Sustainability assessment of future orchard systems

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Background

- directive 2009/128/EC « sustainable use of pesticides »
  - integrated pest management
    - careful consideration of all methods
    - discourage harmful organisms
    - keep intervention at economically and environmentally level
    - minimise risk to human health & environment

- Orchard system case study
  - goal:
    - develop methodology to assess possible future orchard systems
      - in line with 2009/128/EC
      - quantitative
> Partners

- 5 countries
  - CH, DE, ES, FR, NL
  - 2009 - 2010

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> ‘SustainOS’ methodology

**System description**
Context, Target and Crop protection parameters

**Quantitative assessment methods**
- Life Cycle Analysis (LCA)
- Environmental Risk Assessment (SYNOPS)
- Full cost calculation (Arbokost)

**Rating**
aggregated attributes

**Overall Sustainability**

**Hierarchical attribute tree**

**Rating basic attributes**
of ecological and economic sustainability

(a) System description
(b) Quantitative assessment methods
(c) Rating basic attributes
(d) Hierarchical attribute tree
(e) Overall Sustainability
> Context parameters (29)

- overall quality parameters
  - overall pest management, regional climate, landscape elements, regional pest pressure, soil quality, ecological compensation area
- orchard quality
  - cultivar mixture, training system, orchard size, vigour, pest pressure, fertilisation, mulching between rows, % area under weed control
- infrastructure quality
  - irrigation system, storage, post-harvest treatment, tractor used for spraying
- drift reduction
  - hail net, hedges, drift reducing sprayers
- decision support systems (dss)
  - dss types used, decision making and monitoring
- labour
  - application quality, education and training
Target parameters (31)

- target yield
  - total yield, variability, dramatic yield, portion 1st class, industry, lost
- target price
  - price of 1st class, second class and lost fruit
- quality for resistance management
  - maintenance of resistance, tolerant cultivars, minimising resistance to pathogens and arthropods
- impact on arthropods
  - overall impact on arthropod pests, codling moth, other lepidoptera, aphids, mites, other pests
- impact on diseases
  - overall impact on diseases, apple scab, powdery mildew, fire blight, storage diseases, others e.g. calyx rot, fruit tree canker
- impact on beneficial organisms
  - overall impact on arthropod pests, predatory mites, earwig, Coccinellidae, parasitic hymenoptera
Comparison

- context parameters are region specific
  - no comparison possible between European regions
  - comparison between future orchard systems within a region
- basic quantitative information to describe and assess orchard systems
  - methods to control pests
    o synthetic pesticides
    o non chemical methods
  - date of application
  - dose
  - drift
  - etc.
### Available alternative methods

<table>
<thead>
<tr>
<th>Options</th>
<th>BS chosen options</th>
<th>target organisms</th>
<th>AS1 chosen options</th>
<th>target organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 mating disruption</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>2 attract and kill</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>3 sanitary methods</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>4 massstrapping</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>5 exclosure netting</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>6 EPN (Nematodes)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>7 predators/parasitoids</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>8 resistant varieties/rootstocks</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>9 push and pull plants/cultivars (attractance and repellance)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Insecticides / Acaricides

<table>
<thead>
<tr>
<th>Insecticide group</th>
<th>Active ingredient</th>
<th>kg/l product per ha</th>
<th>% active ingredient</th>
<th>g a.i. per ha</th>
<th>Number of applications</th>
<th>BS treatments</th>
<th>target organisms</th>
<th>Number of applications</th>
<th>BS treatments</th>
<th>target organisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pheromones</td>
<td>codemone a.o.</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>x</td>
</tr>
<tr>
<td>2 granulovirus</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>48</td>
<td>x</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>x</td>
</tr>
<tr>
<td>3 IGR's (moulting inhibitors)</td>
<td>novaluron</td>
<td>0.96</td>
<td>10%</td>
<td>96</td>
<td>0.5</td>
<td>22</td>
<td>48</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>4 IGR's (ecdysone mimics)</td>
<td>methoxyfenozid</td>
<td>0.64</td>
<td>24%</td>
<td>153.6</td>
<td>1</td>
<td>27</td>
<td>153.6</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>5 IGR's (Jh mimics)</td>
<td>fenoxycarb</td>
<td>0.96</td>
<td>25%</td>
<td>240</td>
<td>0.5</td>
<td>20</td>
<td>120</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6 Various</td>
<td>Indoxacarb</td>
<td>0.27</td>
<td>30%</td>
<td>81</td>
<td>1</td>
<td>31</td>
<td>81</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7 neonicotinoids</td>
<td>flonicamid</td>
<td>0.16</td>
<td>50%</td>
<td>80</td>
<td>1</td>
<td>25</td>
<td>80</td>
<td>x</td>
<td>1</td>
<td>17,25</td>
</tr>
<tr>
<td>8 neonicotinoids</td>
<td>thiacloprid</td>
<td>0.32</td>
<td>40%</td>
<td>128</td>
<td>1</td>
<td>20</td>
<td>128</td>
<td>x</td>
<td>x</td>
<td>1,20</td>
</tr>
<tr>
<td>9 organophosphates</td>
<td>chlorpyrifos-ethyl</td>
<td>2.4</td>
<td>23%</td>
<td>552</td>
<td>0.5</td>
<td>17</td>
<td>276</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>10 acaricides</td>
<td>tebufenpyrad</td>
<td>0.32</td>
<td>20%</td>
<td>64</td>
<td>1</td>
<td>20</td>
<td>64</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>11 oil</td>
<td>32</td>
<td>95%</td>
<td>30400</td>
<td>0.25</td>
<td>0.25</td>
<td>12</td>
<td>7600</td>
<td>x</td>
<td>x</td>
<td>(x)</td>
</tr>
<tr>
<td>12 novel insecticide</td>
<td>30400</td>
<td></td>
<td></td>
<td></td>
<td>0.33</td>
<td>12</td>
<td>10032</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

**Note:** Necessary number of sprays (drive trough orchard) 2

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> Example

**endure**

**WAGENINGEN UR**

**PRAKTIJKONDERZOEK PLANT & OMGEVING**
Orchard systems

- 4 apple orchard systems defined
  - base line system (BS)
  - advanced system 1 (AS1)
  - advanced system 2 (AS2)
  - innovative system (IS)

- Base line system (BS)
  - good practices
    - resistance management
    - beneficial organisms
  - pesticides allowed in 2009
    - only synthetic
  - common (susceptible) apple cultivars
  - no drift reduction other than 3 m buffer zone
> Advanced systems

- **Advanced system 1 (AS1)**
  - good and best practices
  - apple scab resistant cultivars
  - mating disruption (codling moth), more hail nets, predatory mites, bio control (e.g. fire blight), cover crop
  - pesticides with low ecotoxicity (more antagonists)
  - drift reduction: 45 % of area

- **Advanced system 2 (AS2)**
  - similar to AS1 + . . .
  - mechanical weeding, exclosure netting, natural fungicides after bloom - no residues
  - drift reduction: 80 % of area
> Innovative system (IS)

- like AS2 + . . .
  - cultivars with multiple resistance
    - apple scab
    - powdery mildew
    - fire blight
    - aphids
  - new pesticides, with
    - selective
    - no effects on non target organisms
Conclusion

- parameters chosen
  - adequate to describe apple orchard systems
  - useful for quantitative data collection
  - collected data
    - can be changed for different situations/conditions, European regions
    - are valid now, but should be renewed, if an assessment is made e.g. 10 years from now

- results
  - apple orchards
  - can be adapted for other crops (PURE)
  - direct policy makers and decision makers

- detailed results in next presentations