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

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Outline

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• Understanding the Domain
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  » Domain analysis: Actor / goal modeling
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  » Main requirements
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The Integrated Production Domain

- Integrated Production 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.
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?
Management of the Apple Codling Moth

Preventive actions
Using Pheromone Trapping 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

[Diagram showing the Advisor goals with various nodes and arrows]
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

Preventive actions
Using Pheromone Trapping systems to lower mating

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

Monitoring egg drop in the field

Annotating observations in a spreadsheet

Gathering meteo data

Observations in 2003

Data integration

Analysis

Meteo data
Collecting and analyzing seasonal data

Automate
- Monitoring egg drop in the field
- Annotating observations in a spreadsheet
- Data integration
- Meteo data
- Observations in 2003
- Analysis

Extend the approach
- Gathering meteo data
- Exporting data in Excel
- Analysis with ML techniques

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

- Monitoring egg drop in the field
- Annotating
- Data integration
- Client
- Meteo and disease data per area
- Server
- Analysis
- Export in Excel
- Analysis with ML techniques
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
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