THE ECONOMICAL AND ENVIRONMENTAL EFFECTS OF IMPLEMENTING CTF IN THE VEGETABLE INDUSTRY

(PART OF MY PHD DEFENCE ON: WIDE SPAN TECHNOLOGY FOR EFFICIENT AND ENVIRONMENTALLY FRIENDLY VEGETABLE PRODUCTION)

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Frank W. Oudshoorn
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Top 5 design parameters
- GNSS steering: 7.0%
- Robust and smooth suspension: 6.8%
- Automatic sequential control of functions: 6.0%
- Camera system-covering machine: 5.9%
- High quality components: 5.4%
My CTF journey
Challenges in vegetable production

- High volume (weight) of crops
  Occasional more than 80 ton per ha (i.e.: carrots, onion, cabbage)

- Some crops are often harvested late in the season or in wet conditions

- High value of crop
  -> little insensitive to save costs

Samsø, DK, CTF Europe.eu, 2015
Increasing weight of harvesters

The weight of one front wheel of Claas combine harvesters
Data from Bernhardt et al. (2006); Moitzi and Boxberger (2007) and own estimate

Samsø, DK, CTF Europe.eu, 2015
When harvest traffic is random mechanical repair of the soil is required
Row configuration effects
Less tracks – more room for plants

Conventional 5 x 1.92 m (30 rows) 440,000 pl./ha 21% tracked

CTF 3 x 3.2 m (36 rows) 528,000 pl./ha (+20%) 13% tracked

WS CTF: 9.6 m (39 rows) 572,000 pl./ha (+30%) 6% tracked

Example un illustration: onion drilled at 210 mm row distance

Samsø, DK, CTF Europe.eu, 2015
3. Green house gas effects (GHG)

(Chapter 5 in thesis)

Assessment of Green House Gas emission in relation to the Gross Margin of conventional and different CTF management systems in the Tasmanian vegetable industry

- Objectives:
  - Modify simulation models on economy and GHG emissions to include wide span CTF besides CTF systems based on traditional tractors
  - Estimate the GHG effect of introducing wide span CTF production on vegetable farms

Samsø, DK, CTF Europe.eu, 2015
Parameters for the economy calculation

Table 5.1. Range of variation in input variables, compared to conventional practice.

<table>
<thead>
<tr>
<th>Likely change by</th>
<th>SCTF</th>
<th></th>
<th>CTF (WS and Mixed)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Expected</td>
<td>Min</td>
</tr>
<tr>
<td>Application rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>0%</td>
<td>-5%</td>
<td>-2%</td>
<td>0%</td>
</tr>
<tr>
<td>Fertiliser</td>
<td>0%</td>
<td>-5%</td>
<td>-2%</td>
<td>0%</td>
</tr>
<tr>
<td>Yield change</td>
<td>0%</td>
<td>+5%</td>
<td>+3%</td>
<td>0%</td>
</tr>
<tr>
<td>Modification costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Implements</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soil, drill, spray fertiliser</td>
<td>0%</td>
<td>+30%</td>
<td>+10%</td>
<td>0%</td>
</tr>
<tr>
<td>Contract harvest costs</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

a) the expected change in yield by SCTF and CTF are lower for some crops  
b) Modifications costs for WS implements are assumed lower than for tractor based systems

Price wide span tractors:  
- 200 kW: AU$ 400,000 (€310,000 DKK: 2.3 mill.)  
- 140 kW: AU$ 300,000 (€230,000 DKK: 1.7 mill.)  
- 90 kW: AU$ 200,000 (€155,000 DKK: 1.2 mill.)  

Uncertainty all sizes: +/- AU$ 100,000 (€78,000 DKK: 0.6 mill.)
Reduced tillage intensity by CTF

Establishment of autumn sown onions on case farm 4:

**Conventional:**
- Mouldboard plough
- Ripper
- Power harrow

**Seasonal CTF:**
- Mouldboard plough
- Ripper
- Power harrow

**CTF (Mixed or WS):**
- Ripper
- Light cultivator

Samsø, DK, CTF Europe.eu, 2015
Wide span CTF solutions

A: Full WS CTF system

B: Mixed CTF system

Samsø, DK, CTF Europe.eu, 2015
Five case farms, estimated gross margin

Gross Margin, AUD/ha/year

Case 1  Case 2  Case 3  Case 4  Case 5
Conv SCTF Mixed CTF WS CTF

The bars show the 95% confidence intervals

3. Green house gas effects
Crop results

Samsø, DK, CTF Europe.eu, 2015

Gross margin of crops, AUD/ha/year

-4000 -3000 -2000 -1000 0 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000

- Beans, Case 4
- Broccoli (autumn planted), Case 5
- Broccoli (spring planted), Case 4
- Canola, Case 3
- Carrots, Case 3,4,5
- Onion (autumn sown), Case 3,4
- Onion (spring sown), Case 1
- Peas, Case 1
- Poppies (spring sown), Case 1,3,4,5
- Potatoes, Case 1,4,5
- Pyrethrum Y1, Case 3,5
- Pyrethrum Y2, Case 3,5
- Wheat, Case 3,4,5
- Fallow, Case 1,4,5
- Ryegrass (green manure), Case 1,3,4,5

Conv
SCTF
Mixed CTF
WS CTF

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14 NOVEMBER 2014
# Parameters in the green house gas calculation

**Table 5.2.** List of the GHG emissions that are included in the model as well as the factors that are used to calculate the emissions into CO2 equivalents.

<table>
<thead>
<tr>
<th>Input</th>
<th>Units</th>
<th>On farm</th>
<th>Off farm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel</td>
<td>kg CO2-eq L(^{-1})</td>
<td>2.67</td>
<td>2.89</td>
</tr>
<tr>
<td>Fertiliser manufacture, nitrogen</td>
<td>kg CO2-eq (kg N)(^{-1})</td>
<td></td>
<td>3.3</td>
</tr>
<tr>
<td>Pesticides</td>
<td>kg CO2-eq ha(^{-1}) application(^{-1})</td>
<td>20.5</td>
<td></td>
</tr>
<tr>
<td>Irrigation, low pressure (NEW)</td>
<td>kg CO2-eq ML(^{-1})</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Irrigation, high pressure (NEW)</td>
<td>kg CO2-eq ML(^{-1})</td>
<td>240</td>
<td></td>
</tr>
</tbody>
</table>

Samsø, DK, CTF Europe.eu, 2015
Nitrous oxide emissions from soils

Parameters used in the calculations of nitrous oxide:

- Nitrogen applied in each season (autumn, winter, spring, summer)
- Mean emission factor for NOX (1.25% ; - +/-20%)
- Percentage of area tracked by wheels.
- Placement of fertiliser
  Banded on bed in CTF
- Days when supply of nitrogen is in excess
- The percentage of days with rain during
- Percentage of the rainy days with near to water logged conditions.

Modified after: (Dalal et al., 2003; Rochette et al., 2008)
Five case farms. Estimated green house gas emission

The bars show the 95% confidence intervals

GHG emissions, CO$_2$-eq/ha/year

Samsø, DK, CTF Europe.eu, 2015
GHG by crops

GHG emissions of crops, CO$_2$-eq/ha/year

- Beans, Case 4
- Broccoli (autumn planted), Case 5
- Broccoli (spring planted), Case 4
- Canola, Case 3
- Carrots, Case 3,4,5
- Onion (autumn sown), Case 3,4
- Onion (spring sown), Case 1
- Peas, Case 1
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- Wheat, Case 3,4,5
- Fallow, Case 1,4,5
- Ryegrass (green manure), Case 1,3,4,5

Conv
SCTF
Mixed CTF
WS CTF

Samsø, DK, CTF Europe.eu, 2015
Sources of green house gas emissions

Modified from: Figure 5.4. Sources of GHG emissions, average of the five case farms.
Perspectives
- Wide Span a through history and into the future

Autonomous WS implement carriers: Zentrum für Technisches Design, TU-Dresden

Suitable platform for most agricultural implements

36 m / 12 m slurry distributor / injector. www.mima-invent.com

Samsø, DK, CTF Europe.eu, 2015
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  › Else Torp Christensen
  › Peder Krogsgaard

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And not the least:
› **All the innovative farmers**, that I have meet on my journey

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Samsø, DK, CTF Europe.eu, 2015
Random traffic is not sustainable

“You don’t drive cars over your flowerbeds... We’re driving much heavier machines over the soils we hope to produce crops from and it’s causing a lot of damage”.

Jeff Tullberg