Is Precision Agriculture the Game Changer in Malaysia?

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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)
A farmer’s potential harvest from planting an acre of:

- **rubber**: RM 4,000
- **palm**: RM 37,500
- **coconut**: RM 127,500
- **pineapple (MMD2)**: RM 156,000
- **durian (Musa King)**: RM 156,000

Source: Ministry of Agriculture, Malaysia
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**
Temporal variability

⇒ differences across time/season

Corn grain yield - 1997

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

High to low

Corn grain yield - 1998

Field M1 (30 ac.), Davis-Purdue Ag. Center
### Why is precision agriculture practical?

<table>
<thead>
<tr>
<th>Benefit Occurs</th>
<th>No Benefit Occurs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ACT</strong></td>
<td><strong>Type II error:</strong> Loss caused</td>
</tr>
<tr>
<td>Correct action</td>
<td></td>
</tr>
<tr>
<td><strong>DON’T ACT</strong></td>
<td><strong>Type I error:</strong> Lost opportunity</td>
</tr>
<tr>
<td></td>
<td>Correct inaction</td>
</tr>
</tbody>
</table>

⇒ **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!

Legend
Profitability Category
- Loss
- Break-even
- Cover Variable Costs
- Cover All Costs
- Highly Profitable
Key challenge for precision agriculture

- **Technology structure**
  - Precision agriculture is information-intensive and **not** 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
<table>
<thead>
<tr>
<th>Technological domain</th>
<th>Scope of investigation</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geo-spatial modeling</td>
<td>FFB yields\nLeaf and soil nutrients\nFertilizer trials\nSoil organic carbon</td>
<td>Spatial variability, management zones, nearest-neighbor analysis, operational zones</td>
</tr>
<tr>
<td>Decision support system</td>
<td>Oil yield\nOil quality</td>
<td>FFB harvesting, image processing, surface color, degree of bleachability index</td>
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<tr>
<td>Remote and proximal sensing</td>
<td>FFB yields\nDisease detection\nOil quality\nStand density</td>
<td>Vegetation indices, spectral reflectance, sensor, geographical information system, Google Earth</td>
</tr>
</tbody>
</table>
Our recent outputs: Crop monitoring

A review of neural networks in plant disease detection using hyperspectral data

Kamlesh Golhani *, Siva K. Balasundram *, Ganesan Vadmalai, Biswajeet Pradhan *

Abstract
This paper reviews advanced Neural Network (NN) techniques available to process hyperspectral data, with a special emphasis on plant disease detection.
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
- Remote sensing
- Geographical information system
- Artificial intelligence
- Variable rate application
- Precision Agriculture
- Decision support systems

The next several years (2015-?): Connected farm
- Sensors
- Data analytics
- Precision Agriculture
- Hardware and software systems
- Communication systems
- Telematics
- Positioning systems
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
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
FUTURE FARMS
small and smart

SURVEY DRONES
- precise detection & quick intervention

FLEET OF AGRIBOTS
- microplot application of inputs

FARMING DATA
- rich & varied
- connected
- stored in ‘cloud’

TEXTING COWS
- constant monitoring of animal wellbeing
- alerts & triggers

SMART TRACTORS
- reduces soil erosion

See you there!
Thanks for your attention