Decision Support Systems in agriculture

Need to take decisions and make critical day-to-day and long-term planning on farm management (strategic and tactical).

Support have to be relevant, timely, user-friendly to assist and manage crop cultivation. DSS offer scientific-technical tools often developed by multidisciplinary teams to combine to skills and experience.
A challenge is how to feed an incoming population of 9 B. To meet the demand without significant increases in prices, the need is to produce 70–100% more food, in the light of growing impacts of cc, concerns over energy security, and the Millennium Development target of halving world poverty-hunger by 2015.

The goal is no longer simply to maximize productivity, but to optimize across a far more complex landscape of production, rural development, environmental, social justice and food consumption outcomes.
The top 100 questions of importance to the future of global agriculture

1: **Natural resource inputs**: Climate, water, soil nutrition, erosion, biodiversity, ecosystem services and conservation, energy, climate change and resilience

   *What are the predicted impacts of cc on yield, cropping practices, crop diseases, irrigation…?*
   *What approaches can be developed to increase water use efficiency in agriculture and what is the cost-effectiveness of this approaches?*

2: **Agronomic practice**: production systems and technologies, genetic improvement, P & D management, livestock

   *How we can accelerate the rate of technological change to propel sustainable production? Which approaches to P&D are the most economically and socially sustainable?*
3: **Agricultural development**: networking, solidarity, reciprocity and exchange, farmer participation in technological development.

Farmers involvement enables novel technologies and practices to be learned directly, adopted and adapted. Agricultural and agrometeorological extension services are vital elements to address needs and provide critical services.

4: **Markets and consumption**: food supply chain, food standards, LCA, energy, C footprint, environmental impact.

As energy prices rise, how can agriculture increase its efficiency and use fewer inputs to become economically sustainable and environmentally sensitive, yet still feed a growing population?
Climate resource
Water resource
Genetic resource
Energy resource
Landscape resource
Human resources
Economic resources

New-light technologies, saver innovation, DSS
Crop protection
Crop production
Crop quality
Environmental impact
Mean Annual Losses to Weather Hazards in the United States

- Frost
- Flood
- Drought
- Hail
- Hurricane
- Tornado
- Windstorm
- Lightning

$ per capita

Hazard
Spring frosts: when temperature falls below the melting point (0°C) sensitive crops can be injured.
Whether or not there is frost damage at a particular minimum temperature species, crop variety, hardening, cultural practices (pruning, fertilization, irrigation), INA bacteria, weather conditions.

It occurs in most countries with temperate climates and even in tropical countries at high elevations.
Advices for frost protection

Define meteo & micromet conditions during frost events

Define the most appropriate methods for protection in relation to the climatic hazard and sustainable resources management

Develop instruments able to evaluate the risk

Support farmers in avoiding or mitigating the detrimental effects (active-passive protection)
Foreword to Agricultural Meteorology by Sir John Stuart Forbes of Pitsligo

The Transactions of the Highland and Agricultural Society of Scotland
July 1853 - March 1855

effects. Thus, shelter is indispensable for tempering our climate; but when too close or continued, especially in low situations, the want of circulation condenses the moisture into hoar-frost, and checks early vegetation. So drainage increases
WHY DSS??

Awareness of the risk

Passive protection

Selection of low-risk sites !!!!

Crop selection
Regional topoclimatic model including phenological and growth models to be used operationally

- Define the risk maps for the various crops
- Weekly agrometeorological bulletins
- Climatic regional data-base for land capability
Awareness of the meteorological risk

Active protection ( )

Selection of the appropriate method:
- crop
- location
- climate
- costs

Effectiveness
Efficiency
Risk

Reduce or to avoid the impact of these extremes - microclimate management & manipulation
WHY FARMERS NEED PREVISIONS?

Awareness of the risk

Active protection

What a probability for a frost tonight? Can the thermal levels predicted compromise my crops at this stage? Shall I activate my protection devices? What the ratio cost sustained/cost of the possible damage?

10% damage
Radiation frosts: calm wind - clear sky: heat is lost in form of radiant energy. Temperature falls faster near the surface causing a temperature inversion.
Formación de la inversión

Temperatura (°C)

Altura (pie) / Height (ft)

Altura (m) / Altura (m)

Temperatura

8:00am

4:00am

12:00am

4:00pm
Active protection

High consumption rates

Expensive to operate (2000 €/ha/night)

Total efficiency proportional to the number of heaters and depending on the air temperature
Active protection

Water freezing:
when 1 Kg of water freezes at 0°C, the phase change converts 334 kJ of latent to sensible heat

Low operational costs. High installation costs but sprinklers can be used for irrigation, fertilizer applications, evaporative cooling... Disadvantages: large amounts of water
Uniform application, continuous and adequate water amounts. Problems under windy conditions. Errors in operating (late starting, early stopping, accidental interruptions) can induce major damages.
Under-plant sprinklers

The goal is to maintain the wetted cover crop temperature near 0°C. Intermittency, lower amounts of water (higher sustainability, lower costs). Same sprinklers are used for irrigation. Protects large surfaces.
Irrigated vs. Non-irrigated

Temperature °C

Height (cm)

+ ≈ 3°C
When surface temperature reaches the dew point, condensation forms releasing sensible heat to retard temperature drop.

---

**Frost Protection**

_English Frost Protection Training Units (videos)_

_Spanish Frost Protection Training Units (videos)_

**When to Turn Sprinklers On and Off for Frost Protection**

**FP001 Quick Answer**—This quick answer provides information on using a psychrometer or temperature and dew point data to determine when to start and start sprinklers for frost protection.

**Predicting Temperature Trends during Freeze Nights**

**FP002 Quick Answer**—This quick answer gives a method for predicting the change in temperature during a calm, radiation freeze night.

**A Simple Method to Measure the Dew Point Temperature**

**FP003 Quick Answer**—This quick answer provides information on how to measure the dew point for use in estimating minimum temperature and for starting and stopping sprinklers for frost protection.

**Sprinkler Application Rates for Freeze Protection**

---

**MEASURING THE DEW-POINT TEMPERATURE**

- Materials:
  - Metal can
  - Thermometer
  - Water
  - Ice
  - Salt, if very cold

- When the temperature of the ice-water mixture reaches the dew point, dew or ice forms on the can.

---

**Table 3. Minimum turn-on and turn-off air temperatures (°C) for sprinkler frost protection for a range of wet-bulb and dew-point temperatures (°C)**

<table>
<thead>
<tr>
<th>Dew point Temperature (°C)</th>
<th>Wet-bulb Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-5.0</td>
</tr>
<tr>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>-1.0</td>
<td></td>
</tr>
<tr>
<td>-2.0</td>
<td></td>
</tr>
<tr>
<td>-3.0</td>
<td></td>
</tr>
<tr>
<td>-4.0</td>
<td></td>
</tr>
<tr>
<td>-5.0</td>
<td></td>
</tr>
<tr>
<td>-6.0</td>
<td></td>
</tr>
<tr>
<td>-7.0</td>
<td></td>
</tr>
<tr>
<td>-8.0</td>
<td></td>
</tr>
<tr>
<td>-9.0</td>
<td></td>
</tr>
</tbody>
</table>

*Select a wet-bulb temperature that is above the critical damage temperature for your crop and locate the appropriate column. Then choose the row with the correct dew-point temperature and read the corresponding air temperature from the table to turn your sprinklers on or off. This table assumes a barometric pressure of 1013 millibars (101.3 kPa).*
• Forecast of night temperatures depending on foreseen weather conditions and on temperature at sunset. At 10.00 and 01.00 forecasted temperatures and measured temperatures are checked.
• In case of temperatures below 0 °C, a SMS is sent to all registered users
Appropriate pest management using meteorology and microclimatology can reduce losses: the tactical use of weather information in the prediction of p&d development may allow for near-optimum use and timing of pesticides and/or release of predators.
SAFE

- To guide farmers in the integrated pest management, improve effectiveness of treatments, reduce or avoid pesticides impact and improve quality
- A network of monitoring sites, using pheromone traps or test plots, gives the basic informations to run simulation models
- The system uses weather forecasts and climatology to estimate periods of next insect generations, guiding farmers to choose the best moment for the treatment
- When a threshold is approaching, a SMS alerts the farmer, so that he can plan a treatment if necessary
Velkommen til PlanteInfo

Vandregnskab
Planteinf-redaktionen 10/05/2004
Vandregnskab er et værdsættet program til styringen af vandning. Nye brugere kan læse mere ved at følge linket forneden. Til gamle brugere er her lidt information om Vandregnskab i 2004.
Beregningen af potentielt overspørgs er i 2004 ændret til den såkaldte Maklinsk-formel, som anføres af DJF og DM. Den daglige potentielle fordampling bliver herved i gennemsnit 0,3 mm højere.
Der er tilføjet en yderligere fraforrende figur (klik på Detaljer i Vandbehov). Denne figur viser den aktuelle fordampling fra jordoverfladen og ved afgrænsens forbruget afvand i regionen. Der er en ganske betydelig fordampling fra jordoverfladen efter nedarbejde.
Der er rettet en fejl i beregningen af vandbehov for klærgrøves.
Læs mere...

Råd og kommentar

Vejledning
Se hvordan du bedst bruger PlanteInfo.
Læs mere...

Her bor jeg...
Den røde prik på kartet viser hvorma du får lokale vejrdata i progresse, eVærslig m.m.

Grid 0948 NY

Afsend SMS og Email uden afløse ind
The activities of the German Weather Service in the field of agroclimatology
Plasmo Project - PLASMO on-line

The model, called Plasmo (Plasmopara Simulation Model), simulates grapevine downy mildew biological cycle on the basis of agronomo-climatic parameters, allowing the best timing for fungicide treatments. The model reliability was evaluated during several years of research, comparing the results obtained by applying traditional methods of crop management with those planned according to model simulation.

Plasmo was implemented by collaboration among several institutes: Institute of Biometeorology (IBIET - Firenze) - National Research Council (CNR); Department of Agriculture and Land Management (DISAT) - University of Florence; Centre for the Application of Computer Science in Agriculture (CeSIA) - Accademia dei Georgofili. The online version has been developed and is provided by Institute of Biometeorology (IBIET - Bologna).

PLASMO Project
COST 719
By
Simona Orlandini, Federica Robe, Massimiliano Magli

http://agromet-cost.bo.ibimet.cnr.it/plasmo/
2020 MILLIONS m3 water are withdrawn

Withdrawal is 130 Mm3 higher than recharge, thus inducing a progressive subsidence
What is a "best management practice for water?"
A practical, affordable approach to conserving water without sacrificing productivity, maximizing its use efficiency.

**Good practices for water management**

**Water saving**

- Dry farming
- Crop selection and management
- Improvement of efficiency of irrigation equipments, reduction of losses
- Water balance calculation, agrometeorological support
- Decision Support Systems and Advisories

**Re-utilization**

- Depuration/ phytodepuration
- Irrigation using waste water

To save water, there is not a unique solution, but several strategies can be used together. The saving may reach 20-25%.
IRRIGATION METHODS

The selected irrigation technique has a great importance in limiting water use, and also on leaching of nutrient in soil.

- Flooding
- Furrow
- Subirrigation
- Sprinkling
- Microirrigation (drip, microjets)
At basin level

Transport between the source and the farm

Water withdrawn at source

Efficiency of delivery

Water available at the farm

Efficiency in the farm

Water available in the field

Efficiency of distribution

Efficiency of the crop

Global efficiency

Losses

A / E
Information to the farmers:
Decision support systems for irrigation

Improvement in efficiency of irrigation is possible by modulating timing and quantity of water as a function of meteorological variables, evapotranspiration assessment, and using informing tools for dissemination

When and how much to irrigate?
What is the proper irrigation system?
CER is a consortium distributing water and the most important hydraulic infrastructure

Founded by local Authorities and from regional reclamation consortiums

• Through a channel from Po river water is made available over a 3000 Km² area and the water resources (68m³/s) allow to satisfy the irrigation needs.

• Water is furnished together with the information for its rational and sustainable utilization (IRRINET).
Irrinet in pills

• Started in 1984 with public founding to test telematics in agriculture (Videotex)
• In the WEB in 1999
• GIS extensions & advanced WEB interfaces in 2002
• From 2003: WEB + SMS (IrriSMS)
• Involves more than 11000 farms, covering almost 22% of the irrigated area in the region
• Its application in the 2010 allows a water saving for more than 50 millions m3
Irrinet irrigation model

- Meteo Data Base
- Crop data
- Soil Data Base
- CER
Registered users: farm, soil, crop data are kept in memory and used from the program.

Unregistered users: users can interrogate by selecting crop and finding the farm location.
**Subscription Form**

**Registrazione nel servizio di una nuova azienda**

Inserire i dati necessari alla registrazione. I campi contrassegnati con (*) sono obbligatori.
Il codice azienda viene fornito in automatico dal sistema al termine della registrazione. I dati inseriti possono essere modificati in qualsiasi momento dal menu principale del servizio.
Ricordarsi che la password scelta sarà sensibile al maiuscolo/minuscolo che va rispettato in fase di accesso.
Se viene inserito un indirizzo di email valido si riceverà una email di conferma con i dati di registrazione.

<table>
<thead>
<tr>
<th>Codice azienda</th>
<th>Password (*) [oculto]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Descrizione</td>
<td>Fare attenzione al maiuscolo/minuscolo delle lettere</td>
</tr>
<tr>
<td>Indirizzo</td>
<td>Località</td>
</tr>
<tr>
<td>Provincia</td>
<td>Scegliere una provincia</td>
</tr>
<tr>
<td>Comune</td>
<td>Scegliere un comune</td>
</tr>
<tr>
<td>Email</td>
<td>Cellulare</td>
</tr>
</tbody>
</table>

Necesario per attivare il servizio IrriSMS

**Registra la nuova azienda**
Irrinet GIS approach

Click on the map to find user farm and download the following data:

- METEO DB: Meteorological data: daily ET, temperature; hourly rainfalls
- PEDO DB: Soil texture
- WATER DB: average water table depth
The system provides soil data, automatically downloaded from Regional Soil Information System; if the data are not similar to those of the farm, the user can input their own data from field analysis.
## Irrinet Output page

### 19 MELONE sabbioso

Stazione meteo: CAMPAGNOLO EMILIA - Batteria di falda: 05RE
I dati della stazione meteo sono aggiornati a lunedì 21 aprile 2008 (ultimo dato pervenuto)
Suolo: Spessore 1,4 mt Sabbia 85% Argilla 4% Schelatro 0%
Impianto irriguo: Impianto a poggia fisso

| Consumo giornaliero effettivo della coltura in mm (ETE) | 2,4 |
| Data prevista per l’irrigazione | 24/04/2008 |

Visualizza Grafico

### 20 MELONE argilloso

Stazione meteo: CAMPAGNOLO EMILIA - Batteria di falda: 05RE
I dati della stazione meteo sono aggiornati a lunedì 21 aprile 2008 (ultimo dato pervenuto)
Suolo: Spessore 1,4 mt Sabbia 4% Argilla 60% Schelatro 0%
Impianto irriguo: Ala gocciolante
Sesto erogatori: 0,3mt x 2mt - Portata erogatore: 2,0lt/h - Portata impianto: 3.333mm/h

| Consumo giornaliero effettivo della coltura in mm (ETE) | 2,4 |
| Data prevista per l’irrigazione | Oggi |
| Volume irriguo da fornire alla coltura in mm | 4,3 |
| Tempo di funzionamento dell’impianto irriguo in ore e minuti | 1:17 |
| Numero di giorni previsti per l’irrigazione successiva | 2 |

Visualizza Grafico

Inserisci irrigazione

---

Predicted evapotranspiration

Next day to irrigate

Water irrigation amount (mm when sprinkler irrigation or h/ min when microirrigation applied)
IrriSMS structure

Message sender: who is providing this service: an irrigation company, a public body etc..

Farm crop: peach, corn, sugar beet

Irrigation scheduling: yesterday crop evapotranspiration; when you have to irrigate; (forecasted data); water applying to that date
Micrometeorological approach to assess water requirements of crops:

Ex: for kiwifruit, measured crop evapotranspiration allowed to give new indication to irrigation schedule programs, able to save 15-20% water.
Criteria
Stima delle esigenze irrigue

H2O - Irrigazione (mm)
Conduzione Colturale:
Storia della particella
01/01/2008 - 20/09/2008

0 50 100 150 200 250 300 350 400 450 500
DSS on Digital Agriculture: farm-level mapping, comprehensive data base creation on resources generated through space-based inputs and field observations to make a detailed plan of work for maximizing yield and reducing inputs and their costs.

5 R rule: “applying the Right input in the Right amount at the Right time in the Right place and in the Right manner”.
NEE
(t C ha\(^{-1}\) y\(^{-1}\))
-5.6

Sink - source
5.6 - 1.35 = 4.25 tC/ha/yr
5.6 - 3.1 = 2.5 tC/ha/yr

<table>
<thead>
<tr>
<th>COLTURA</th>
<th>EMISS CO2 (tC/yr/ha)</th>
<th>+ transport to Germany (tC/yr/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>albicocco</td>
<td>4.91</td>
<td>6.64</td>
</tr>
<tr>
<td>susino</td>
<td>8.46</td>
<td>11.92</td>
</tr>
<tr>
<td>pesco</td>
<td>11.08</td>
<td>14.33</td>
</tr>
<tr>
<td>arancio</td>
<td>4.96</td>
<td>11.40</td>
</tr>
</tbody>
</table>

DOCUMENTO TECNICO
Valutazione dei gas serra emessi e dell’energia rinnovabile utilizzata nel ciclo di vita dei prodotti agroalimentari

Green Thinking
Information for farmers-government/agro-business

DSS on agricultural management strategies, land use planning, water resource management, depletion/erosion of soil resources, economic evaluation of impacts on yield