Horticulture Science

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Precision Farming

What does Precision Agriculture Mean?

What does Precision Agriculture Mean?

Manage Crop Production on a Site Specific Basis to:

- optimize profit
- reduce waste
- maintain environmental quality

Typical Elements for "Precision Agriculture",
(as defined by Michael Rasher, USDA-NRCS).

- Soil sampling-the ability to determine the physical characteristics and the variability of the soil in the field.

- Variable rate application-the ability to precisely apply the required type and quality of chemical nutrient needed to specific areas of the field.

-Yield monitoring-the ability to accurately measure the yield and simultaneously record the location in the field.

Optical	*SAR (Radar)*
NASA Landsat MSS (1972)	JERS (1992)
NOAA AVHRR (1978)	Radarsat (1995)
SeaSat (1978)	ERS 1/2 (1991/95)
NASA Landsat TM (1984)	
MOS (1987)	
SPOT (1986/90/94/98)	

EOS-TERRA (1999)

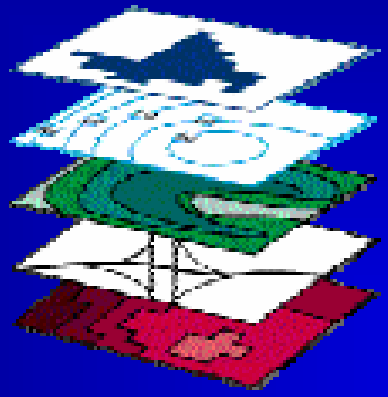
EOS-MODIS

What Is Remote Sensing?

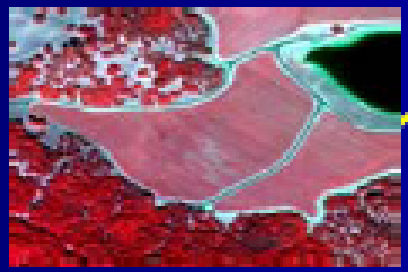
Remote sensing is the **noncontact** recording of information from the ultraviolet, visible, infrared, and microwave regions of the **electromagnetic spectrum** by means of instruments such as cameras, scanners, lasers, linear arrays, and/or area arrays located on platforms such as **near-field, aircraft or spacecraft**, and the analysis of acquired information by means of **visual, digital image processing, and model simulations**

What Is *Not* Remote Sensing?

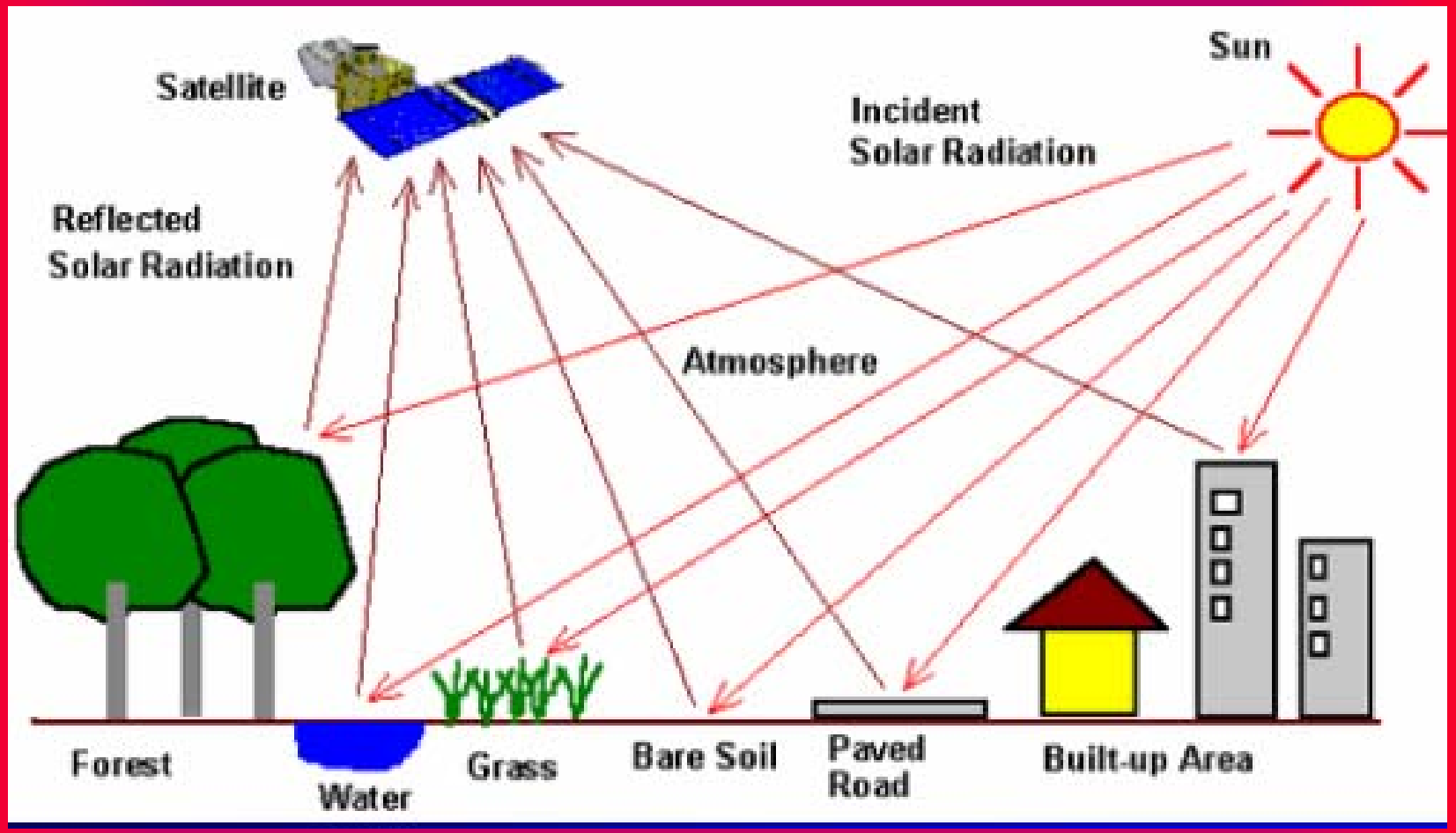
GIS (Geographic Information Systems)

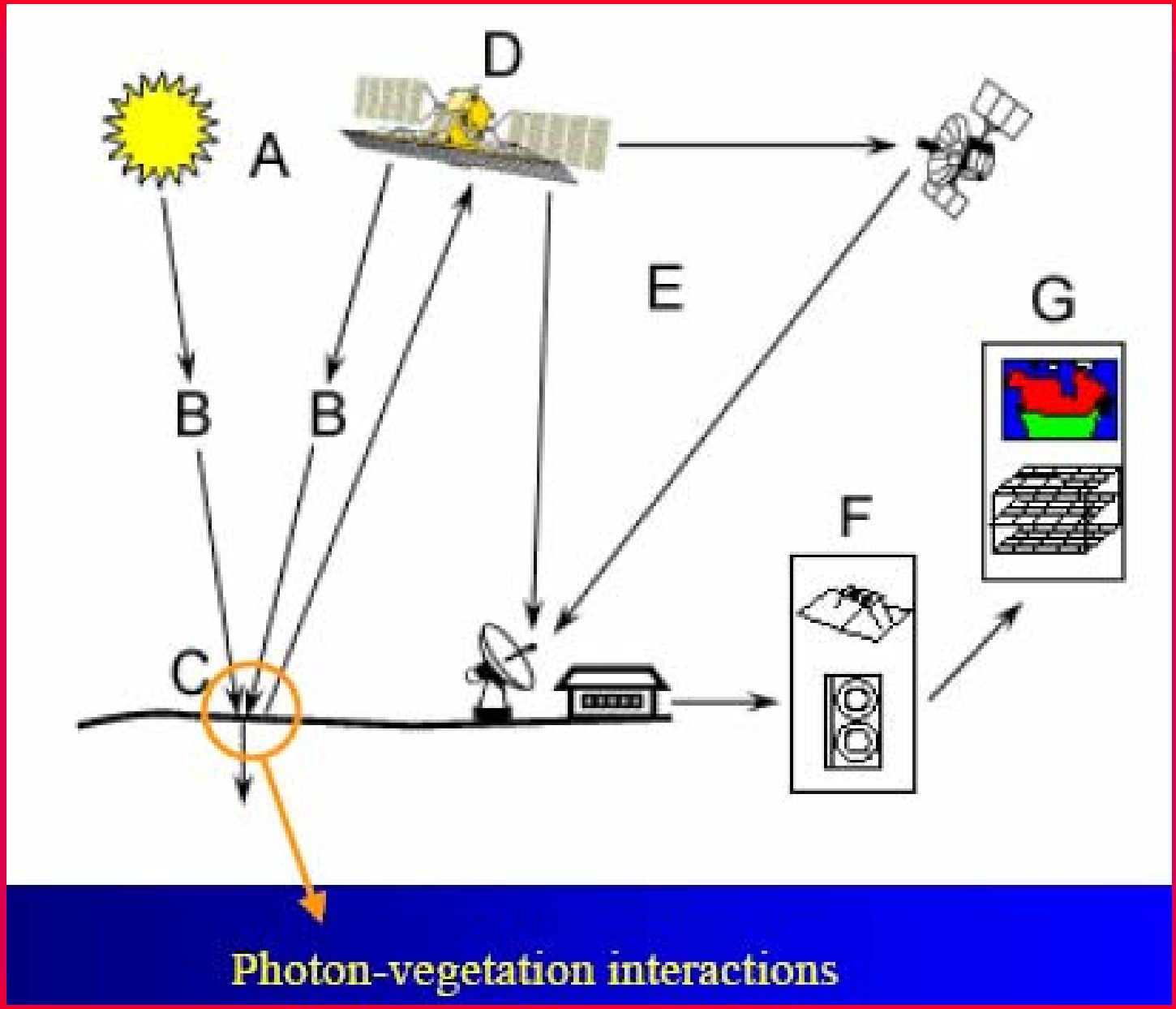


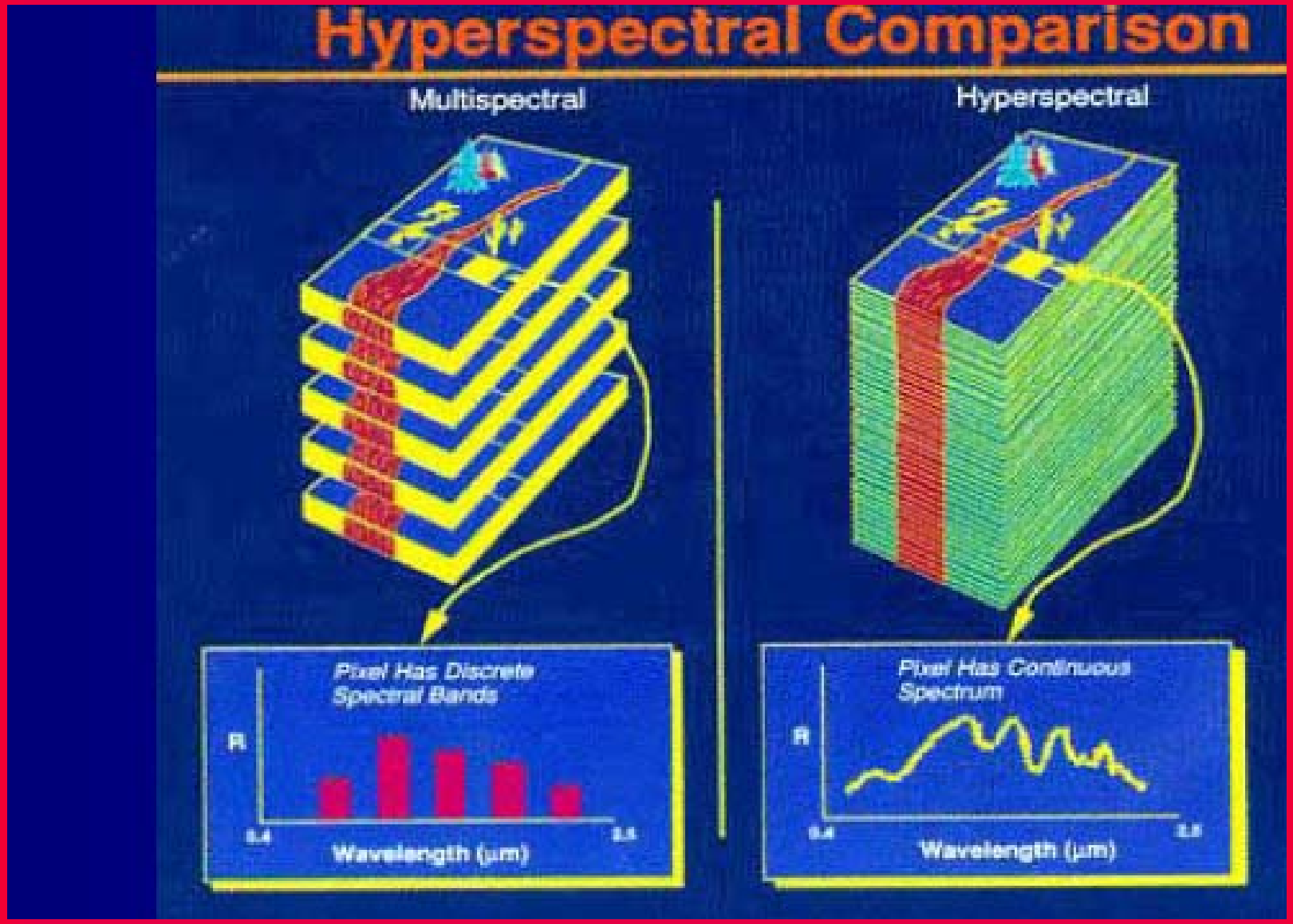
RS (Remote Sensing)

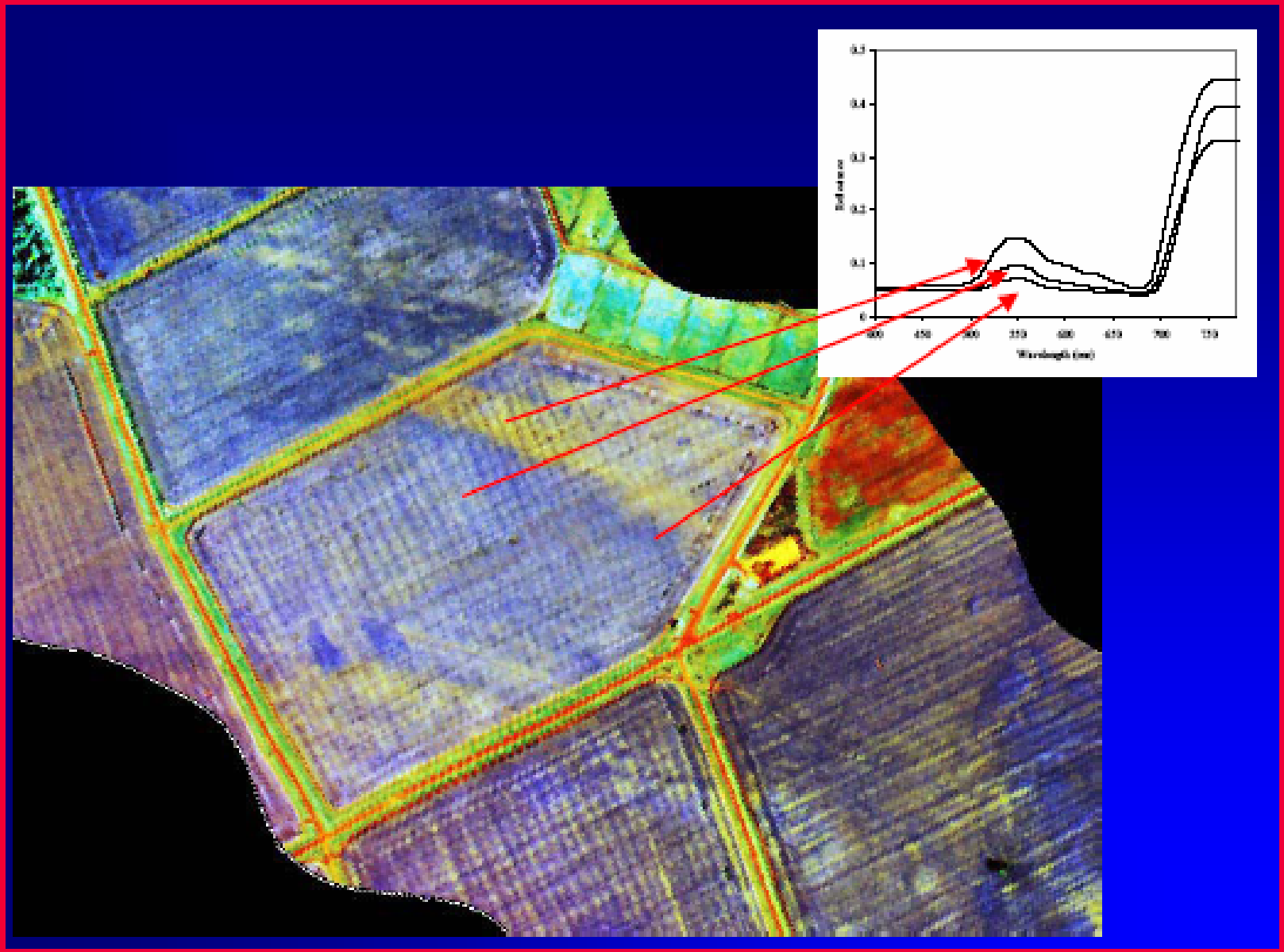


GPS (Global Positioning System)

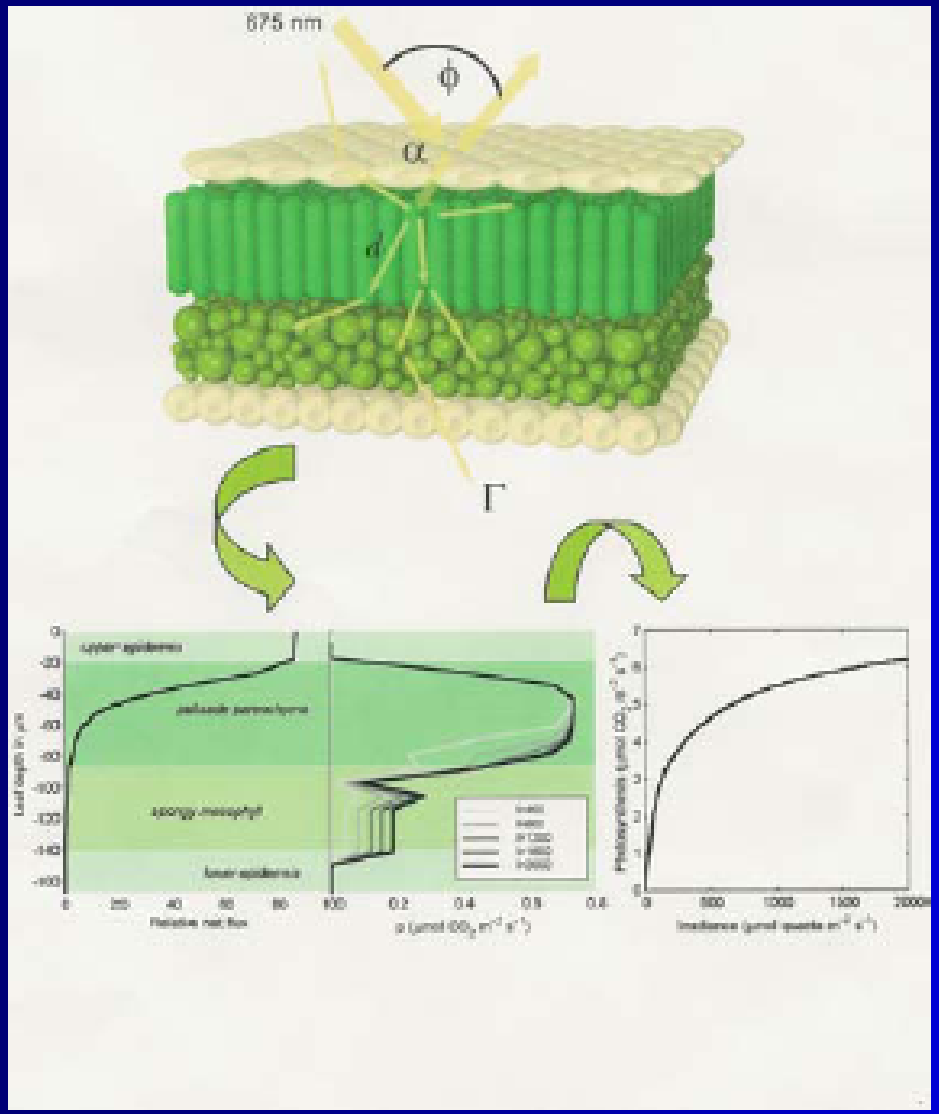

Satellite
Sun
Incident
Solar Radiation
Reflected
Solar Radiation
Atmosphere
Forest
Water
Grass
Bare Soil
Paved
Road
Built-up Area


D
A
E
G
B
B
F
C
Photon-vegetation interactions

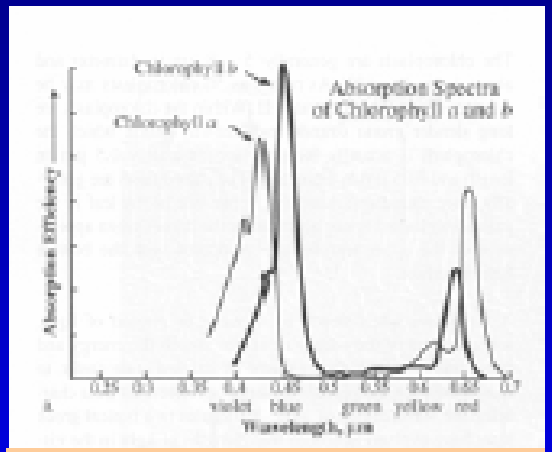

Hyperspectral Comparison
Multispectral
Hyperspectral
Pixel Has Discrete Spectral Bands
R
0.4
2.5
Wavelength (μm)
Pixel Has Continuous Spectrum
R
0.4
2.5
Wavelength (μm)

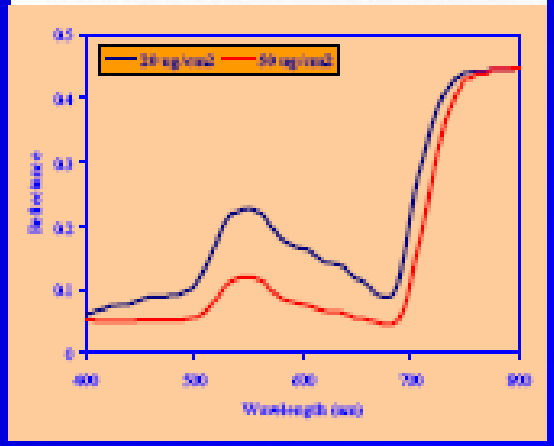


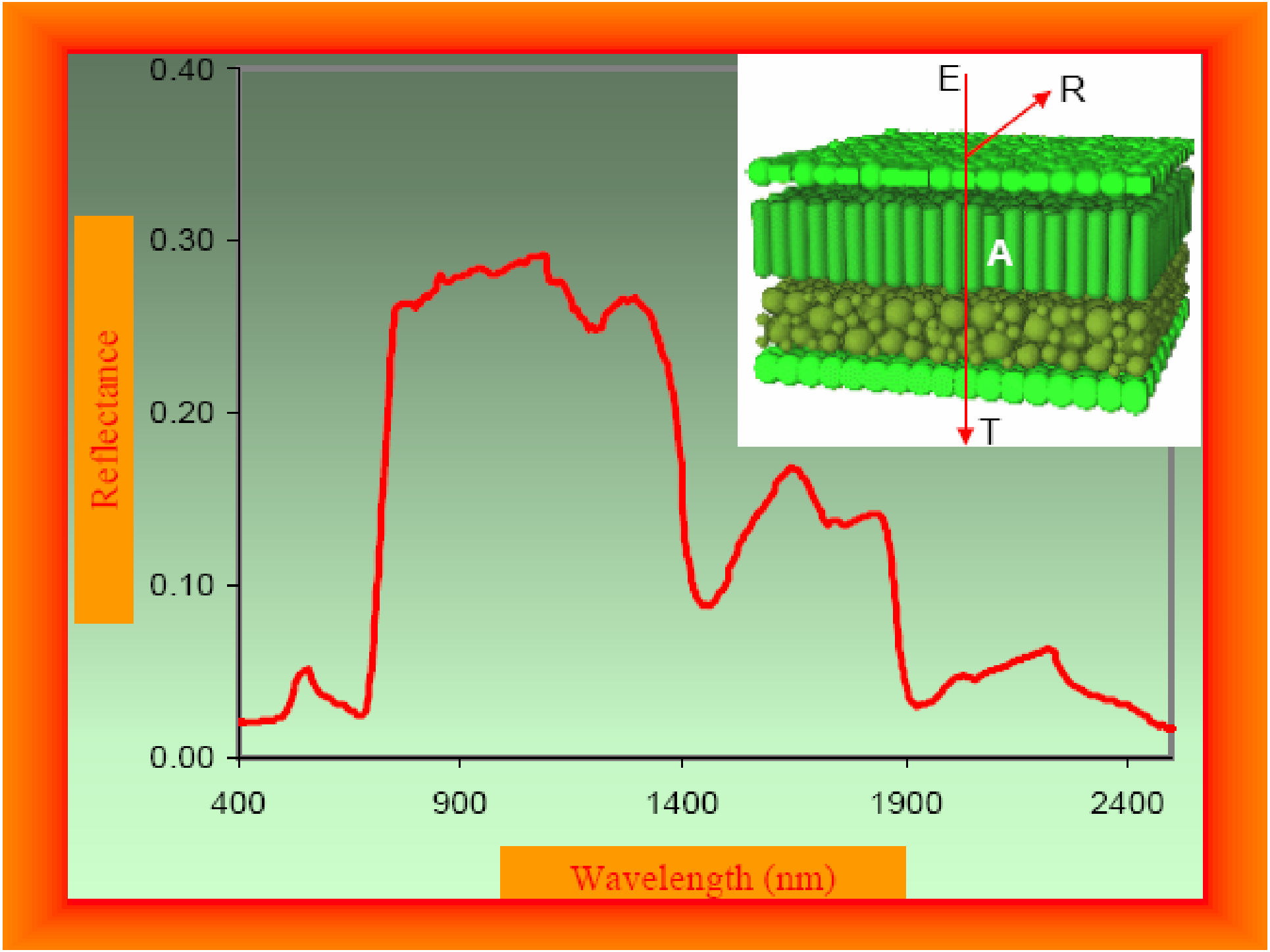
Introduction: Optical Properties and Absorption



- Changes in Leaf optical properties due to pigment content variation






0.40
0.30
0.20
0.10
0.00
Reflectance
400
900
1400
1900
2400
Wavelength (nm)
E
R
A
T

Differences:

1. Optical Properties
2. Canopy Structure
3. Soil/Bckgrnd Effects
4. Atmospheric Effects

Issues

Spatial resolution OK ?

- *Tree dimensions*
- *Grids with large background effects*
- *Vineyards: large shadow effects*

Spectral resolution OK ?

- *Can we estimate chlorophyll ? (chlorosis)*
- *Can we estimate biophysical parameters ?*
- *Objectives:*
  - *nutrient deficiencies (C_{ab}, N)*
  - *water stress detection (thermal)*


HA12DE

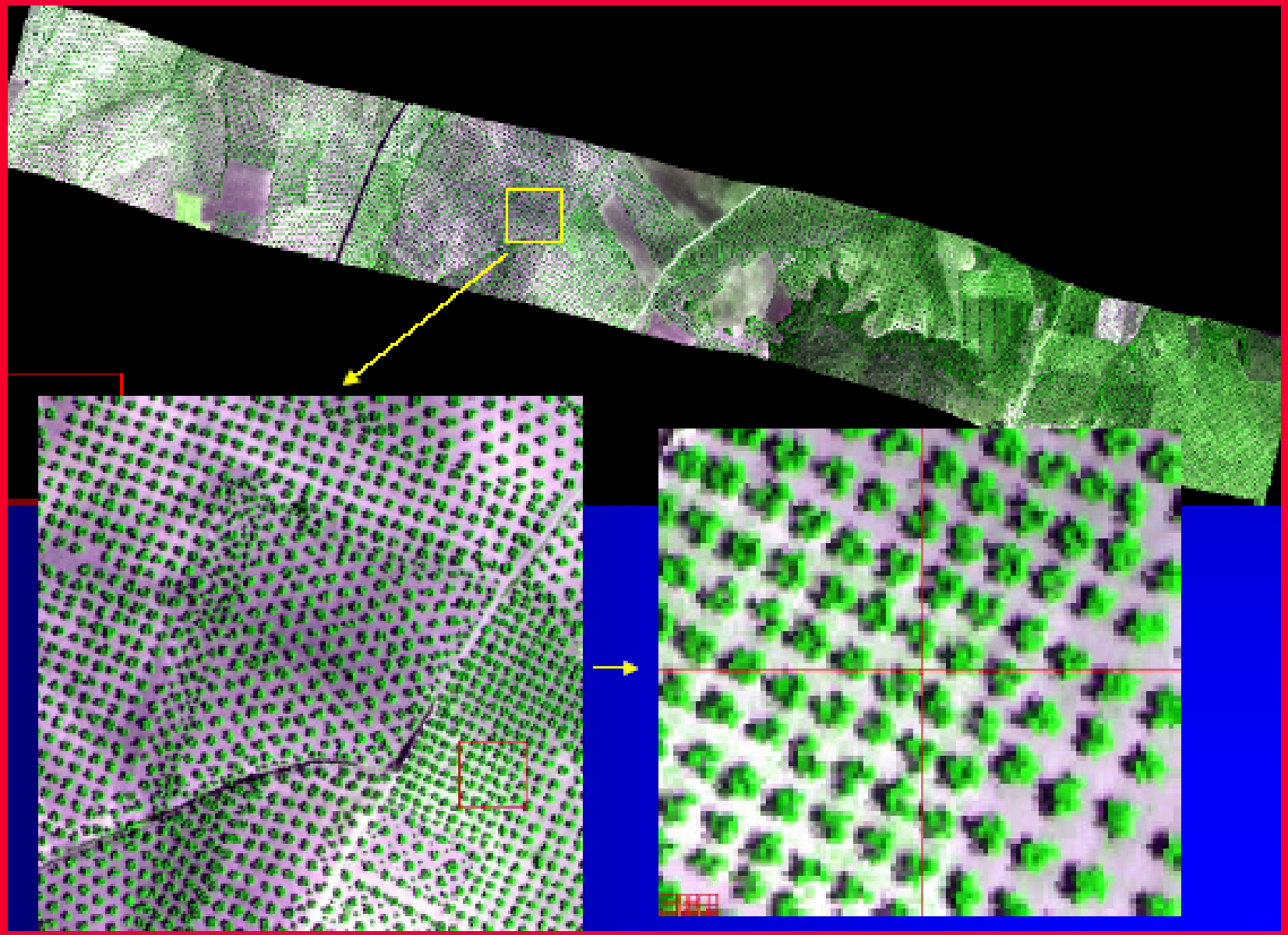
Instalación de sensores de teledetección en el Instituto Nacional de Técnica Aeroespacial (INTA)

Consola de Adquisición de Imágenes

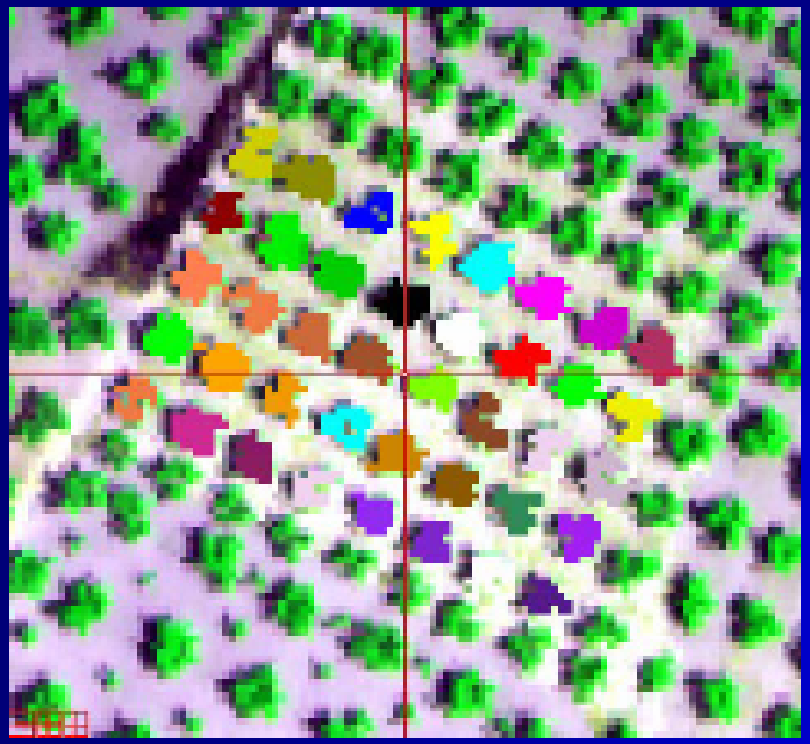
Sistema de Adquisición de Imágenes

Sistema de Navegación Inercial

Sensor hiperespectral aerotransportado

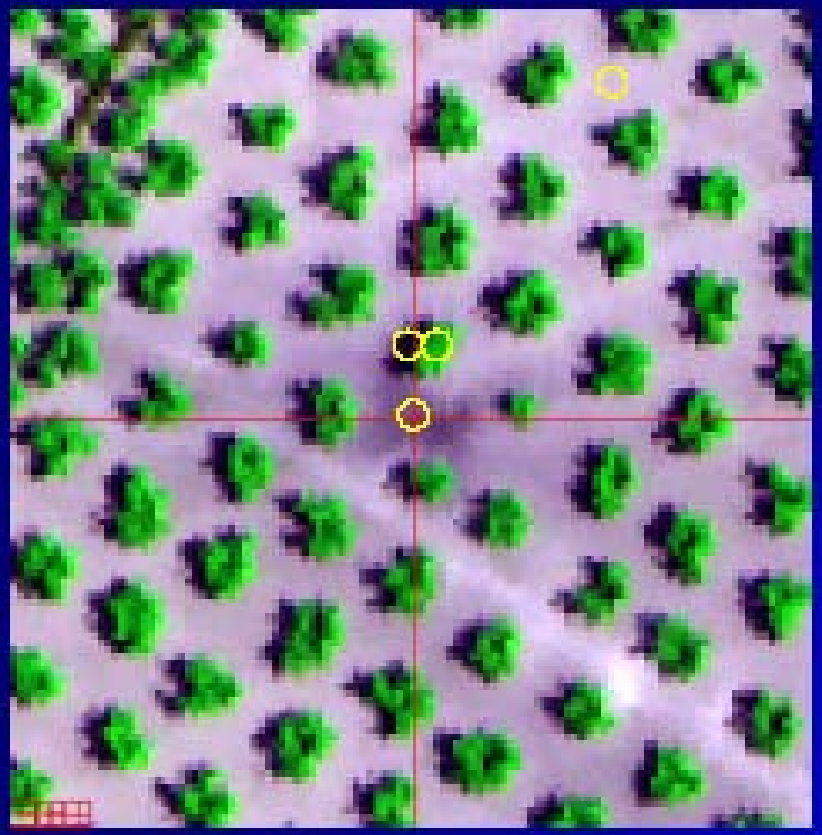


Study Areas Olive Fields



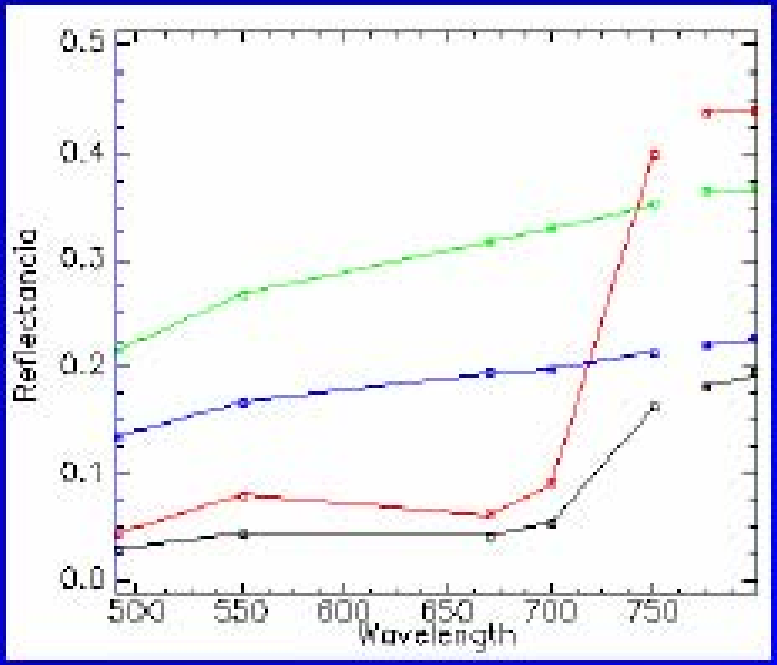
33	34	35	36	37	38	39	40
32	31	30	29	28	27	26	25
17	18	19	20	21	22	23	24
16	15	14	13	12	11	10	9
1	2	3	4	5	6	7	8

- Q_0 (Testigo)
- Q_1 (Q Fe 4.8 o-o)
- Q_2 (+33% Q_1)
- Q_3 ($2Q_1$)
- Q_1^*(Q Fe 2.3 o-o)

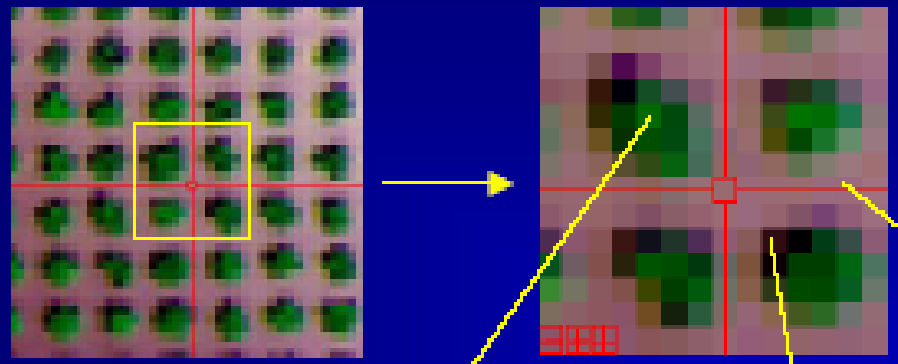


8 bands, 4-12 nm FWHM

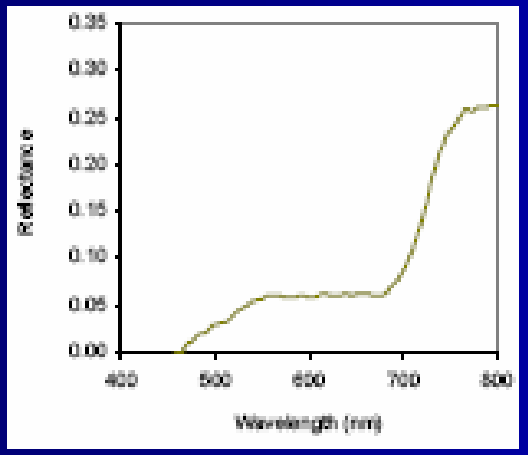
1 m spatial resolution



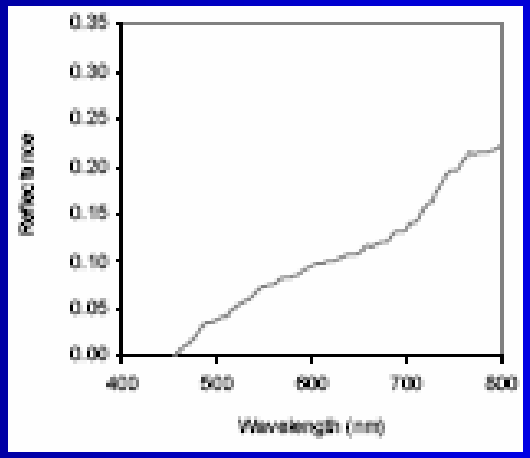
Scene components crown, shadow and soil reflectance extracted from ROSIS 2-m data



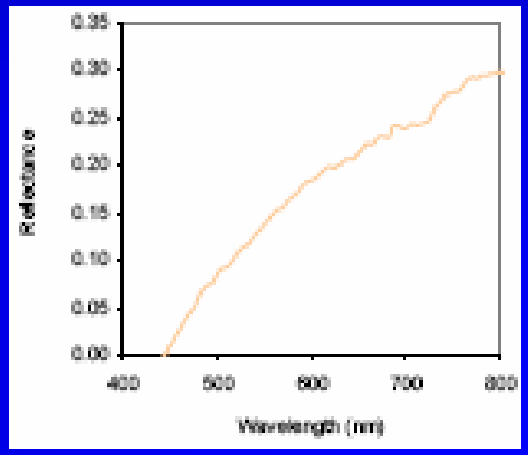
Crown

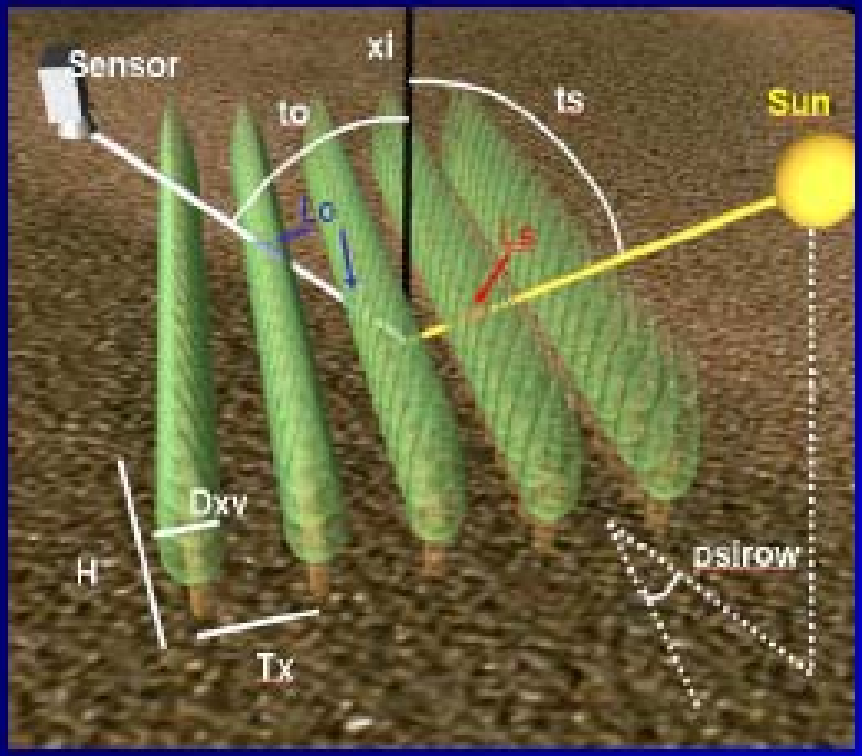


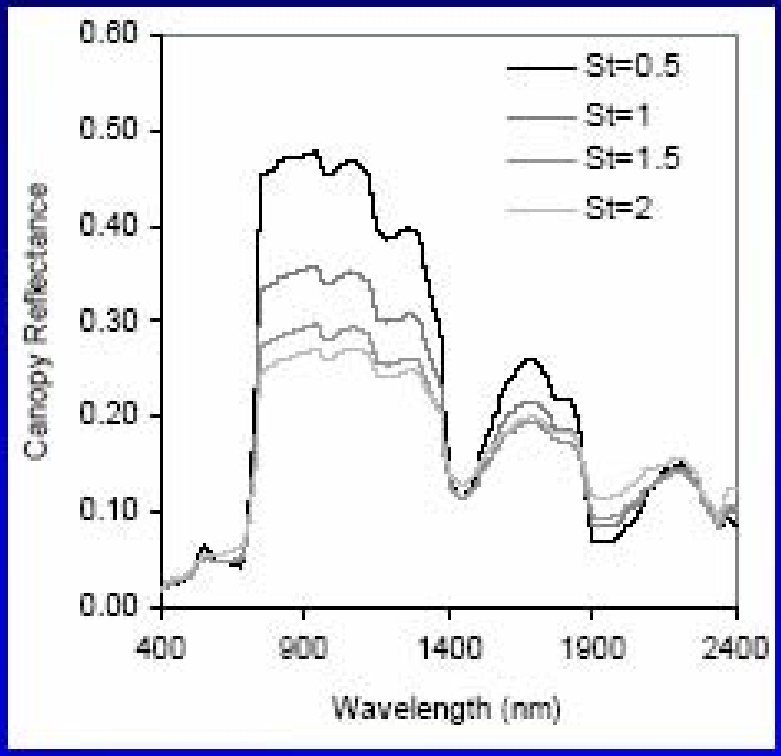
Shadow



Soil







Model simulation of row-structured discontinuous canopies with rowMCRM radiative transfer model (left). Vineyard canopy reflectance simulation as function of the visible strip length in the row crop (St=0.5, 1m, 1.5m and 2m) (right).

Comprehensive precision agriculture has five major objectives:

- Increased production efficiency
- Improved product quality
- More efficient chemical use.
- Energy conservation.
- Soil and ground water protection.

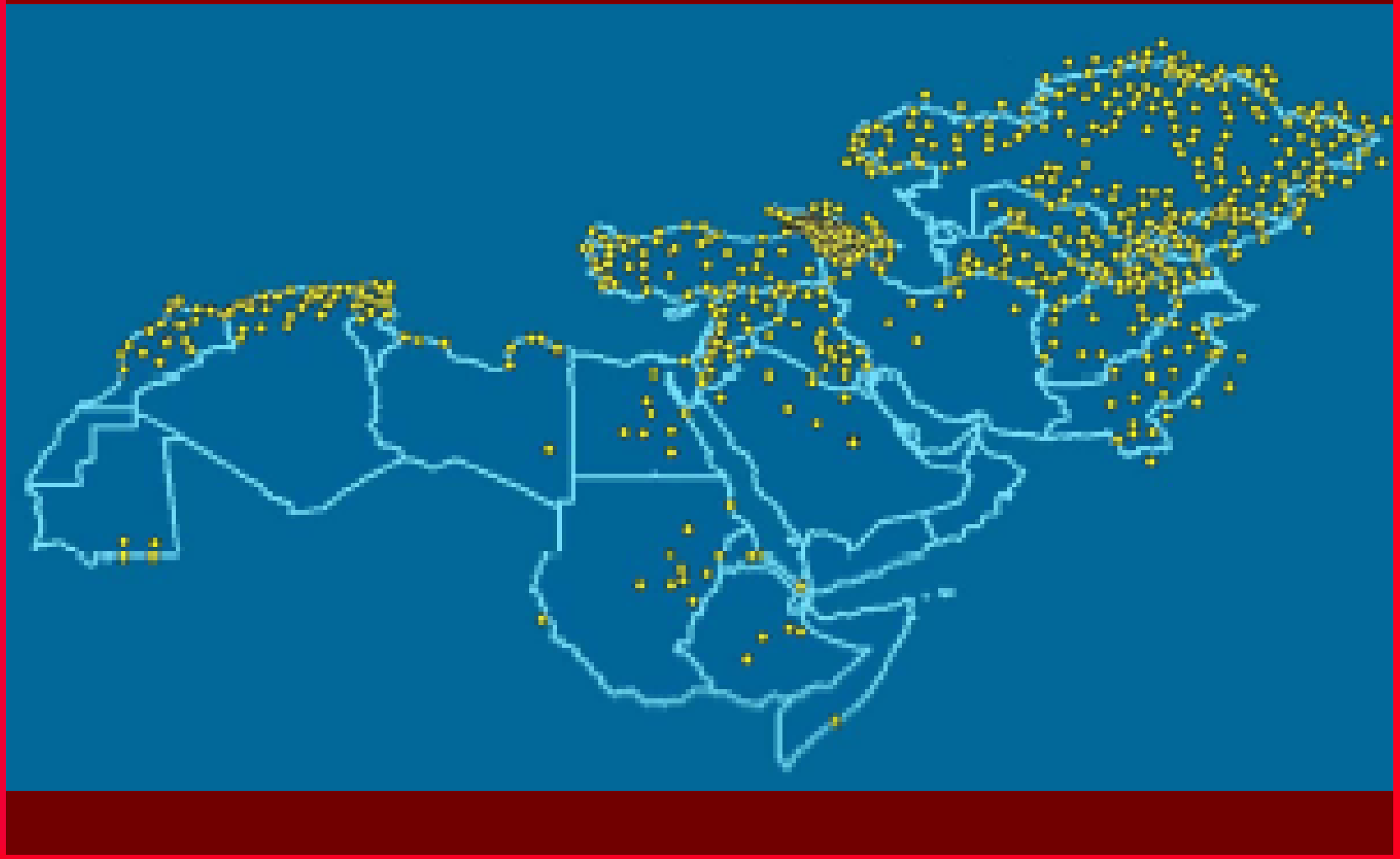
To be successful, comprehensive precision agriculture relies on three key elements:

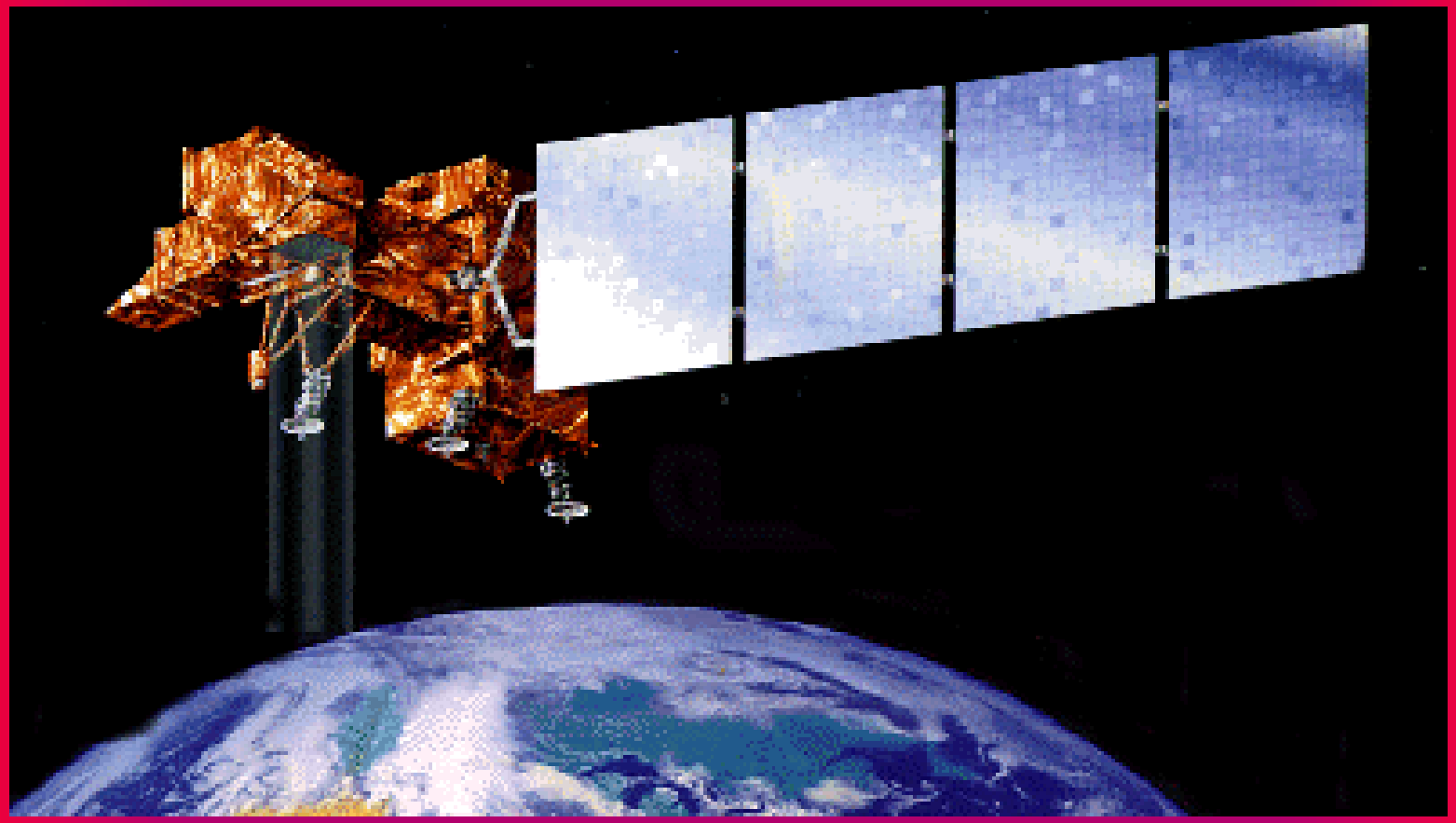
- Information
- Technology
- Management

With this background in mind, comprehensive precision agriculture system can be viewed in two phases.

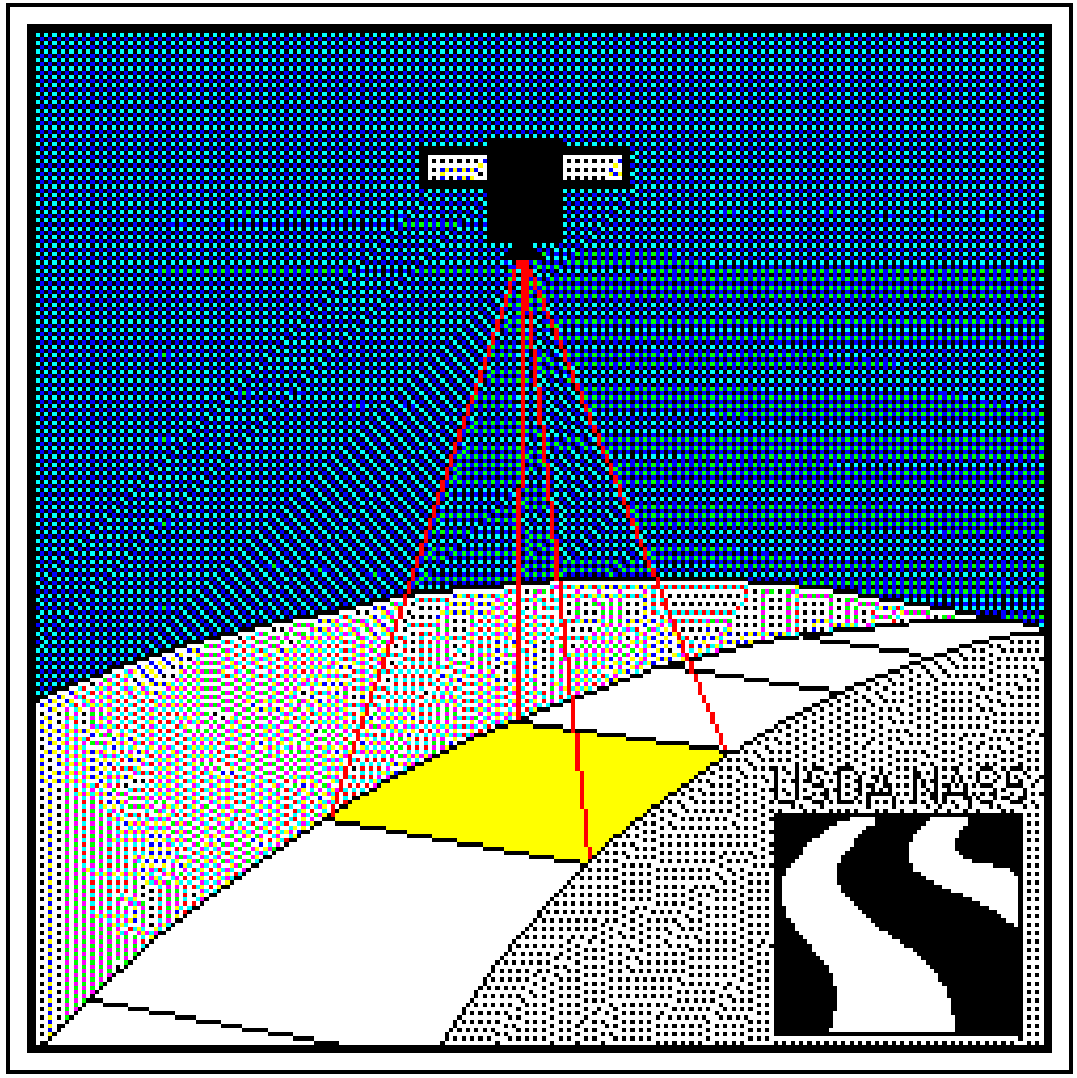
- Site Specific Management
- Post-harvest Process Control

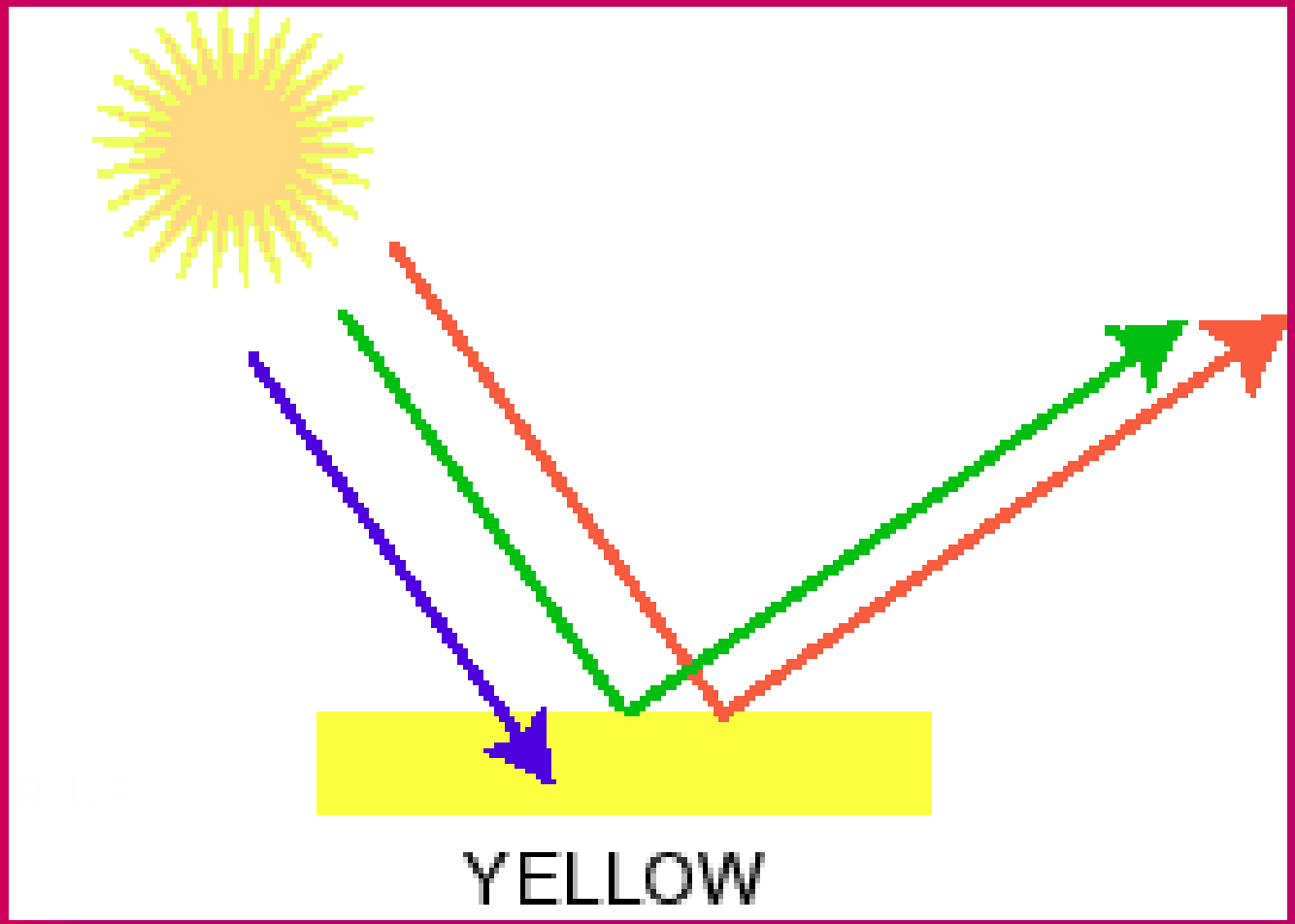
GLDS Station distribution

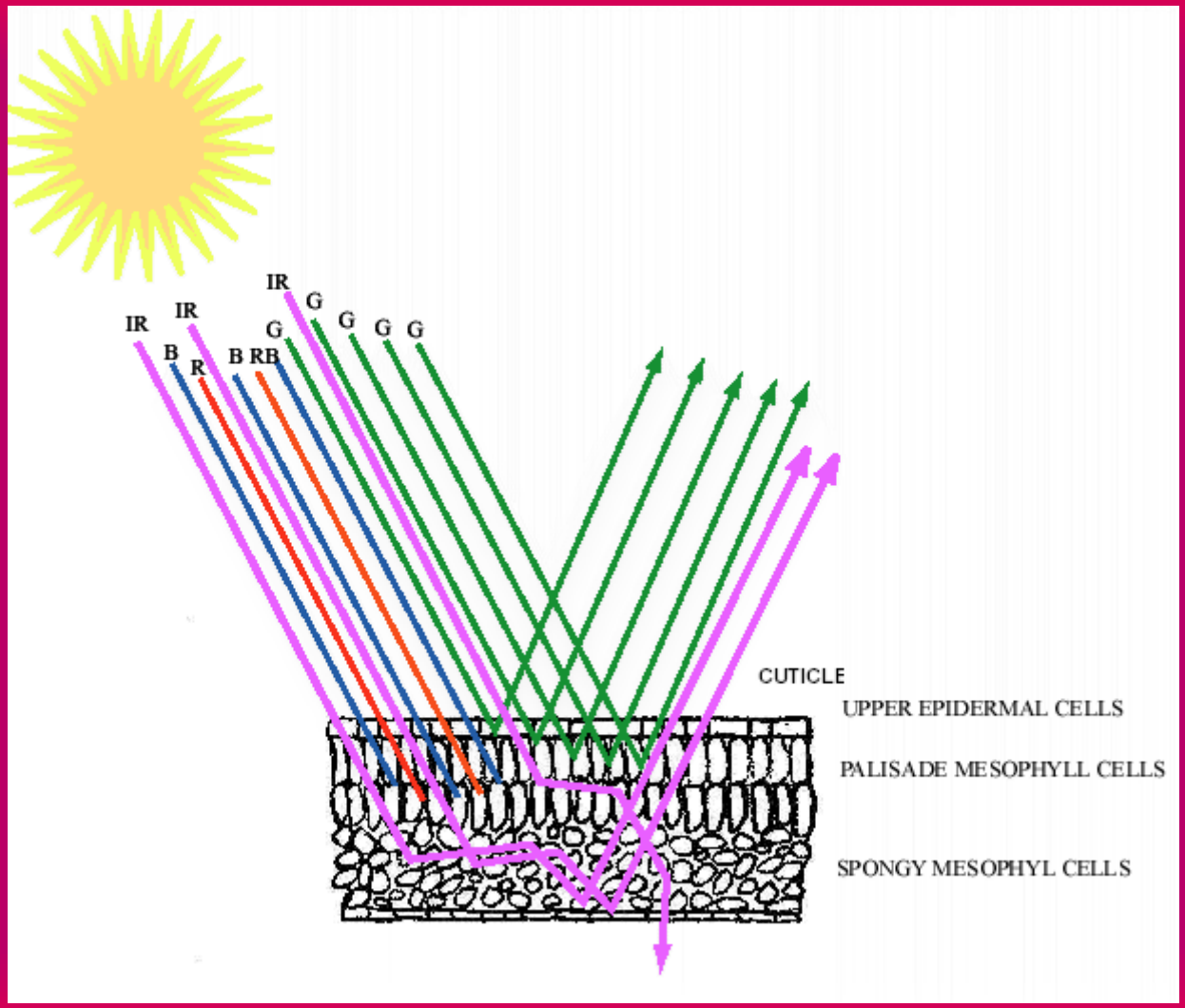


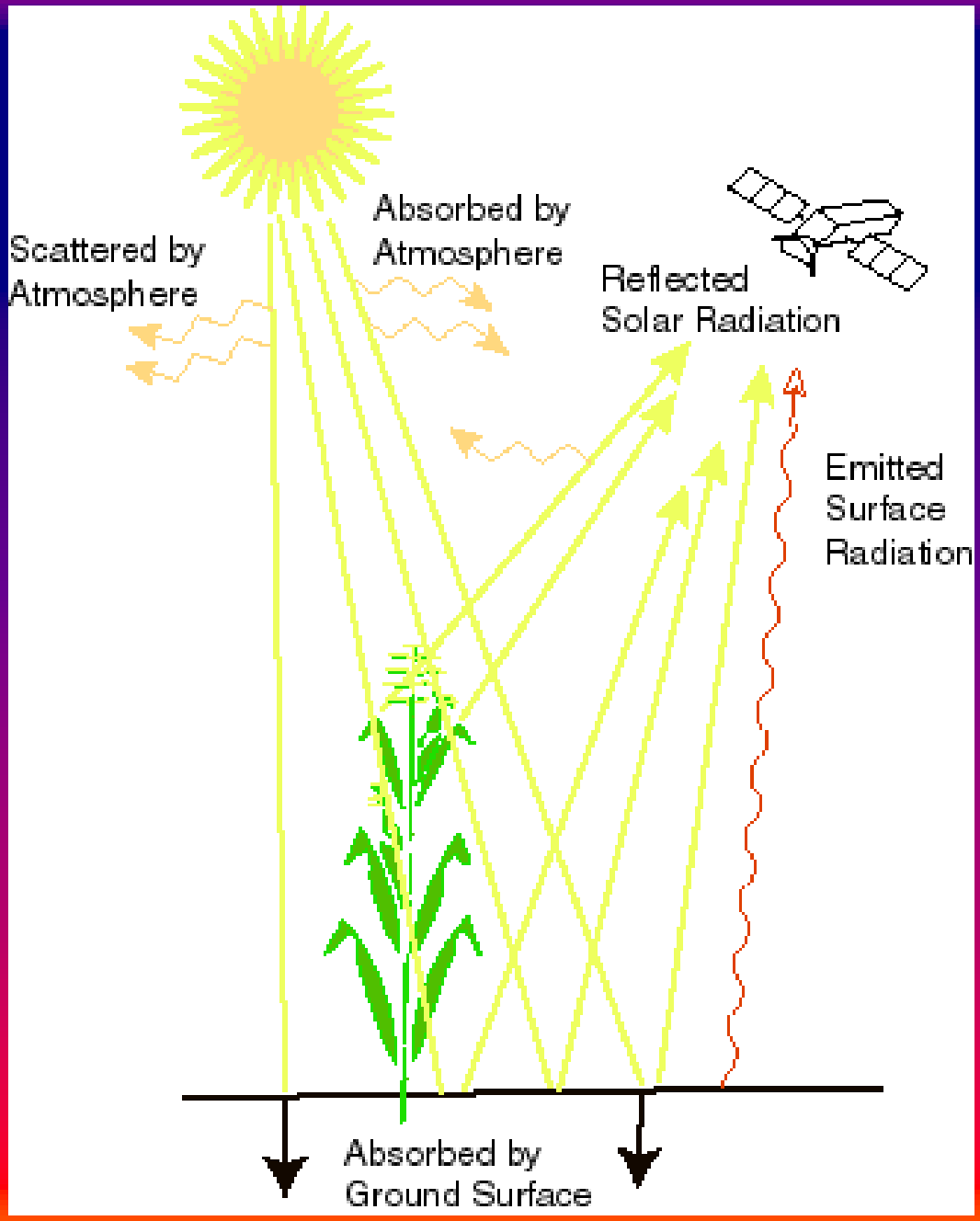


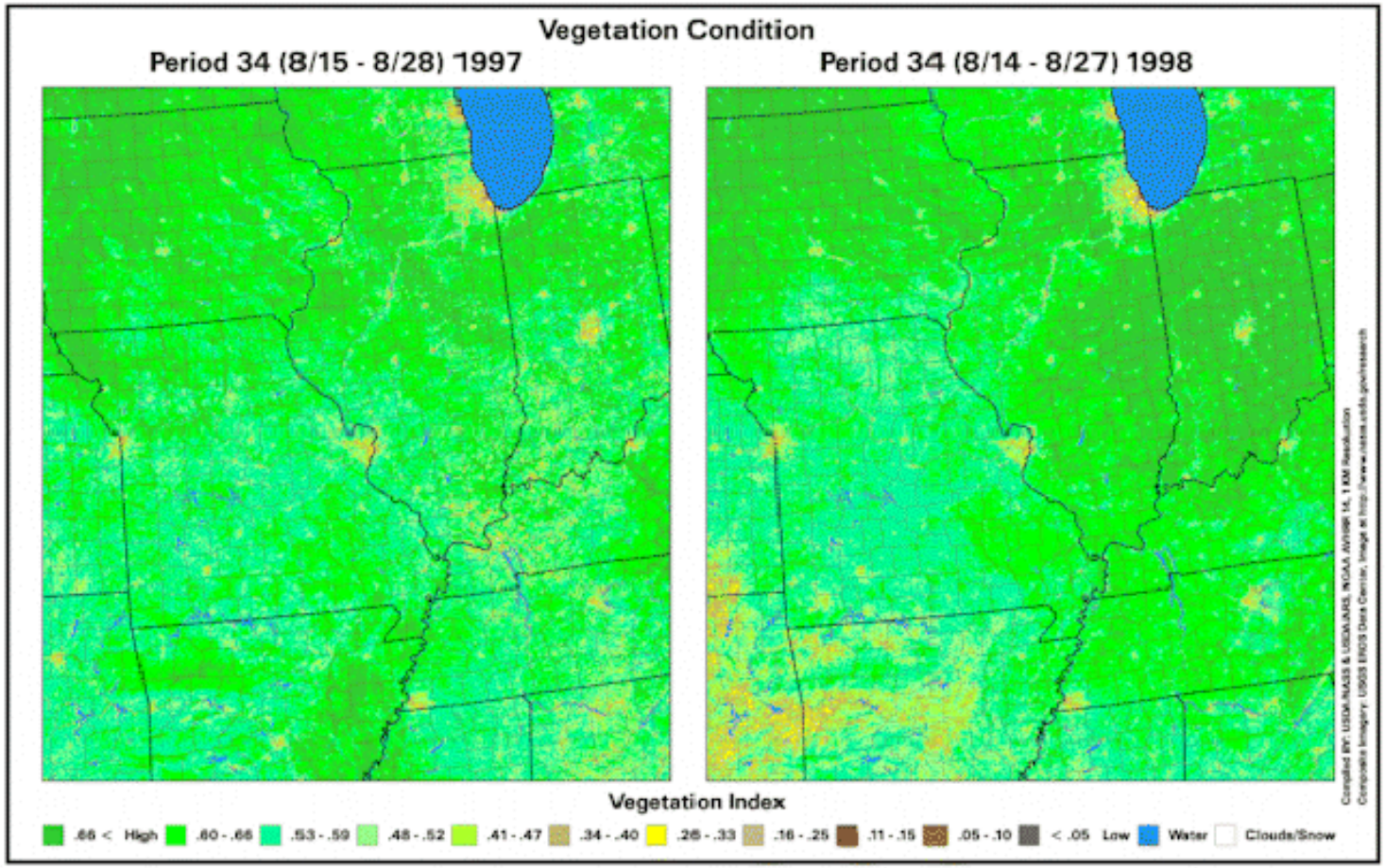
Dryden Flight Research Center EC94 42883-2
SR-71 photographed from tanker 12/94

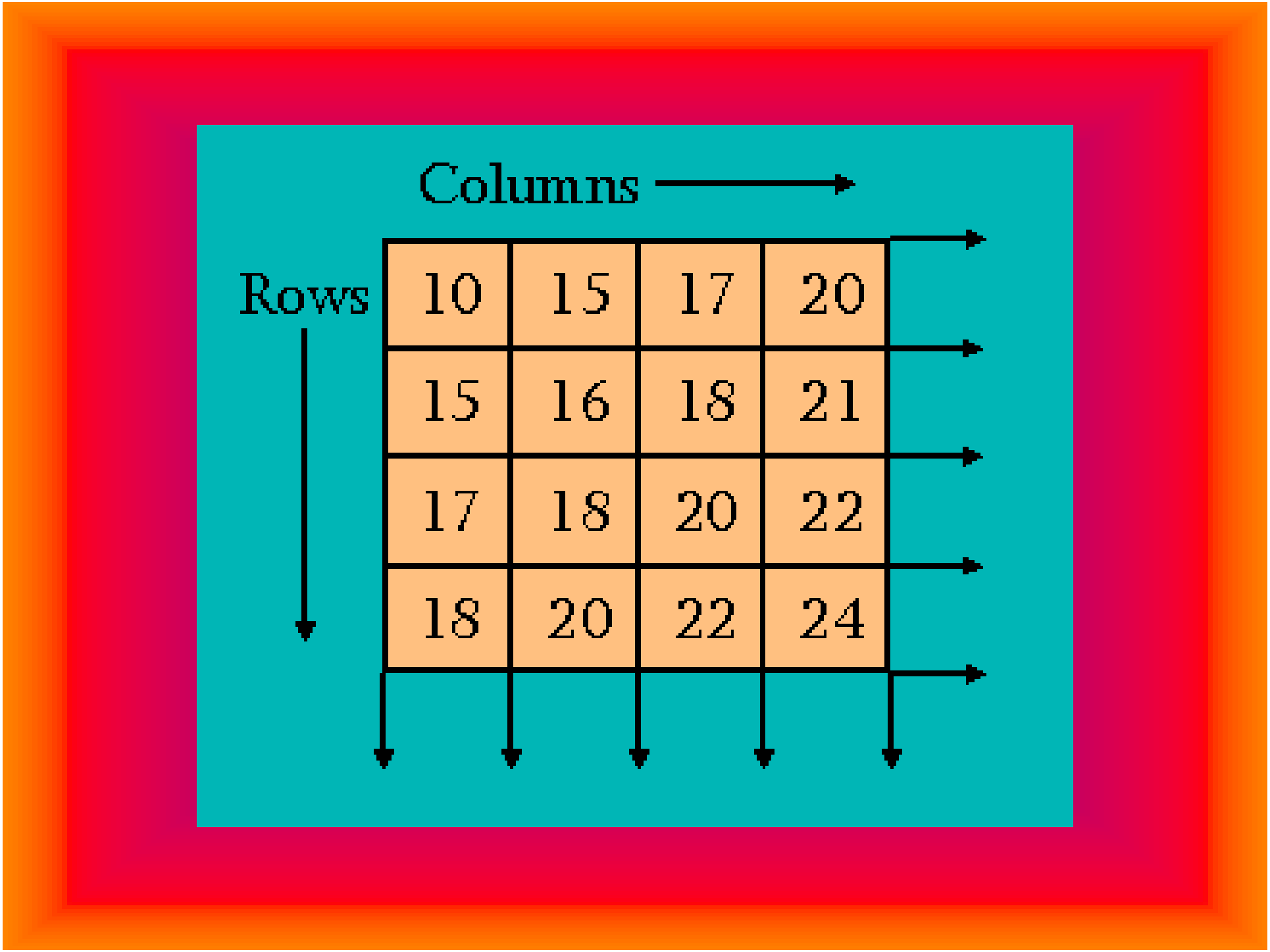


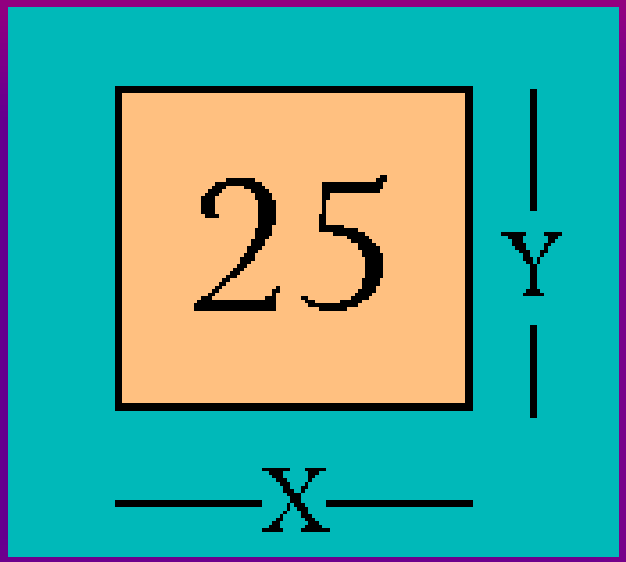

YELLOW


IR
IR
IR
G
G
G
G
G
IR
B
R
B
R
B
CUTICLE
UPPER EPIDERMAL CELLS
PALISADE MESOPHYLL CELLS
SPONGY MESOPHYL CELLS


Scattered by
Atmosphere
Absorbed by
Atmosphere
Reflected
Solar Radiation
Emitted
Surface
Radiation
Absorbed by
Ground Surface


Vegetation Condition
Period 34 (8/15 - 8/28) 1997
Period 34 (8/14 - 8/27) 1998
Vegetation Index
.66 < High
.60 - .66
.53 - .59
.48 - .52
.41 - .47
.34 - .40
.26 - .33
.16 - .25
.11 - .15
.05 - .10
< .05 Low
Water
Clouds/Snow

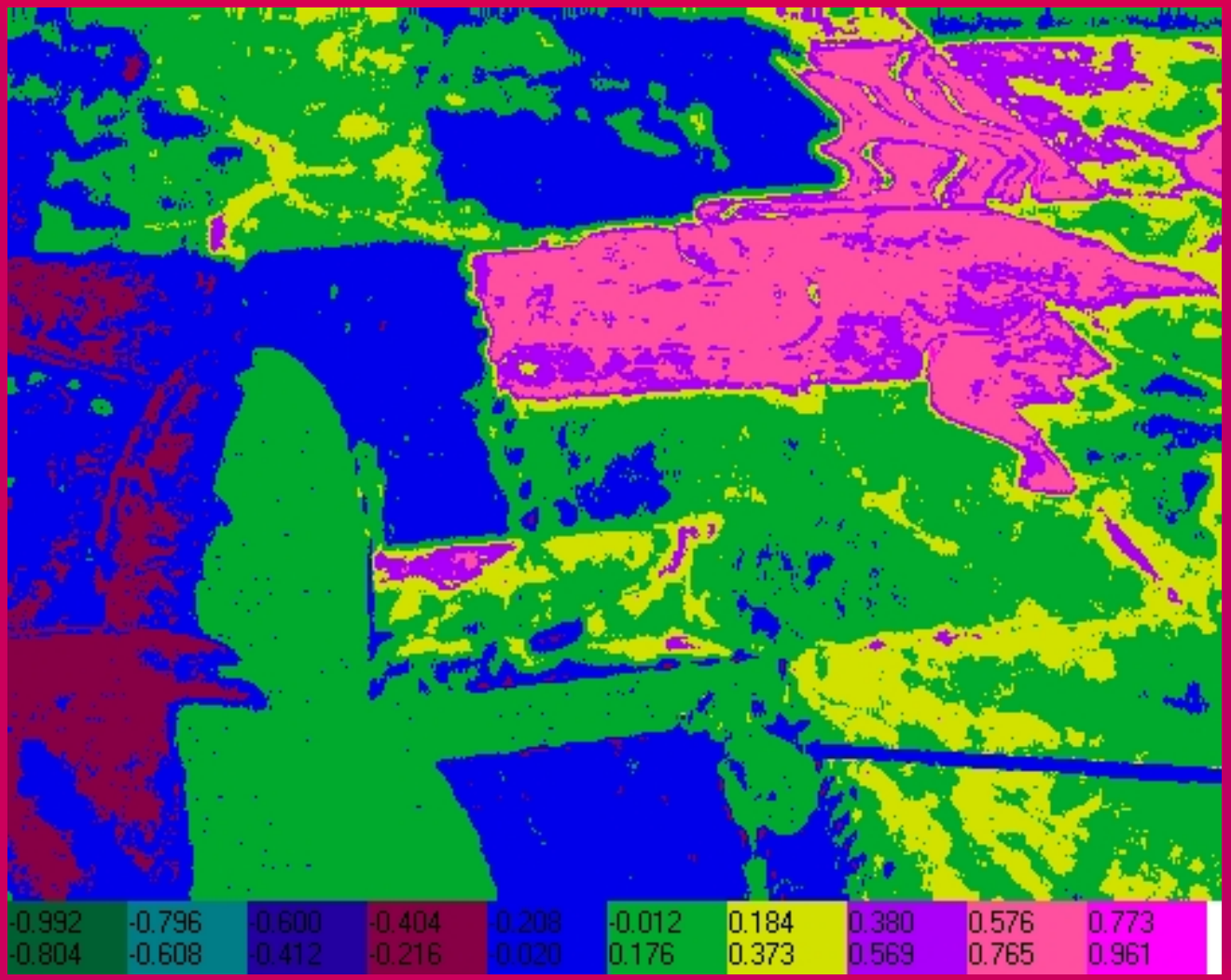

Columns
Rows
10 15 17 20
15 16 18 21
17 18 20 22
18 20 22 24

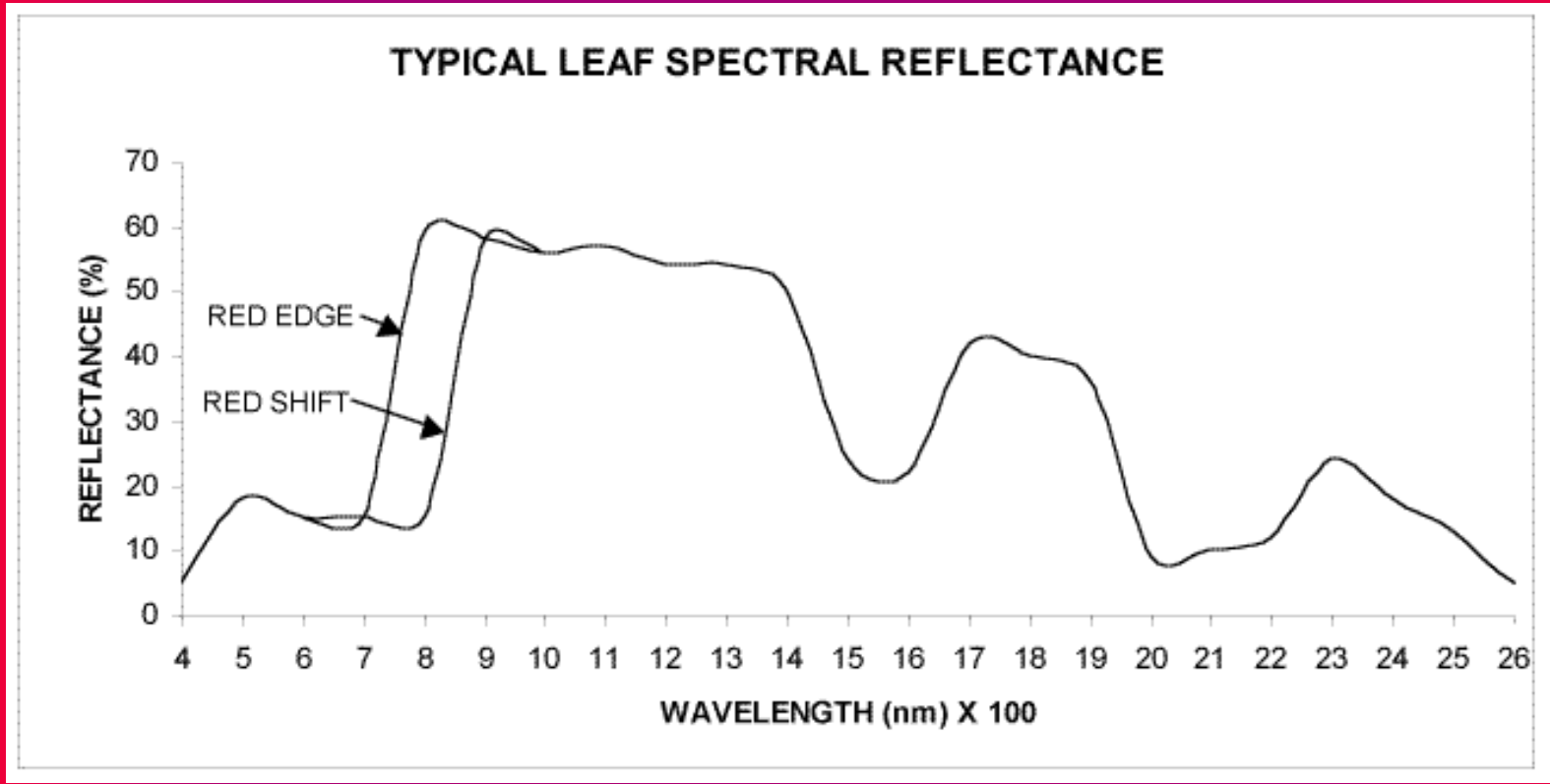

25
Y
X

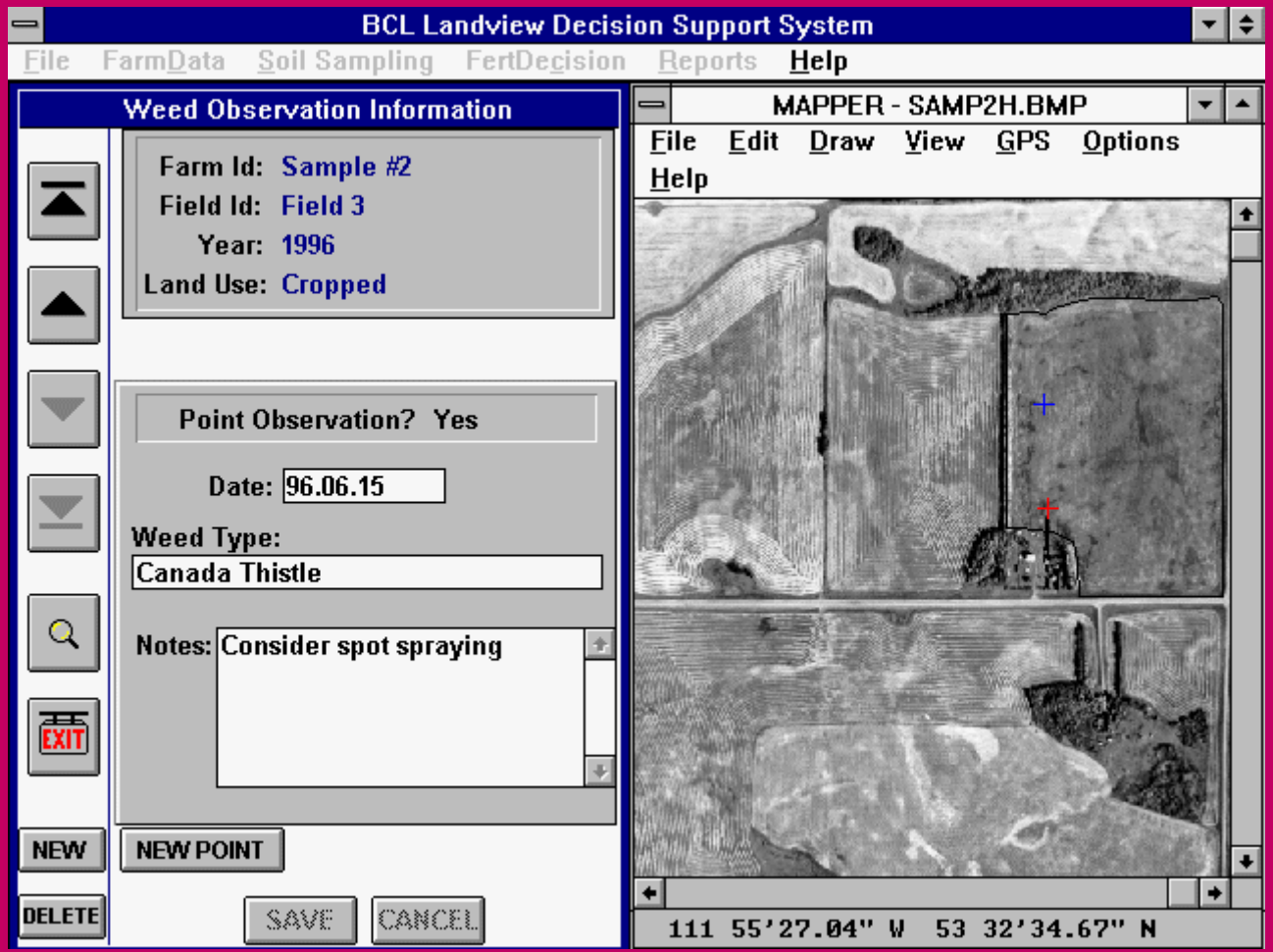

Ag Leader
PF3000

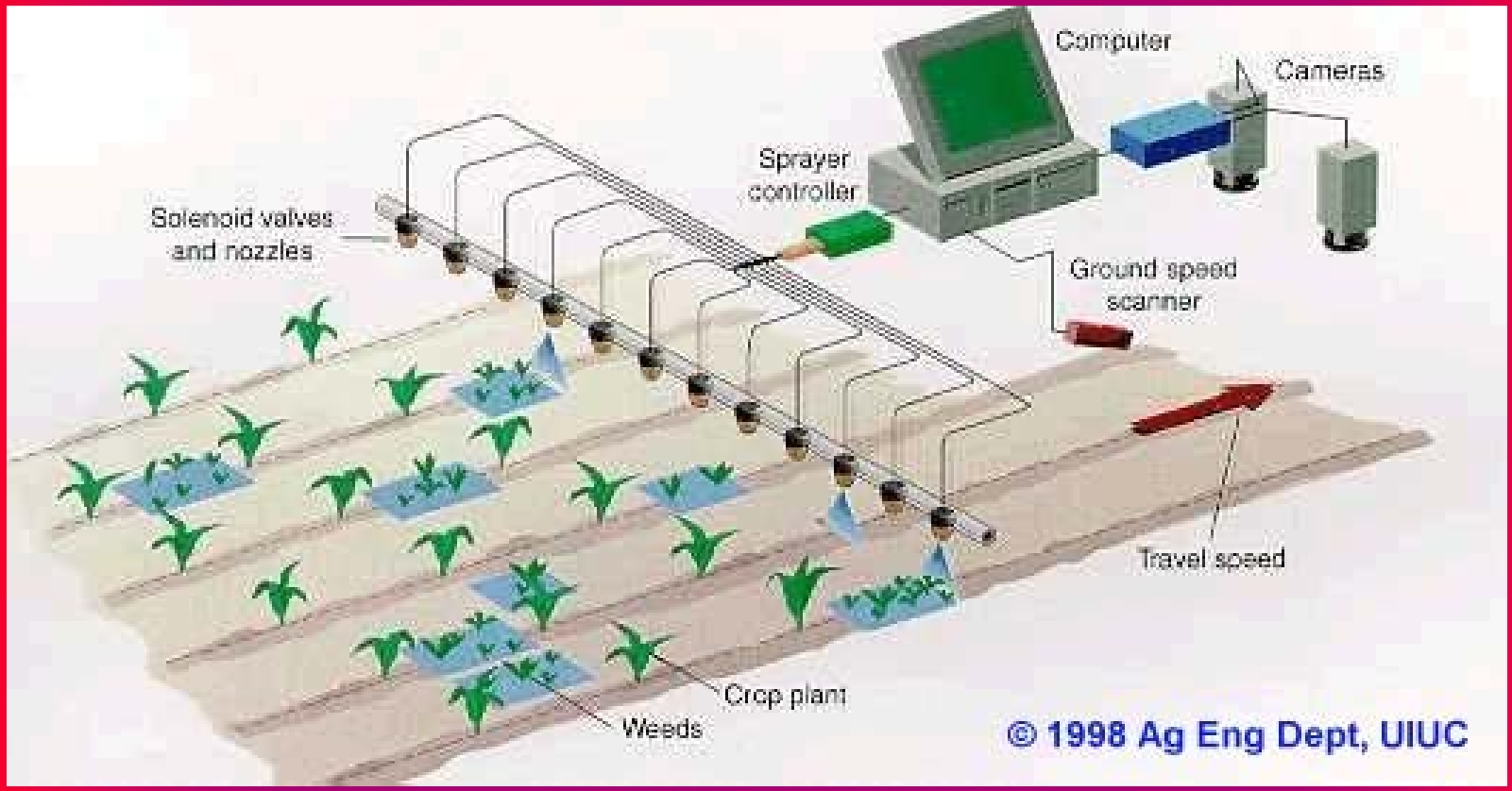

YIELD MONITOR

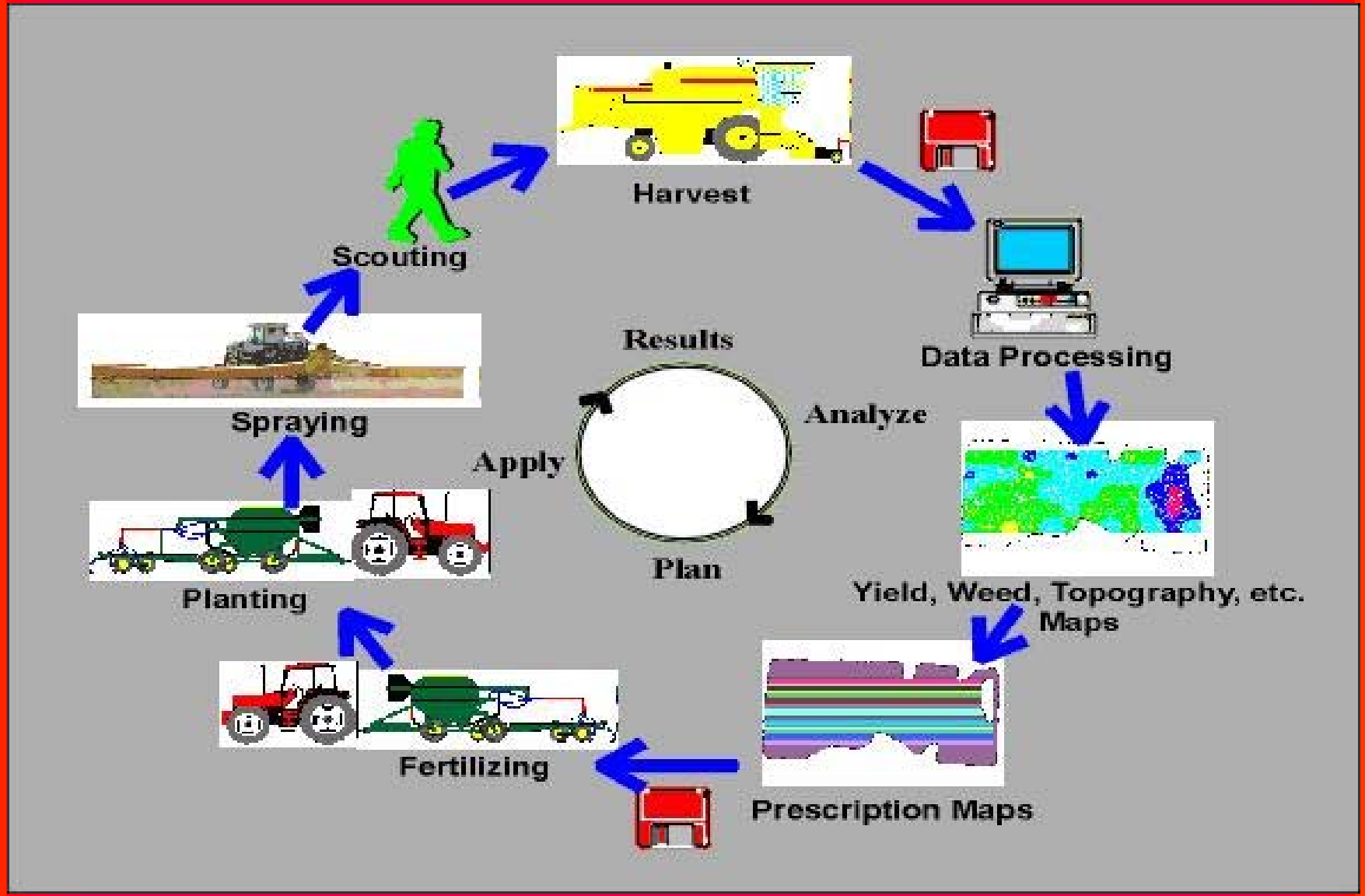

24M-Q5

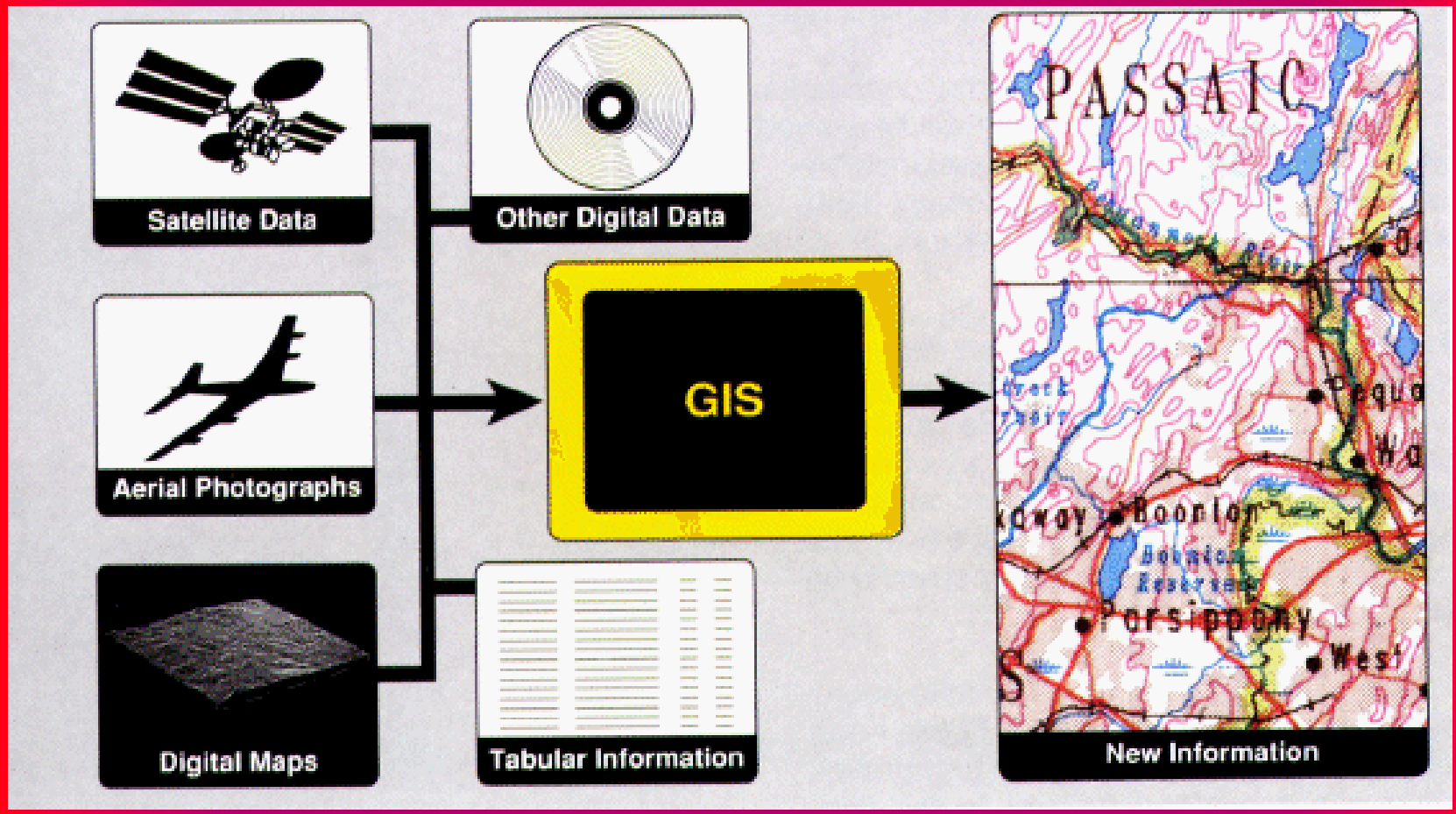

-0.992
-0.804
-0.796
-0.608
-0.600
-0.412
-0.404
-0.216
-0.208
-0.020
-0.012
0.176
0.184
0.373
0.380
0.569
0.576
0.765
0.773
0.961


TYPICAL LEAF SPECTRAL REFLECTANCE
REFLECTANCE (%)
70
60
50
40
30
20
10
0
RED EDGE
RED SHIFT
4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
WAVELENGTH (nm) X 100


BCL Landview Decision Support System
File FarmData Soil Sampling FertDecision Reports Help
Weed Observation Information
Farm Id: Sample #2
Field Id: Field 3
Year: 1996
Land Use: Cropped
Point Observation? Yes
Date: 96.06.15
Weed Type:
Canada Thistle
Notes: Consider spot spraying
EXIT
NEW
NEW POINT
DELETE
SAVE
CANCEL
MAPPER - SAMP2H.BMP
File Edit Draw View GPS Options
Help
111 55'27.04" W 53 32'34.67" N


Computer
Cameras
Sprayer controller
Solenoid valves and nozzles
Ground speed scanner
Travel speed
Crop plant
Weeds
© 1998 Ag Eng Dept, UIUC


Harvest
Data Processing
Yield, Weed, Topography, etc. Maps
Prescription Maps
Fertilizing
Planting
Spraying
Scouting
Results
Analyze
Plan
Apply


Satellite Data
Other Digital Data
Aerial Photographs
GIS
Digital Maps
Tabular Information
PASSAIC
New Information


Questions?

elboray2000@yahoo.com