DIGITAL PADDY CULTIVATION
IS IT POSSIBLE?

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THE FACT...

Rice is a staple food for Malaysia and a defining feature of our culture. Malaysians consume the grain daily either as cooked rice or indirectly in the form of rice flour. *Nasi lemak, bihun goreng, laksa, kuih apam* and *lepat pisang*, are some of the many rice-based foods we consume. During festive occasions, we see *pulut kuning* at Malay weddings and red tortoise cakes during Chinese New Year. Therefore, it is not surprising that in 2016, we consumed 80kg of rice per person, which is about 26% of the total caloric intake per day, costing an average of RM44/month per household. Among the states, households in Sabah spent the most on rice at RM73/month while households in Perlis spent the least at just RM13/month. This means that in the same year, 2.7m MT of rice was consumed, whereby 67% was produced locally, and the rest imported primarily from Thailand, Vietnam and Pakistan.

“Toward 2050, rising population and incomes are expected to call for 70% more food production globally, and up to 100% more in developing countries, relative to 2009 levels(...) The largest contribution to increases in agricultural output will most likely come from intensification of production on existing agricultural land. This will require widespread adoption of sustainable land management practices, and more efficient use of irrigation water through enhanced flexibility, reliability and timing of irrigation water delivery.”

Source: KRI

Source: UN Food and Agriculture Organisation
THE FACT...

Malaysia consumed **2.7 million** tonnes of rice in 2016. Of the amount consumed, **67%** was produced locally, while the rest was imported primarily from Thailand, Vietnam and Pakistan.

**Malaysia performed fairly well in terms of paddy yield, in terms of paddy yield in 2016 at **3.2 million tonnes vs Thailand’s **2.9 million tonnes per hectare.**

Malaysia’s rice consumption grew faster than its production. Compared to neighbouring countries, its rice consumption and production remain relatively small.

<table>
<thead>
<tr>
<th>Country</th>
<th>Population (million)</th>
<th>Production</th>
<th>Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>World</td>
<td>7.466.9</td>
<td>501.5</td>
<td>447.5</td>
</tr>
<tr>
<td>Asia</td>
<td>4,462.7</td>
<td>453.2</td>
<td>434.4</td>
</tr>
<tr>
<td>Indonesia</td>
<td>261.1</td>
<td>45.6</td>
<td>46.7</td>
</tr>
<tr>
<td>Malaysia</td>
<td>31.2</td>
<td>1.8</td>
<td>2.7</td>
</tr>
</tbody>
</table>

**Notes: Statistics based on year 2016**

South-East Asia plays a central role in the global rice economy, accounting for **16 million** tonnes, or **40%**, of world’s rice exports, with Thailand and Vietnam being the region’s top exporters. Malaysia, Indonesia and the Philippines are net importers.

**Rice Exporters**

- Thailand: 9,870,079 (24.5%)
- Indonesia: 529,888 (1.3%)
- Vietnam: 5,210,843 (12.9%)

**SSL: Self-sufficiency level**

- Philippines: 446,268 (1.2%)
- Malaysia: 821,849 (2.2%)
- Indonesia: 1,282,427 (3.4%)

Albeit the declining trend, the paddy and rice industry continue to receive more budgetary assistance than any other crops.

**Paddy subsidies and incentives vs percentage of Ministry of Agriculture’s expenditure**

<table>
<thead>
<tr>
<th>Year</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMbil</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Of the **14 million** employed persons in Malaysia, **1.6 million** workers, or **11.4%**, belonged to the agriculture, forestry and fishing industry. Within this category, around **200,000** were paddy farmers, mostly aged 50 years and above. The monthly household income for paddy farmers stood at **RM2,527**, putting them in the Bottom-40 income category.

Source: NST
THE FACT...

<table>
<thead>
<tr>
<th>Granary</th>
<th>Area (ha)</th>
<th>Production (t)</th>
<th>Ave. paddy yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MADA</td>
<td>187,413</td>
<td>941,889</td>
<td>612,228</td>
</tr>
<tr>
<td>KADA</td>
<td>38,641</td>
<td>159,800</td>
<td>103,870</td>
</tr>
<tr>
<td>IADA:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kerian Sg. Manik</td>
<td>41,955</td>
<td>188,586</td>
<td>122,581</td>
</tr>
<tr>
<td><strong>Barat Laut Selangor</strong></td>
<td>37,833</td>
<td><strong>237,594</strong></td>
<td><strong>154,436</strong></td>
</tr>
<tr>
<td>Pulau Pinang</td>
<td>20,610</td>
<td>120,383</td>
<td>78,249</td>
</tr>
<tr>
<td>Seberang Perak</td>
<td>27,686</td>
<td>126,027</td>
<td>81,918</td>
</tr>
<tr>
<td>Ketara</td>
<td>9,752</td>
<td>54,114</td>
<td>35,175</td>
</tr>
<tr>
<td>Kemasin Semerak</td>
<td>5,383</td>
<td>18,815</td>
<td>12,229</td>
</tr>
<tr>
<td><strong>Total (MADA, KADA, IADA)</strong></td>
<td>369,273</td>
<td>1,847,208</td>
<td>1,200,686</td>
</tr>
<tr>
<td><strong>Malaysia</strong></td>
<td><strong>606,846</strong></td>
<td><strong>2,555,132</strong></td>
<td><strong>1,648,414</strong></td>
</tr>
</tbody>
</table>

1Muda Agricultural Development Authority
2Kemubu Agricultural Development Authority
3Integrated Agricultural Development Areas

PAST, PRESENT, FUTURE AGRICULTURE

Source: Accenture
PAST, PRESENT, FUTURE AGRICULTURE

- Connected Farm/ Farm Area Network (FAN)
- IoT + Artificial Intelligence (AI)
- Precision Agriculture (PA)
What end users say....

More than 60% of farmers agree that the high investment costs of smart farming technologies and coverage issues are the major pain points which must be addressed. This is followed by long deployment time and bandwidth concerns.

More than 70% of farmers are willing to pay for more advanced technologies to be implemented provided that they can improve productivity and profits. Farmers are ready to invest more in both precision farming and farm management.

Source: HUAWEI: A Smart Agriculture Market Assessment
Selected PRESENT IoT Prototypes and Products in Agriculture
e-PADI

An IoT-based Paddy Productivity Monitoring and Advisory System

[Our Past Experience]
Motivation: pH

(a) Different soil pH vs. paddy development. (good pH 5.5-6.5)
(b) Paddy development due to inefficient nutrient absorption (pH < 5.0)
(c) Leaf colour chart (by IRRI)

Motivation: Water Level

Water Level   Yield
1cm           80%
15 cm         50%

source: Jabatan Pertanian Kedah
Midori (Japan)  
MYR 15K

E padi  
Midori Cloud

Agrosense

E Kakashi

IRIS

Vegetative Growth

Reproductive

Ripening

E padi  
Midori Cloud

E Kakashi

Agrosense

IRIS

A sensor box of Midori Cloud
e-PADI: How it works?

Node #1

Node #2

Gateway

Gateway

Node #3

Node #4

Cloud

Data Analysis

User Application
# e-PADI Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Voltage</td>
<td>5V DC</td>
</tr>
<tr>
<td>Processor operating frequency</td>
<td>16 MHz</td>
</tr>
<tr>
<td>Power consumption (e-PADI system)</td>
<td>~ 1W</td>
</tr>
<tr>
<td>Gateway (GW)</td>
<td></td>
</tr>
<tr>
<td>Sensor Node</td>
<td></td>
</tr>
<tr>
<td>Measured parameters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>✓ Soil PH (good paddy PH 5.5 - 6.5)</td>
</tr>
<tr>
<td></td>
<td>✓ Water Level (for different paddy development stage)</td>
</tr>
<tr>
<td></td>
<td>✓ Water temperature</td>
</tr>
<tr>
<td></td>
<td>✓ Soil EC (good paddy EC 0.1- 2.0 mSiemen/cm)</td>
</tr>
<tr>
<td></td>
<td>✓ Environment temperature and humidity</td>
</tr>
<tr>
<td></td>
<td>✓ Light Intensity</td>
</tr>
<tr>
<td></td>
<td>✓ Battery level</td>
</tr>
<tr>
<td>Maximum measuring range</td>
<td>8km to 13km</td>
</tr>
<tr>
<td>(from GW to sensor nodes)</td>
<td></td>
</tr>
<tr>
<td>LoRa frequency band</td>
<td>915 MHz (900~931 MHz)</td>
</tr>
<tr>
<td>Communication topology</td>
<td>Star-network</td>
</tr>
<tr>
<td>Number of Gateway</td>
<td>1</td>
</tr>
<tr>
<td>Number of Sensor nodes</td>
<td>10</td>
</tr>
</tbody>
</table>
e-PADI sensor node

Start

Initialization

LiPo Gauge Connected

YES

Sensors Ready?

YES

NO

NO

Transmit data through LoRa

Convert Data and combine into single string

Collect Sensor Data

1. Ultrasonic
2. Temperature
3. Humidity
4. Electrical Conductivity
5. PH Sensor
6. Light Intensity
7. Battery LiPo Gauge
8. Water Temperature
e-PADI Gateway:

- Start
  - Initialization
    - Start Lora Serial at 9600 baud rate
    - Input-Output Initialize
  - Wait WiFi Connected
    - Change Lora to setting mode
  - Wait for NodeMCU To Ready
    - Change Lora address to node 1,2,3,4...
    - No Response
      - Combine string to another form of packet before send to WiFi module (NodeMCU)
      - Transmit data to NodeMCU Through Wired Serial Communication
    - YES
      - Wait for Transmitter (Sensor Node) Data
  - NO
    - Transmit data to NodeMCU Through Wired Serial Communication
    - NO
      - Transmit data to NodeMCU Through Wired Serial Communication
Soil pH

Continuous variables (soil pH) measurement on node 1-10
Water Level (centimeters)

Continuous variables (water level) measurement on node 1-10
Paddy Productivity in Metric Tonnes/ha

<table>
<thead>
<tr>
<th></th>
<th>Feb-18</th>
<th>Sep-18</th>
<th>Feb-19</th>
<th>Sep-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL220</td>
<td>5.48</td>
<td>6.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RC2</td>
<td>6.67</td>
<td></td>
<td></td>
<td>6.95</td>
</tr>
<tr>
<td>303</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

National average: 6.35

Target: 6.95

per hectare
e-PADI Ver. 0 (2017)

Data From Sensor Node 1

System Information
Reset Plantation Date

Plant date: 4/20/2018
7 Days (Vegetative Stage)

PH Level: 1.24
Water Level: 40 cm

Water level must be 2 - 5 cm

Paddy is in Stem elongation stage
Testing#1

e-PADI Ver. 0 (2017)

Batu 19, Kampung Sena, Kuala Nerang Kedah

[MASDAR Agro]
e-PADI Ver. 1 (2018)
Site Visit to e-PADI Project at Batu 19, Kampung Sena, Kuala Nerang, Kedah. e-PADI is an IoT-based paddy productivity monitoring and advisory system using a Wireless Network Protocol.

Dr Mohd Nazrin Md. Isa from UNIMAP leads the briefing and demonstrate the project progress to Tuan Haji Aisharuddin Nuruddin and Encik Ismail Osman from MCMC and Puan Zaleha Abu Bakar, MTSFB General Manager.

Date: 20 September 2018
Venue: Batu 19, Kampung Sena, Kuala Nerang, Kedah
Next Plan….PADISensE

- Kompleks Latihan MADA Alor Serdang
  Kampung Selarong Panjang, 06800
  Simpang Empat, Kedah
- Plot 3, 8 dan 11
Current Status (PADISensE)

Region A

Field A

Field B

Field C

Entities

<table>
<thead>
<tr>
<th>Entity name</th>
<th>Entity type</th>
<th>address</th>
<th>latitude</th>
<th>longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field A</td>
<td>Asset</td>
<td>Kampung Selarong Panjang, 06800 Simpang Empat, Kedah</td>
<td>5.993315</td>
<td>100.386117</td>
</tr>
<tr>
<td>Field B</td>
<td>Asset</td>
<td>Kampung Selarong Panjang, 06800 Simpang Empat, Kedah</td>
<td>5.979833</td>
<td>100.386822</td>
</tr>
<tr>
<td>Field C</td>
<td>Asset</td>
<td>Kampung Selarong Panjang, 06800 Simpang Empat, Kedah</td>
<td>5.979507</td>
<td>100.387683</td>
</tr>
</tbody>
</table>

Region A > Field A

Entities

<table>
<thead>
<tr>
<th>Entity name</th>
<th>Entity type</th>
<th>Humidity</th>
<th>Temperature</th>
<th>lightLevel</th>
<th>waterLevel</th>
<th>Battery</th>
<th>ec</th>
<th>ph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device A-1</td>
<td>Device</td>
<td>53.00%</td>
<td>22.50°C</td>
<td>28.00LUX</td>
<td>22.00cm</td>
<td>61.80%</td>
<td>0ms/cm</td>
<td>8.85</td>
</tr>
<tr>
<td>Device A-2</td>
<td>Device</td>
<td>52.90%</td>
<td>22.40°C</td>
<td>27.00LUX</td>
<td>22.00cm</td>
<td>61.80%</td>
<td>0ms/cm</td>
<td>8.77</td>
</tr>
<tr>
<td>Device A-3</td>
<td>Device</td>
<td>53.80%</td>
<td>22.40°C</td>
<td>28.00LUX</td>
<td>22.00cm</td>
<td>61.80%</td>
<td>0ms/cm</td>
<td>8.77</td>
</tr>
</tbody>
</table>
Current Status (PADISensE)
Challenges

“The Future of Farming is about higher productivity and more efficient use of land, water and fertilizer. When everything from sensors to field equipment has the ability to report data back to a central wireless ”location”, the possibilities for better management of crop production, as well as farm operations, are almost endless”.

Source: Kverneland

“....efficiency connectivity from a wide range of sensors with long battery life over reliable, low cost, secure, licensed spectrum”. Source: Huawei-market assessment

Investor view: 4G and 5G farming

“Sensors with computer vision at a granular level can dramatically improve the identification of plants that need extra care. Some of these sensors can be connected to tractors and harvesters and analysed at the edge. However for full field analysis, one would need a 4G/5G network to upload and analyse data in the cloud. A full-stack yield optimisation solution would have sensors, high bandwidth connectivity, and AI-powered analytics. “With the low cost of mobile devices, farm workers can be more productive if they can communicate with their managers, get instructions, complete tasks, and capture images. Field force automation technologies focused on farmers and workers can significantly improve productivity on the farm. To provide full coverage of a farm, a cloud-connected 4G/5G network is required.”

Upal Basu, partner, NGP Capital (pictured)

“For full field analysis and predictions, a 4G/5G network is required to upload and analyse data in the cloud”

Increase and immigration becomes restrictive, farmers will be pushed to seek robotic solutions to their harvesting needs.”
Challenges

- Sensors: cost vs. reliability, maintenance and life span
- Low power sensor nodes vs. real-time monitoring
- Data intensive computation (IoT + AI)
- Different communication protocols
- Weather and geographical location
- Protected vs open field agriculture
- Higher speed and Higher demand
Precision Agriculture: The way forward...

Source: Monsanto