# Understanding the Requirements of a Decision Support System for Integrated Production in Agriculture

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## Outline

- **The Problem Domain**
- **Understanding the Domain**
  - » Main questions
  - » Domain analysis: Actor / goal modeling
- **The Decision Support System**
  - » Main requirements
  - » Changes in domain organizations
- **Conclusion**

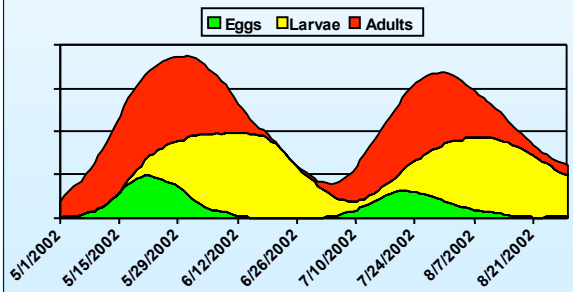
## The Integrated Production Domain

- **I**ntegrated **P**roduction in Agriculture consists of a set of practices aimed at favoring the set up of a development model characterized by a reduced environmental impact.
- **Plant Disease management**, according to IP, consists in using low-impact and/or natural techniques to maintain the disease damage of a crop under a specific tolerance threshold.
- Developing DSS at support of IP application requires to take into account **two main dimensions of complexity**:
  - the organizational dimension dealing with all the dependencies among domain stakeholders involved in management tasks (e.g. the producers, the technicians of the advisory service, government agencies);
  - the technical dimension concerning the modeling of environmental phenomena.



## The Apple Codling Moth (*apple bug*) case

- a critical pest for apple
- it is resistant to pesticides
- specialized chemicals for eggs /larvae/ adults
- pest management requires a high number of actions in a season




The CM life cycle in Trentino:

- at least **2 generations**
- **critical events**: the starting of egg-drop
- qualitative models for predicting the pest evolution tend to fail due to the area' s **heterogeneous orography**

## Understanding the Domain

**Main questions**

**Who** performs the management activities? **Why**?

Are there any organizational **processes** these activities rest on? or Who **depends on** whom **for** what?

What are the critical **info/knowledge**?

Which are most the critical, **decisional steps** in these processes?

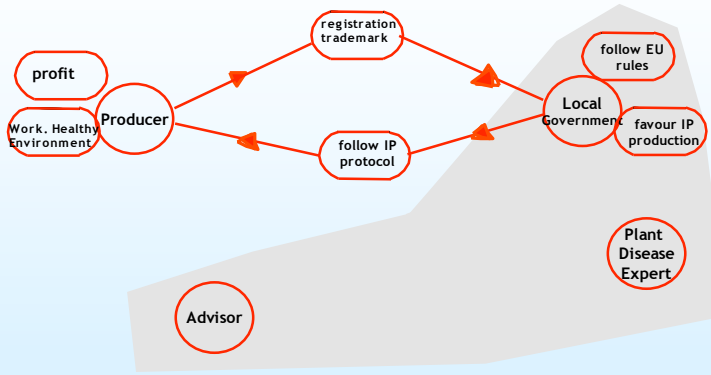
Are there **alternative** ways to perform a decision making steps?

**Which decision** could be supported by a DSS? **Who** will be the user?

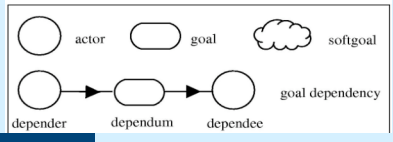
**Analysis approach** Interviews of producers, technicians and domain experts, acquisition of domain documentation.
Analysis of actor roles and of the strategic dependencies between actors, goal-analysis, plan-analysis.



## Actor / goal modeling
Domain stakeholders




**Geographic distribution of actors needs to be taken into account.**

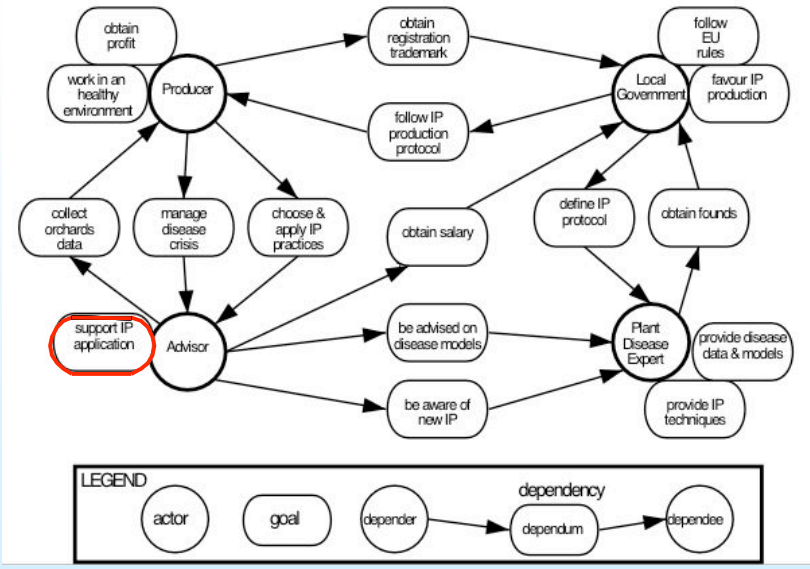


# IP domain strategic dependencies

- The **Local Government** funds an *Advisory Service* to support the producers in using IP practices and *research* on novel agronomic techniques
- Where does the strategic dependencies between **Advisor** and **Producer** come from?
- What is the role of the **Plant Disease Expert** in the strategic dependency network?



# IP domain strategic dependencies cntd



# Management of the Apple Codling Moth

Before eggdrops | I generation | II generation

Preventive actions

Using **P**heromone **T**rapping systems to lower mating

Periodic assessment of the infection degree and choice of a remedy action (disease management *plan*)

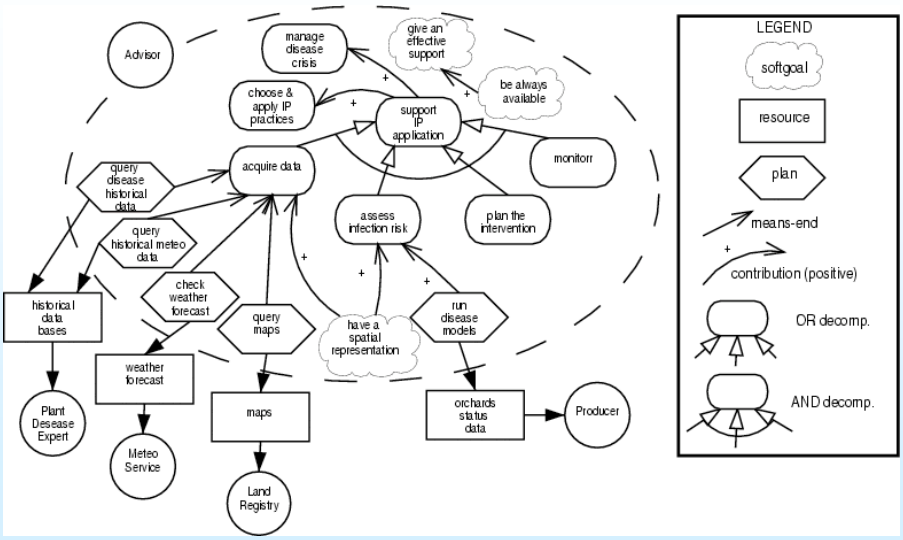
**What are the data and knowledge these management activities rest on? And who owns them?**

**geometrical features** of the orchards and information on the presence of **infection sources**, **diffusion barriers** are needed to design a PT system

**models to predict** the disease evolution on the basis of a limited set of environmental data will support the definition of more effective disease management plans

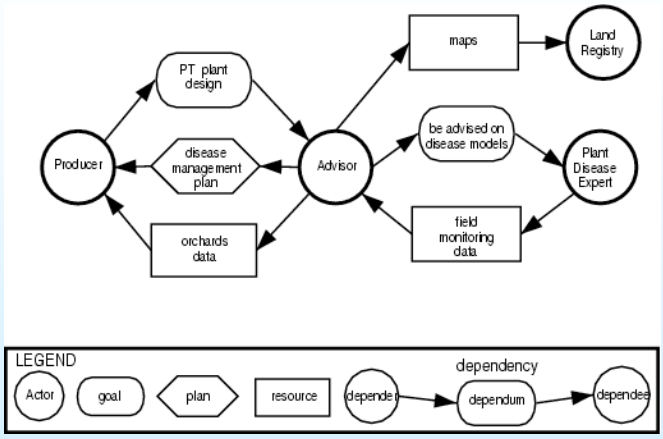


# The Advisor goals



# IP domain strategic dependencies

Focusing on the CM case




The Producer delegates to the Advisor the goal of designing an appropriate PT system for her/his orchard.
The Advisor depends on the Producer to get the necessary data on the orchard.



# The DSS for the Management of the Apple CM

| Before eggdrops | I generation | II generation |
|---|---|---|

Preventive actions

Using **P**heromone **T**rapping systems to lower mating

The **advisor** uses orchards **maps** and takes into account **geometrical features** and information on the presence of **infection sources**, **diffusion barriers**, etc. to design a PT system

Periodic assessment of the infection degree and choice of a remedy action (disease management *plan*)

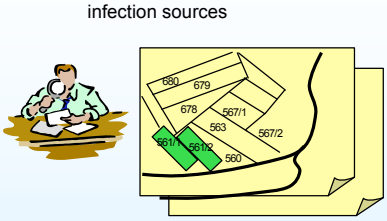
On the basis of a regular collection of data,

- the **expert** defines models to predict the disease evolution,
- the **advisor** identifies alerting events that will be communicated to the producers

**The DSS users and tasks**

# Designing a Pheromone Trapping system

Analyze production data and identify infection sources




Production info

Ton 561/1 Melo m9
Ton 561/2 Melo m9
… … … …
… … … …
… … … …

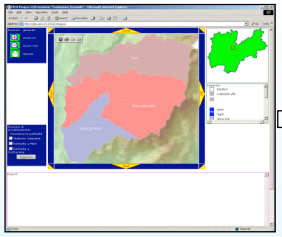
Get geographical and land registry's maps

Report on Pheromone usage on the area

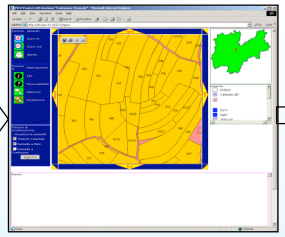
| *Town* | *Particella* | *rootstock* | *#dispenser* |
|---|---|---|---|
| Ton | 561/1 | m9 | 200 |
| … | … | … | … |



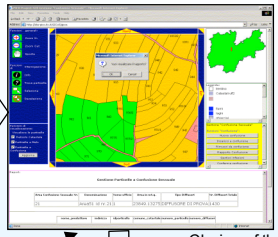
# GIS based design of a PT system



Area managed by the advisor

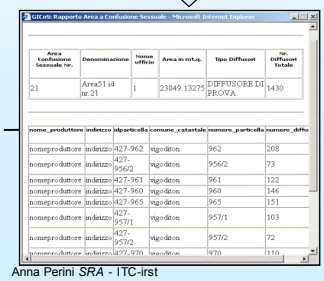


Production info for this area

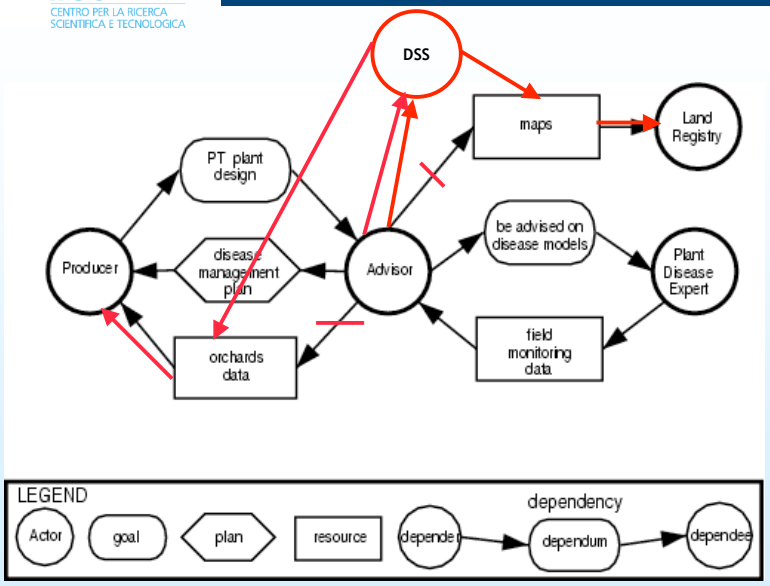


Choice of the orchards where PT will be installed

Report of PT features for the area



## How does it affect the IP strategic dependencies?



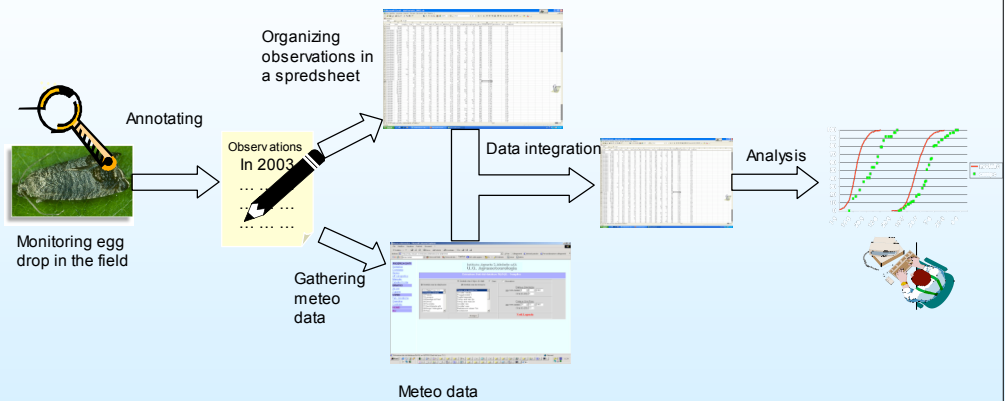

**It will acquire data on behalf of the advisor (the user)**

**It will make orchard data directly available to the advisors. These data are collected by producers organizations in a DB accessed by the DSS**

**It will support also "novice" technicians to do a good job**



## Collecting and analyzing seasonal data



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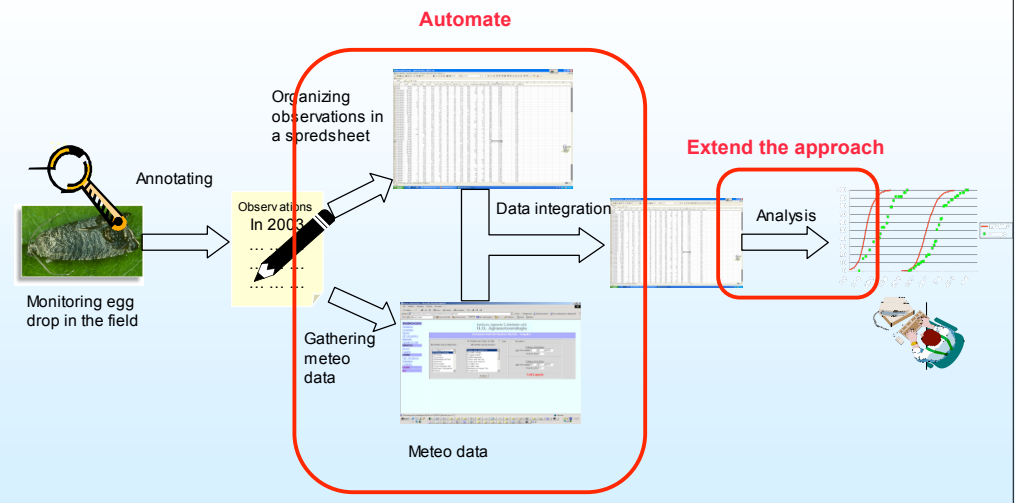
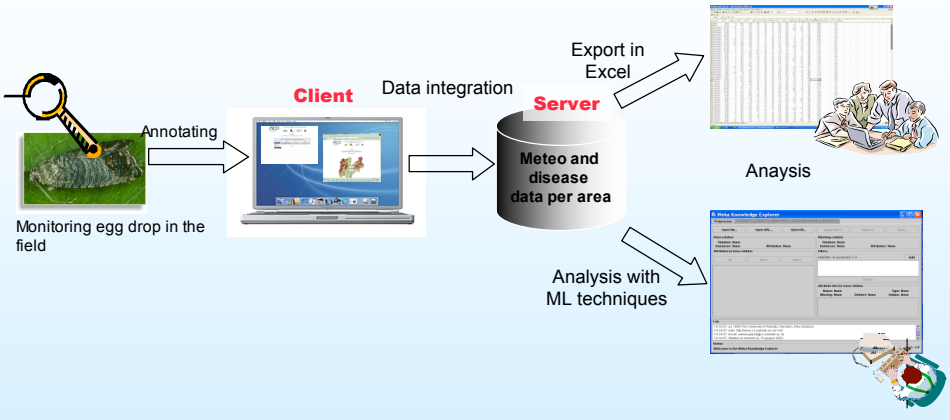
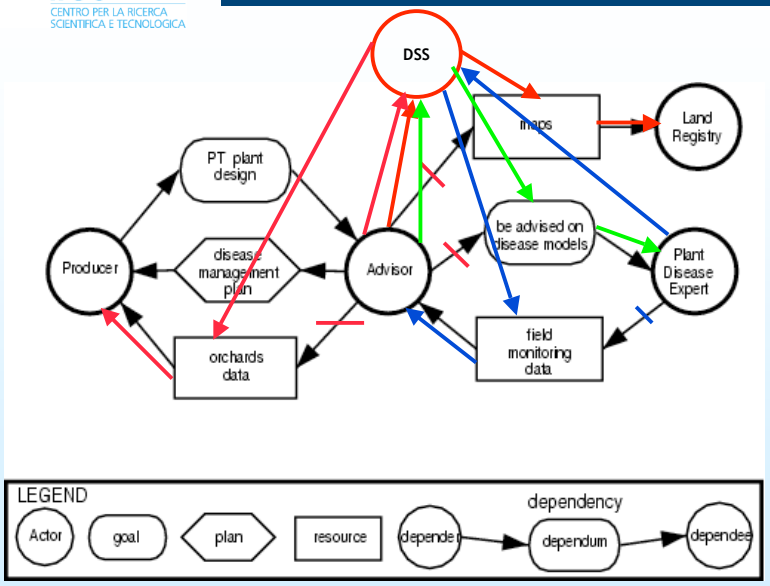





# The DSS supporting data collection and analysis for disease management plan definition



## How does it affect the IP strategic dependencies?




It will acquire data on behalf of the advisor (the user)

It will make orchard data directly available to the advisors. These data are collected by producers organizations in a DB accessed by the DSS

It will support also "novice" technicians to do a good job

**It will provide the advisor with new disease models and made available to the experts data produced by the advisors.**



## Conclusion

- An agent-oriented software development methodology which provides **intentional analysis** techniques has been used for:
  - understanding the strategic interests of domain stakeholders and their mutual dependencies for goal achievement;
  - analyzing the system requirements and the architecture.
- Lessons learned:
  - An organization model can be effective in supporting the communication between the analysts and the domain stakeholders (including users)
  - Allow to model (and reason on!) process reengineering

# Acknowledgment and References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- Papers

  - Perini, Anna; Susi, Angelo, "Supporting Decision Making in Plant Disease Management", Published in Proceedings of the 4th Workshop on Binding Environmental Sciences and Artificial Intelligence [BESAI'2004], pp. 3-1/3-7. Ref. No. P04-10-03
  - A. Perini and A. Susi. Designing a Decision Support System for Integrated Production in Agriculture. An Agent-Oriented approach. Environmental Modelling and Software Journal, 19(9), September 2004.