Agricultural Decision Support System

Guided by WMO-134 (Guide to Agricultural Meteorological Practices (GAMP) 2007 completely revised version)
Agricultural Decision Support System in Iran

• The project was started in 2008 in two provinces of Iran, Fars and Qazvin, located on the South & North West of the country, where the agricultural sector is the major employer. The provinces are the top producers for quite a few crops and for livestock as well. Fars Province has an area of 122,400 km² and Qazvin Province has an area of 15,567 km².
• The GAMP (WMO-134, 2007 revised 3rd Edition), the "Guide for Agricultural Meteorological Practices" was set to be followed as the road map for implementation of the project.
• Reaching sustainability in agriculture, by implementation of a “Decision Support System“ which is based on a comprehensive database, is the ultimate operational goal of the project.
• Following the “Farmer First” paradigm and the establishment of a “bridge” between science and field conditions are the conceptual basics.
Technologies & Science utilized

- Agronomy
- Meteorology
- SCADA, Supervisory Control And Data Acquisition
- RS, Remote Sensing
- GIS, Geographic Information System
- IT, Information Technology
- Anthropology
- Economy
- World Wide Experiences with Agrometeorological Services (China, Cuba, India & Portugal, as collected in Prof Stigter’s Roving Seminars)
“DSS, Organization” Conceptual Model (Prof. Stigter’s Roving Seminars)

A = Sustainable livelihood systems

B = Local adaptive strategies (knowledge pools based on traditional knowledge and indigenous technologies)

+ Contemporary knowledge pools (based on science and technology)

+ Appropriate policy environments (based on social concerns and environmental considerations, scientifically supported and operating through the market where appropriate)

C = Support systems to agrometeorological services: data + research + education/training/extension + policies
“DSS, Organization” Conceptual Model (Prof. Stigter’s Roving Seminars)

E1 = Agrometeorological Action Support Systems on Mitigating Impacts of Disasters

E2 = Agrometeorological Services Supporting Actions of Producers
“DSS, Organization” Conceptual Model (Prof. Stigter’s Roving Seminars)

- Scientific Support System
- Applied Tools & Models
- Field & Concentrated “DSS”
- Farmers Livelihoods
Project data structure

- Land portfolio
- Meteorology
- Economy
- Soil
- Water
- Plant
Supporting Scale & Time

Sustainable Agriculture
Seasonal Projections
Mid-Range Support & Services
Short Term Services
Real-Time Supports
On-Farm
Water shed
County
Province
National
Decision Support System
Science, Models, Maps, Tools, Software & Hardware
Land use, Water, Soil, Plant, Weather & Economy
Decision Support System
Generally Followed Services Model (Gommes et al. in Stigter (Ed.), 2010)

Information flow in a Farm Adaptive Decision Optimisation (FADO) system.
Land portfolio
All the values and properties of a piece of land

• Land use + land owner + land product + land spatial & 720 other values pinned to “Land”

• Substratum to all other layers in “GIS” base databank

• Initial land maps created using “Geo-eye” near real time satellite images

• “Cadastre” database & maps were prepared for the whole province

• A web-based interface was created to work with other layers of data
Land portfolio
All the values and properties of a piece of land

<table>
<thead>
<tr>
<th>Area</th>
<th>Hectares</th>
<th>ID</th>
<th>Village</th>
<th>Father</th>
<th>GPS No</th>
<th>Owner</th>
<th>PRODACUT</th>
<th>KINDCRO</th>
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<tbody>
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<td>342636.667</td>
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<td>سیدمهدی هاشمی ودب</td>
<td>27</td>
<td>علی‌گنجی</td>
<td>ای</td>
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<td>نرگس</td>
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<td>ای</td>
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<td>ای</td>
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<td>نرگس</td>
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<td>نارگی</td>
<td>ای</td>
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<tr>
<td>186689.573</td>
<td>18.669</td>
<td>D40</td>
<td>جهانپور</td>
<td>فریبرز</td>
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<td>نرگس</td>
<td>ای</td>
<td></td>
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<tr>
<td>50633.542</td>
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<td>D41</td>
<td>مطهر هوشیار</td>
<td>خر</td>
<td>41</td>
<td>نرگس</td>
<td>ای</td>
<td></td>
</tr>
</tbody>
</table>
Land portfolio
Land use Maps
Land portfolio
Land Database
Land portfolio
Land & Water (Drop Per Crop per Unit of Land)
Land portfolio
Land / Soil Type map
Land portfolio
Land / Anthropology map/ Farmers education levels
Land portfolio
Land / Crop Type
Agricultural Meteorology

- Agricultural meteorology is concerned with meteorological, hydrological, pedological and biological factors affecting agricultural production and with agriculture’s interaction with the environment. Its objectives are to elucidate such effects, and then to assist farmers to prepare themselves by applying this supportive knowledge and information in agro-meteorological practices and through “agro-meteorological services” (presently called “climate services for agriculture”).

GAMP Chapter 1
Agricultural Meteorology / Spatial Practice area

a) Microclimate

The instrumental practice of agricultural meteorology is carried out by (Automatic) Weather Stations, Soil scanners, Soil/Water probes. The “FADO” Service model is utilised to serve the “Farmer First” paradigm, at this level.

b) Mesoclimate

The measurements at this level are done by “Remote Sensing” and preparation of GIS based maps from the collected data. The tiled maps will help to make the right recommendations and decision support for this level.

c) Macroclimate

This level is created by junctions of previous layers in combination with the Satellite images and remote sensing data. The planners, researchers and policy makers are the target groups for this level of data gathering and processing.
Agricultural Meteorology
Weather Stations

• Stations Types (Gamp Chapter 2/2.1 classifications)

a) Principal Station (Research Carried out)
b) Ordinary Station (Routine Measurements e.g. IPM /Risk Stations)
c) Auxiliary Station (Evapotranspiration Stations)
d) Special Purpose (Soil or Water data collection)
Agricultural Meteorology
Service Centers

• **Service Centers types**  (Stigter’s Roving Seminars)

1) **Centralised Service Centers type AEIB**  (Utilised for both Qazvin and Fars Projects)

2) **Distributed Service Centers AEIA**  (Utilized for “Fars” Project)

[AEI = Agrometeorological Extension Intermediaries;
A (domain): Farmers’ Livelihoods
B (domain): Where farmer problems are solved using adaptive strategies, knowledge and policies]
Agricultural Meteorology
Weather Stations Network

Fars Province
- 39 ET-St.
- 11 Risk-St.
- 4 Research St.
- 50 Soil data

Qazvin Province
- 14 ET stations
- 6 Risk St.
- 1 research
Agricultural Meteorology
Measured & calculated parameters @Weather Stations

1. Temperature
2. Humidity
3. Rain & Rain rate
4. Wind speed & Direction
5. Solar Radiation
6. Ultra Violet
7. Pressure
8. Dew point
9. Evapotranspiration
10. GDD
11. Chilling Hours
12. Bright Sunshine Hours
13. Pest & Diseases models
14. Interactive frost awareness
15. Interactive Data inquiries

“Sayedan” ET- Station Fars-Iran
Data Collection and Processing (Stations Level)
Monitoring Software
Monitoring Software / Web & Mobile Reporting

- Instant (30 Min) reports
- Daily Reports & Graphical
- Weekly Reports & Diagrams
- Monthly Summary & Detail reports
- Yearly Summary reports and previous years overlays
Management and Operational Tools Models

• Agronomy Models
  – Crop Growth Simulations
  – Yield & production
  – Pests & diseases
  – Irrigation recommendation

• Meteorology Forecast Models
  – GFS Short and Mid term Forecasts
  – WRF Mid & Long term Forecast
  – Short term “Frost” forecasts

• Operational tools & Applications
  (developed based on Real time Meteo data)
  – GDD & Harvest planning
  – Chilling requirements
  – Bright Sunshine hours
  – Irrigation recommendation
  – Radiative Frost Alarm
  – Plant date recommendation
  – Crops Quality monitoring
  – Yield Estimation (Wheat)
Operational Models

- Pest & Diseases assessment models for
  - Stone Fruits
  - Nuts
  - Apple & Pears
  - Grape

- User Defined Pest & Diseases (GDD Base) Models
  - Degree Day Calculations (Integration, Cut-off & Min-Max)
### Agronomy Operational Models (Pest & Diseases risk assessment)

#### Pest Risk Assessment Summary

<table>
<thead>
<tr>
<th>Pest Name</th>
<th>Risk Index / Degree Days</th>
<th>Risk Level</th>
<th>Current Stage</th>
<th>Next Stage Dev</th>
<th>Start Date</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Grape Root Borer</td>
<td>3981.52</td>
<td>(6) High</td>
<td>Adult Emergence: Restar</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Grape Root Borer</td>
<td>3981.52</td>
<td>(6) High</td>
<td>Adult Emergence: Restar</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Grape Scale</td>
<td>3981.52</td>
<td>(1) None</td>
<td>Two Generations: Time</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Variegated Cutworm of Grape</td>
<td>4318.06</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>Pacific Spider Mite of Grape</td>
<td>3642.35</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Grape Berry Moth Pennsylvania</td>
<td>4906.73</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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</tr>
<tr>
<td>Eastern Grape Leafhopper</td>
<td>3981.52</td>
<td>(1) None</td>
<td>Two Generations: Time</td>
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<td>1/1/2011</td>
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<tr>
<td>European Red Mite of Grape Males</td>
<td>3792.46</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>European Red Mite of Grape Fem</td>
<td>3792.46</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
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<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>European Corn Borer of Grape</td>
<td>3938.37</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>Eastern Grape Leafhopper</td>
<td>3981.52</td>
<td>(1) None</td>
<td>Two Generations: Time</td>
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<td>1/1/2011</td>
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<tr>
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<td>4612.20</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
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<td>1/1/2011</td>
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<td>Glassy-winged Sharpshooter of Grape</td>
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<td>1/1/2011</td>
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</tr>
<tr>
<td>European Red Mite of Grape Fem</td>
<td>3792.46</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Western Grape Leafhopper</td>
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<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>European Corn Borer of Grape</td>
<td>3938.37</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Onciferous Leaflitter of Grape</td>
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<td>Generation Time: Egg to</td>
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<td>1/1/2011</td>
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<tr>
<td>Western Grape Leafhopper</td>
<td>3894.86</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>Potato Leafhopper of Grape Field</td>
<td>3258.24</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>Redbandled Leaflitter of Grape</td>
<td>4911.56</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
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<tr>
<td>Light Brown Apple Moth of Grape</td>
<td>4612.20</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Tawny Empid Mite of Grape</td>
<td>3464.50</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Anthracnose of Grape</td>
<td>0.00</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Black Rot of Grape</td>
<td>0.00</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Phomopsis Cane &amp; Leaf Spot of G.</td>
<td>0.00</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
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<td>1/1/2011</td>
<td></td>
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<tr>
<td>Downy Mildew of Grape</td>
<td>0.00</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Anthracnose of Grape</td>
<td>0.00</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
<td></td>
</tr>
<tr>
<td>Potato Leafhopper of Grape Field</td>
<td>3258.24</td>
<td>(1) None</td>
<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Botrytis Bunch Rot of Grape</td>
<td>2213.18</td>
<td>(1) Unknown</td>
<td>Three Generations: Time</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<tr>
<td>Variegated Cutworm of Grape</td>
<td>4318.06</td>
<td>(1) Unknown</td>
<td>Generation Time: Adult 1</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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<td>Vine Mealybug</td>
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<td>Tawny Empid Mite of Grape</td>
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<td>Generation Time: Egg to</td>
<td>*** Done ***</td>
<td>1/1/2011</td>
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</table>

#### Grape Root Borer

- **Date**: 02/15/12
- **Time**: 7:00am
- **Degree Day**: 50.30
- **Outside Temp**: 49.89
- **Comments**: None

- **Date**: 02/16/12
- **Time**: 8:00am
- **Degree Day**: 49.95
- **Outside Temp**: 48.95
- **Comments**: None

- **Date**: 02/17/12
- **Time**: 9:00am
- **Degree Day**: 48.75
- **Outside Temp**: 47.75
- **Comments**: None

- **Date**: 02/20/12
- **Time**: 11:00am
- **Degree Day**: 45.15
- **Outside Temp**: 45.15
- **Comments**: None

- **Date**: 02/21/12
- **Time**: 12:00am
- **Degree Day**: 43.55
- **Outside Temp**: 43.55
- **Comments**: None

- **Date**: 02/24/12
- **Time**: 3:00am
- **Degree Day**: 40.85
- **Outside Temp**: 40.85
- **Comments**: None

- **Date**: 02/25/12
- **Time**: 5:00am
- **Degree Day**: 39.50
- **Outside Temp**: 39.50
- **Comments**: None

- **Date**: 02/26/12
- **Time**: 7:00am
- **Degree Day**: 43.45
- **Outside Temp**: 43.45
- **Comments**: None

- **Date**: 02/27/12
- **Time**: 8:00am
- **Degree Day**: 40.95
- **Outside Temp**: 40.95
- **Comments**: None

- **Date**: 03/01/12
- **Time**: 12:00am
- **Degree Day**: 42.85
- **Outside Temp**: 42.85
- **Comments**: None

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Ohio State University
Agronomy Operational Models (Pest & Diseases)
Plant Monitoring

Growing degree day Classification maps
Plant Growth and Vegetation Index

- Ground and Satellite Data Calibration

“NDVI” Mapper
Operational Models (Frost Risks / Dew point Tracking / Short term Forecasting)
Operational Models (Frost Risks / Min-Temp Trend) Snyder/FAO35
Operational Models (Irrigation recommendation / ET estimation)
Operational Models (Drought monitoring and modeling)
Operational Tools (Irrigation recommendation / ET calculation)
Operational Applications

(“Yellow berry“ factor monitoring versus Temperature for cereal protein level)
Meteorological Operational Models (Forecast spatial selection)
Meteorological Operational Models (Forecasts mapping)
Meteorological Operational Models (Short & Mid-term Forecasts)
Meteorological Satellite Maps & Forecasts
Remote Sensing

1. Polar Orbiter Meteorology & Multispectral Satellites
2. Geo-Stationary Meteorology & Multispectral Satellites

MODIS Station @ Shiraz University
Remote Sensing Data and Mapping

- **Atmosphere**
  - MOD 04 - Aerosol Product
  - MOD 05 - Total Precipitable Water (Water Vapor)
  - MOD 06 - Cloud Product
  - MOD 07 - Atmospheric Profiles
  - MOD 08 - Gridded Atmospheric Product
  - MOD 35 - Cloud Mask

- **Land**
  - MOD 09 - Surface Reflectance
  - MOD 11 - Land Surface Temperature & Emissivity
  - MOD 12 - Land Cover/Land Cover Change
  - MOD 13 - Gridded Vegetation Indices (Max NDVI & Integrated MVI)
  - MOD 14 - Thermal Anomalies, Fires & Biomass Burning
  - MOD 15 - Leaf Area Index & FPAR
  - MOD 16 - Evapotranspiration
  - MOD 17 - Net Photosynthesis and Primary Productivity
  - MOD 43 - Surface Reflectance
  - MOD 44 - Vegetation Cover Conversion
Meteorological Satellite Weather Monitoring (real time)
Reaching Farmers

- Bilateral Text messages
- Interactive SMSs
- Info-Billboards
- Parcel Managers
Reaching Farmers

- Monthly Agricultural Meteorology & ADSS Bulletins
Steps to go

- Soil Data
  - Salinity
  - Nutrition Management
  - Soil Spatial Maps

- Water
  - ET Calibrations (Scientillometry)
  - Water in Soil (Lysimetry)
  - Surface Water monitoring
  - Ground Water monitoring

- Plant
  - Ground NDVI /LAI
  - Phenology Models
  - Growth Simulations

- Anthropology
  - Farmers’ education
  - Reaching Farmers
  - NGOs enabled to utilize DSS
  - Disasters Mitigation
  - Bridges Between Science & Field

- Economy
  - Market Price & Trends
  - Farmers Income Sustainability
  - Crop Patterns & Paradigm