ADCON TELEMETRY Smart Wireless Solutions

Introduction to Disease Modeling

addVANTAGE Professional

» The purposes of agro-meteorology

Agro-Meteorology has many objectives

- Identify micro-climates
- Determine the suitability of a plot for a specific crop
- Assist to identify seeding/harvesting time, germination, maturity
- Compute growth models
- Compute yield models
- Compute disease models
- Compute irrigation models
- Provide research with data for assessing the efficiency of new varieties (of seeds, fertilizers, agro-chemicals)

» The purposes of agro-meteorology

Agro-Meteorology has many objectives

- Provide Traceability (which spray/irrigation was applied when + why)
- Prevent application of agro-chemicals when wind speed is too high and wind comes from the wrong direction
- Provide database to protect against punitive/damage claims (water, health,...)
- Prevent overhead irrigation if wind speed is too high
- Provide insurance companies with real-time ag-met data for micro-insurance products

» The purposes of agro-meteorology

What are the tools of Agro-Meteorology ?

- Micro- and Macro-climatic monitoring equipment (weather stations)
  - Air temperature and relative humidity
  - Precipitation
  - Wind speed and direction
  - Solar Radiation: global radiation, PAR, UV
  - Leaf wetness
  - Soil temperature, moisture, conductivity, salinity
- A wide variety of computer models: growth, yield, pest, disease, ETo, ETc
- Field observations (scouting)

» What are Disease Models?

- **Disease models estimate a) growing conditions and/or b) the growth stages for a pest/pathogen**
  - Identify key periods when inputs (labor, pesticide, etc) can positively control the pest/disease
  - Models vary depending upon the researcher who designed them
  - Weather can significantly effect the initiation and growth of disease/pests
  - Most models use a some combination of temperature, relative humidity, leaf wetness, and/or precipitation

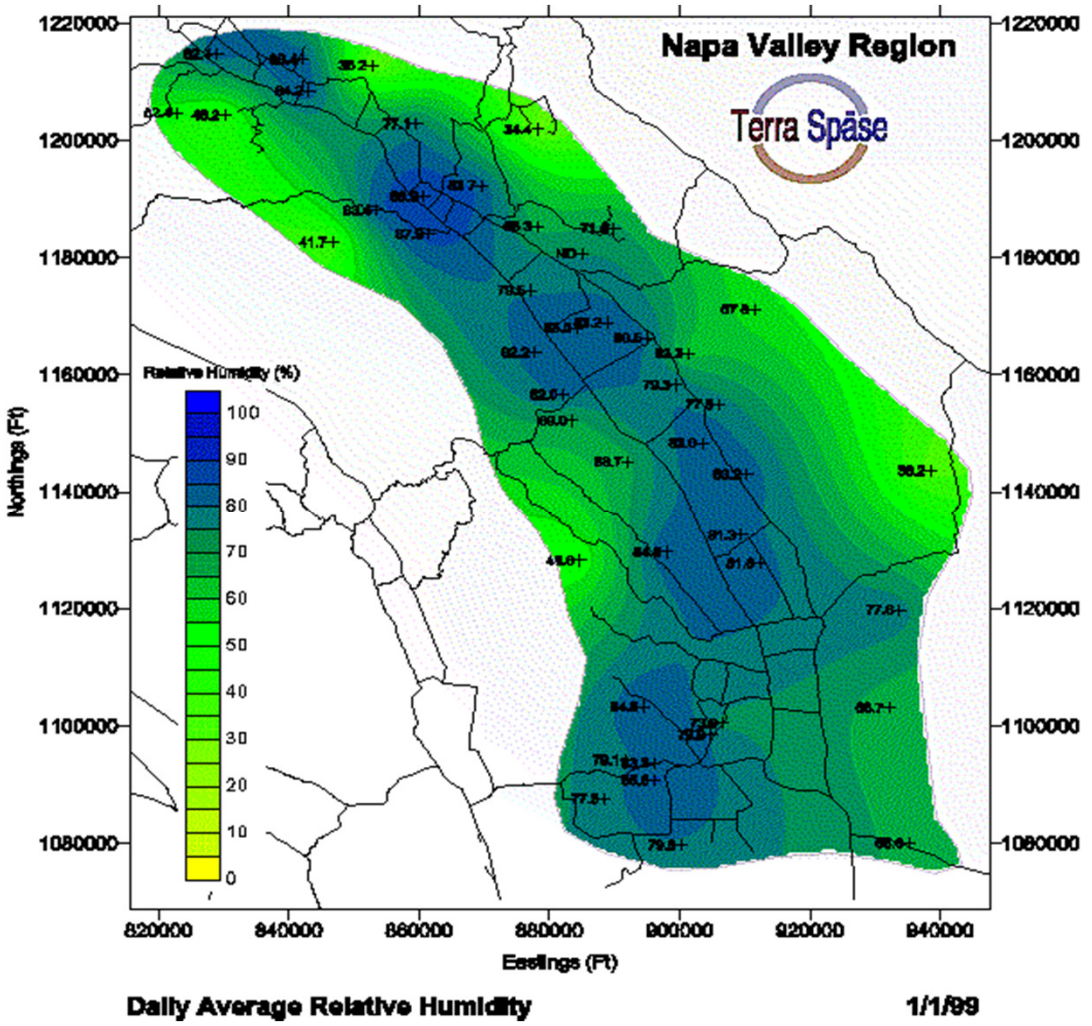
» Site Specific Weather

- **In the past weather data for agriculture was collected regionally**
  - Airports
  - Local extensions offices
  - Regional weather mesonets

- **Site specific data has been shown to be significant in the past 15 years relative to disease modeling**
  - Basic weather parameters change over short distances
  - Timing of inputs can be crucial (especially given resistance issues)

» Weather Variability

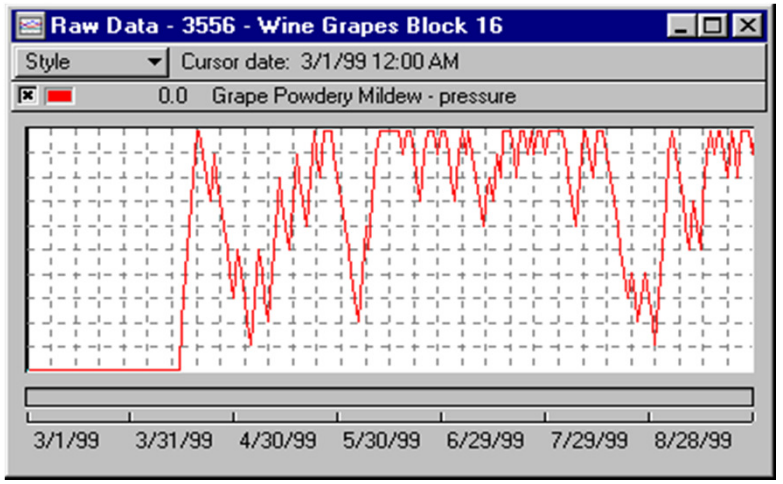
- **Daily Average RH**
- **Napa Valley, CA**
- **7 days**

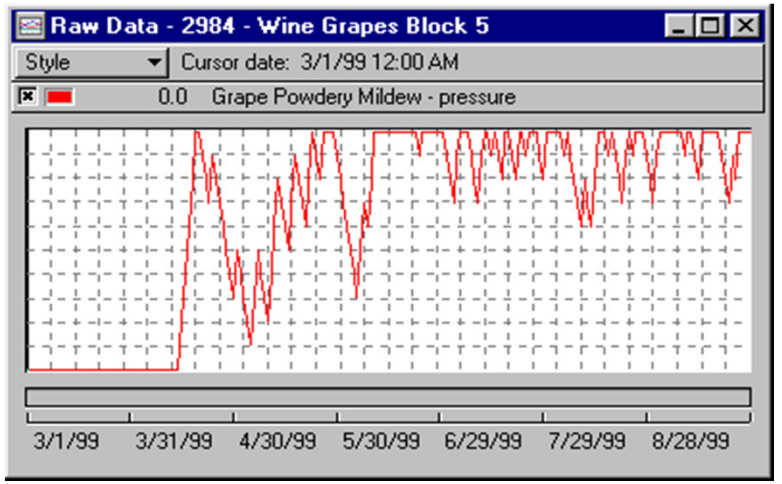


Map courtesy of Terra Spase
St. Helena, CA

» Local Weather Effects on Disease Models

- **Two sites**
- **Six miles apart**
- **Grape powdery mildew**
- **Nearly identical disease pressure in 1999**





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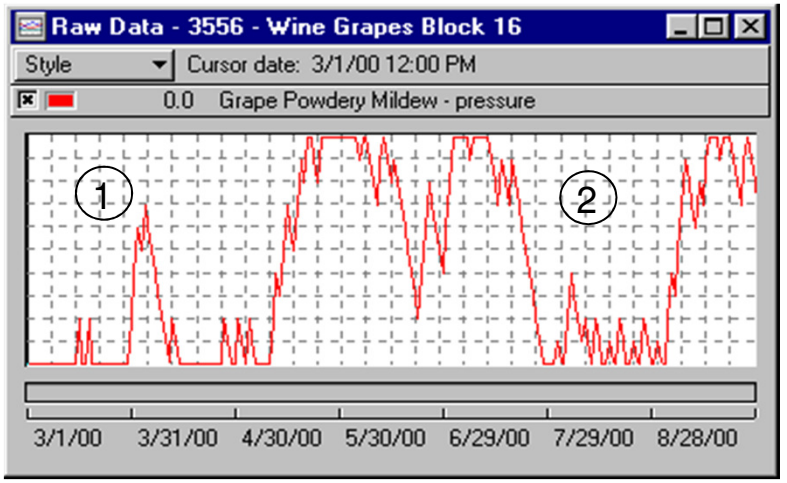
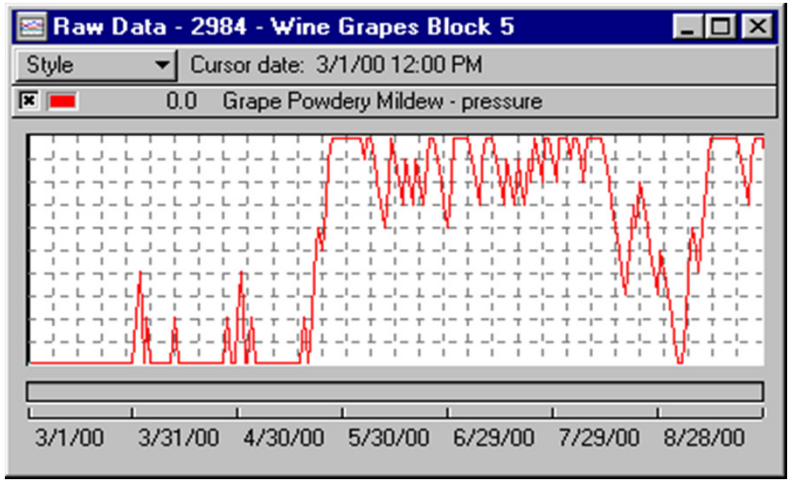
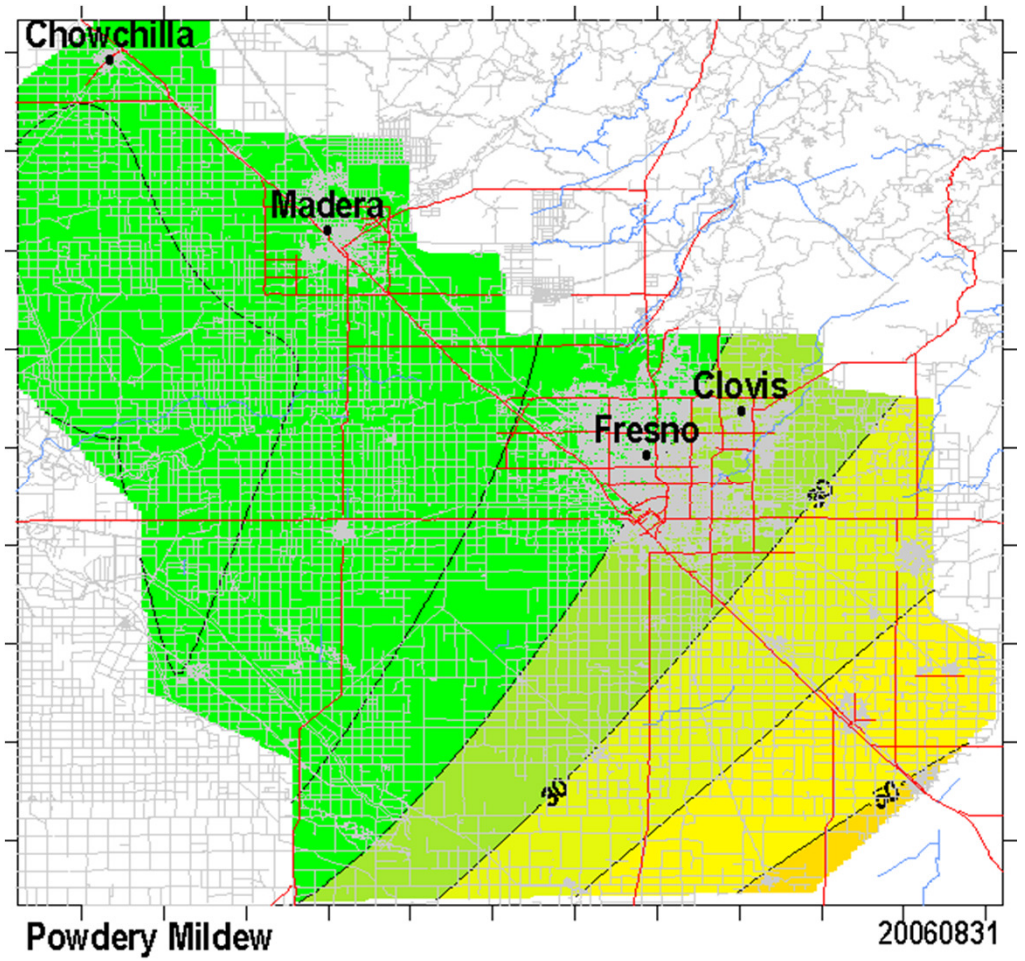


- **Different pressure in 2000**
- **High pressure in Block 1G earlier (1)**
  - Starting treatment late - risks infection
- **Low pressure mid season (2)**
  - in Block 1G allows spray interval to be "stretched"
  - opportunity for less treatments



» Effect on Disease Models Regionally

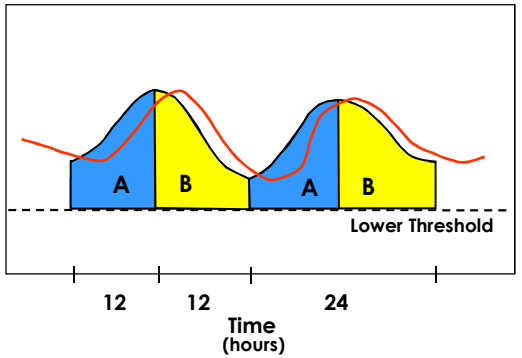
- Grape Powdery mildew
- Madera/Fresno area CA
- June through August 2006
- Early & late season pressure is very similar
- Mid-season pressures and treatment schedules should vary greatly

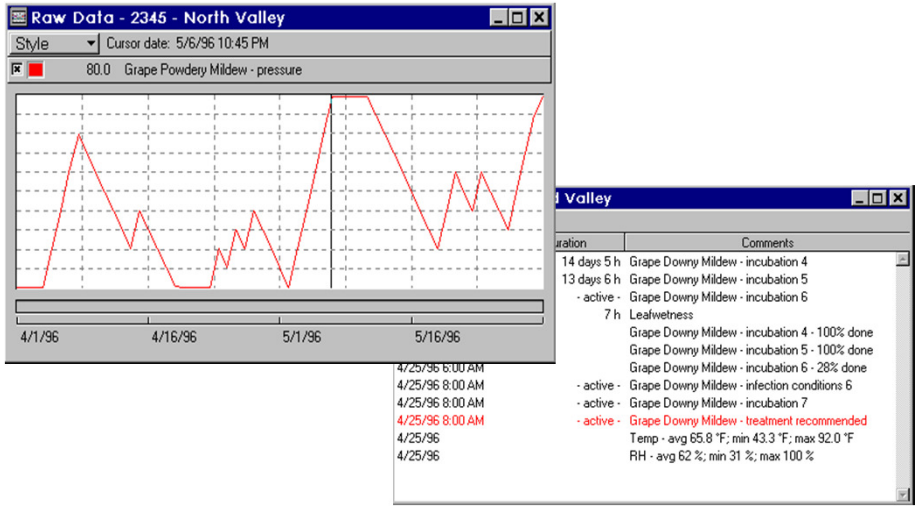


Maps courtesy of Western Farm Service
Madera, CA

» General Methods of Modeling

- **Heat units**
  - Degree-Days
  - Degree-Hours
  - Growing Degree Days (GDD)
  - Chilling/heat hours
- **Disease Models**
  - Pressure models
  - Risk models





» Heatunits

Why measure heat unit accumulation?

- Many organisms grow based on the amount of heat received over time, ***not*** based on calendar time.

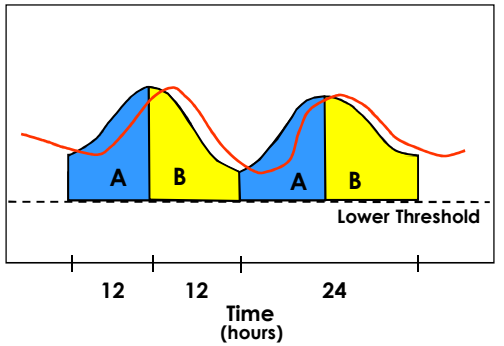
- Arthropods (Insects, mites. etc)

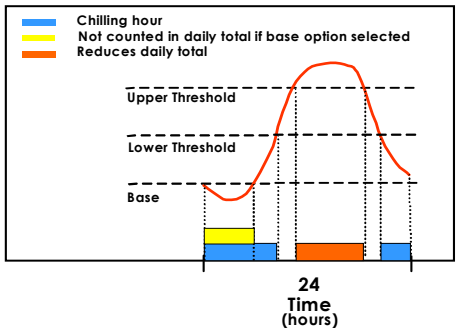
- Plants (growth stage, harvest, etc)

- Pathogens/Fungal life stages

» How are Heatunits calculated?

- **Temperature is used as measure of „heat“**
- **A number of standardized formulas exist**
  - Degree Days
    - Single or double sine
    - Single of double triangle
    - GDD
    - Averaging
  - Chilling Hours
    - Standard
    - Utah method
  - Heat Hours





» How are Heatunits used?

- **Critical thresholds are identified**
- **Growers can track upcoming thresholds and plan for action**

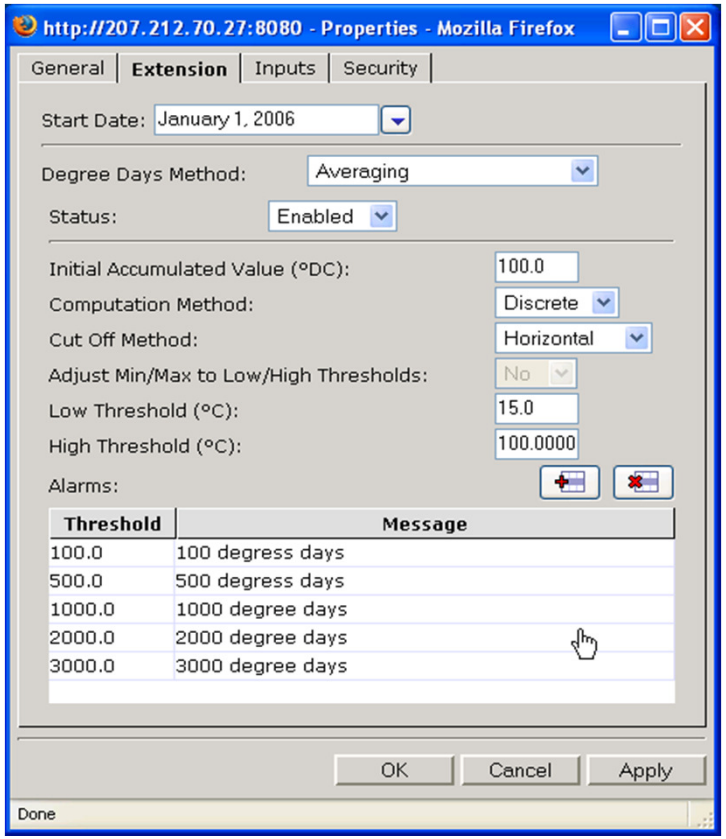
Events - 3000 - Standard Station

Style

Date	Duration	Comments
8/1/96		Heatunit - Wine Grapes - cumulative value 2337.6
8/1/96		Heatunit - Wine Grapes - daily value 16.5
8/2/96		Heatunit - Wine Grapes - cumulative value 2352.5
8/2/96		Heatunit - Wine Grapes - daily value 14.8
8/3/96		Heatunit - Wine Grapes - cumulative value 2370.0
8/3/96		Heatunit - Wine Grapes - daily value 17.6
8/4/96		Heatunit - Wine Grapes - cumulative value 2389.8
8/4/96		Heatunit - Wine Grapes - daily value 19.7
8/5/96		Heatunit - Wine Grapes - cumulative value 2406.7
8/5/96		Heatunit - Wine Grapes - daily value 16.9
8/6/96		Heatunit - Wine Grapes - cumulative value 2425.1
8/6/96		Heatunit - Wine Grapes - daily value 18.3
8/7/96		Heatunit - Wine Grapes - cumulative value 2443.0
8/7/96		Heatunit - Wine Grapes - daily value 18.0

» Available Heatunit Models

- Researchers have used heatunit models for years (especially degree day models)
- Hundreds of validated models are available
- The addVANTAGE Pro 6 Heatunits extension is designed to allow the user to select the calculation method and enter thresholds and custom warning messages

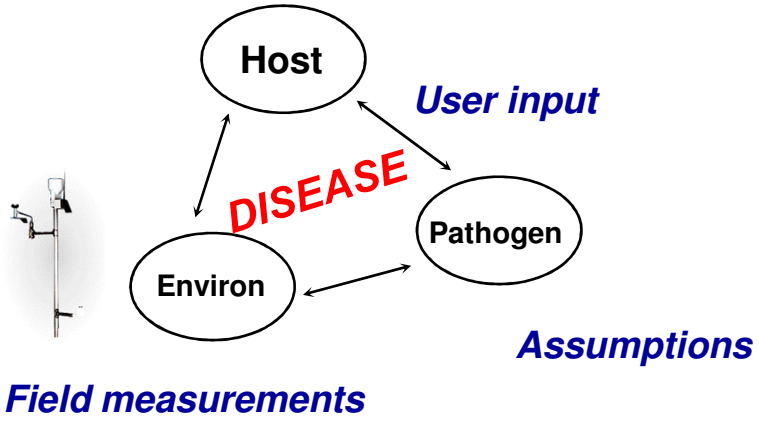


» Disease Risk Models

- **Typically attempt to track and/or predict the initiation or growth of a disease**
  - Models vary from very simple to complex
  - Some models focus on growing conditions for the disease
  - Some models focus on the risk of infection/outbreak
  - Some models are effective regionally while others function better with site specific information
  - Most models use temperature, rH, rainfall and/or leaf wetness as model inputs

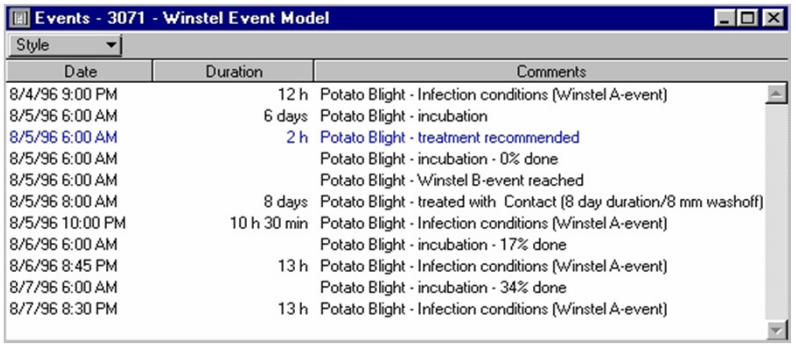
» Common Elements

- **Most disease models have common elements**
  - analogous to the Disease Triangle
  - infectable host, pathogen, and appropriate environmental conditions must exist for disease to be present
  - user provides info on infectable tissue
  - pathogens are always assumed to be present
  - weather station provides data on environmental conditions

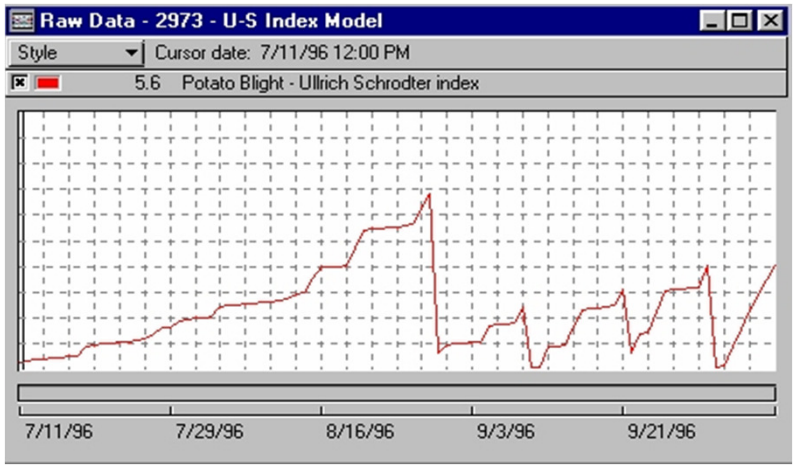


» Basic Types of Disease Models

Events model - Model output is typically binary in nature and in text format. Tracks various conditions and typically provides a warning when some condition(s) has been surpassed (qualitative).



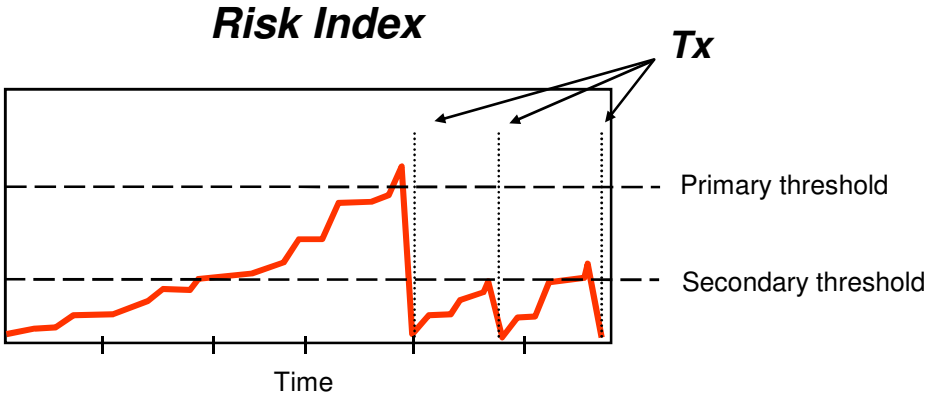
Index model - The model generates a numeric value. The index typically models changes in disease pressure (quantitative). The model recommends treatments based upon combinations of index value, treatment thresholds, and other rules.



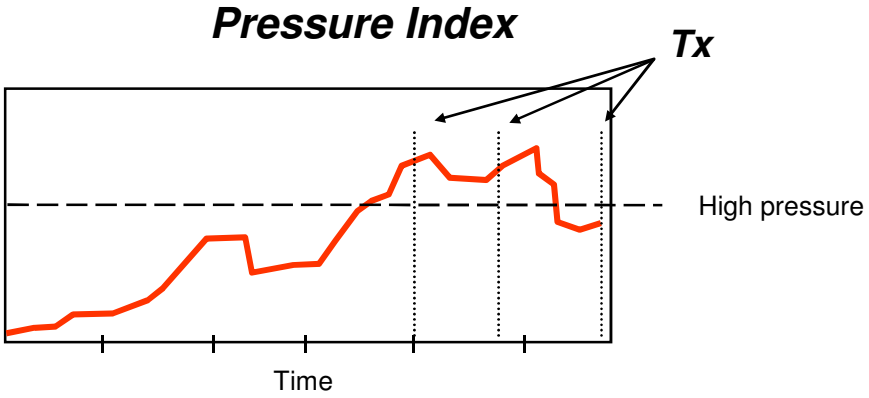
Events & Index - Combination of events & index models

» Types of Index Models

Risk - Once a treatment is applied the index is reset to zero (0) and the index begins accumulating points again.



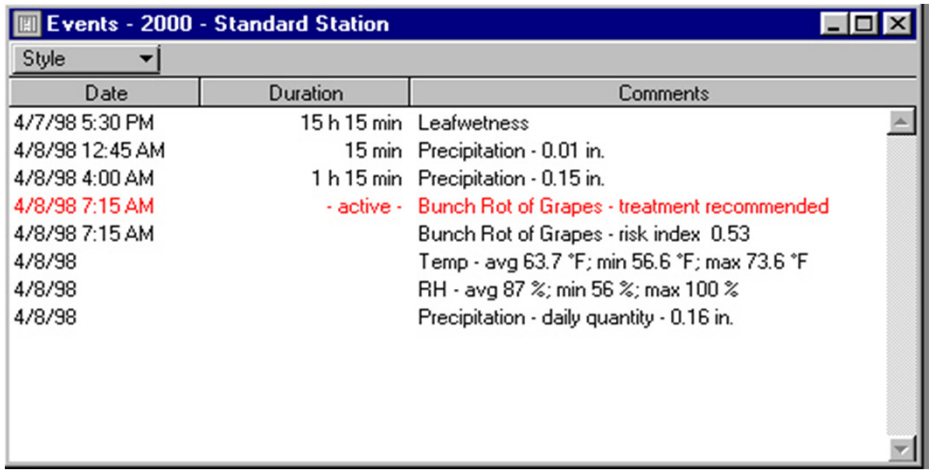
Pressure - These indexes generally model growth conditions for a disease. The index value does not reset to zero (0) after a treatment.



» Example of an Events Model

General Summary

- Events model for Bunch Rot of Grapes
- Regression to compute an index through leaf wetness periods
- Treatment warning is issued when the index exceeds a set threshold (0.50 in California)
- Model does not change in different phenological stages

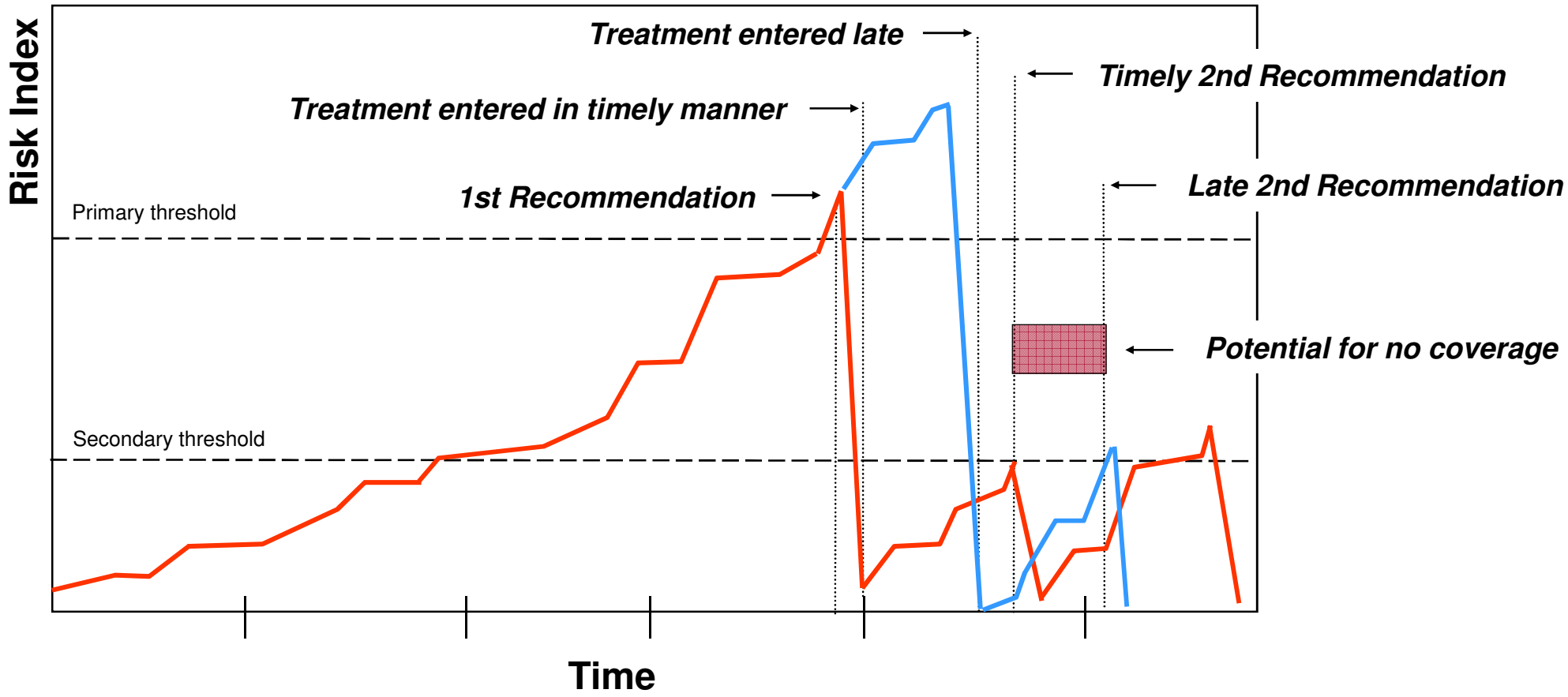


» Example of a Risk Model (Ullrich-Schrodter)

General Summary

- "Risk" type model for late blight of potato
- Model activates at phenological phase *Emergence*
- Ullrich-Schrodter index is computed daily based upon factors such as average temperature and the duration of high relative humidity
- Daily index values are accumulated until an initial threshold of 150 points is reached
- The first treatment warning is issued when the accumulated index > 150 pts and the daily index = 8 pts or greater
- Accumulated index is **reset** to zero (0) upon treatment
- Daily values accumulate until a secondary threshold of 40 pts is reached (for susceptible cultivars).
- All secondary treatment warnings are issued when the accumulated index > 40 pts and the daily index = 8 pts or greater

» Example of a Risk Model (Ullrich-Schrodter)

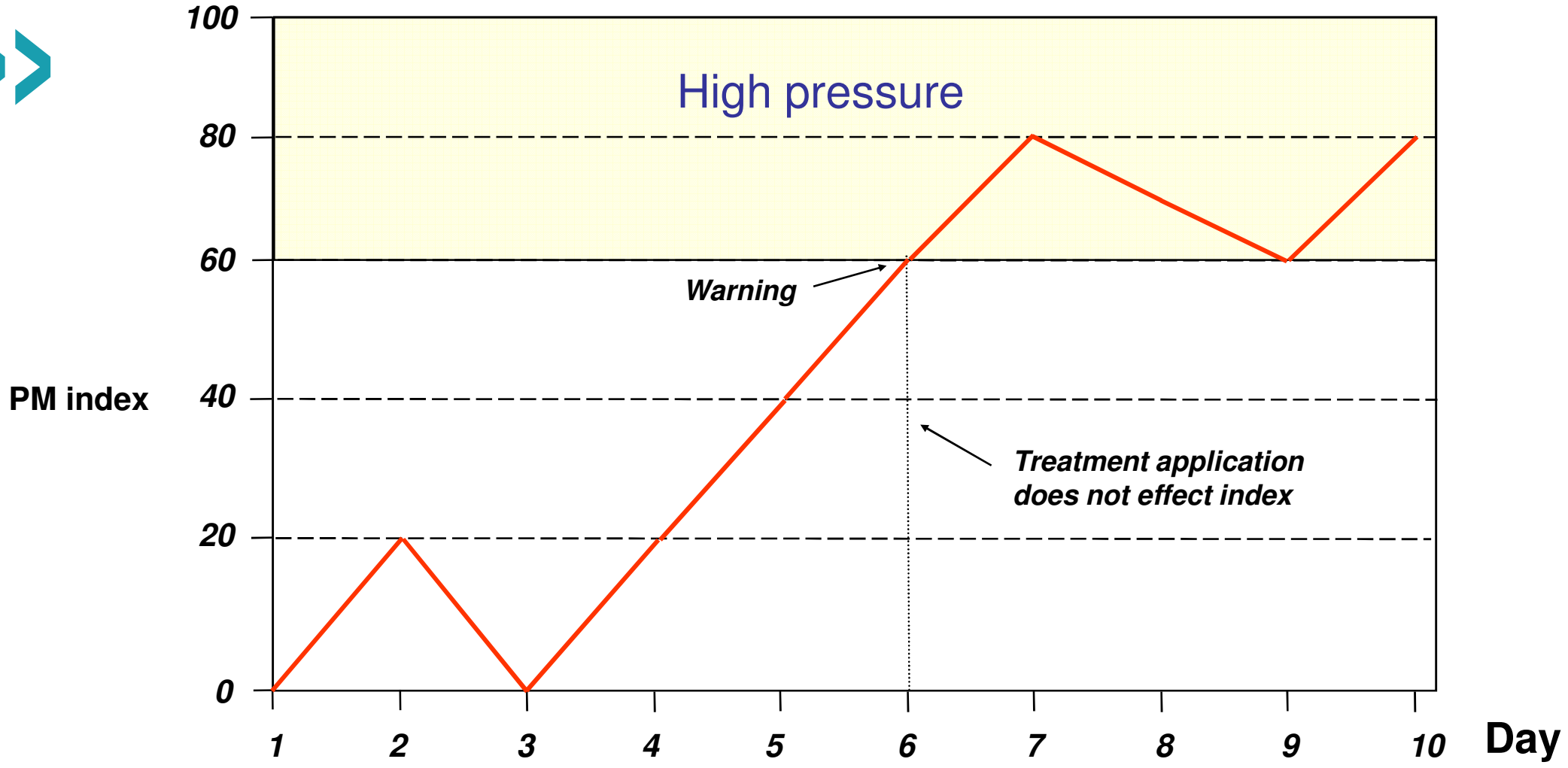


» Example of a Pressure Model (Gubler-Thomas)

General Summary

- Combination of events & index model for grape powdery mildew
- Model activates at phenological phase *Budbreak*
- Events portion predicts ascospore events based on 2/3 Mills table
- Index calculated daily based upon temperature
  - Add 20 pts if 6 or more consecutive hours 21<T<30
  - Subtract 10 pts if less than 6 consecutive hours 21<T< 30
    (except in early season until the first time 60 pts in accumulated)
  - Subtract 10 pts if T>35°C
- Daily values accumulated: Minimum index = 0
  Maximum index = 100
- Treatment warnings issued when: Automatically at budbreak
  Based upon index oriented intervals starting from budbreak
- Integrated treatment duration stretching algorithm

» Example of a Pressure Model (Gubler-Thomas)



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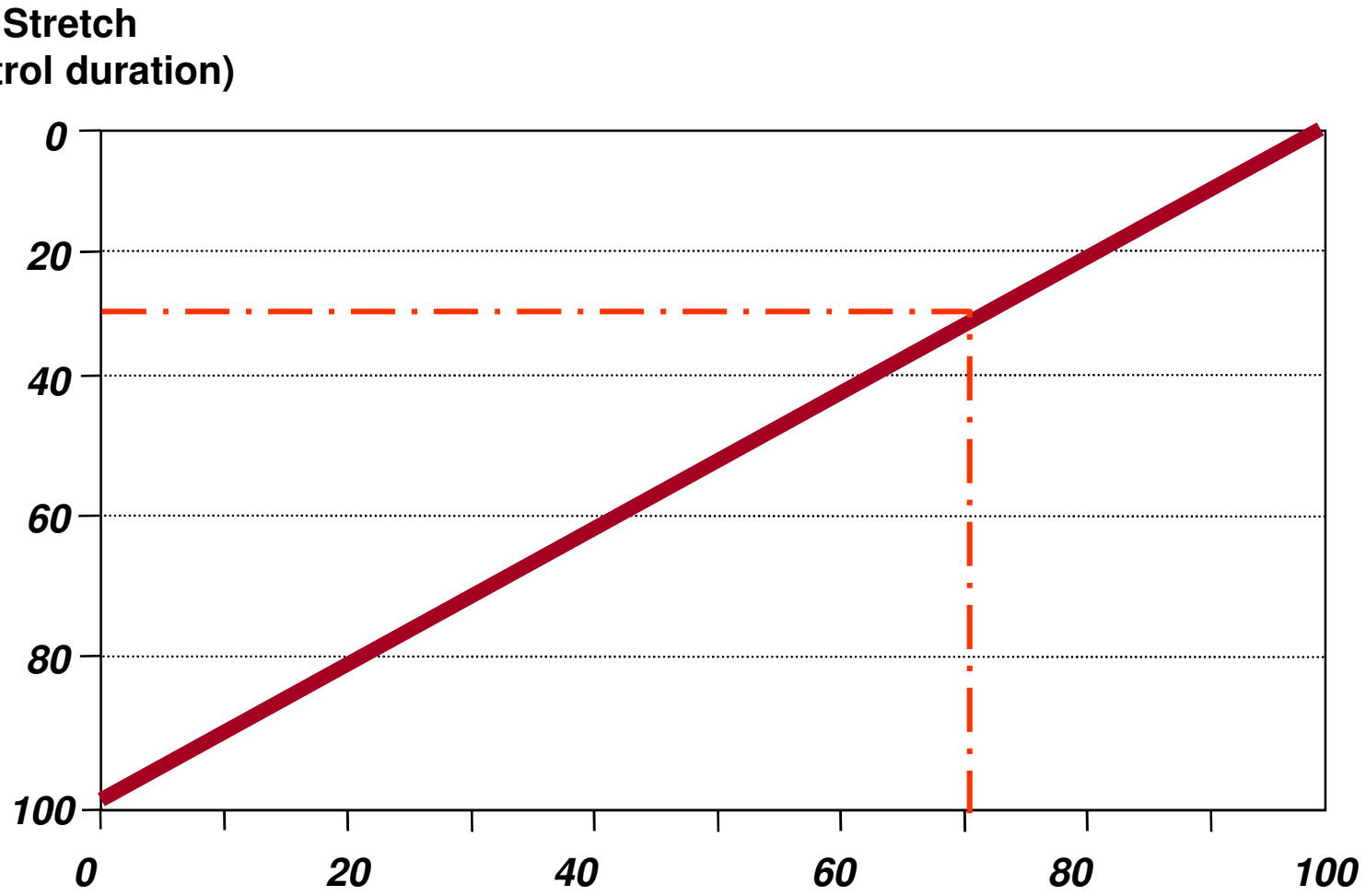
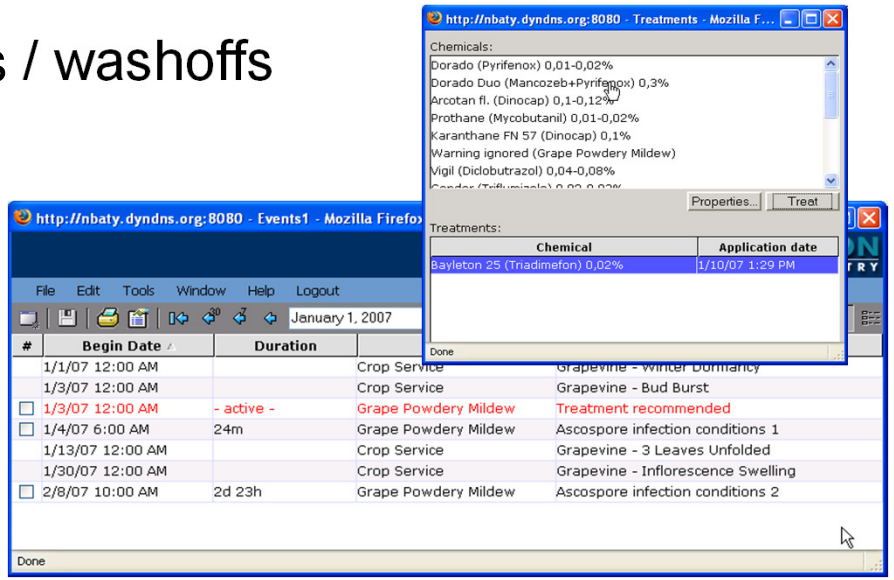


» Alternative Ways to Use Models

- **Most models have multiple ways they can be used:**
  - Detailed PC/computer based options
  - As guidelines for pressure/outbreaks through the season
  - Identifying the initial onset of disease risk/growth conditions

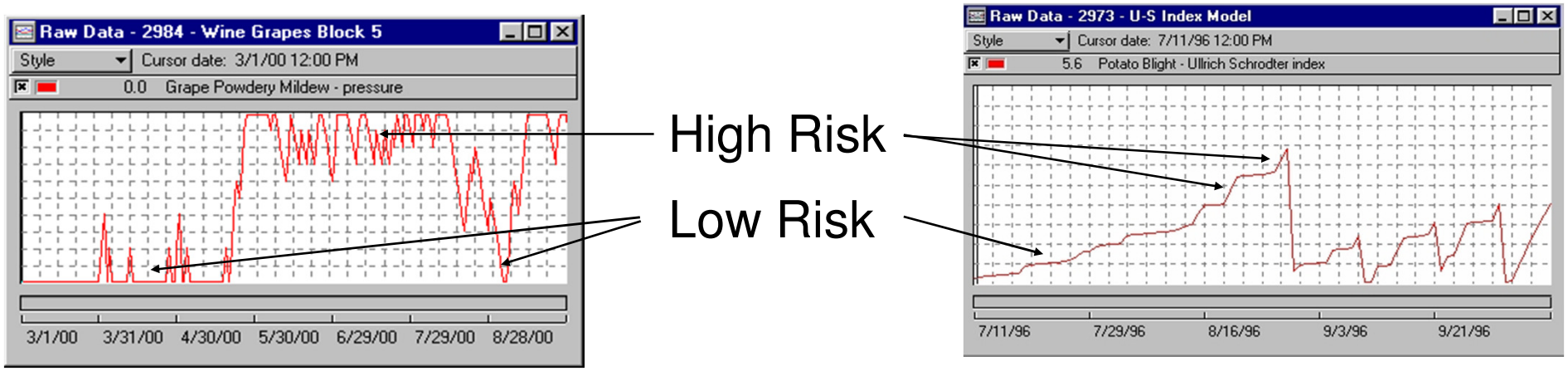
» Models Use – Detailed PC Based Options

- **PC based options allow many details to be incorporated into the model outputs:**
  - Site specific phenology
  - Site specific treatment schedules/recommendations
  - Treatment specific control durations / washoffs
  - Sensitivity by crop / field
  - Automated changes in model sensitivity by phenological stage
  - Automated warnings for washoff conditions, etc.



» Model Use – as Guidelines during the Season

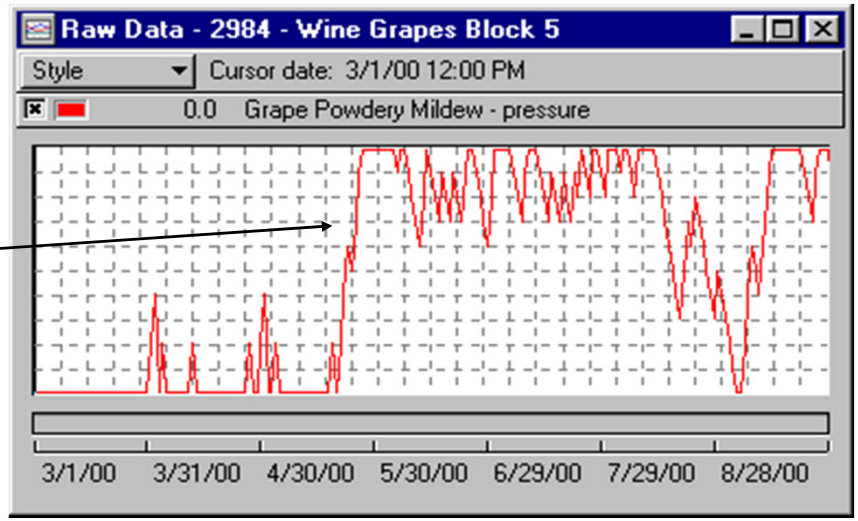
- **Many times logistics do not allow detailed use**
- **Following pressure / risk conditions:**
  - Helps keep spray intervals tight during risky periods
  - Identify periods when treatments can be stretched / skipped versus treatments called for using calendar methods



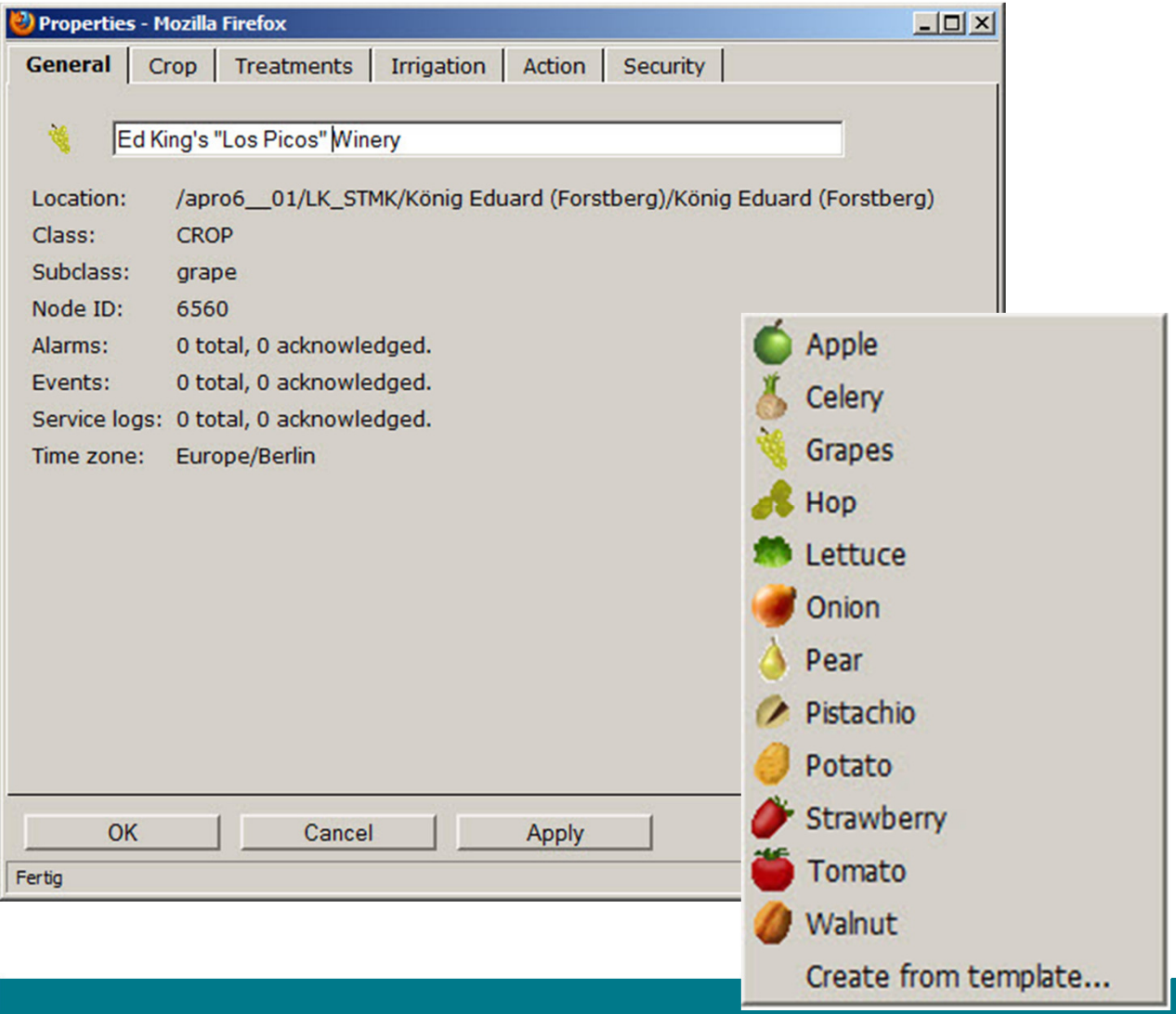
» Models Use – Identifying First Onset

- **Simplest method is to identify the initiation of disease growth conditions**
  - Wait until conditions are ripe for disease growth
  - Start calendar schedule when first conditions are present
  - Minimally avoid wasting inputs until they are needed

Start calendar treatment schedule



» New approach to disease models with addVANTAGE Pro 6



The Crop Node:

Separates the properties of the crop from the disease models.

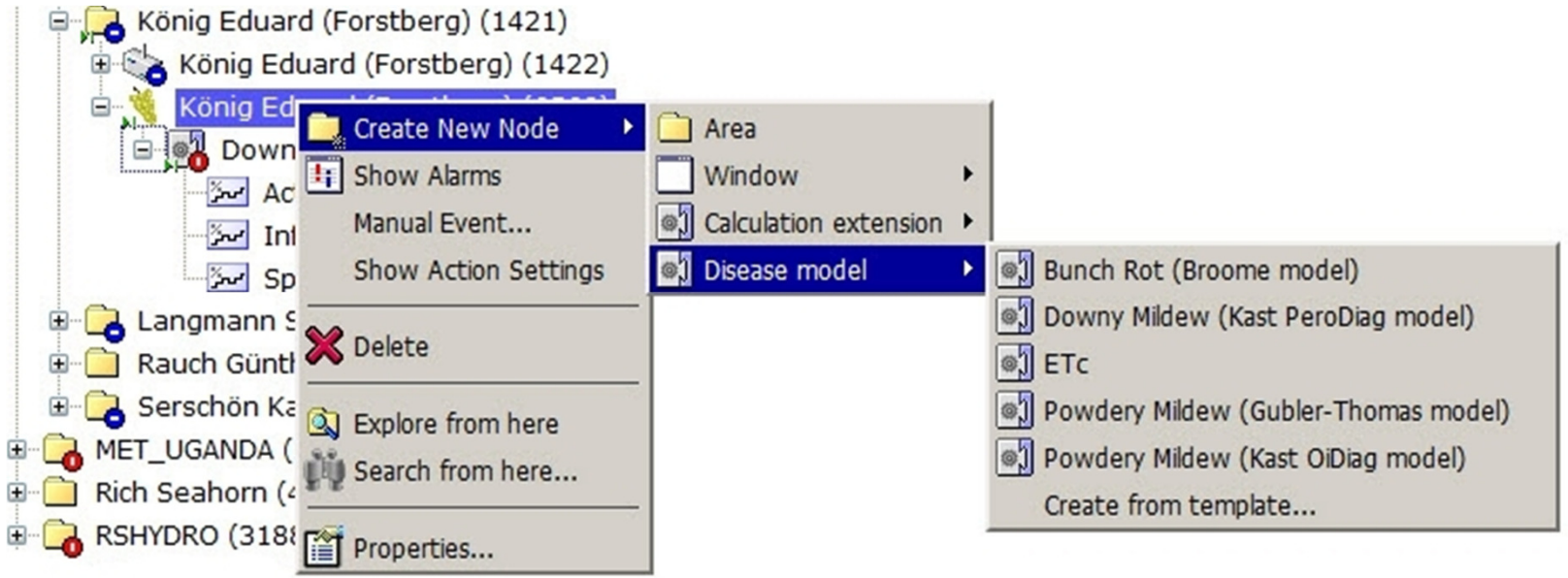
Insert all information regarding a crop only once for all your disease models:

- Phenological phases
- Treatments
- Irrigations
- Actions

» THE CROP NODE

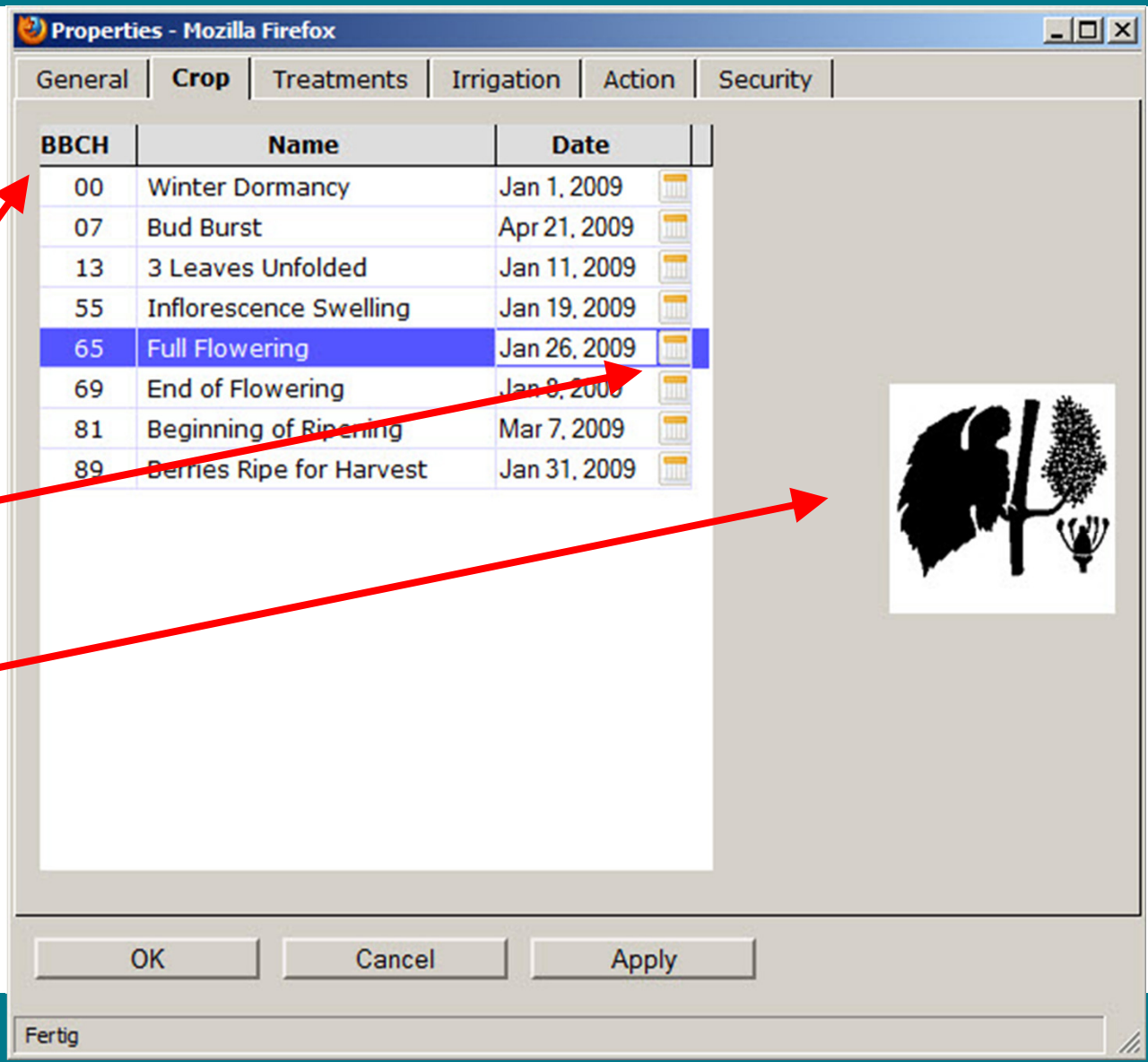
Connect as many disease models as you like –

e.g. connect the same model 5 times with different settings - perfect for rapid model validation



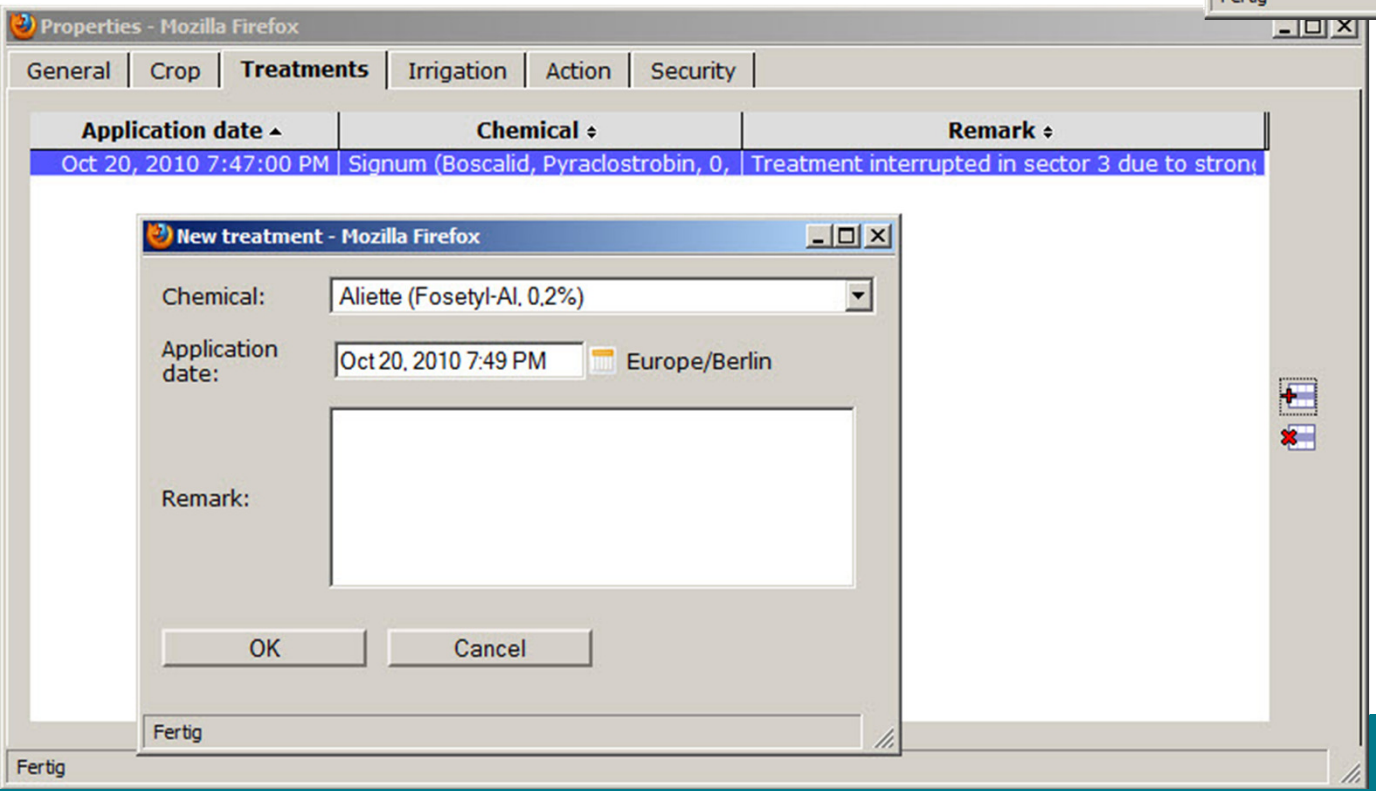
» THE CROP NODE

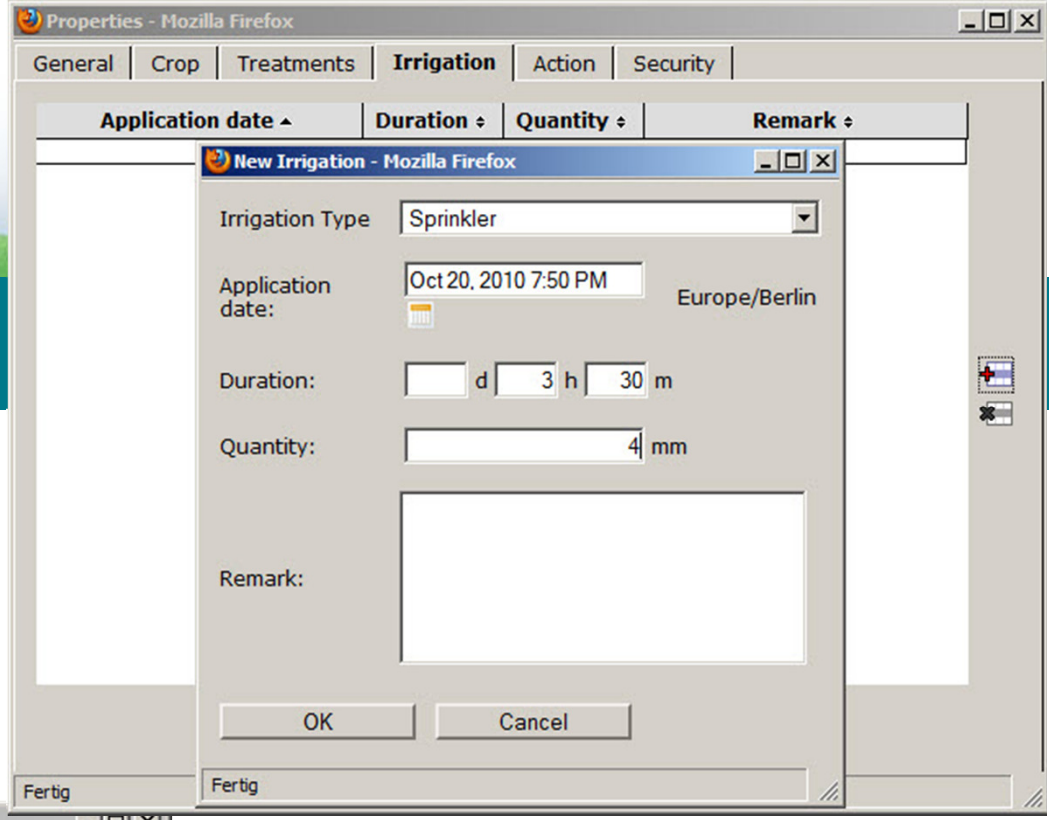
- Contains all info on phenological phases.
- Automatic progress based on BBCH table.
- Modify start dates as needed.
- An image helps identify the crop stage.



» THE CROP NODE

» Insert treatments: select chemical from your own database, enter treatment date, add a remark.



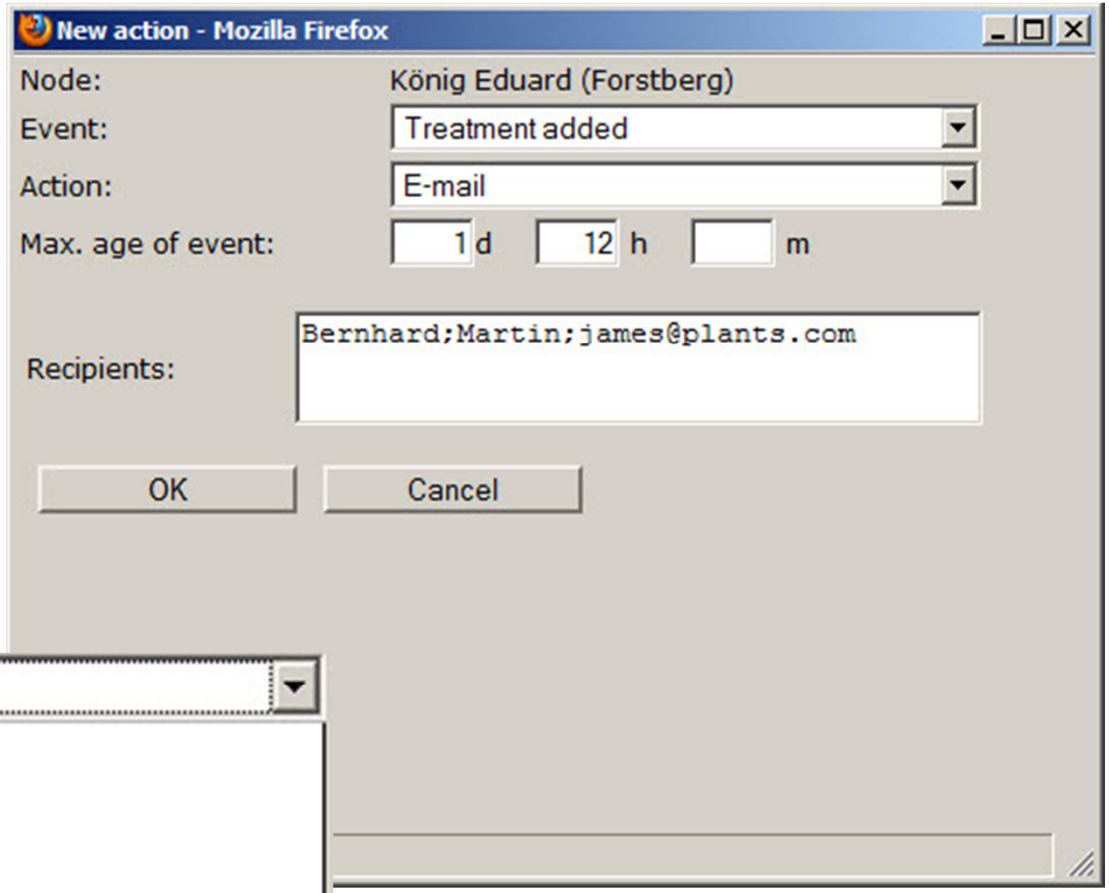


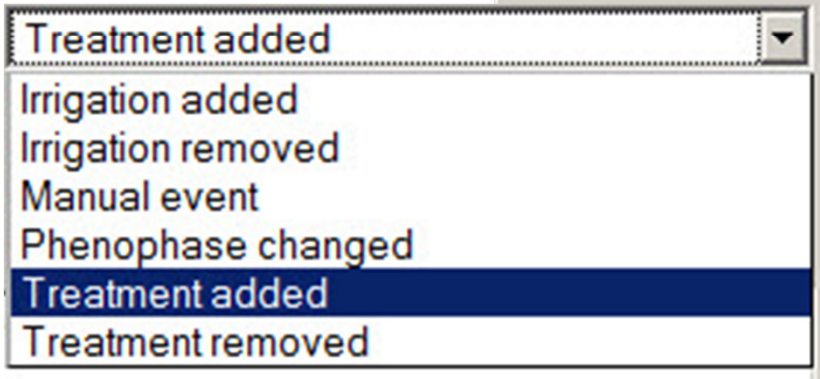
Insert irrigations:

- Type of irrigation
- Date
- Duration
- Quantity
- Remark

» THE CROP NODE

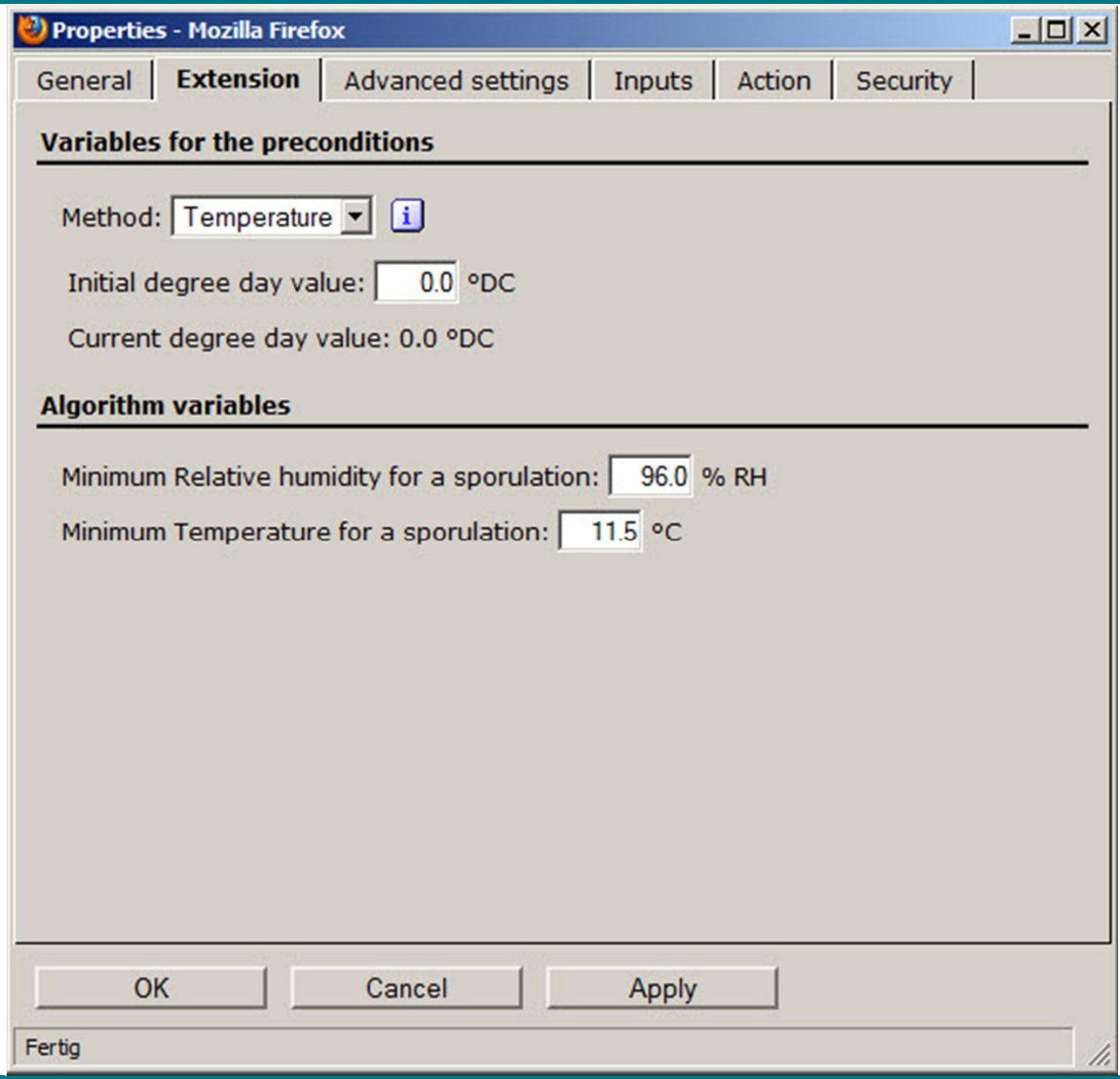
Get information by email on many actions of the user and the model, e.g. when a user enters or deletes a treatment or irrigation, or when a pheno-phase changes.





» The new, advanced disease extensions of Pro 6

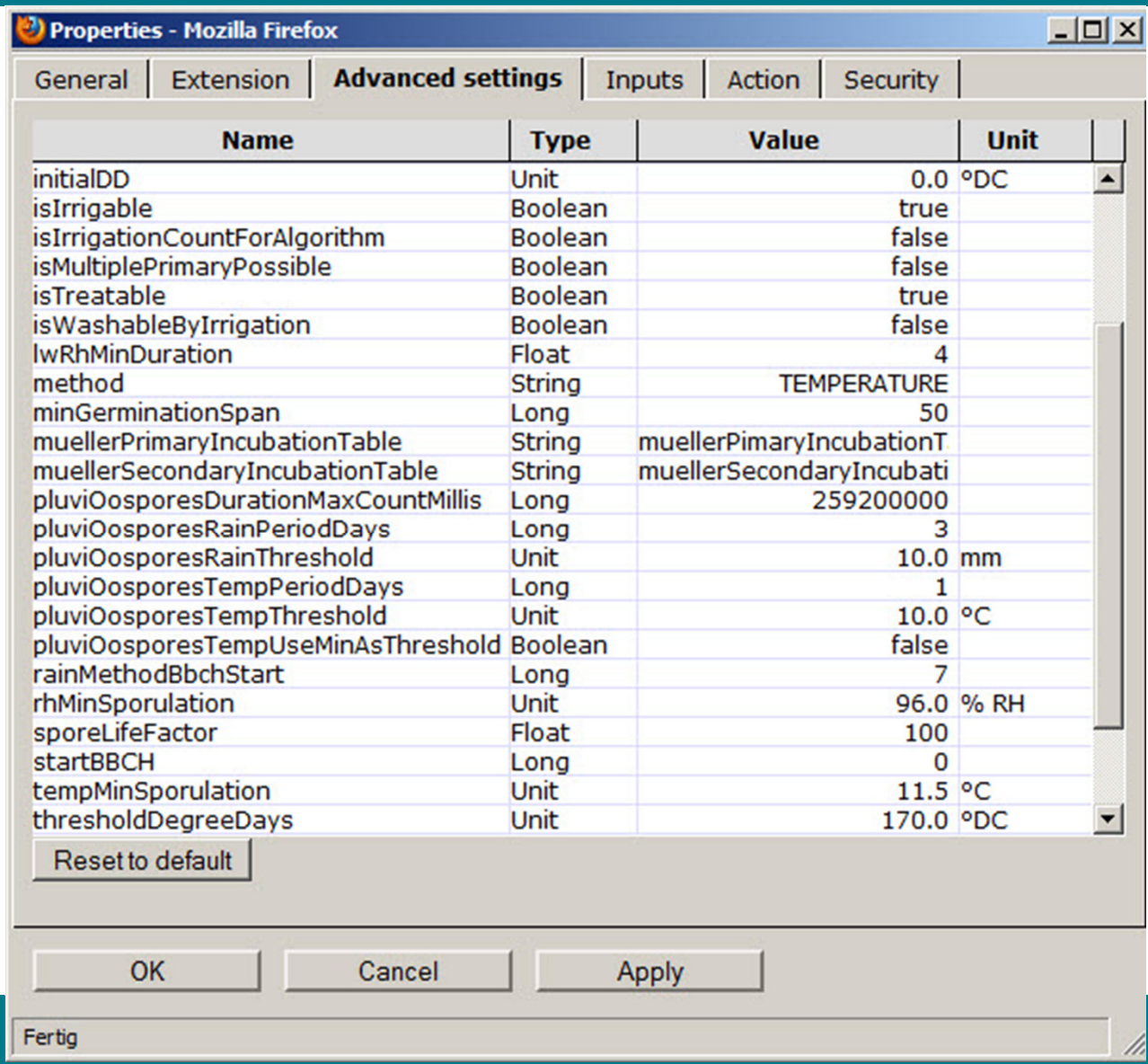
Enter setup information required by the model and the model developer.



» The new, advanced disease extensions of Pro 6

Advanced settings for research and model validation:

Modify every single parameter of the algorithm!



» Disease Modeling with addVANTAGE Pro

- **Grapes**
  - Powdery Mildew
  - Downy Mildew
  - Botrytis
- **Apples**
  - Apple Scab
  - Powdery Mildew
  - Fire Blight
- **Potatoe**
  - Phytophtora
- **Various Nuts**
  - Pistacchio
  - Walnuts
- **Hops**
  - Downy Mildew
  - Powdery Mildew
- **DSV Extension**
  - TomCast &
  - Wisdom TomCast for
  - - Tomatoes (late blight),
  - - Potatoes (late blight),
  - - Carots (Alternaria),
  - - Celery (Septoria)
- **Strawberries**
- **Degree Days**, many methods

» REFERENCES – Who is Who of Adcon Users

Austria: the Chambers of Agriculture network

Since 1995 the Austrian Chambers of Agriculture as the National Extension Service has built a network of over 300 weather stations.

This network covers all major grape, apple, pear, and potatoe growing areas, from East to West, from North to South.

Purpose: disease advise

Since 2008: 25 stations added for FireBlight prediction in Apples

Adcon Market Share: ~ 90%


Prof. Samuel Ortega,
Univ. of Talca, Chile
Dipl.Eng. Weigl and
Dipl.Eng. Schmiedl, heads of
Lower Austrian Chamber of
Agriculture

» REFERENCES – Who is Who of Adcon Users

Austria: the Chambers of Agriculture network

Achievements:

Grapes: reduction of Sprays between 25 and 60%!

Apples: reduction of sprays on average 30%

Potatoes: reduction of sprays 30%;

» REFERENCES – Who is Who of Adcon Users

Honduras: the WWF for Nature

Since 2006 the WWF with its HQ in Honduras is building a network of weather stations in Central America.

a) To monitor Climate Change

b) To bring Kow How to the Farmers

c) To improve sugar cane irrigation and reduce fertilizer runoff

A central addVANTAGE Pro Server operated by agronomists will bring the chance to give many people access to data and agronomical know how.

http://www.youtube.com/watch?v=TPe98r1kXhU

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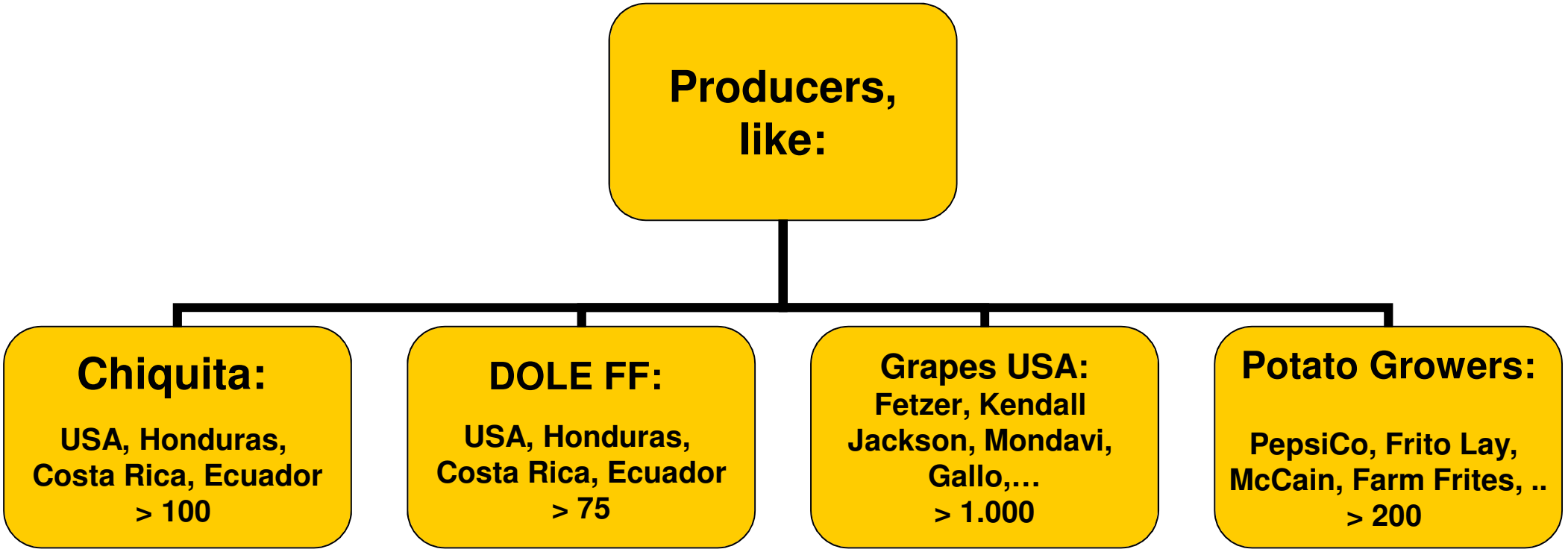

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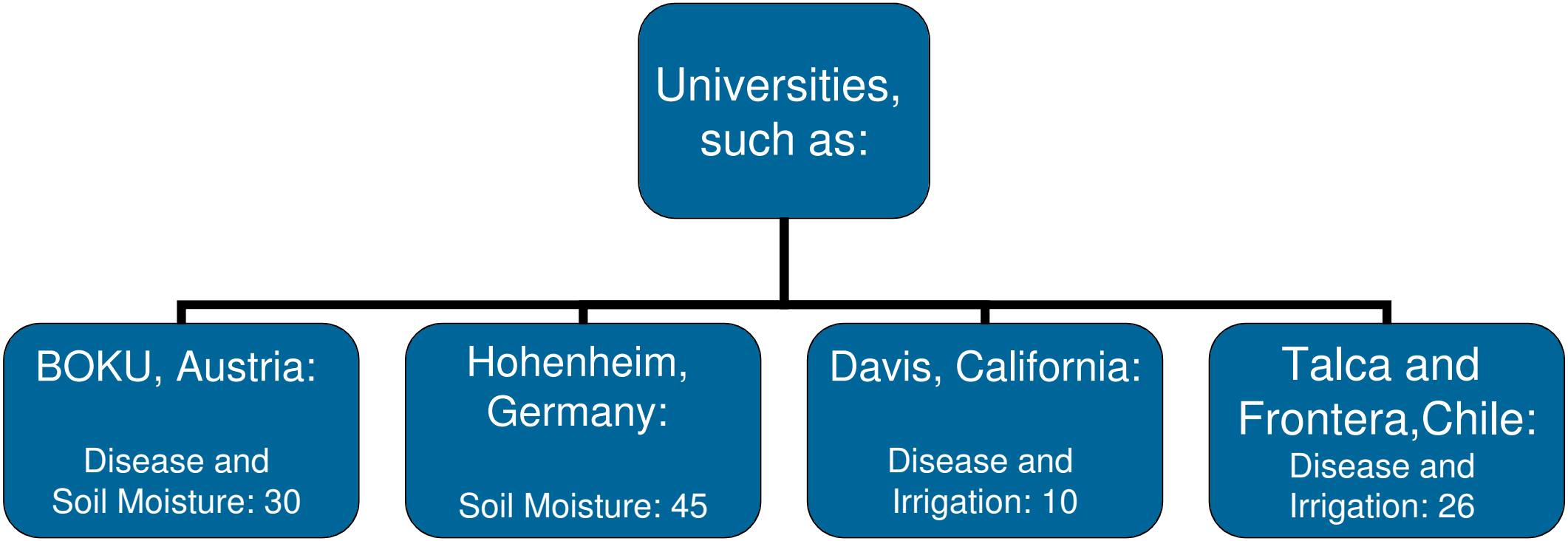
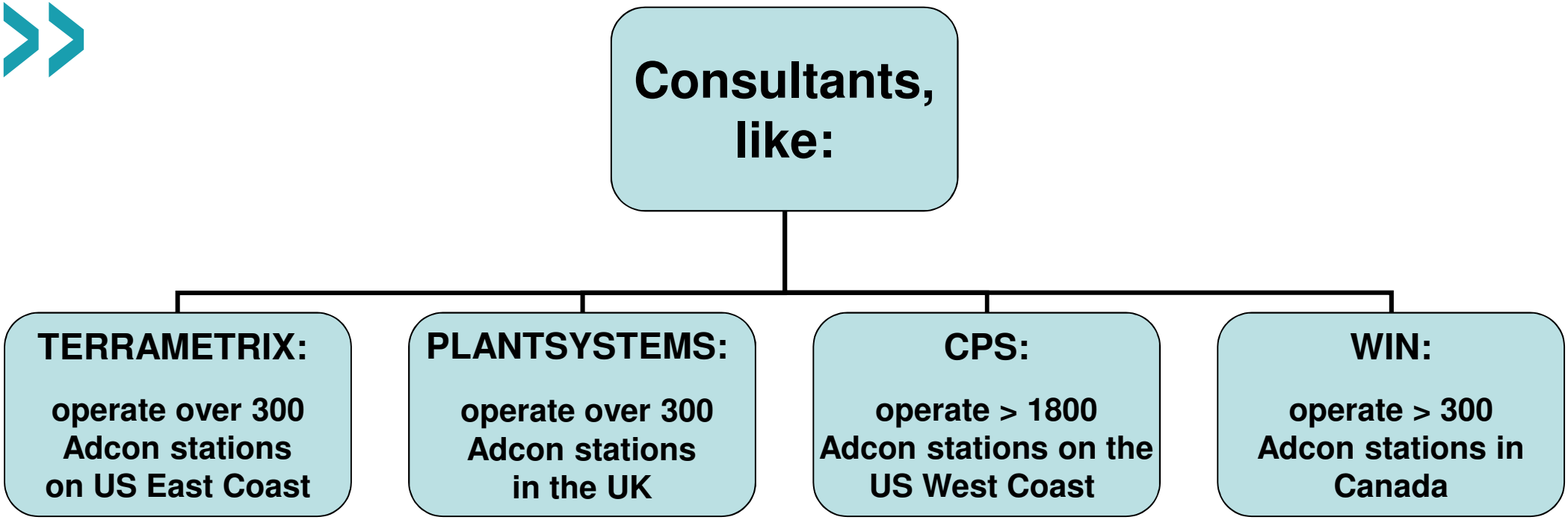
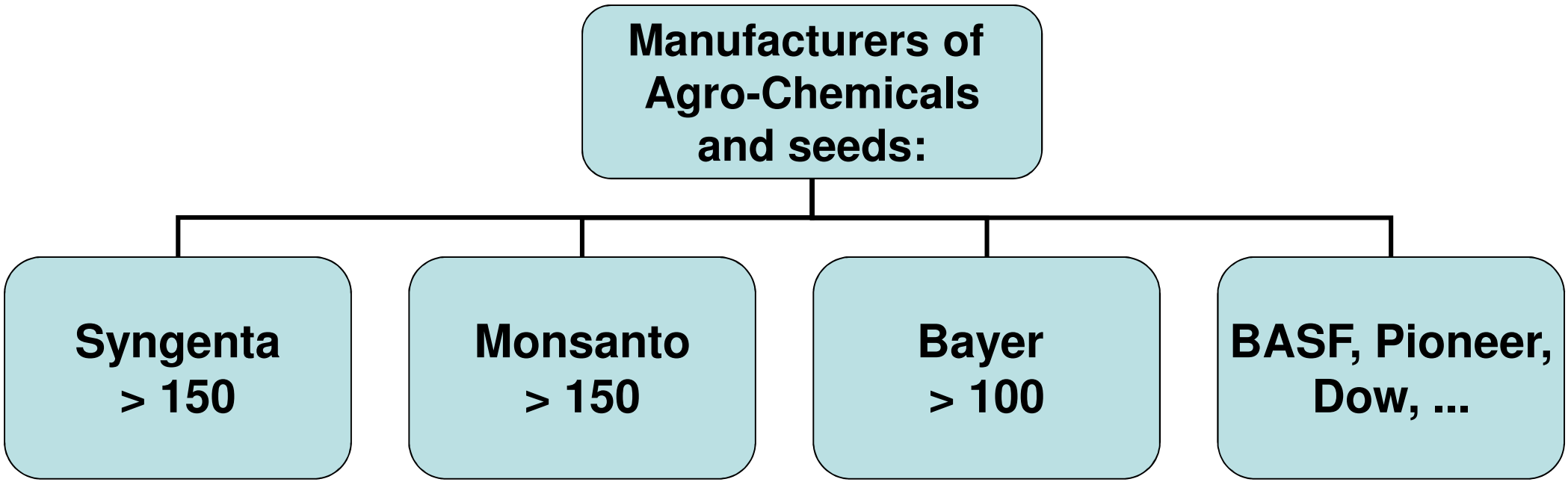


» REFERENCES – Who is Who of Adcon Users



» REFERENCES – Who is Who of Adcon Users



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Thank you for your attention!

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