Precision Agriculture and Decision Support Systems in Horticultural Crops

Wolfram Spreer
Chiang Mai University
Precision farming operations

- Seeding
- Spraying
- Fertilizing
- Implement Guidance
- Guidance
- Corrections
- Yield Mapping
- Water Mgmt
- Software
- Telematics
Precision irrigation
Sample collection and geo-referencing

Drying of samples

Soil analyses
Descriptive statistics

interpolation

Soil variability maps
Positioning system

Control system

Solenoid valves

monitoring

Reference map

Leon Mostacero, 2012
Water use of the machine

Application map

Actual application
Control and operation

- Speed Control
- Zone Control
Control and operation

- Remote access to data
- Online control and operation
Automated irrigation
Automated irrigation
Greenhouse irrigation
Automation in greenhouse

- Internet of things
- peer to peer network
Greenhouse

Take me Home Tomato
Pong Yaeng, Chiang Mai
Fertigation
Sensors for precision irrigation

- Climate data for climatic water balance (T, RH, u, Rad)
- Radiation sum
- Plant based sensors
  - Leaf temperature (CWSI)
  - Sap flow
  - Gas exchange
  - Chlorophyll fluorescence
- Soil based sensors
Thermal imaging

Wiriya-Alongkorn
unpublished
Drought stress monitoring by root respiration
Experimental set up
Moisture regime

Volumetric substrate (sand) water content (SWC) of ten split-root potted longan trees.

Wiriya-Alongkorn et al., 2016
Increase in CO$_2$ concentration as indicator for CO$_2$ production by roots and substrate water content (SWC) on the left side (A) and on the right side (B) of split-root potted longan trees.

Wiriya-Alongkorn et al., 2016
Influence of temperature

Average daily ambient temperature and CO$_2$ concentration as indicator for CO$_2$ efflux from the rootzone in the control during the time of experiment.

Wiriya-Alongkorn et al., 2016
Continuous Monitoring of CO$_2$

Spohrer et al., 2016
Need for drainage
GPS basics

- With the help of 3 satellites the GPS Receiver knows its x, y Position

- If 4 or more satellites are used, the GPS Receiver also knows the height z
GPS Basics

Satellite Systems

Accuracy of GPS?
- +/- 5 meters

Possible error sources
- Ionospheric interference
- Reflected Signals (Multipath-error)
- Quality of electronic GPS Hardware
- Unfavorable Satellite Constellation (DOP)

→ Correction signal needed (DGPS)

<table>
<thead>
<tr>
<th></th>
<th>Egnos</th>
<th>RangePoint RTX</th>
<th>CenterPoint RTX</th>
<th>RTK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Path-to-Path</td>
<td>20 cm</td>
<td>15 cm</td>
<td>3.8 cm</td>
<td>2.5 cm</td>
</tr>
<tr>
<td>Year-to-Year</td>
<td>90 cm</td>
<td>50 cm</td>
<td>3.8 cm</td>
<td>2.5 cm</td>
</tr>
</tbody>
</table>

Field operations

<table>
<thead>
<tr>
<th></th>
<th>Egnos</th>
<th>RangePoint RTX</th>
<th>CenterPoint RTX</th>
<th>RTK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spraying / spreading</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Seeding</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Water Management</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
<td>✔</td>
</tr>
</tbody>
</table>
dGPS
Water logging management

**FieldLevel II**
- Optimizes water balance on the field
- Water drains away evenly on the field

**WM-Drain**
- Dehydrates water from the field
Water logging management

**Field Level II**

- Optimized use of water
  - Levelling of fields (+/- 1cm)
  - Removal of hills with water scarcity
  - Straightening depths with surplus water

**WM-Drain**

- Drainage
  - Installation of drainage
  - Controlled water flow
Always 3 steps:

Survey
- Take the boundary of the field
- Drive over the whole field

Design
- Topography is recorded
- Optimized Topography is calculated

Steering
- Begin at the highest point
- Drive in circles
Visualization of flow
Precise field levelling
Combined application
Direct injection
Wiriya-Alongkorn et al.: Influence of water supply on CO$_2$ concentration in the rootzone of split-root potted longan trees
Wiriya-Alongkorn et al.: Influence of water supply on CO$_2$ concentration in the rootzone of split-root potted longan trees
Precision Weed-control

Wegener et al., 2016
Orchard sprayers

- Gap detection
- Recovery
Pesticide application by UAV
Pesticide application by UAV

- Promising technology
- Unsuitable to replace field sprayers
- Potential for SE Asia
- Need for dGPS control