Innovative IPM in pome fruit and strategies for implementation

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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

Pillar 1
Design-Assessment-Adjustment cycle

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

IPM Solutions

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

Pillar 2
New knowledge & technologies for IPM

Test and Development

Design and refining of New knowledge and technologies

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

New knowledge or technologies

In-field evaluation

Task 1
IPM design with stakeholders

Task 2
Ex-ante assessment including stakeholder input

WP12
Dissemination

WP13
Co-innovation

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

IPM Solutions

Task 3a
On station experimentation

Task 3b
On-farm experimentation

Pillar 1
Design-Assessment-Adjustment cycle

Task 4
Ex-post assessment including stakeholders input

Pillar 3
Dissemination and Co-innovation
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: 30
- Treat 2: 40
- Treat 3: 50
- Treat 4: 40
- Standard: 60
- Untreated: 80

Letters indicate significant differences:
- Treat 1 and Treat 2: 'a'
- Treat 3: 'c'
- Treat 4: 'b'
- Standard: 'a'
- Untreated: '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

![Graph showing leaf degradation over time with different treatment groups.]

- **AULDC** vs. **Day**
- **Sv**, **treat 1**, **treat 2**, **treat 3**, **treat 4**, **treat 5**, and **Untreated control** are represented.

The graph illustrates the degradation of leaves over time, with each line representing a different treatment group.
total AULDC (Area Under Leaf Degradation Curve)

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

Categories: a, b, c

Legend:
- a
- b
- c
Total conidia of *Stemphylium vesicarium*
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) vs. winged forms

- **NETS**
- **UNCOVERED**
- **NETS winged forms**
- **UNCOVERED winged forms**

Dates:
- 15-Apr
- 22-Apr
- 29-Apr
- 6-May
- 13-May
- 20-May
- 27-May
- 3-Jun
- 10-Jun
- 17-Jun
Exclusion netting: on station

mean number of natural enemies of rosy apple aphid per shoot

- Other
- Cecidomyiidae
- Coccinellidae
- Syrphidae
- Miridae & Anthocoridae

![Graph showing mean number of natural enemies of rosy apple aphid per shoot with different species categories.](image)
DEXi software (1)

- Allows analysing a complex decision problem breaking it into smaller thematic attributes organised hierarchically in a decision tree.
assessment tool DEXiPM

- **Overall sustainability**
  - Environment
  - Economy
  - Social

- **Multi-criteria assessment**
  - Aggregated attributes
  - Input attributes

- **DEXiPM**
  - Qualitative aggregation based on decision rules/weights

- **Prototypes adaptation**

- **Pest management system design**
  - System Description
    - Current System (CS)
    - Alternative system (AS)
    - Innovative System (IS)

- **Context**
- **Cropping system**

- **Quantitative Assessment Methods**
  - Social assessment
  - Econ. assessment
  - Environ. assessment
    - Life Cycle Assessment (LCA)
    - INDIGO
    - Other methods

- Set values for input criteria
  - a) Qualitative
  - b) Quantitative
Lay-out DEXi

- attributes scored: qualitative (high, medium, low)
- aggregated through utility functions (if-then qualitative rules): weight of attribute on upper one

Diagram:

- Sustainability
  - Environmental sustainability
  - Economical sustainability
  - Social sustainability

Weight:
- Very low
- Low
- Medium
- High
- Very high
## Decision rules

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DEXi Pomefruit overview

Overall sustainability
- Input attributes
- Aggregated attributes

Environmental sustainability
- Resource use
- Biodiversity
- Environmental quality

Economical sustainability
- Real profitability
- Viability
- Production chain

Social sustainability
- Fruit grower
- Society

Environmental sustainability
- Water use
- Energy use
- Land use
- Non-renewable fertilizers

Economical sustainability
- Functional aerial biodiv.
- Flora
- Air quality
- Water quality
- Soil quality

Social sustainability
- Potential profitability
- Production risk

Overall sustainability
- Stability
- Investment
- Technical support
- Access to inputs
- Access to output market
- Health risks
- Operational difficulties
- Job gratification
- Accessibility of product
- Acceptance
- Landscape perception
- Employment
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

**Conditions** (fixed variables)
- Climate (infection periods)
- Cultivars (susceptibility)
- Planting density (shadow)
- Grower skills (including decision support systems)
- Soil activity (earth worms, soil microflora, manure use)
- Inoculum (ascospores, leaf infection, fruit infection)

**Measures** (control variables)
- Leaf shredding
- Urea / vinasse
- Antagonist
- Fungicide A + features
- Fungicide B + features
- Fungicide C + features

**Indicators** (result variables)
- Infestation level
- Infected fruits
- Labour costs
- Machine costs
- DSS/advisory costs
- Number of sprays
- Kinds of fungicides
- Risk potential
  - environment
  - workers
  - consumers
- Orchard stars

Dashboard data provide basis for ex-ante comparison

**Dashboard**

**Linkages with Synops**
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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PREMISE: Example 1st stage

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**MEASURES**

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

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
PREMISE: Outcome

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