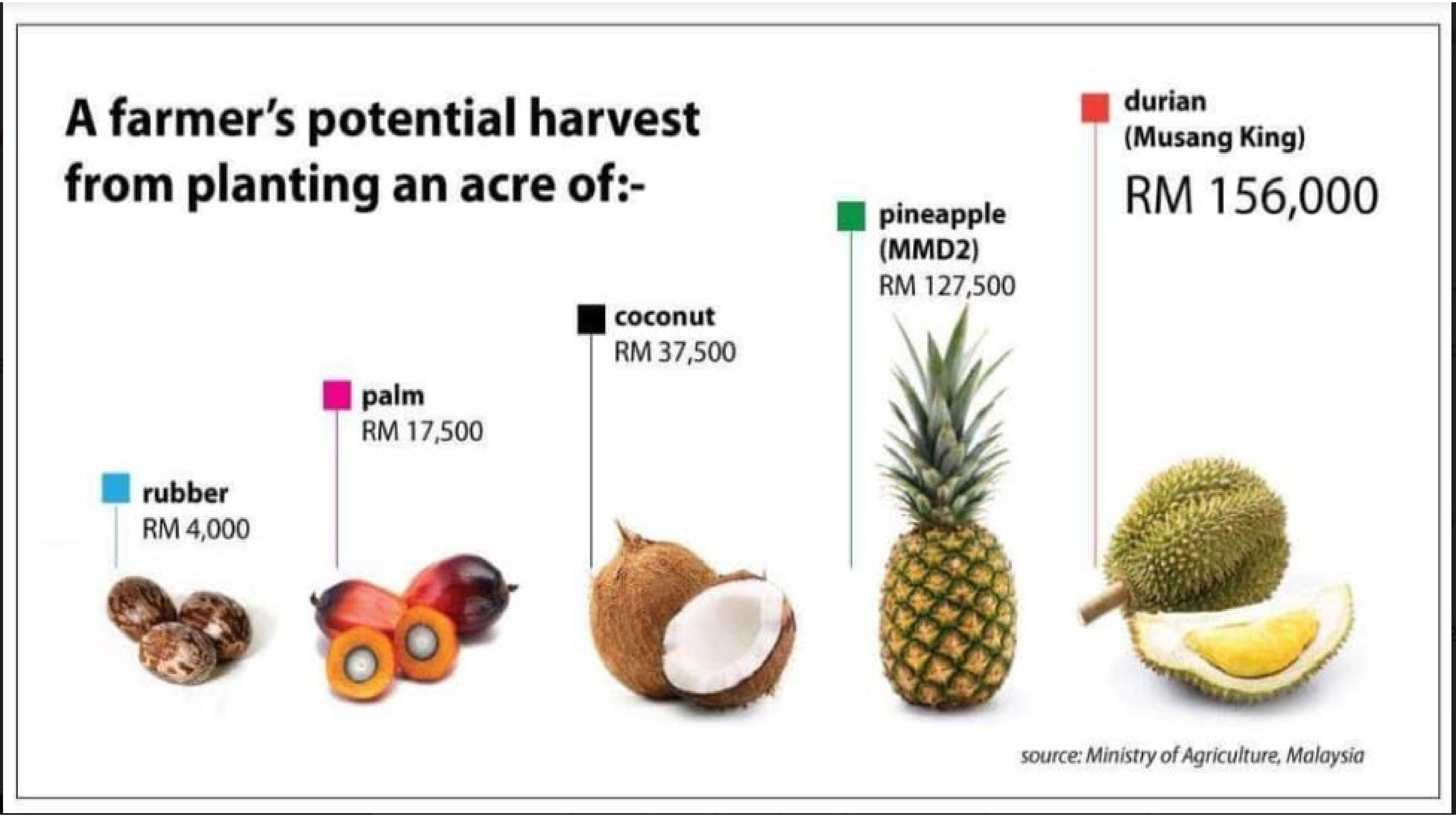








Income potential … (based on 2018 calculations)

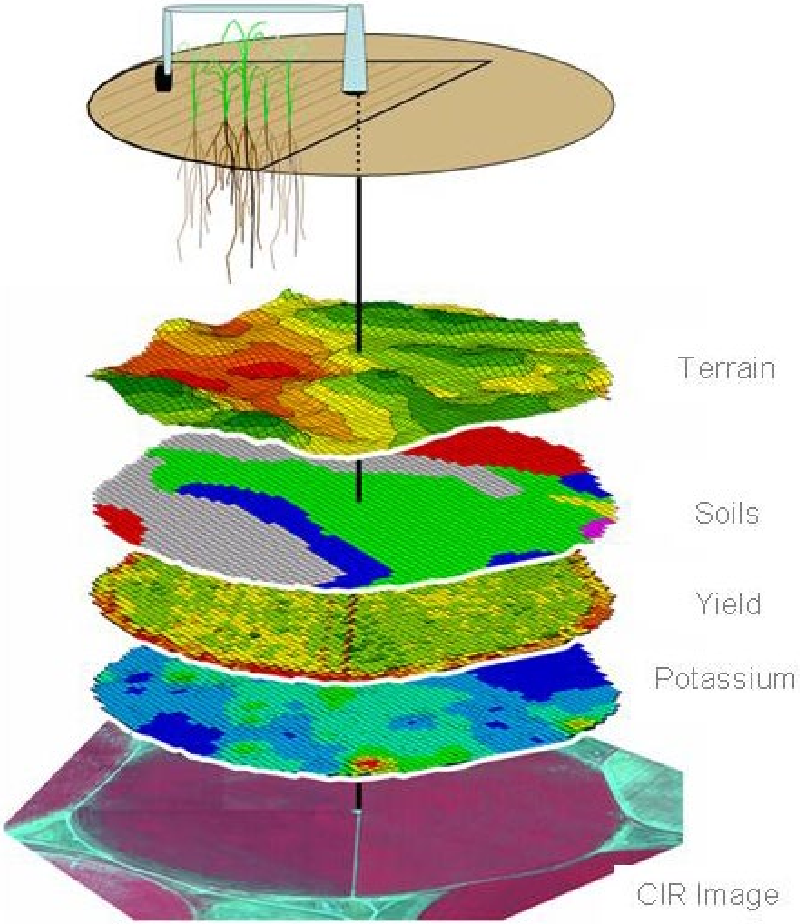


Precision agriculture

- A management practice applied at the **right rate**, **right time** and the **right place**

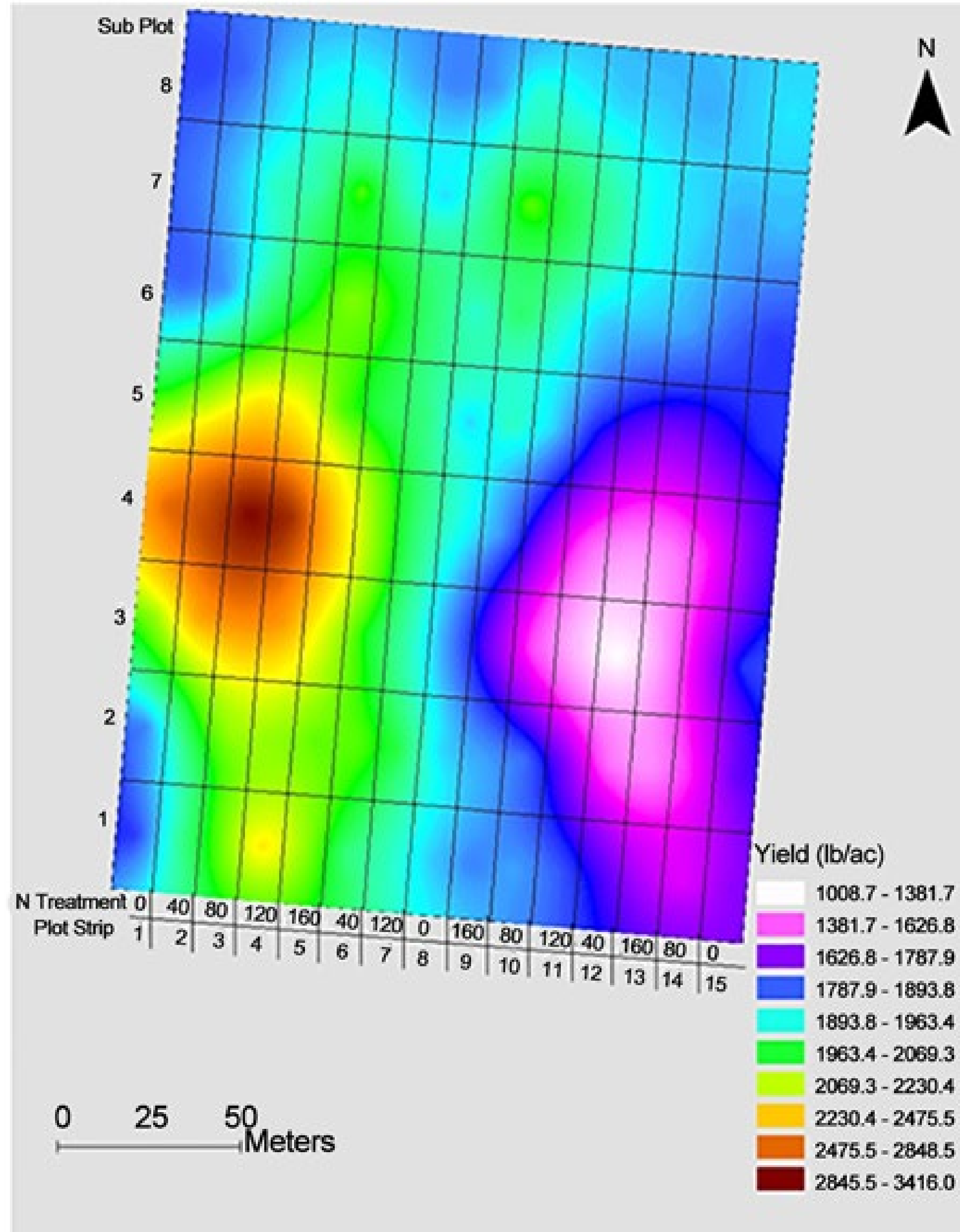
- Field sub-region management
  - nutrients
  - drainage/irrigation
  - pests and diseases
  - tillage and seeding

Individual field focus
➡ spatial variability
➡ temporal variability



Spatial variability

⇨ **differences across space/distance**

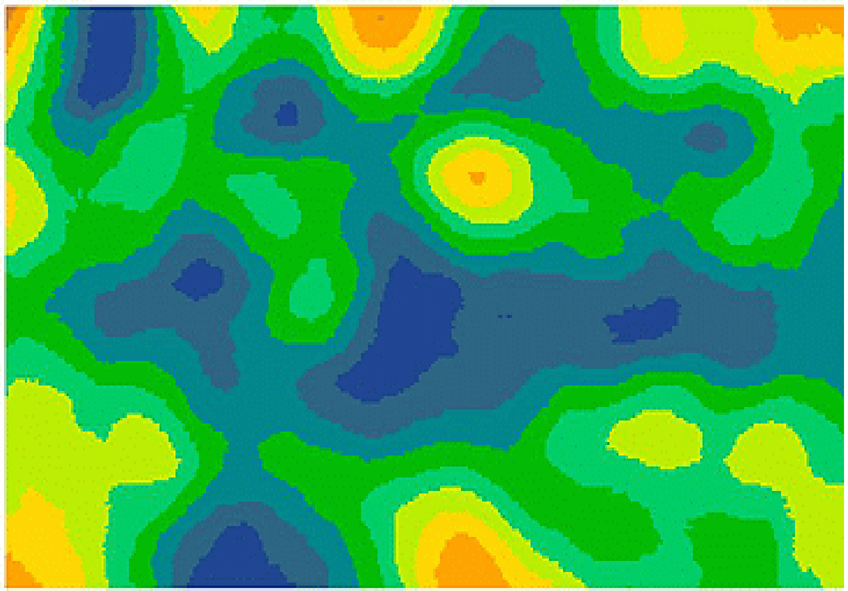


Yin, X. 2016. Geostatistical analyses of field spatial variability of cotton yield. *Journal of Geoscience and Environment Protection*, 4: 75-87

Temporal variability

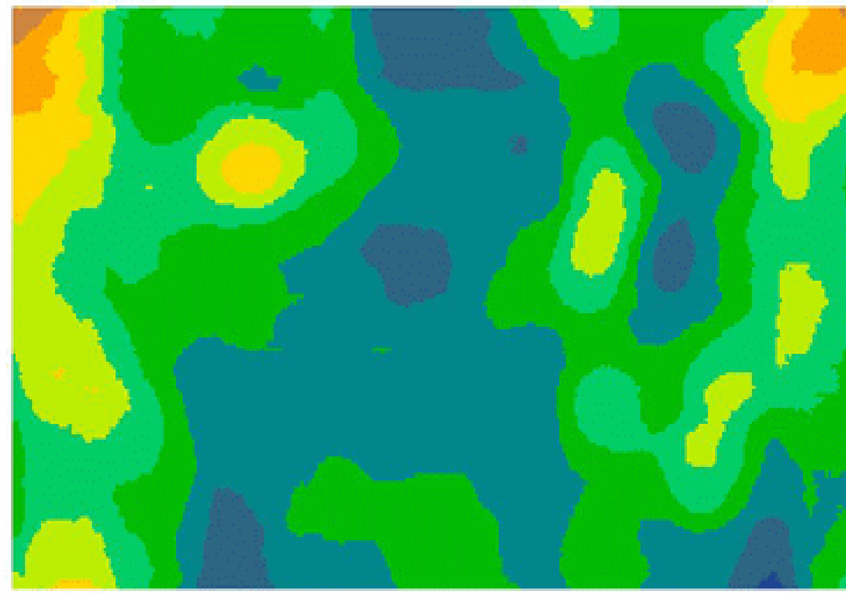
⇨ differences across time/season

Corn grain yield - 1997



Field M1 (30 ac.), Davis-Purdue Ag. Center

Corn grain yield - 1998



Field M1 (30 ac.), Davis-Purdue Ag. Center

High to low

Why is precision agriculture practical?

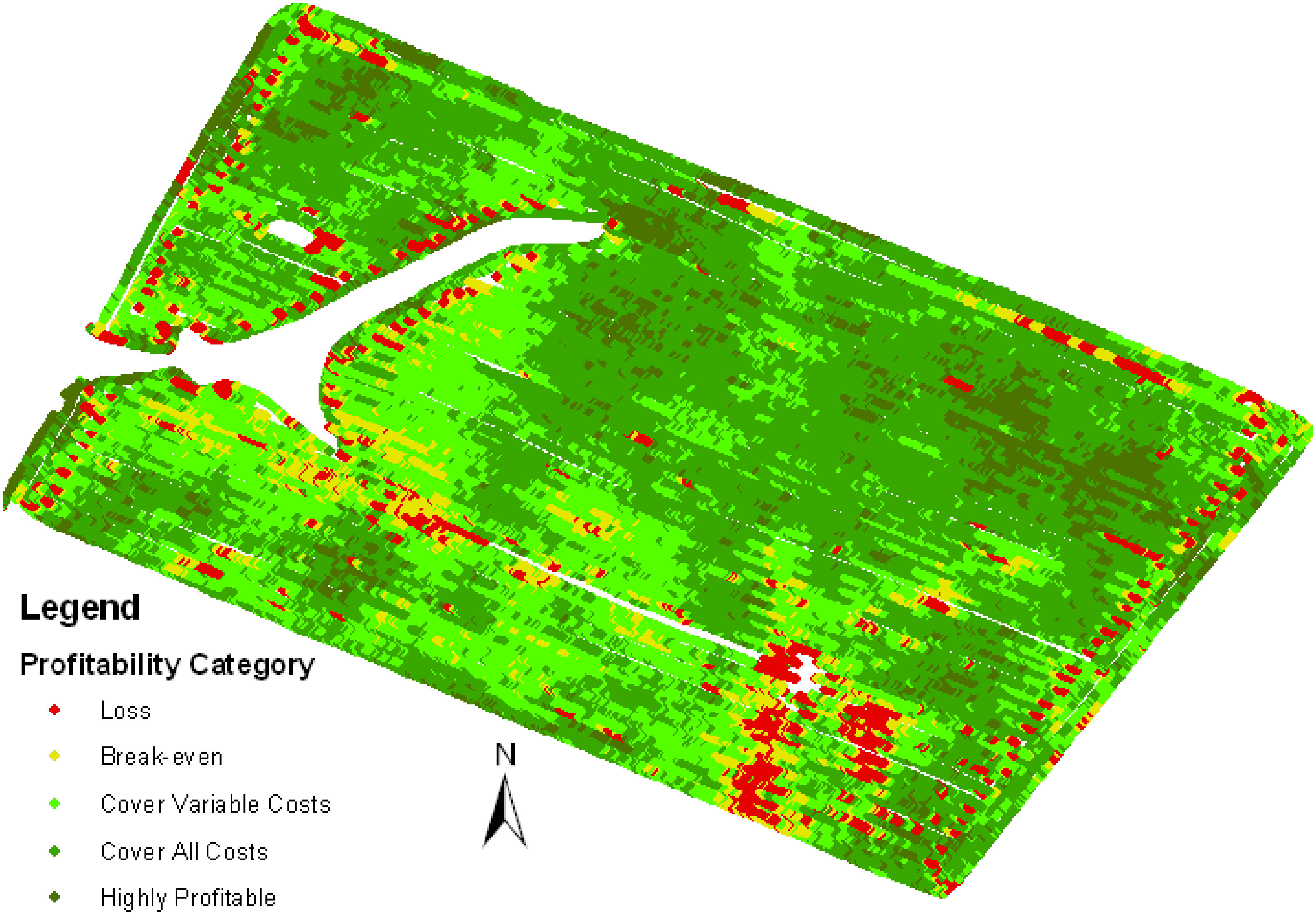
	Benefit Occurs	No Benefit Occurs
ACT	Correct action	Type II error: Loss caused
DON'T ACT	Type I error: Lost opportunity	Correct inaction

⇨ **Precision agriculture minimizes Type I & Type II errors**

Possible outcomes from using precision agriculture

- ⇨ Higher yield with the same level of inputs
- ⇨ The same yield with reduced inputs
- ⇨ Higher yield with reduced inputs

Mapping out the bottom line!



Key challenge for precision agriculture

Technology structure

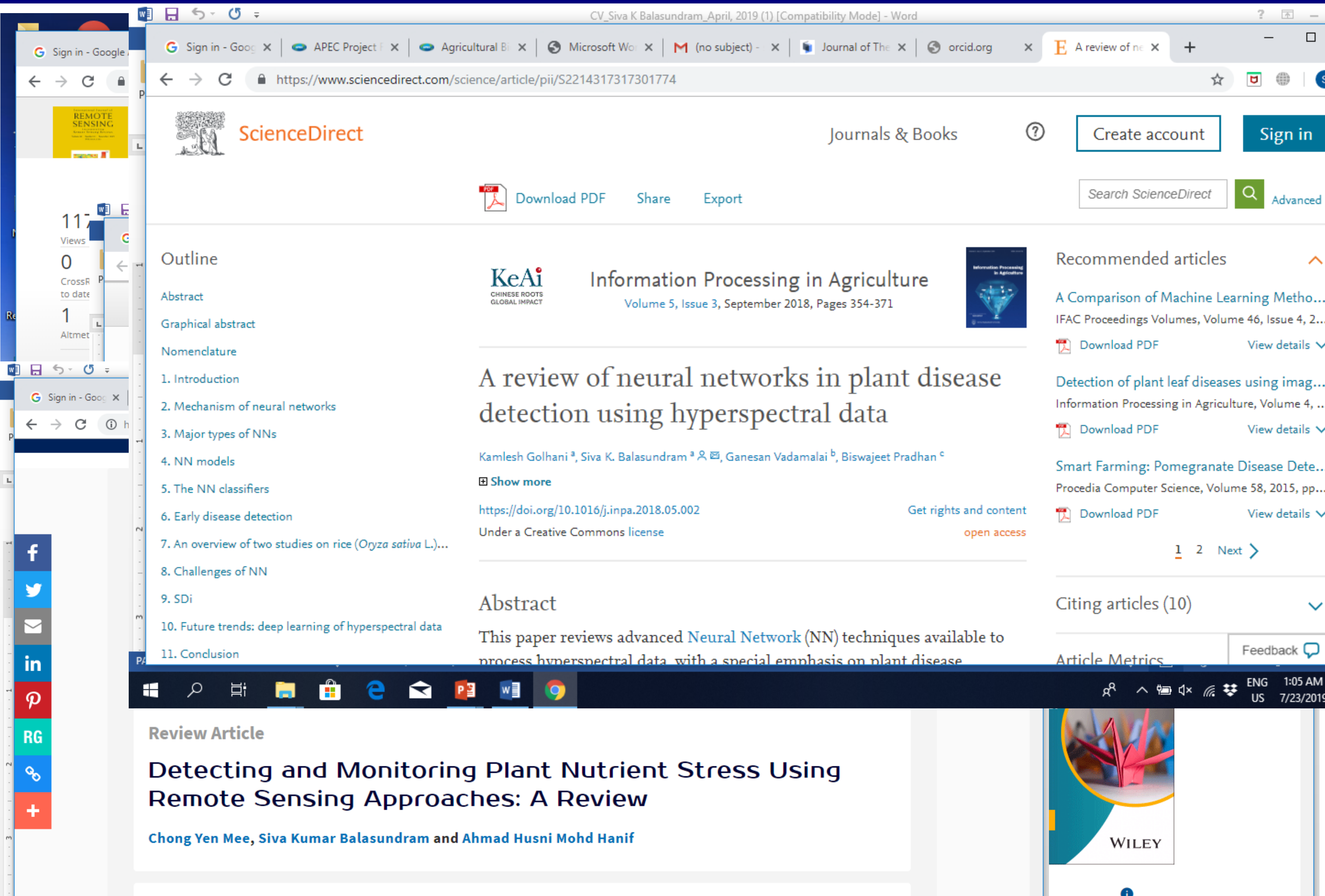
- **Precision agriculture is information-intensive and <u>not</u> embodied knowledge (e.g. hybrid seeds, GMO)**

  ➲ **need to transform precision agriculture into embodied knowledge so that end-users can understand better, without having to understand the complex science behind it**

Balasundram, S.K. 2016. Selected precision agriculture studies in oil palm: A 10-year summary. *Revista Palmas*, 37(1): 243-266. (In Spanish)

Technological domain	Scope of investigation	Keywords
Geo-spatial modeling	FFB yields Leaf and soil nutrients Fertilizer trials Soil organic carbon	Spatial variability, management zones, nearest-neighbor analysis, operational zones
Decision support system	Oil yield Oil quality	FFB harvesting, image processing, surface color, degree of bleachability index
Remote and proximal sensing	FFB yields Disease detection Oil quality Stand density	Vegetation indices, spectral reflectance, sensor, geographical information system, Google Earth

Our recent outputs: Crop monitoring



Our recent outputs: Landuse and hydrological modeling

Journal of Water Resource and Protection, 2012, 4, 870-876
http://dx.doi.org/10.4236/jwarp.2012.410102 Published Online October 2012 (http://www.SciRP.org/journal/jwarp)
Scientific Research

APPLIED SPATIAL ANALYSIS AND POLICY

Applied Spatial Analysis and Policy
March 2016, Volume 9, Issue 1, pp 1–19

Springer Link

Environmental Earth Sciences

Environmental Ear
February 2015, V

Journal of Applied Remote Sensing: Journal Home Current Issue All Issues
Journal of Applied Remote Sensing | Volume 7 | Issue 1 | Research Papers >

Journal
Hydrological Sciences Journal >
Volume 59, 2014 - Issue 10

Original Articles

SWAT-based hydro
land-use scenarios

Modélisation hydr
d'utilisation des so
modèle SWAT

Hadi Memarian, Siva K. Balasundram, Kari
Sood

Pages 1808-1829 | Received 17 May 2012, Accepted 14 Aug 2013, Accepted a
2014

Computers and Electronics in Agriculture 93 (2013) 98–110

Contents lists available at SciVerse ScienceDirect

Computers and Electronics in Agriculture

journal homepage: www.elsevier.com/locate/compag

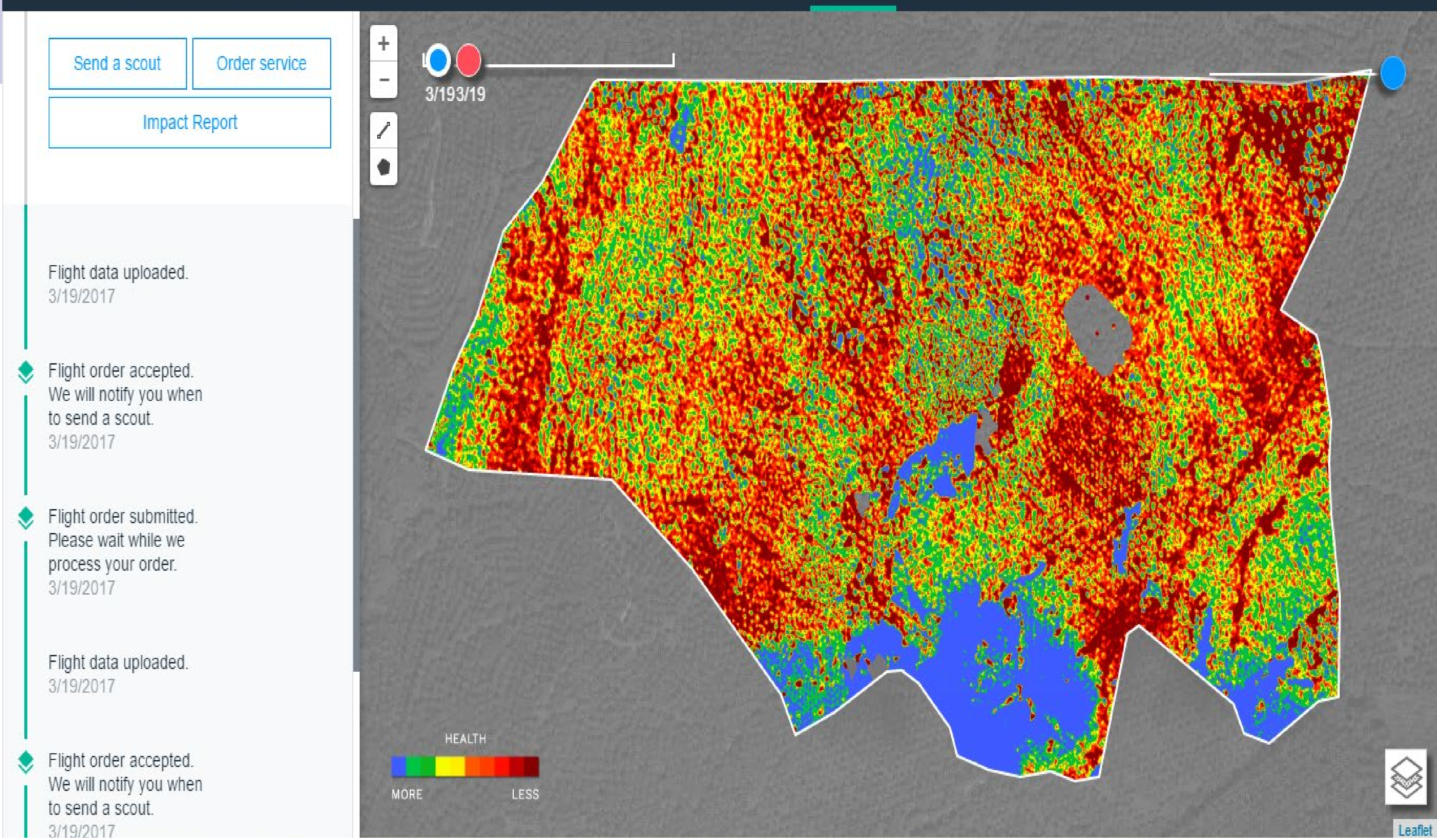
ELSEVIER

Agriculture Land Suitability Evaluator (ALSE): A decision and planning support tool for tropical and subtropical crops

Ranya Elsheikh [a], Abdul Rashid B. Mohamed Shariff [a], Fazel Amiri [a,b,*], Noordin B. Ahmad [c], Siva Kumar Balasundram [d], Mohd Amin Mohd Soom [e]

Our ongoing work

Monitoring of oil palm stress using drone technology (mounted with an NDVI sensor)



Stress factors under investigation:

♦ nutrient imbalance ♦ pest infestation ♦ water flow

Our ongoing international collaboration

Digital farming for citrus orchards

Key areas for further work

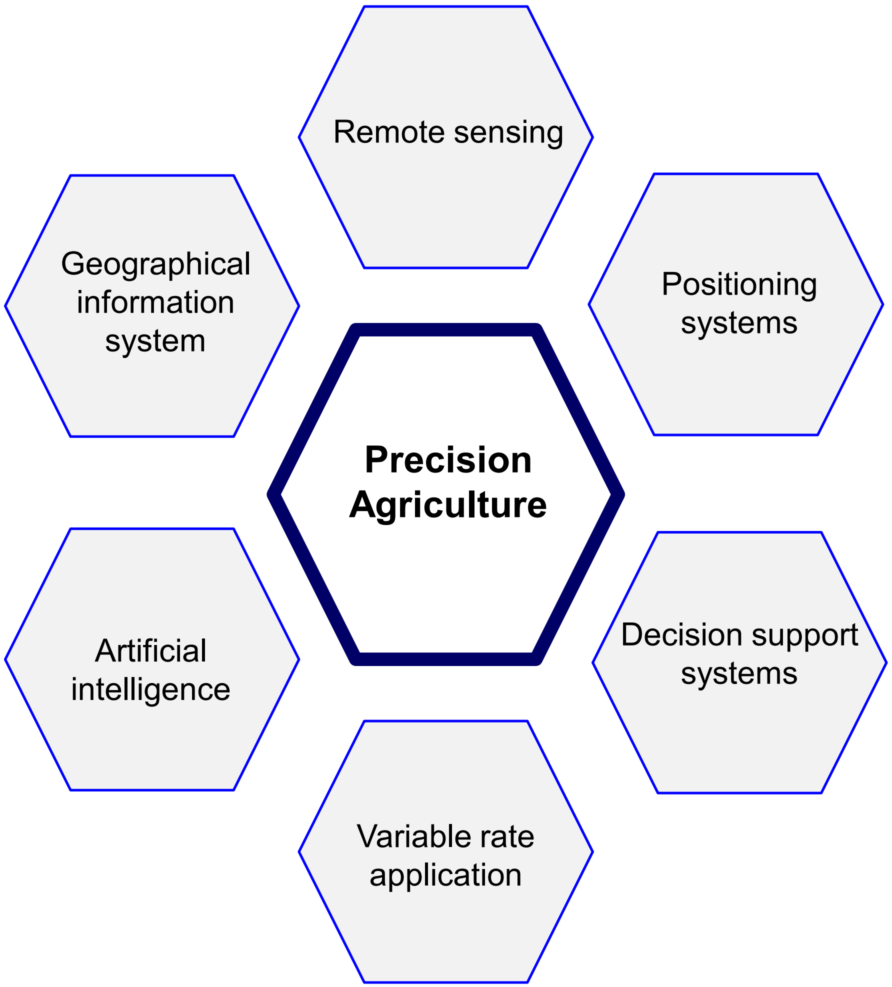
1. Crop nutrition
   - Nutrient balance index
2. Pest and disease control
   - Early detection in a non-destructive way
3. Harvesting/Crop recovery
   - Optimum ripeness detection protocol
   - Optimized quality

Other areas that require further work

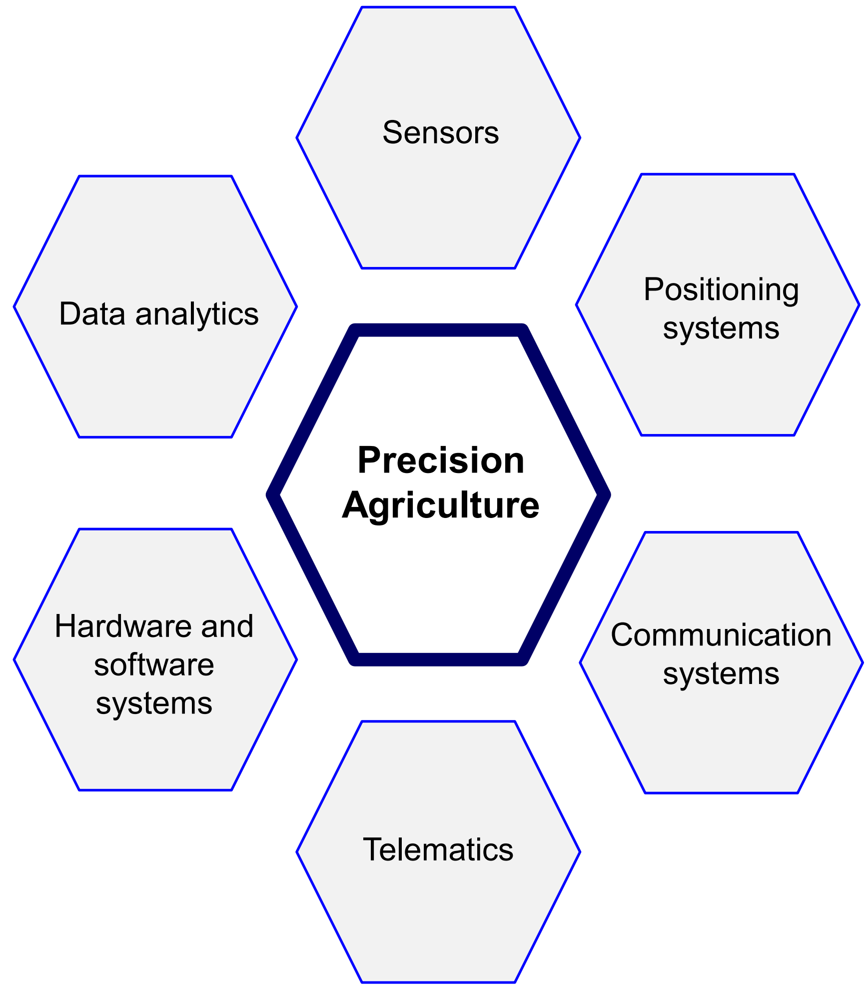
- Mapping of carbon sequestration potential in different oil palm ecosystems
- Development of sustainability indicators that include spatial and temporal variability
- Development of appropriate spatial scale to monitor shifts in yield maxima
- Geospatial modeling of water flow in sloping land
- Improvement of data processing methods, e.g. drone data should be in sync with spatio-temporal data

Evolution of precision agriculture

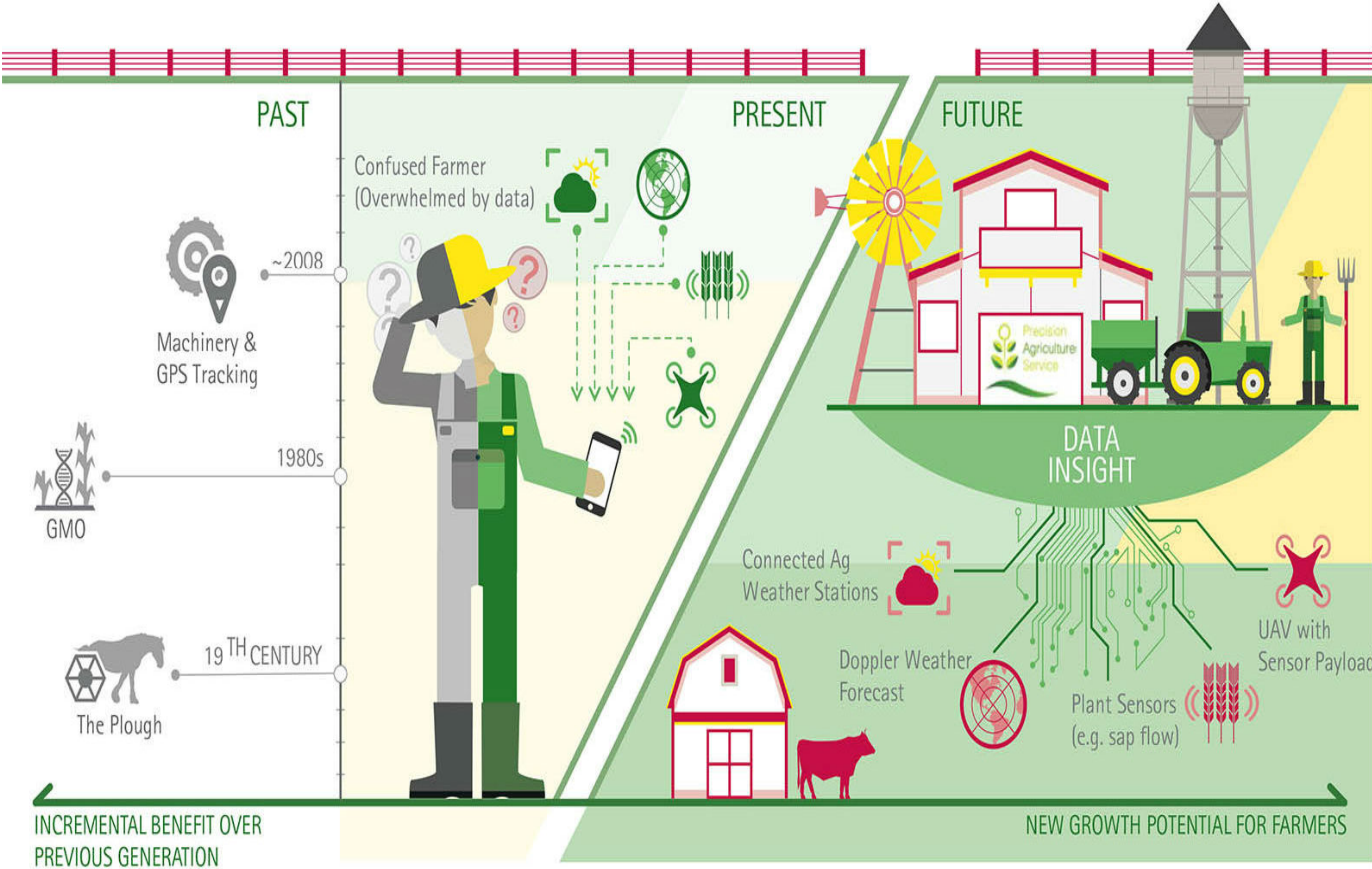
The first 25 years (1990-2015): Efficient farm



The next several years (2015-?): Connected farm



Towards a connected farm …



Source: Accenture (2015)

Where are we going with all these?

Climate-smart agriculture

▪ Efficient ▪ Cost-effective ▪ Practical ▪ Pollution free

Making the crop fit the environment (always changing) → resilience

instead of the old way of changing the environment to fit the crop

Where are we going with all these? ... (2)

Internet of Things (IoT) in Agriculture

- ➡ A means of connecting systems so as to allow an integrated, multidimensional view of farming activities, enabling deeper understanding on how the whole ecosystem works
  - Smart devices than can collect and send data in real time to increase speed for decision making
  - Big data

See you there!

Thanks for your attention