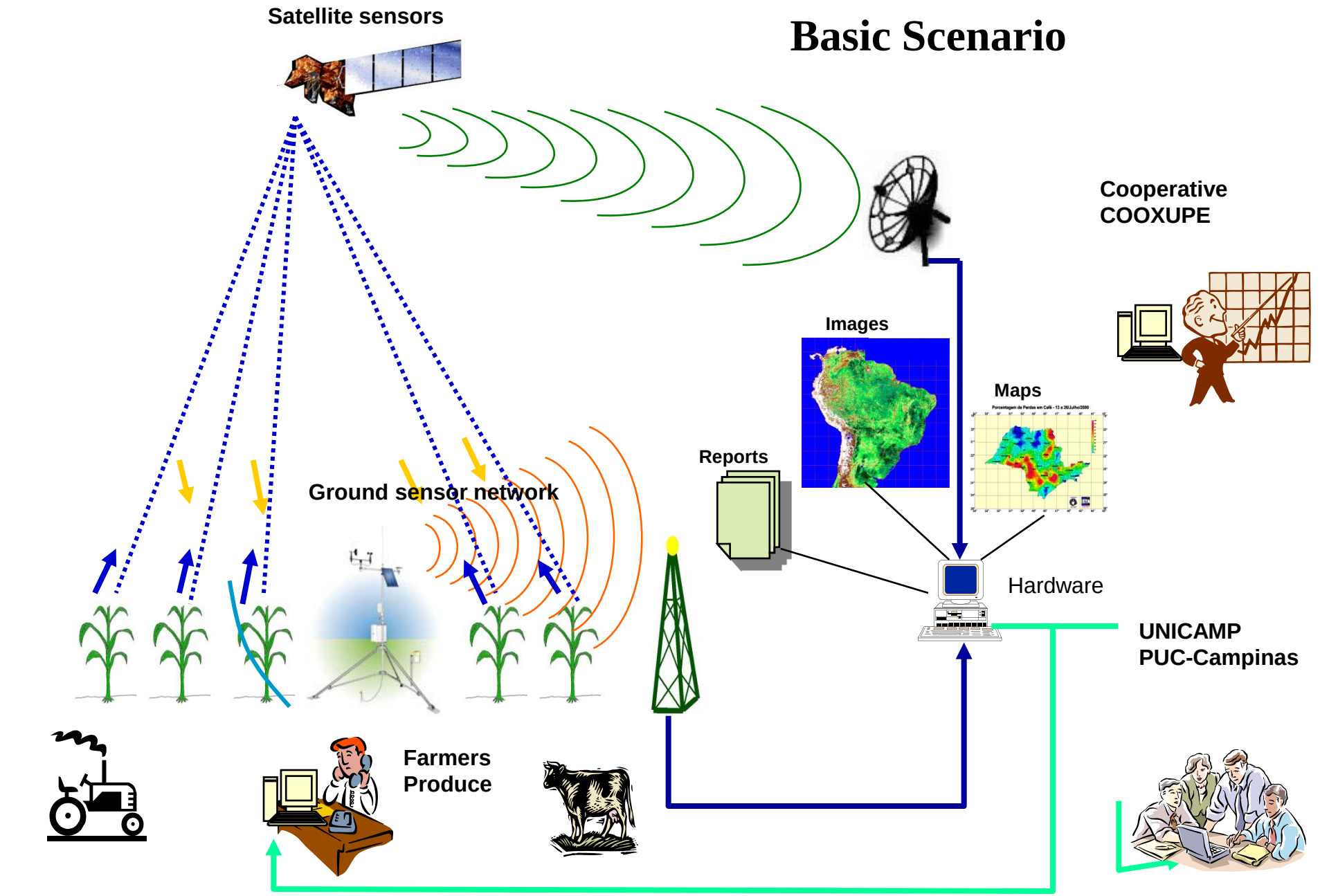
e-FARMS: a two-way road from small farms into the networked world

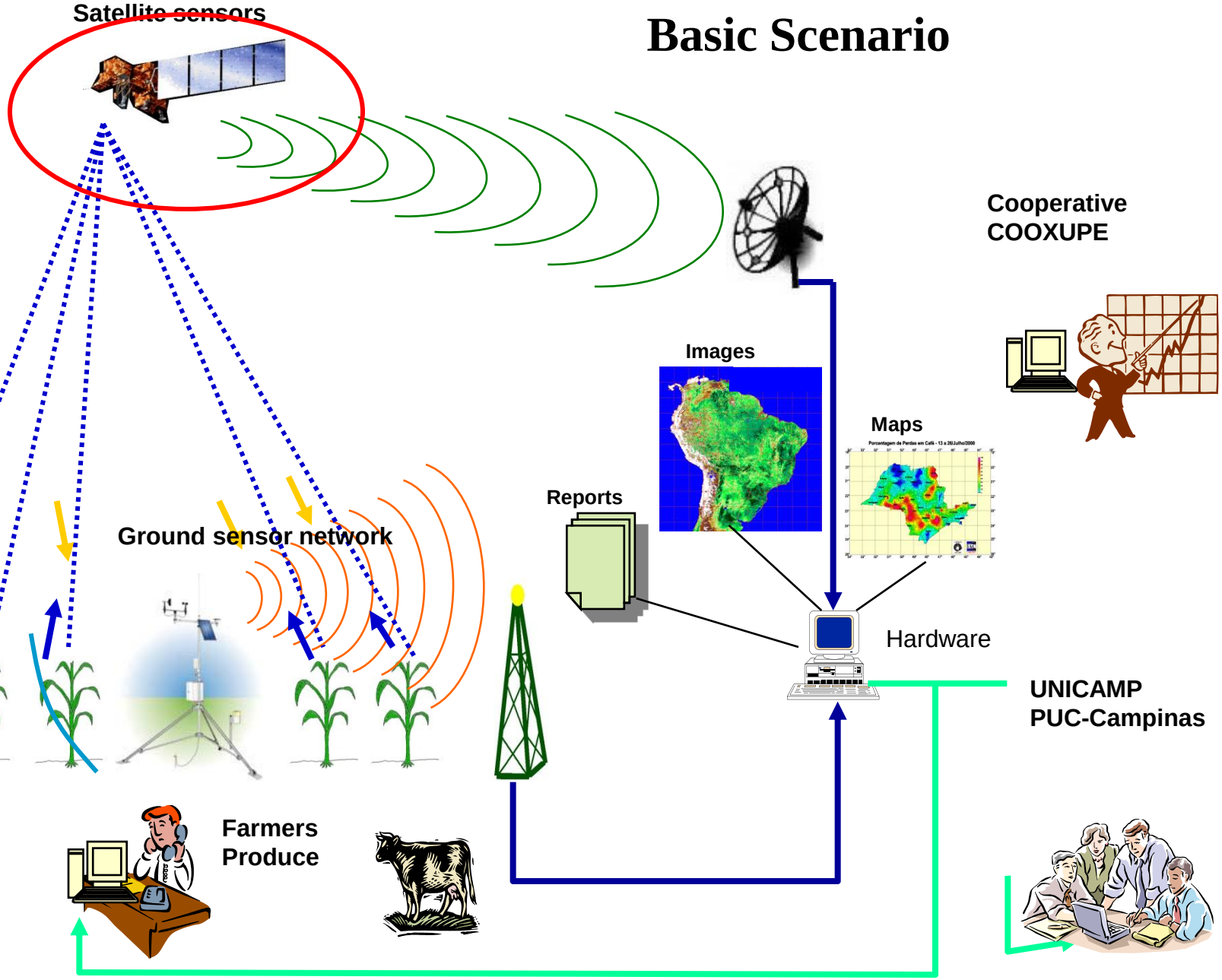
http://www.lis.ic.unicamp.br/projects/efarms

from small farms
into the networked world

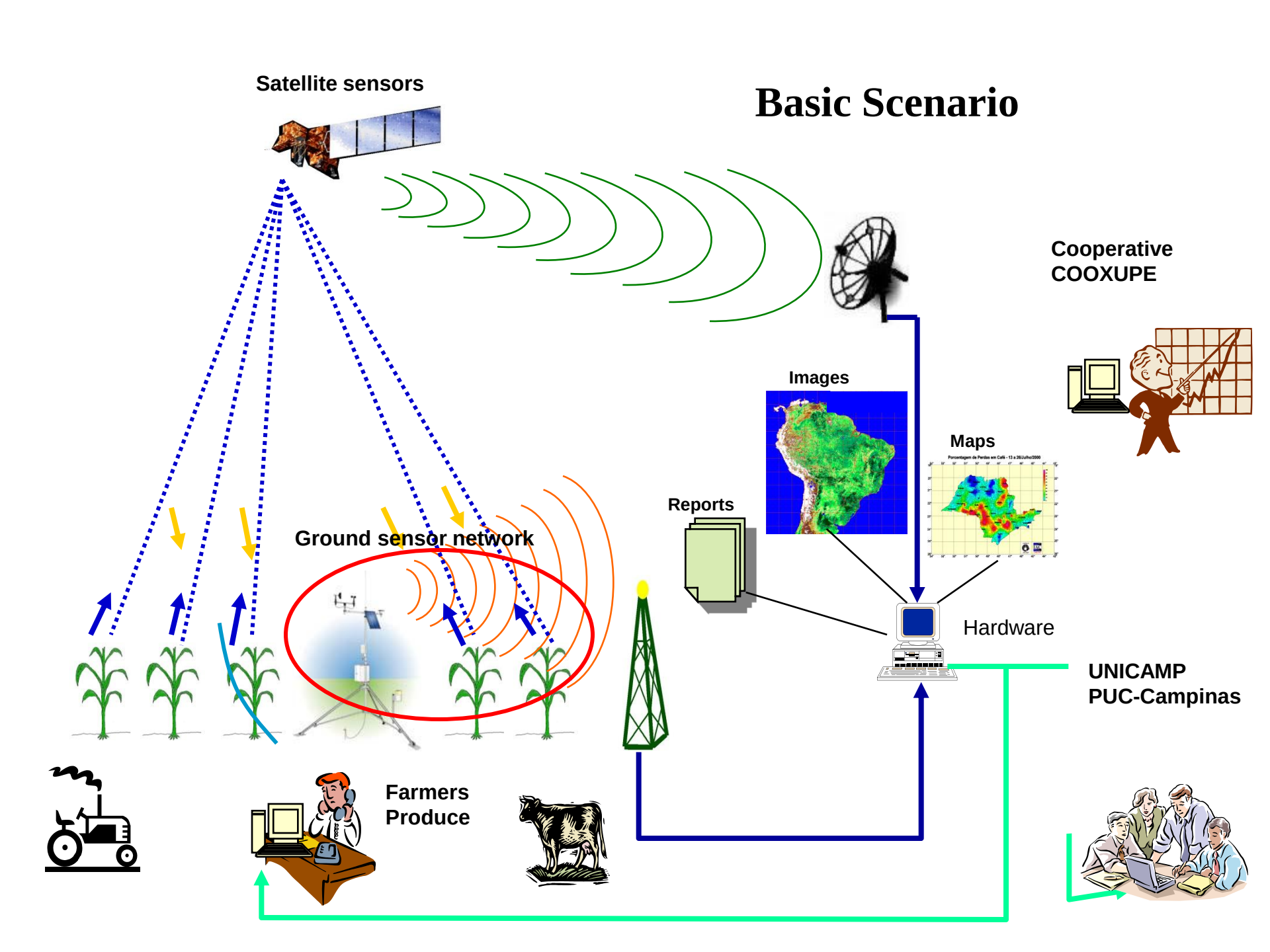
Basic Scenario

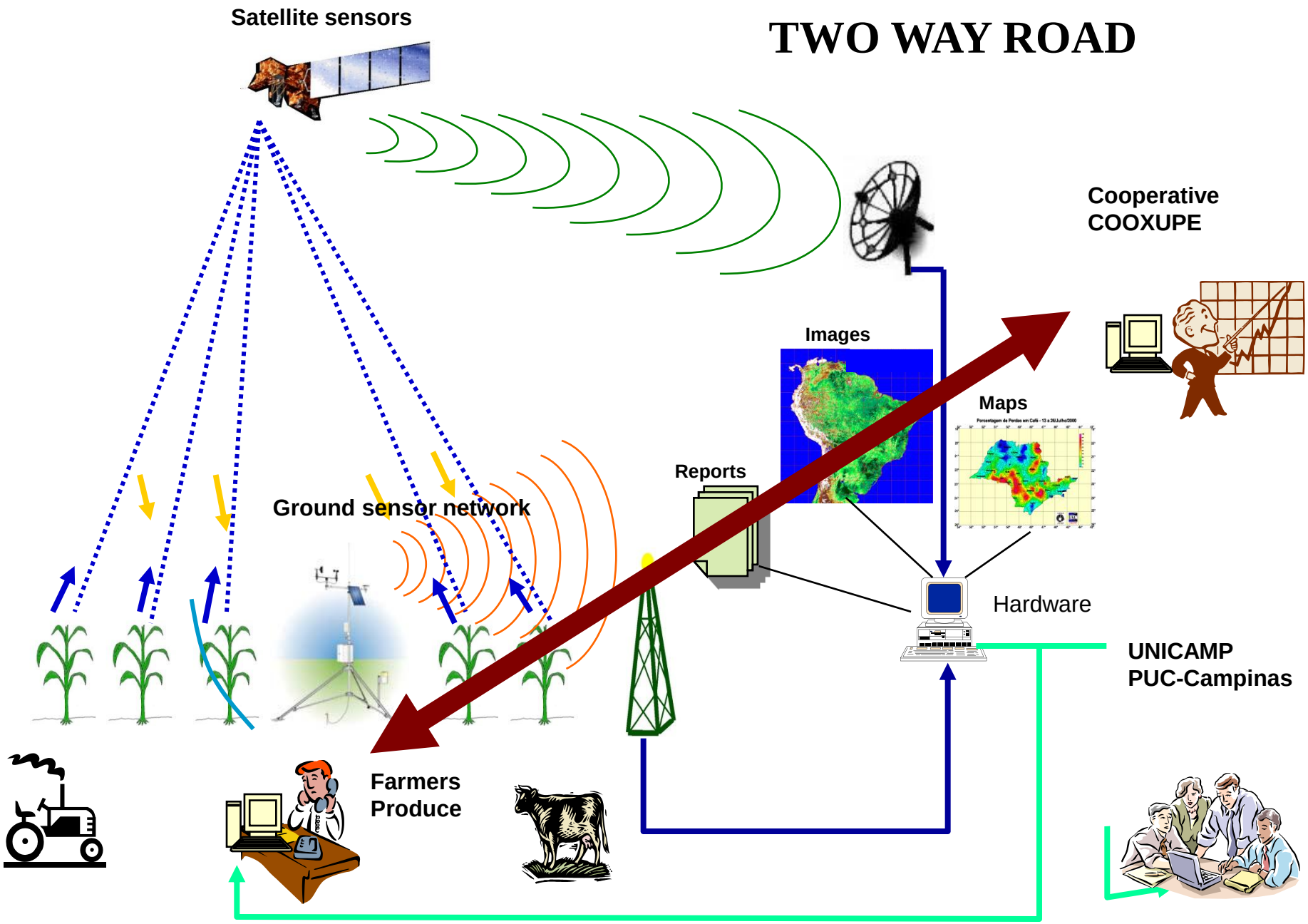


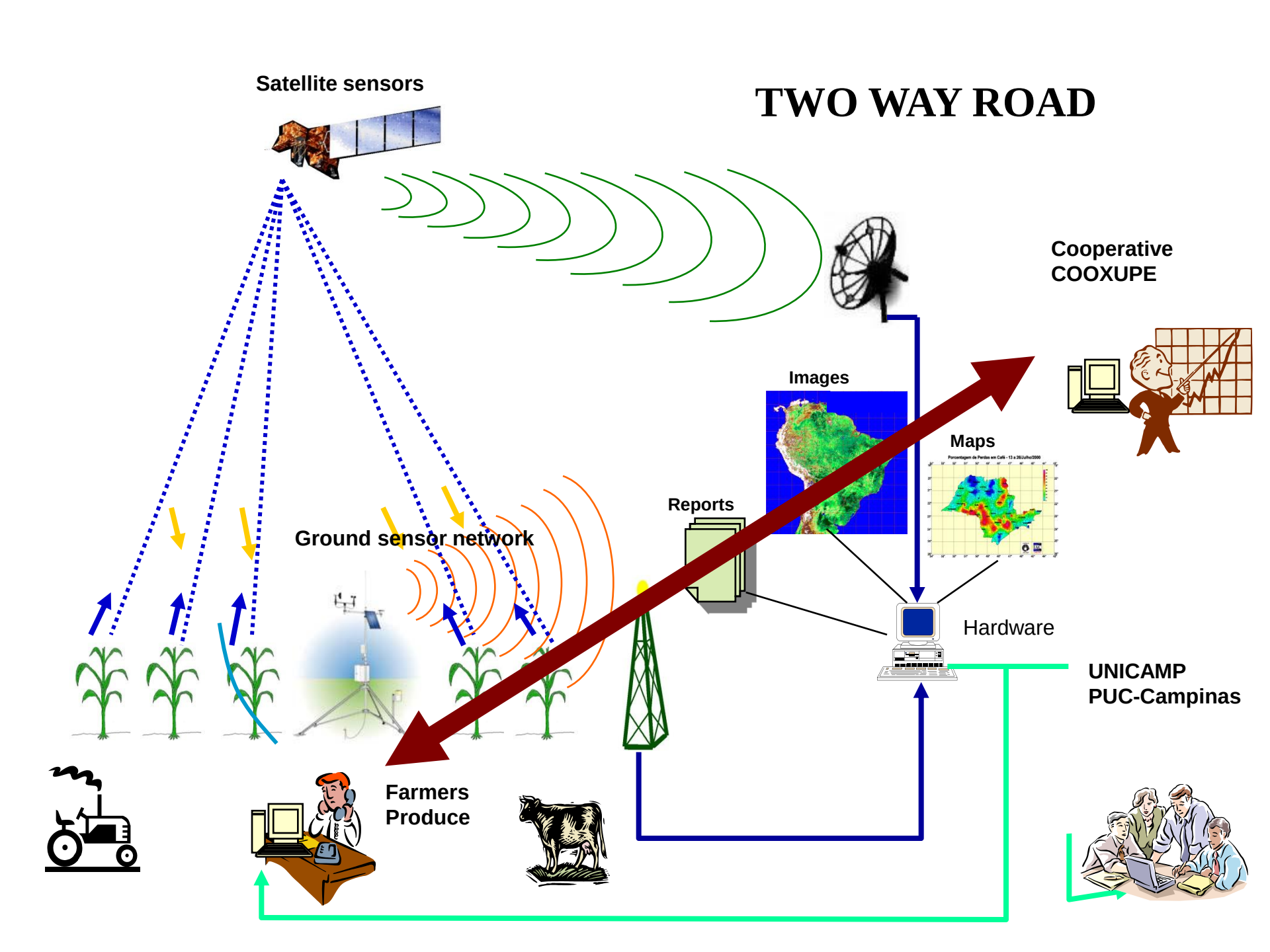
Basic Scenario



Basic Scenario




Satellite sensors
TWO WAY ROAD
Cooperative
COOXUPE
Images
Maps
Reports
Ground sensor network
Hardware
UNICAMP
PUC-Campinas
Farmers
Produce


Satellite sensors
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Farmers
Produce

GOALS – Science & Technology

- **Sensor-based agricultural data management**

⇒MODELS, METHODS, ALGORITHMS

⇒MANAGEMENT, INTEGRATION, ANALYSIS, VISUALIZATION

- **Wireless data communications in rural areas**

=> INFRASTRUCTURE, PERFORMANCE

GOALS – Social Impact

- **Decision support in agriculture**

⇒ MODELS + SOFTWARE TOOLS

- **Wireless data communications in rural areas**

=> LOW COST SOLUTIONS

Project members

- Four computer scientists
  - Databases, image processing, networks, interoperability
- Three agro-scientists
  - Remote sensing, precision farming, soil management
- One (very) large coffee cooperative
  - 12,000 farms
  - Three states

Results – Science & Technology

- Technology (networks and prototypes)
  - Communications infra
- Research
  - Models for yield forecasting
    - MSc & PhD research (Paper drafts)
  - Image processing
    - Satellite image segmentation using GP (2 papers)
  - Databases
    - Time series mining (1 journal paper submitted)
    - Content annotation (1 journal paper + 1 PhD workshop)

RESULTS

PUBLICATIONS

- C. D. Ferreira, J. A. Santos, R. S. Torres. **A genetic programming approach for relevance feedback in region-based image retrieval systems**. Proc SIBGRAPI, Oct 2008
- O. A. B. Penatti, R. S. Torres. **Color descriptors for web image retrieval – a comparative study.** Proc SIBGRAPI, Oct 2008
- C.G. Macário, C. B. Medeiros, **A Framework for Semantic Annotation of Geospatial Data for Agriculture.** Int. J. Metadata, Semantics and Ontology, Accepted for publication
- C.G. Macário, C. B. Medeiros. **Specification of a Framework for Semantic Annotation of Geospatial Data on the Web.** ACM-GIS 2008 PhD workshop
- L. Mariotte, C. B. Medeiros, R. S. Torres. **TIDES – A new descriptor for time series oscillation behavior**. Submitted to Geoinformatica.

Results - Networks

From sensors to Internet

Phase 1

– Laboratory experiments

Phase 2

– Temperature sensor to base (antena at 5,8GHz, stability tests)

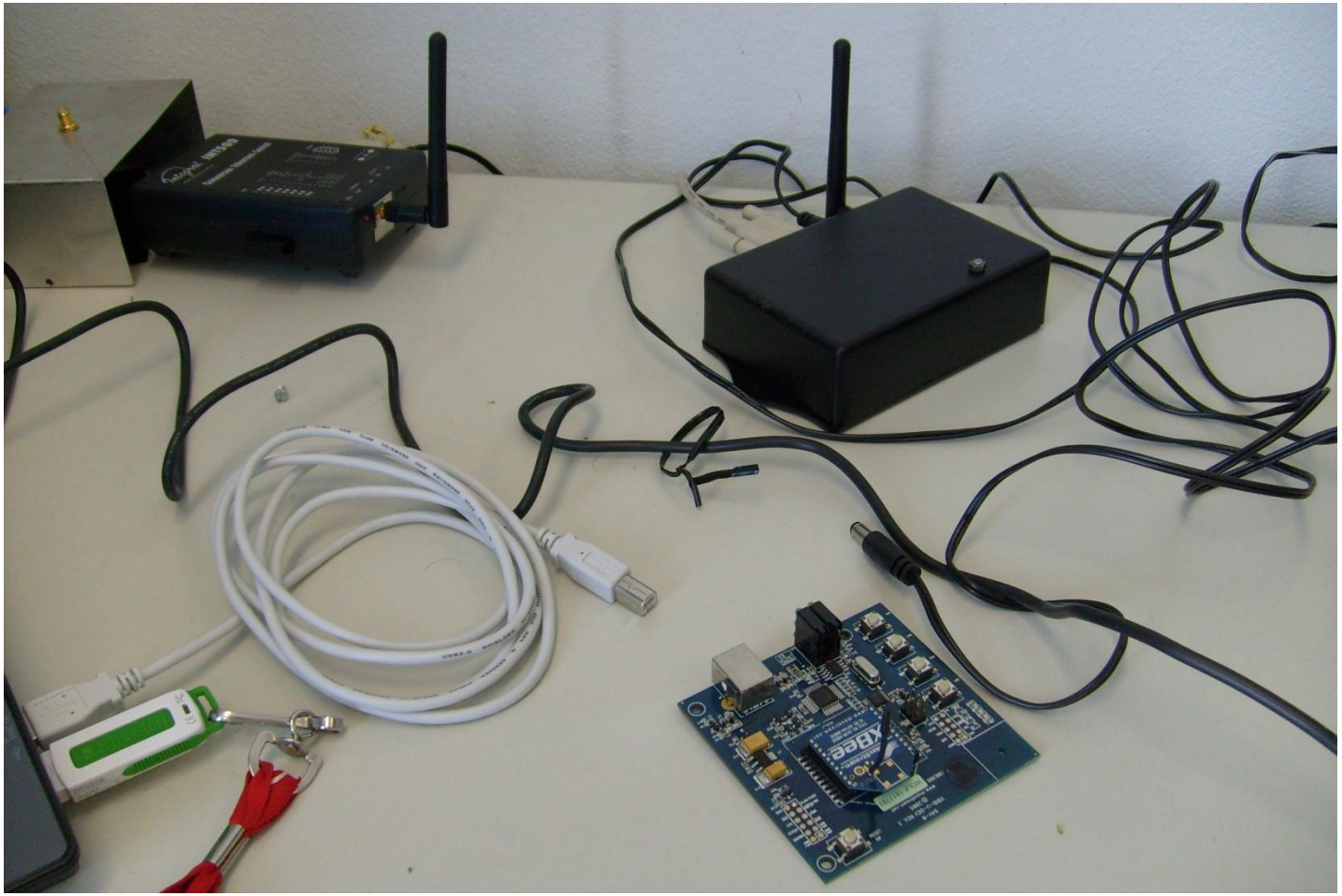
Phase 3

– Sensor -> base -> “farm” -> Internet

Phase 4 (ongoing)

– Extend to 3 “farms”, 3 sensor types

Phase 1 – Lab Tests



Phase 2 - Antenae

Temperature in LIS
Last temperature sensor reading in LIS was: 25.89 Celsius at 2008-09-19 17:20:23-03:00

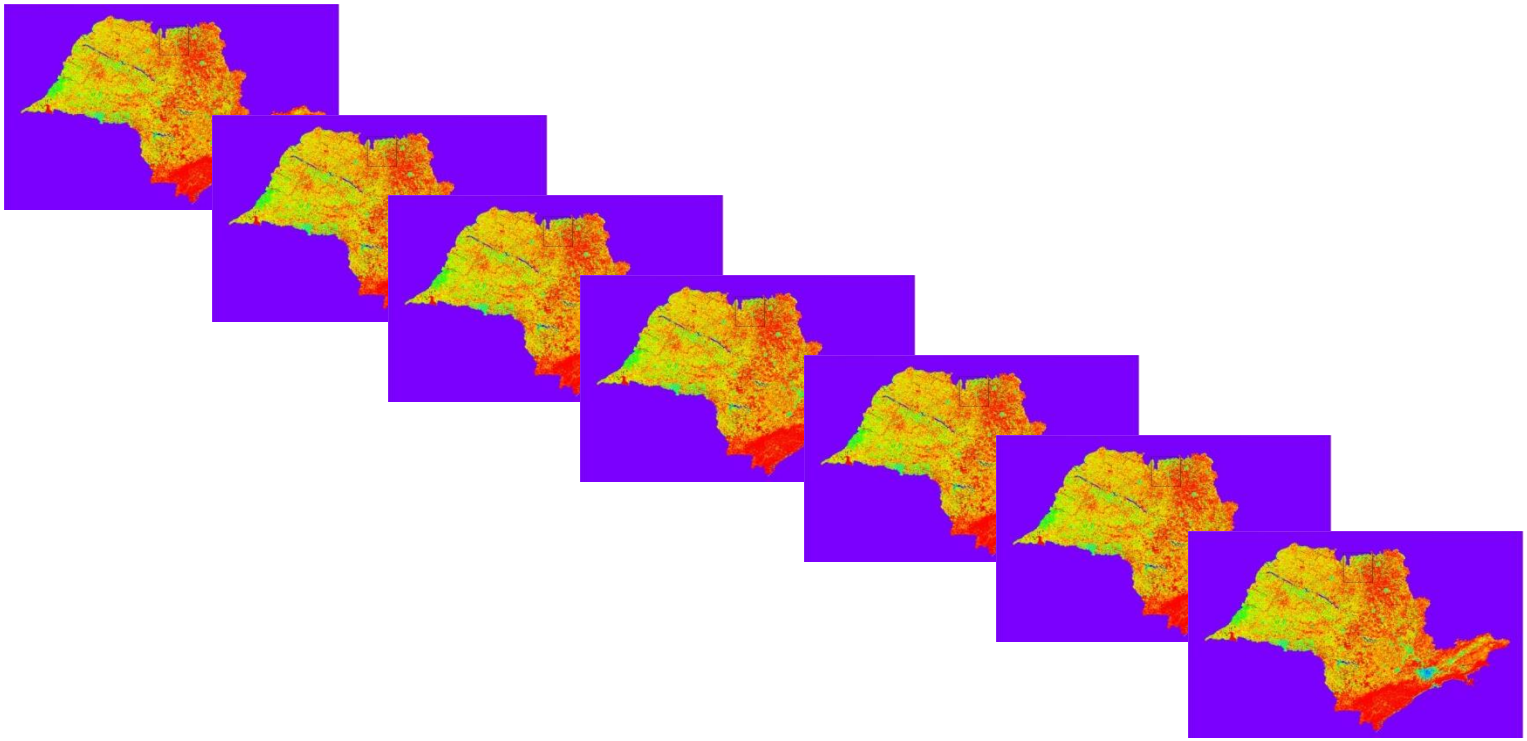
Phase 4 – 3 “farms” in 2009

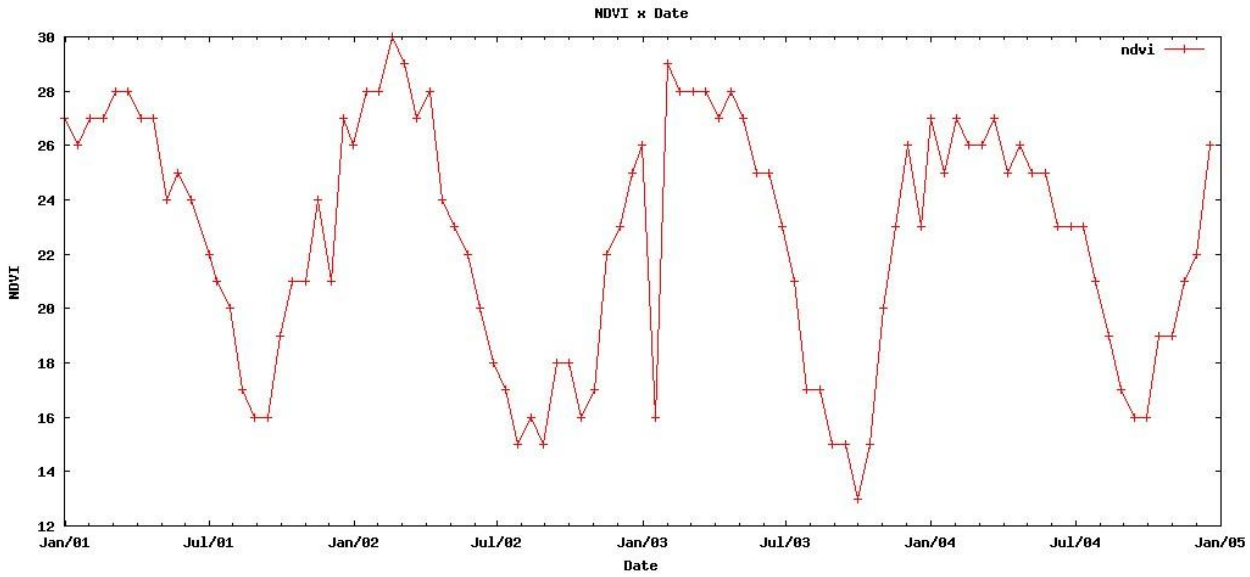
Moisture network

Cooperative

Radiation, temperature

Results – Models, Images, DB




NDVI x Date
ndvi
NDVI
Date
30
28
26
24
22
20
18
16
14
12
Jan/01
Jul/01
Jan/02
Jul/02
Jan/03
Jul/03
Jan/04
Jul/04
Jan/05

Webmaps - Firefox

File Edit View Go Bookmarks Tools Help

http://proj.lis.ic.unicamp.br/webmaps/Region/319/view_details/

Webmaps | Webmaps

WebMaps UNICAMP

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Busca

Usuário: jansle | Sair | Configurações

WebMaps

- O que é o Webmaps
- Equipe
- Apoio

Documentação

- Cálculo de NDVI

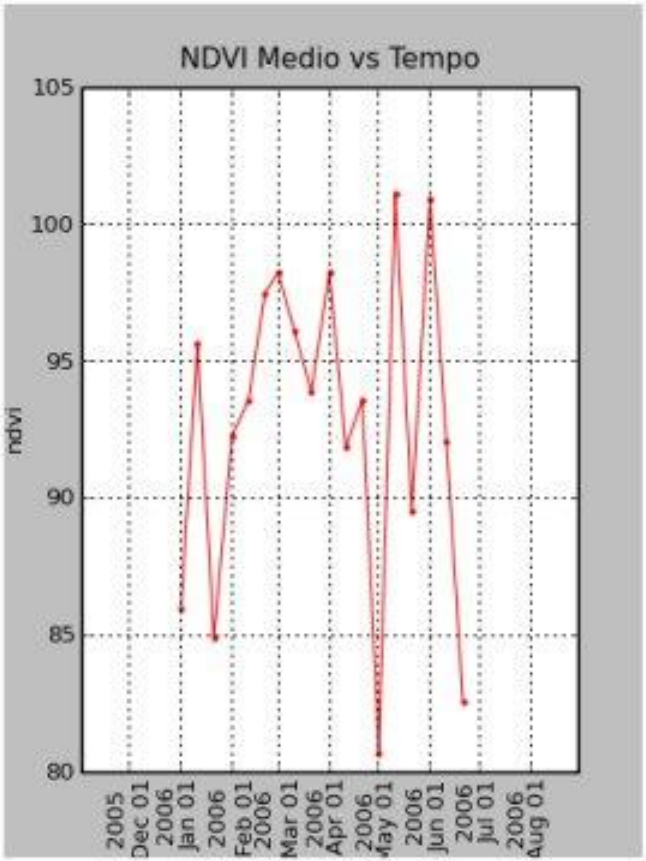
Cadastros

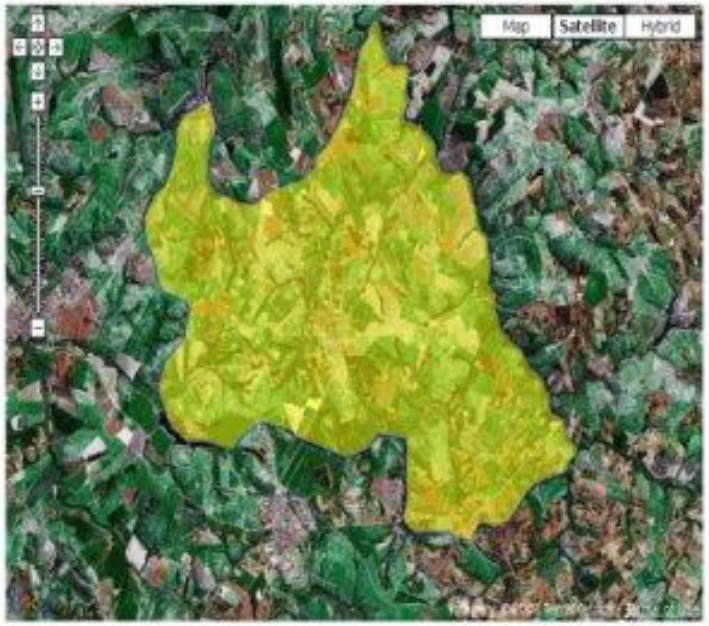
- Cultura
- Região
- Propriedade
- Talhão

Produtos

- NDVI
- Pluviosidade
- Temperatura

Ariranha





Rain

Temperature

Radiation

Roots and buds (1)

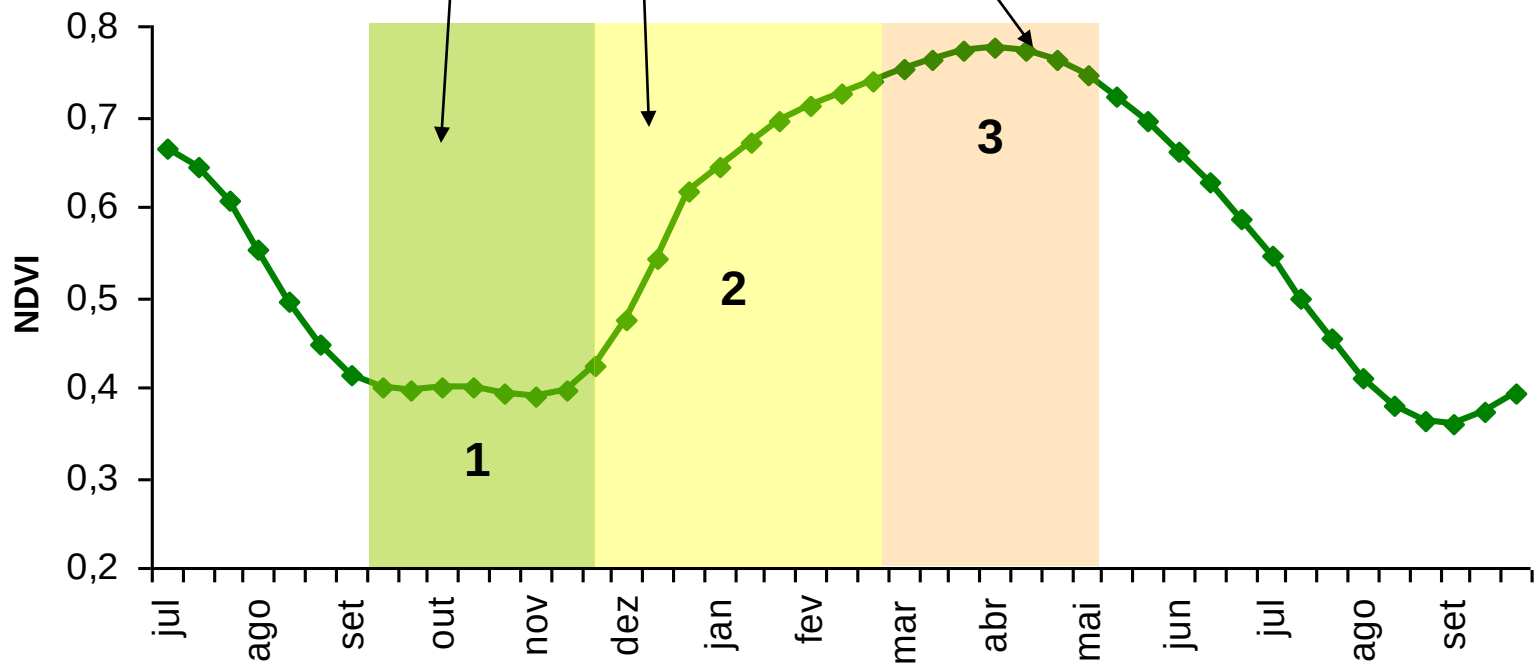
Growth (2)

Maturation (3)

=

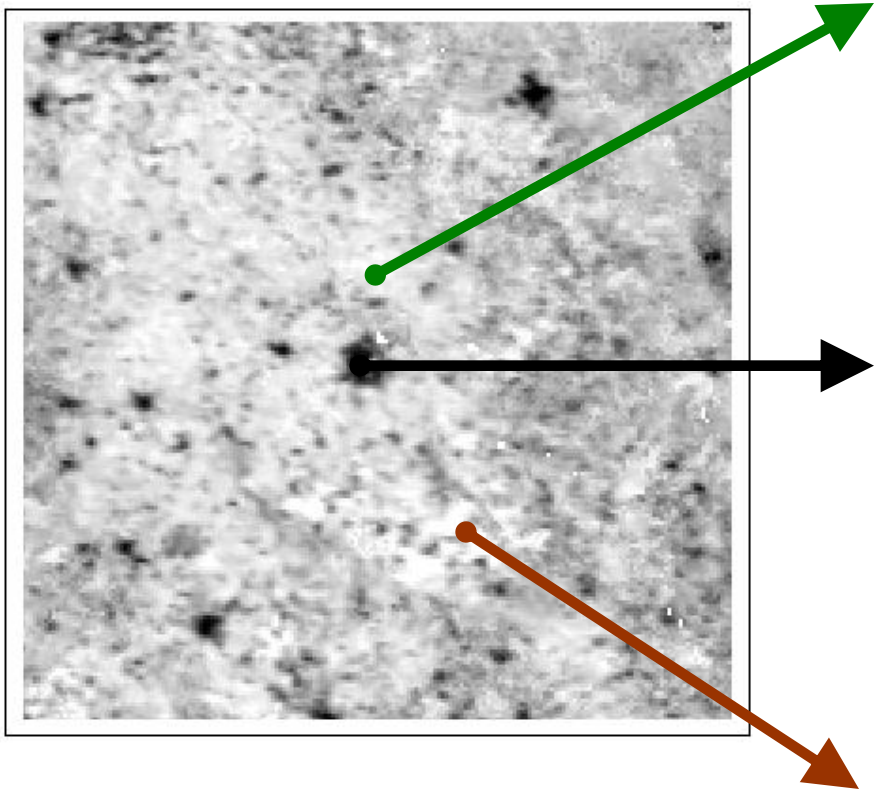
Productivity ?

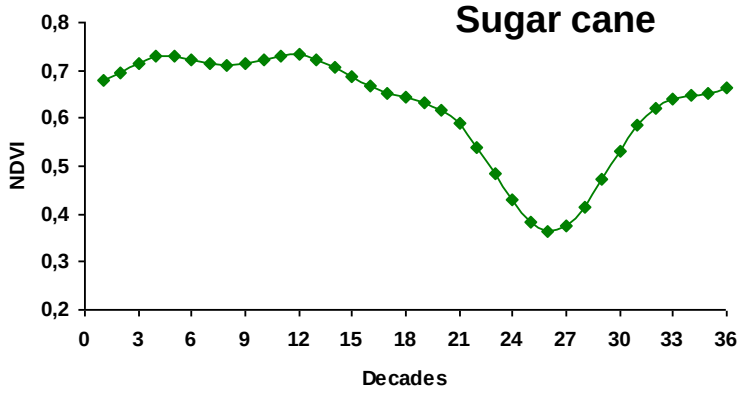
(IBGE)



NDVI time series, Araraquara, 1999/2000

NDVI




Sugar cane
NDVI
0,8
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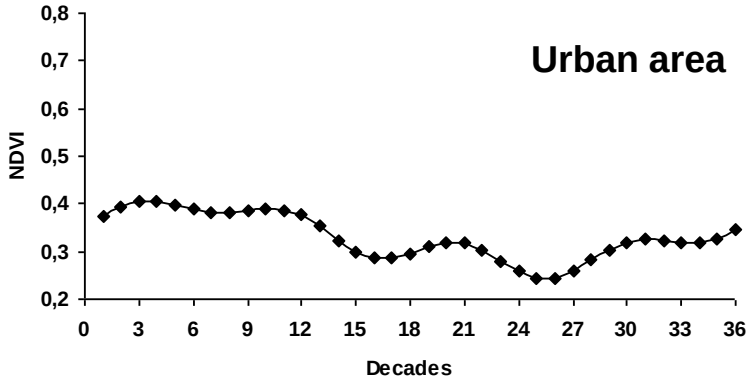
0,2
0 3 6 9 12 15 18 21 24 27 30 33 36
Decades


Urban area
NDVI
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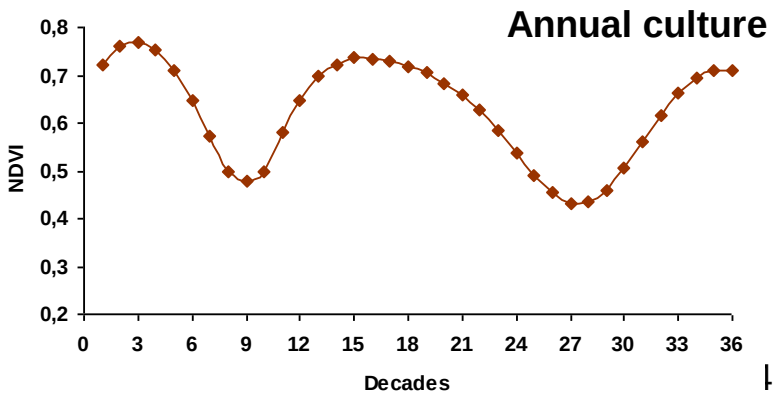
Decades


Annual culture
NDVI
0,8
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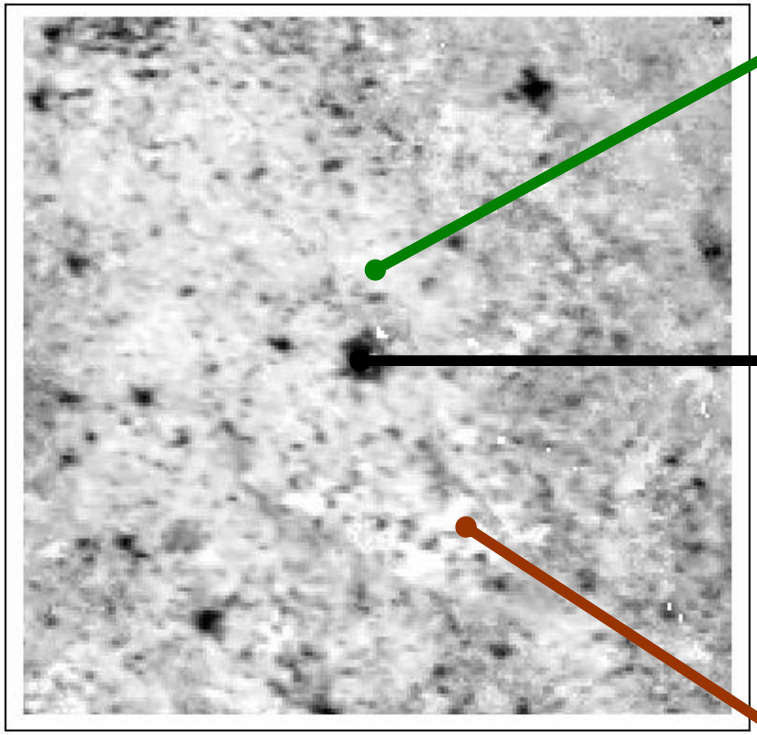
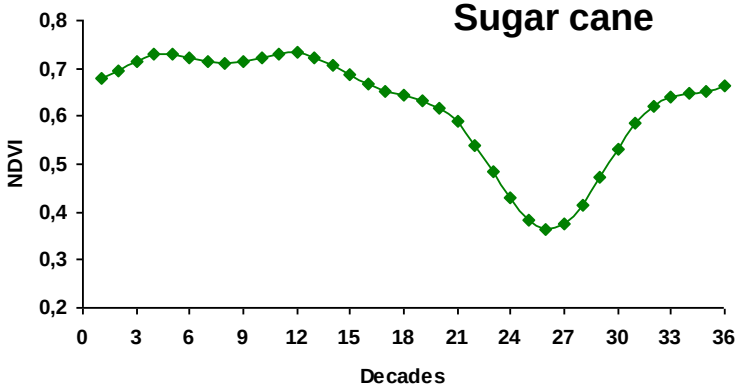
0 3 6 9 12 15 18 21 24 27 30 33 36
Decades

NDVI

Models




Sugar cane
NDVI
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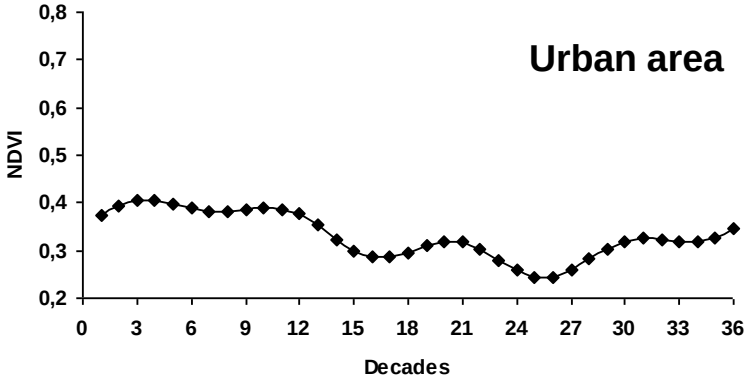
0 3 6 9 12 15 18 21 24 27 30 33 36
Decades


Urban area
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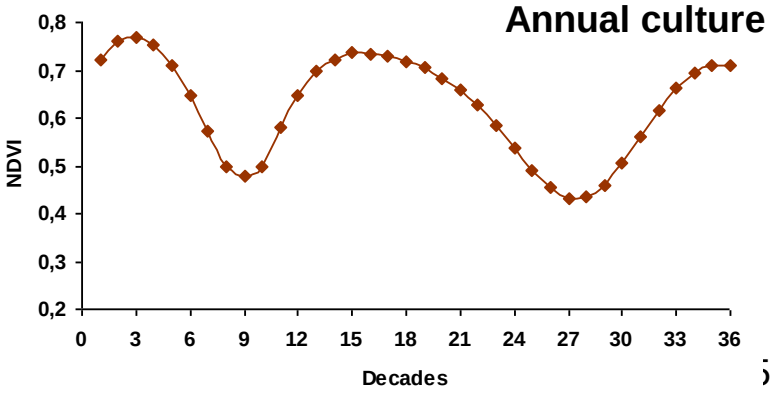
Decades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Decades

NDVI

Models

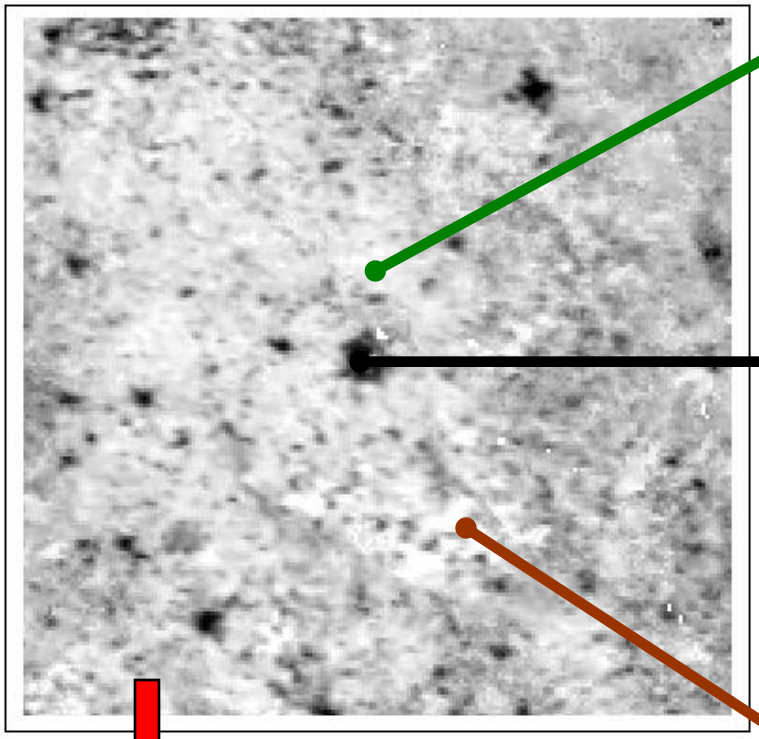
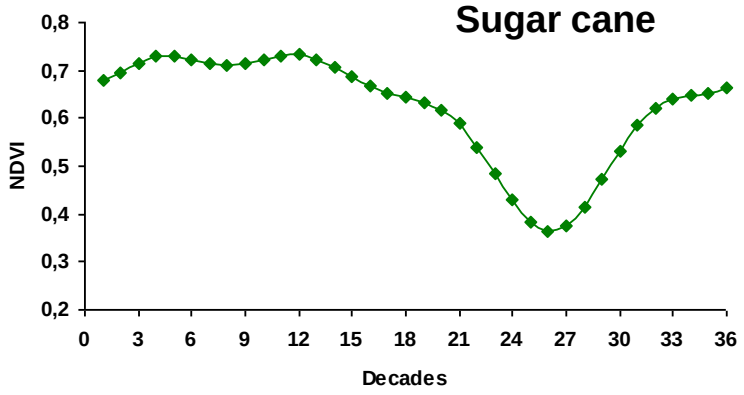
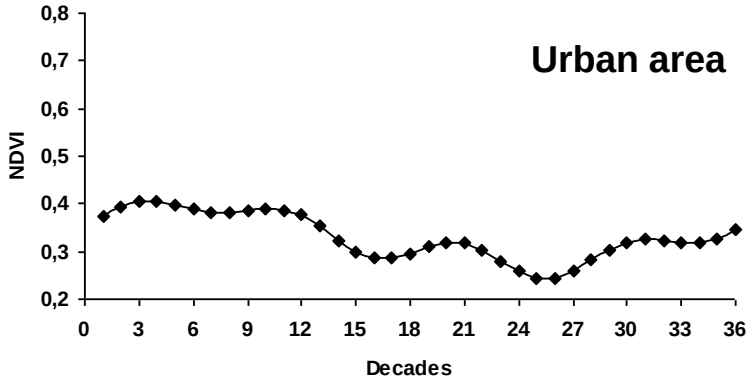
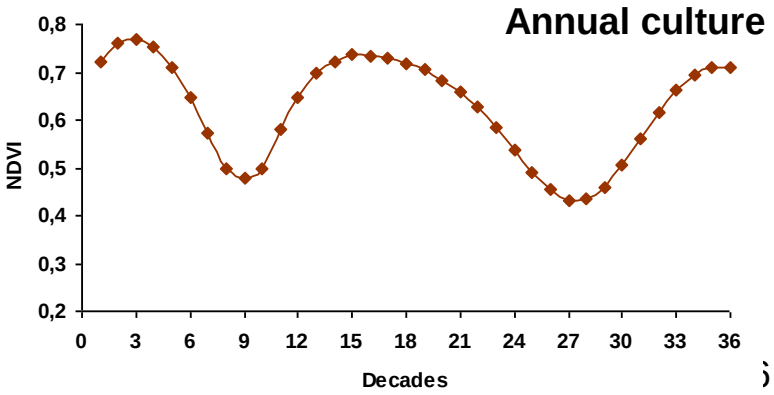


Image Processing

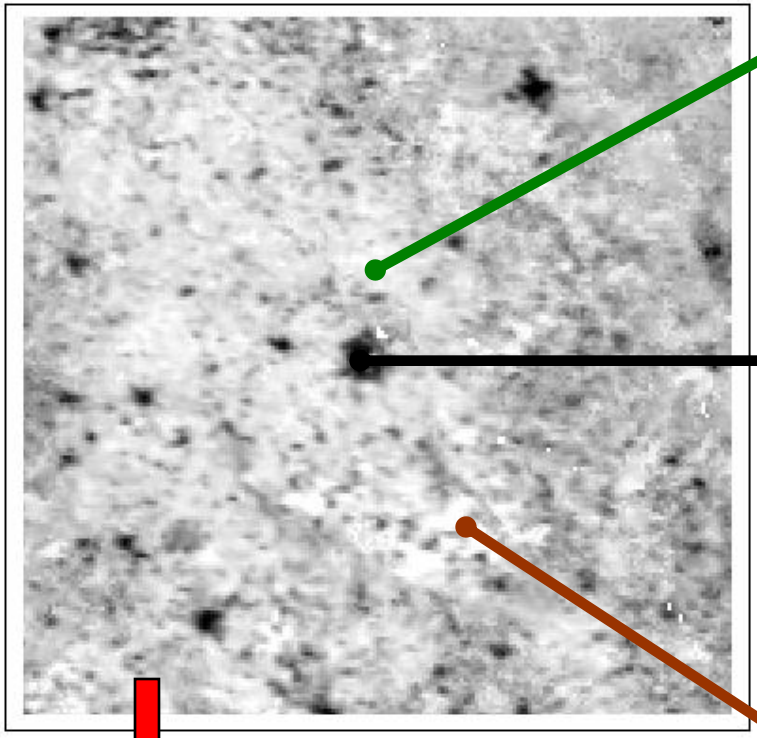


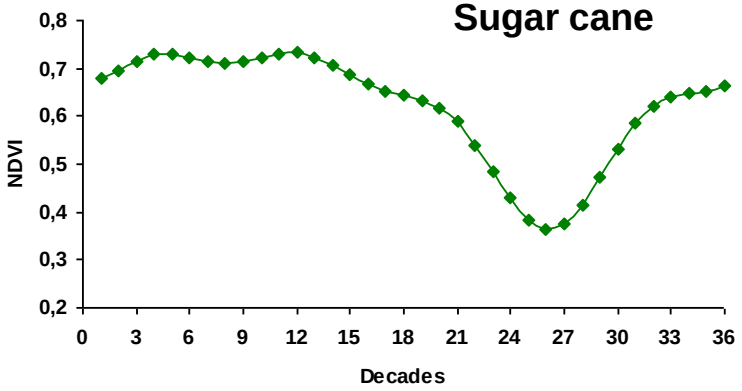


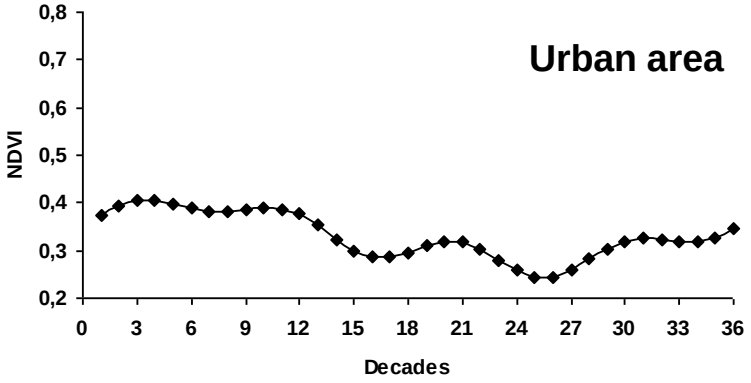


NDVI

Models







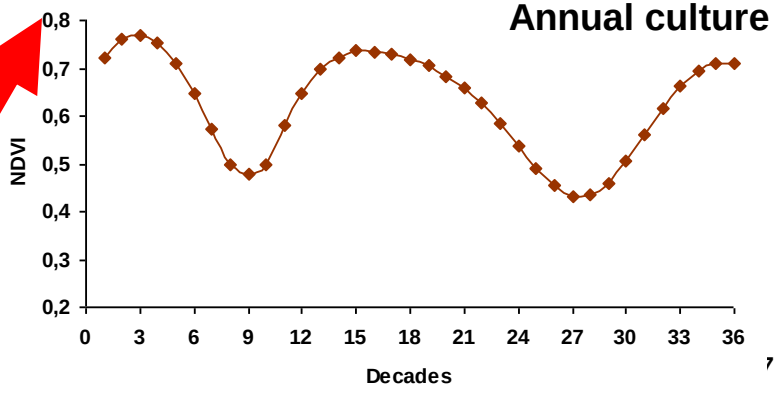
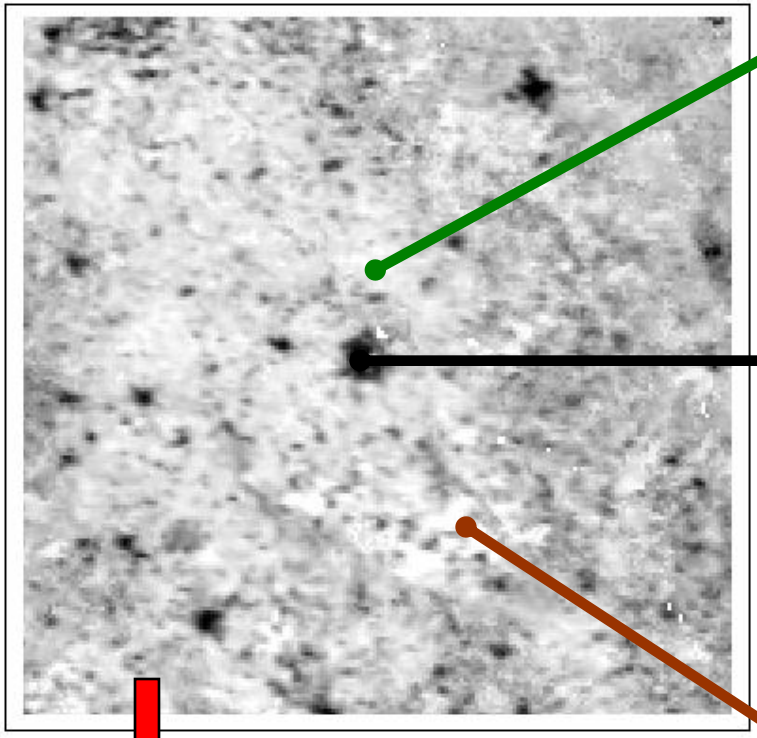


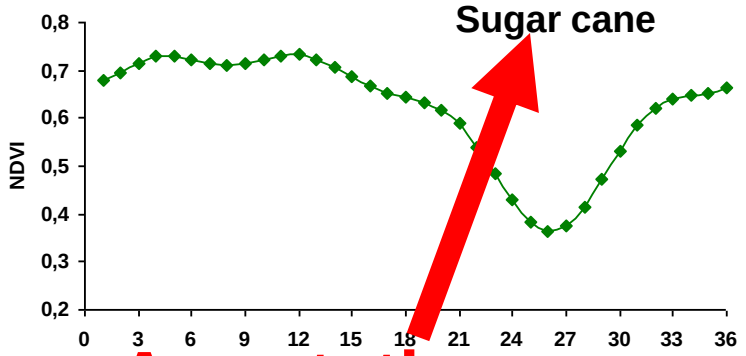
Image Processing

Series Mining

NDVI

Models





Annotations

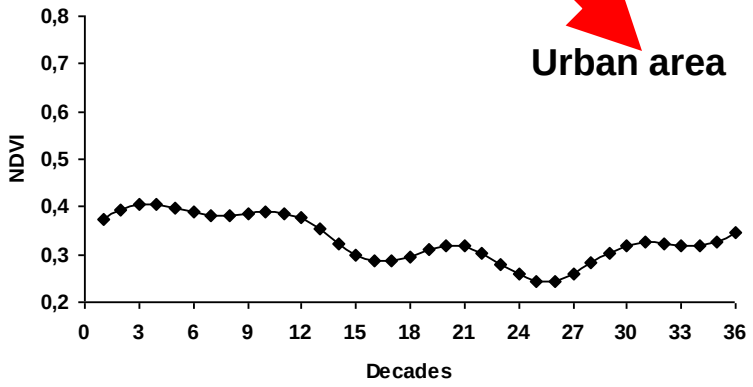
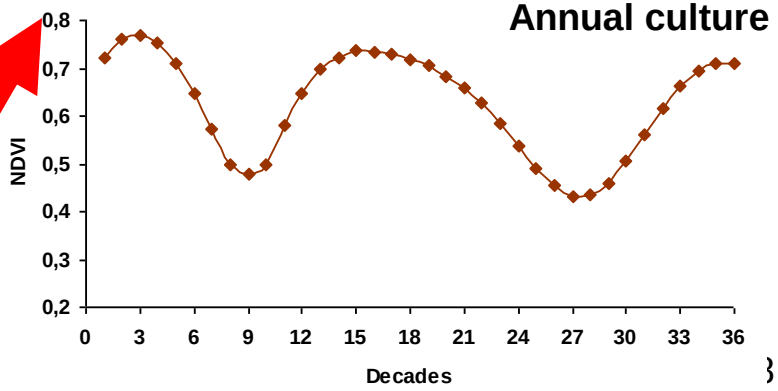
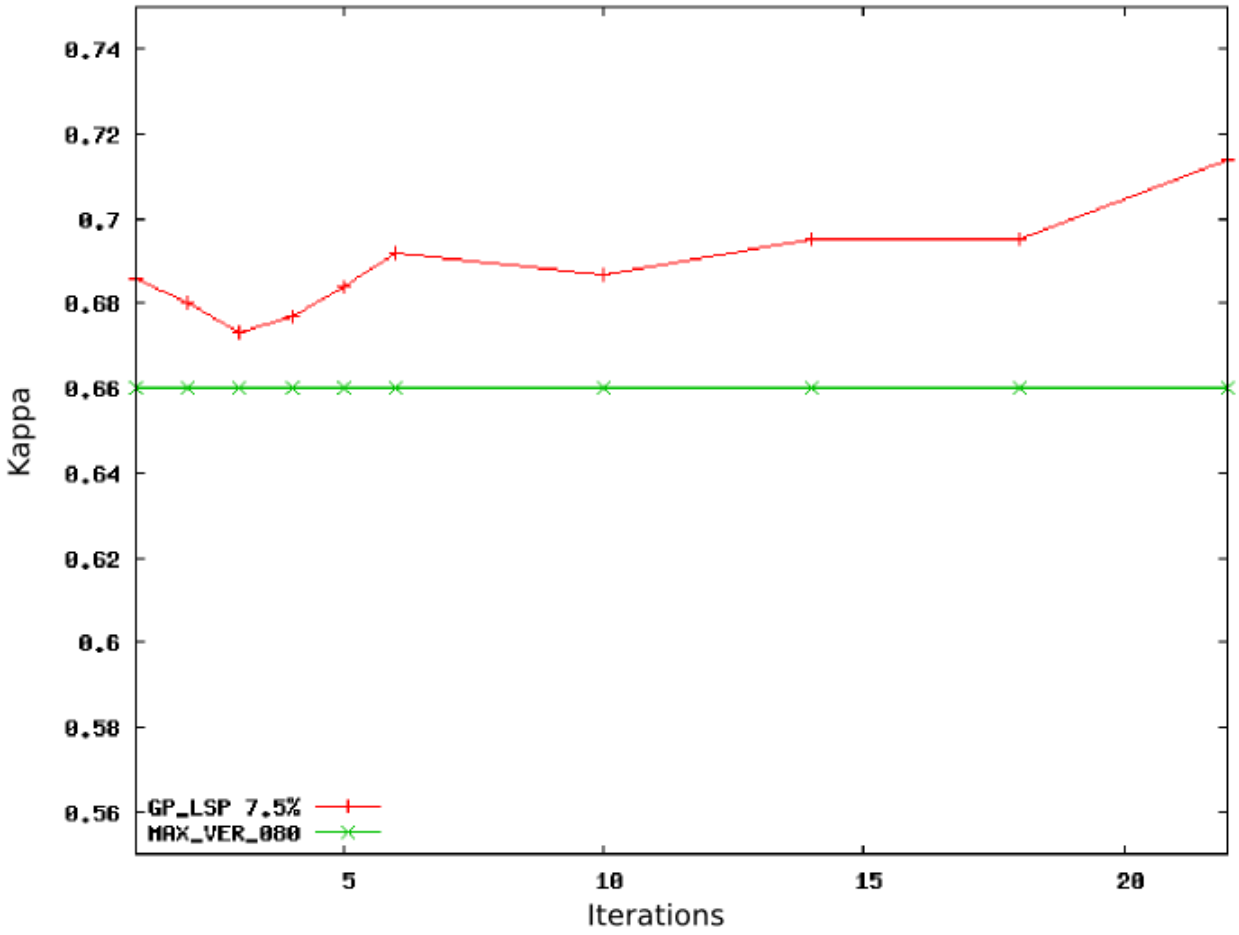


Image Processing



Series Mining

Classification of image regions

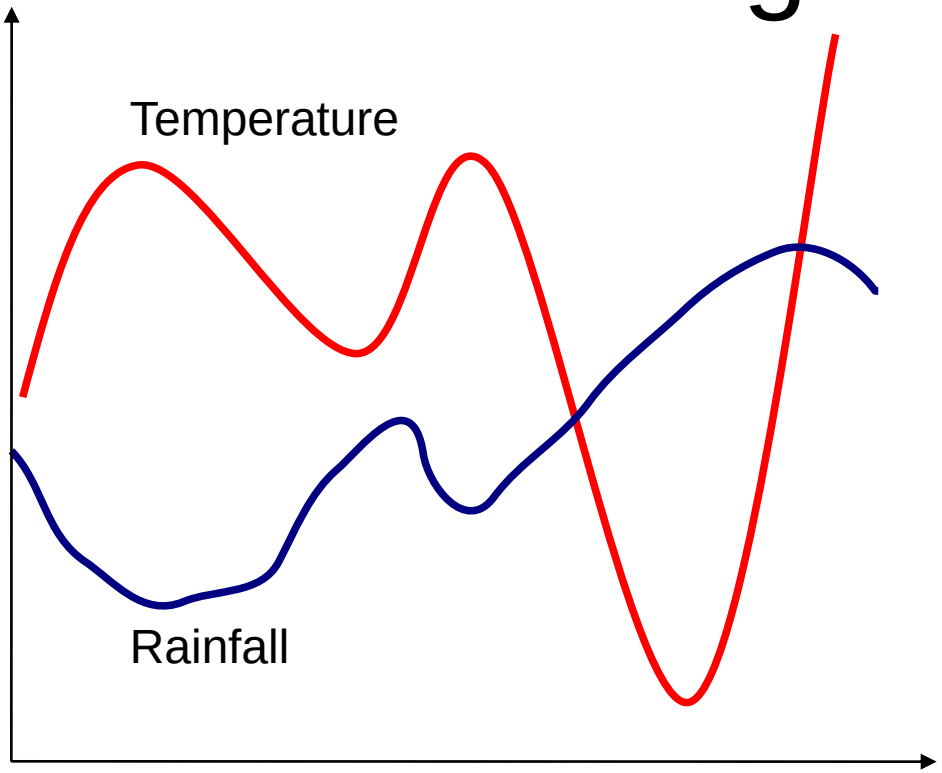


GP-LSP

MaxVer

Identification of coffee

Series mining – co-evolution

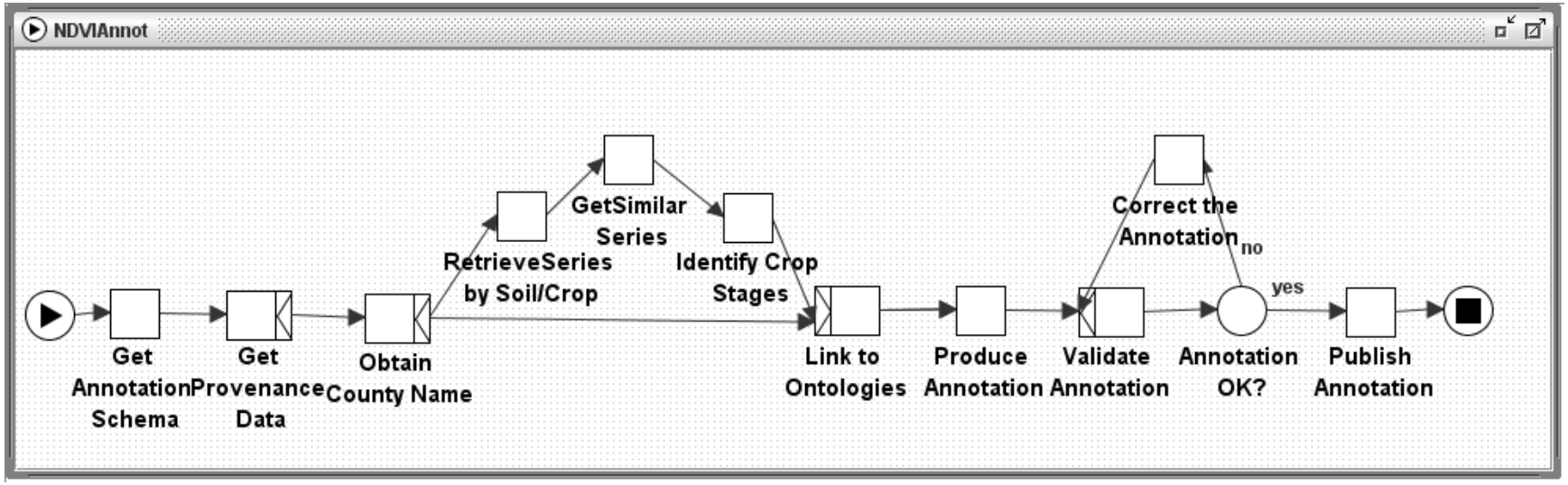


Temporal warp

Estimate joint future behavior?

Search for joint patterns?

Annotations – semi-automatic generation



Meet the Real world challenges

Corn – 15 and 27 days after planting

Conventional system

Direct planting

IC
FEAGRI

Research challenges

Directions

- In the domain (agricultural sciences)
- In CS (databases, networks, image processing, software engineering)
- A combination of both

Challenges in the domain

- **MODELS**
  - How to describe crop behavior
  - How to describe physical, husbandry environment
- **DATA**
  - Which data to collect, and how
- **DECISION SUPPORT**
  - How to influence future
  - How to interpret and adapt models

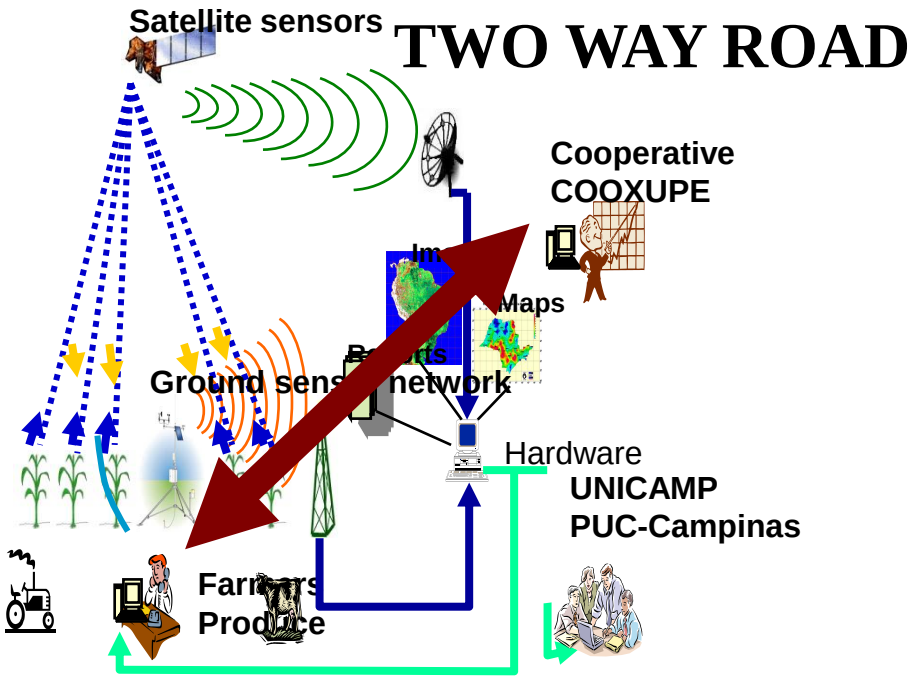
Challenges in CS

- Data heterogeneity
  - Spatio-temporal scales, sampling, devices, purposes, collection methods
- Image processing
  - Classification, segmentation
- Retrieval mechanisms
  - Mining, provenance
- Sensor network management - QoS

Challenges in CS + domain

- Domain requirements -> new algorithms
- Model management
- Decision support
- Requirements eliciting
- Testing

Summing up



Technological results
Networks
Prototypes

Scientific results
1 short paper
2 full papers
1 journal paper
1 submitted journal

Students financed
2 IC
1 MSc

Acknowledgements

- FAPESP and Microsoft Research
  the Virtual Institute
- UNICAMP
  - IC, FEAGRI, CEPAGRI
- CNPq and CAPES
- COOXUPÉ