Innovative IPM in pome fruit and strategies for implementation

Bart Heijne, Aude Alaphilippe, Vittorio Rossi, Imre Holb, Tito Caffi, Gabriele Fortino, Sylvaine Simon, Jan Buurma, Wil Hennen, Jörn Strassemeyer, Martina Mayus
Overview of the presentation

- introduction of PURE
  - Pesticide Use-and-risk Reduction in European farming systems with Integrated Pest Management
  - FP7, March 2011 – March 2015

- Françoise Lescourret, INRA, France
- first results Innovative pome fruit
- stakeholder interactions
PURE objectives

- scientific knowledge to design future solutions
  - based on innovative research in challenging fields
- toolbox of approaches, methods and tools for implementing efficient IPM solutions (flexibility)
- provide practical IPM solutions to reduce dependence on pesticides (farming system-specific)
  - design and test in real conditions
  - goal: robustness
Guiding principles

- solutions concretising the « Integrated» of IPM
  - solutions = combinations of tactics and strategies
  - systems approach

- design-evaluation-adjustment process
Pure dynamics

Task 1
IPM design with stakeholders

Task 2
Ex-ante assessment including stakeholder input

Task 3a
On station experimentation

Task 3b
On-farm experimentation

Task 4
Ex-post assessment including stakeholders input

6 x WP
- Wheat based
- Maize based
- Field Vegetable
- Pome fruit
- Grapevine
- Protected vegetables

Pillar 1
Design-Assessment-Adjustment cycle
Pure dynamics

Pillar 3
Dissemination and Co-innovation

WP12
Dissemination

WP13
Co-innovation

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61x505
Pillar
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Pillar 1
Design-Assessment-Adjustment cycle

Pillar 2
New knowledge & technologies for IPM

4 x WP
- Pest evolution
- Plant-pest-enemies interactions
- Ecological engineering
- Emerging technologies

New knowledge or technologies

In-field evaluation

6 x WP
- Wheat based
- Maize based
- Field Vegetable
- Pome fruit
- Grapevine
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Test and Development

Design and refining of New knowledge and technologies

Pure dynamics
Work Package 5

- Innovative IPM pome fruit systems
- Implement an innovative system (multipest)
  - Initially focus on key pests
  - Ultimately aiming at integration innovative IPM tools into system strategies
- Repetitive cycle
  - Design IPM strategy, testing, assessing, redesign
- Ex-ante and ex-post assessment of IPM strategies
  - Over-all, economic, environmental & health risks
- Stakeholder interaction
WP 5 pome fruit subjects

- scab – apple: Imre Holb - Hungary
- codling moth – apple: Aude Alaphillipe - France
- brown spot – pear: Vittorio Rossi - Italy
- pear psylla – pear: Herman Helsen – Netherlands
ex-ante, ex-post evaluation

- overall assessment – DEXiPM
  - Gabriele Fortino – INRA, France

- environment - SYNOPS
  - Jörn Strassemeyer - JKI, Germany

- economic - PREMISE
  - Wil Hennen – LEI, Netherlands
  - Jan Buurma – LEI, Netherlands
Integrated apple scab management

- sanitation measurements
  - urea, Vinasse at leaf fall
  - leaf shredding
- antagonists: reduction inoculum winter
  - Athelia
  - Microsphaeropsis
- environmental friendly products
  - plant extracts
  - potassium bicarbonate
Efficacy of H39 on apple scab

apple scab incidence on leaves

- treat 1
- treat 2
- treat 3
- treat 4
- standard
- untreated

Legend:
- a
- b
- c
Innovative management brown spot of pear

- *Stemphylium vesicarium* – *Pleospora allii*
- leaf infestation – leaf drop
- fruit infestation – fruit rot
- severe damage Italy, Spain
- incidental damage Belgium, Netherlands
Non-chemical methods to reduce the inoculum of *Stemphylium vesicarium*

- Conference leaves collected at leaf fall from pear orchard not affected by brown spot (autumn)
- autoclaved & inoculated with *S. vesicarium*
- 2-days incubation
- treated
- leaves exposed outdoor
  a grass
- randomised block design
  3 replicates
Leaf degradation

- Degradation leaf litter
  - periodically: from leaf fall
  - to complete degradation in the summer
Leaf degradation in time

- Sv
- treat 1
- treat 2
- treat 3
- treat 4
- treat 5
- Untreated control

Day

AULDC
total AULDC (Area Under Leaf Degradation Curve)

Sv     treat 1     treat 2     treat 3     treat 4     treat 5     Untreated

15000 a a
14000 14500 b b
13000 13500 b
12500
11500 12000 12500 13000 13500 14000 14500 15000
Total conidia of *Stemphylium vesicarium*

![Bar chart showing total conidia percentage](chart.png)
Effects of codling moth exclusion netting

- efficacy on codling moth
- effect on rosy apple aphid
- effect on beneficials (natural enemies predating in rosy apple aphid colonies, predation and parasitism on eggs of codling moth)
Exclusion netting: on station

Mean rosy apple aphid number per shoot (total) (winged forms)

120 110 100 90 80 70 60 50 40 30 20 10 0

15-Apr 22-Apr 29-Apr 6-May 13-May 20-May 27-May 3-Jun 10-Jun 17-Jun

NETS UNCOVERED NETS winged forms UNCOVERED winged forms
Exclusion netting: on station

mean number of natural enemies of rosy apple aphid per shoot

- Other
- Cecidomyiidae
- Coccinellidae
- Syrphidae
- Miridae & Anthocoridae
DEXi software (1)

- Allows analysing a complex decision problem breaking it into smaller thematic attributes organised hierarchically in a decision tree.
attributes scored: qualitative (high, medium, low)
aggregated through utility functions (if-then qualitative rules): weight of attribute on upper one
## Decision rules

<table>
<thead>
<tr>
<th>Economical sustainability</th>
<th>Social sustainability</th>
<th>Environmental sustainability</th>
<th>Overall sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>33%</td>
<td>33%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
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<td>Low</td>
<td>Medium</td>
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<td>Medium</td>
<td>Very high</td>
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</tr>
</tbody>
</table>
Conclusion and perspective DEXi fruit

- model is a research tool: continuously improved
- 1st version transferred to specialist
- to be tested and used as an assessment tool
- structure, criteria, aggregation rules, etc. feedback
- further improvements will be implemented spring-summer 2013
PREMISE; economic model for ex-ante assessment

- goal: ex-ante evaluation IPM solutions orchards
- start prototype; case scab in apples NL
- PREMISE is a chain risk model with 3 stages:
  - link epidemiology to economy
    - quiescence (saprophytic)
    - ascospore (primary)
    - conidia (secondary)
- situation on farm: conditions and measures
Specification: 3 types of variables

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Measures</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>(fixed variables)</td>
<td></td>
<td>(result variables)</td>
</tr>
<tr>
<td>Climate</td>
<td>Leaf shredding</td>
<td>Infestation level</td>
</tr>
<tr>
<td>Cultivars (susceptibility)</td>
<td>Urea / vinasse</td>
<td>Infected fruits</td>
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<tr>
<td>Planting density (shadow)</td>
<td>Antagonist</td>
<td>Labour costs</td>
</tr>
<tr>
<td>Grower skills (including decision support systems)</td>
<td>Fungicide A + features</td>
<td>Machine costs</td>
</tr>
<tr>
<td>Soil activity (earth worms, soil microflora, manure use)</td>
<td>Fungicide B + features</td>
<td>DSS/advisory costs</td>
</tr>
<tr>
<td>Inoculum (ascospores, leaf infection, fruit infection)</td>
<td>Fungicide C + features</td>
<td>Number of sprays</td>
</tr>
<tr>
<td>Regional road</td>
<td>Driver</td>
<td>Kinds of fungicides</td>
</tr>
<tr>
<td></td>
<td>Linkages with Synops</td>
<td>Risk potential</td>
</tr>
<tr>
<td></td>
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<td>• environment</td>
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<tr>
<td></td>
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<td>• workers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• consumers</td>
</tr>
<tr>
<td></td>
<td>Dashboard</td>
<td>Orchard stars</td>
</tr>
</tbody>
</table>

Dashboard data provide basis for ex-ante comparison
PREMISE: Example 1st stage

CONDITIONS

Stage 1: Quiescence

- # leaf litter wetness days winter: < 30
- soil activity (%org.matter topsoil): < 1%
- # sprays after harvest in last season: 1
- PAD from last season: medium (201-1000)

Three lines

- Reference: worst case, conditions have worst value
PREMISE: Example 1st stage

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MEASURES

- Leaf shredding: 1
- Leaf removal: 1
- Urea: 2
- Antagonist: 0
- Vinasse: 1
- Fungicides [all stages!]: 1

Three lines

- Reference: worst case, conditions have worst value
- Conditions only: actual condition value (below ref.)
- Effect: measures improve situation at condition
PREMISE: Effect of measures

- **Stage 1: Quiescence**
  - Severe: High
  - High: Moderate
  - Moderate: Fairly Low
  - Fairly Low: Low
  - Low: Low

- **Stage 2: Ascospores**
  - Severe: Low
  - High: Fairly Low
  - Moderate: Low
  - Fairly Low: Low
  - Low: Low

- **Stage 3: Conidia**
  - Severe: Low
  - High: Low
  - Moderate: Low
  - Fairly Low: Low
  - Low: Low

- **Leaf shredding**
  - Urea: 0
  - Vinasse: 1
  - Fungicides [all stages]
Uncertainty
not 1 outcome-class but membership value (%) for more classes -- fuzzy sets
PREMISE: cost-benefit analysis

Questions PREMISE may answer:

- Is application of measure X cost-effective?
- Does investment for measure X pay off?
- IPM solution A compared to IPM solution B?
Stakeholder interaction
Acknowledgement

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- my co-authors
Thank you for your attention