Pome fruit case study and orchard system

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> Partners

- 9 countries
  - BE, CH, DK, DE, ES, FR, IT, NL, SE
- 11 major European pome fruit production area

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Introduction

- integrated control well established
  - corner stones
    - spider mites – predatory mites
    - pear psylla – predatory bugs
    - wooly aphids – parasitoids and predators
    - codling moth – mating disruption
    - apple scab – warning system
- IPM practices known versus used
  - inventory on state of the art of IPM methods used
    - questionnaire
    - self expanding network
    - analyses
- orchard system assessment
  - future development
> IFP in pome fruit

- long history - non-the-less: high pesticide use
- a lot of questions
  - what tools are available?
  - to what extent used in practice?
  - bottlenecks
    - why not used?
      - economic, practical, technical
- 3 pomefruit problems with high pesticide demand
  - codling moth (*Cydia pomonella*)
  - apple scab (*Venturia inaequalis*)
  - brown spot of pear (*Stemphylium vesicarium*)
Innovative control of codling moth

- warning systems (DSS)  
  - further development

- pheromone disruption  
  - RAK, Isomate

- virus  
  - granulosis virus

- other techniques
Innovative control of apple scab

- resistant cultivars
- warning systems (DSS)
  - Rimpro
  - further development ongoing
- sanitation
  - survival on fallen leaves
  - leaf shredding
  - urea
  - removing leaves from orchards
- antagonists
  - *Microsphaeropsis*
Brown spot of pear

- *Stemphylium vesicarium*
  - problem since 1980\textsuperscript{th} and increasing
  - north Spain, north Italy, Rhone valley France, Belgium, Netherlands
- leaf drop and fruit rot
Results questionnaire

- only “ready to use” IFP (IPM) methods
  - no method “still under development”
- get realistic data
  - sometimes easy, difficult
  - very variable: difficult to summarise
- judgement
  - lighter color: positive for integrated system
  - darker color: negative
<table>
<thead>
<tr>
<th>IFP tool</th>
<th>no. regions</th>
<th>use in practice</th>
<th>obstacles</th>
</tr>
</thead>
<tbody>
<tr>
<td>pheromone traps</td>
<td>all</td>
<td>5 – 100</td>
<td>none</td>
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<tr>
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<td>1 – 100</td>
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<tr>
<td>monitoring damage H</td>
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<tr>
<td>corrugated cardboards</td>
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<td>dss – adults</td>
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<td>dss – oviposition</td>
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<tr>
<td>dss – larval emergence</td>
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<tr>
<td>dss – generations</td>
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<tr>
<td>dss – thresholds</td>
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<td>70</td>
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## Summary Codling Moth 2

<table>
<thead>
<tr>
<th>IFP Tool</th>
<th>No. Regions</th>
<th>Use in Practice</th>
<th>Obstacles</th>
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<tr>
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<tr>
<td>Sanitation</td>
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<td>0 – 50</td>
<td>Labour</td>
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<td>Labour, Economic, Practical</td>
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<td>Practical</td>
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<td>Combinations</td>
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<td>Priority IGR’s</td>
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<td>IFP tool</td>
<td>no. regions</td>
<td>use in practice</td>
<td>obstacles</td>
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<tr>
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<td>technical</td>
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<td>none</td>
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<tr>
<td>alternation</td>
<td>all</td>
<td>90</td>
<td>none</td>
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<td>resistant cultivars</td>
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<td>economic, practical</td>
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## Summary apple scab

<table>
<thead>
<tr>
<th>IFP tool</th>
<th>no. regions</th>
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<th>obstacles</th>
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<td>economic, technical</td>
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<tr>
<td>monitoring</td>
<td>90</td>
<td>10 – 70</td>
<td>labour</td>
</tr>
<tr>
<td>decision support</td>
<td>all</td>
<td>50 – 100</td>
<td>none</td>
</tr>
<tr>
<td>sanitation</td>
<td>all</td>
<td>0 – 70</td>
<td>labour</td>
</tr>
<tr>
<td>chemical control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>protectant fungicides</td>
<td>all</td>
<td>100</td>
<td>none</td>
</tr>
<tr>
<td>alternation</td>
<td>all</td>
<td>90</td>
<td>none</td>
</tr>
<tr>
<td>resistant cultivars</td>
<td>none</td>
<td>0</td>
<td>none</td>
</tr>
</tbody>
</table>
Conclusions questionnaire

- knowledge IFP methods: quickly and well spread
- spreading: governmental or private
  - extension services or advisors
- decision support systems: widely used
  - information by modern communication (SMS, e-mail, website)
- ready to use IPF tools: used everywhere in Europe
  - no differences between northern or southern regions
- resistant cultivars: not used!
  - except organic growers
- lack of selective pesticides
- registration of products is tedious and costly

- hindrances to implement: e.g. economic & labour
  - development: assessment methodology orchard systems
> 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
> ‘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**
  - Rating basic attributes of ecological and economic sustainability

- **Overall Sustainability**
  - Overall Sustainability rating

- **Hierarchical attribute tree**
  - (a)
  - (b)
  - (c)
  - (d)
  - (e)
> 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
> Parameters

- context parameters
  - overall quality parameters
  - orchard quality
  - infrastructure quality
  - drift reduction
  - decision support systems (dss)
  - labour

- target parameters
  - target yield
  - target price
  - impact on arthropods
  - impact on diseases
  - impact on beneficial organisms
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
    - synthetic pesticides
    - non chemical methods
  - date of application
  - dose
  - drift
  - etc.
### Example

#### 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>x</td>
<td>x</td>
</tr>
<tr>
<td>2 attract and kill</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>3 sanitary methods</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 masstrapping</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5 enclosure netting</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6 EPN (Nematodes)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7 predators/parasitoids</td>
<td>-</td>
<td>-</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>8 resistant varieties/rootstocks</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>9 push and pull plants/cultivars</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Insecticides / Acaricides

<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>Insecticide group</td>
<td>treatments</td>
<td>g Al per ha and season</td>
<td>Number of applications</td>
<td>calendar week</td>
</tr>
<tr>
<td>Active ingredient</td>
<td>Number</td>
<td>g Al per ha and season</td>
<td>Number of applications</td>
<td>calendar week</td>
</tr>
<tr>
<td>kg/l product per ha</td>
<td>% active ingredient</td>
<td>g a.i. per ha</td>
<td>calandar week</td>
<td>g Al per ha and season</td>
</tr>
<tr>
<td>1 pheromones</td>
<td>codlemone a.o.</td>
<td>0 g Al</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td>2 granulovirus</td>
<td>0</td>
<td>0 g Al</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>3 IGR's (moulting inhibitors)</td>
<td>novaluron</td>
<td>0.96% 96 g Al</td>
<td>0.5</td>
<td>22</td>
</tr>
<tr>
<td>4 IGR's (ecdysone mimics)</td>
<td>methoxyfenozid</td>
<td>0.64% 153.6 g Al</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>5 IGR's (Jh mimics)</td>
<td>fenoxycarb</td>
<td>0.96% 240 g Al</td>
<td>0.5</td>
<td>20</td>
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<tr>
<td>6 various</td>
<td>indoxacarb</td>
<td>0.27% 81 g Al</td>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>7 neonicotinoids</td>
<td>flicamid</td>
<td>0.16% 80 g Al</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>8 neonicotinoids</td>
<td>thiacyclid</td>
<td>0.32% 128 g Al</td>
<td>1</td>
<td>20</td>
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<tr>
<td>9 organophosphates</td>
<td>chlorpyrifos-ethyl</td>
<td>2.4% 552 g Al</td>
<td>0.5</td>
<td>17</td>
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<td>10 acaricides</td>
<td>tebufenpyrad</td>
<td>0.32% 64 g Al</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>11 oil</td>
<td>32</td>
<td>95% 30400 g Al</td>
<td>0.25</td>
<td>12</td>
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<td>12 novel insecticide without non-target effects</td>
<td>?</td>
<td>?</td>
<td>0.25</td>
<td>12</td>
</tr>
</tbody>
</table>

**Necessary number of sprays (drive trough orchard)**

2
> 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