

# Convergence of world and simultaneous constraints on agriculture becoming new stakes

- **Demography**
- **Land, water and soils uses, forest and nature preservation**
- **Necessary and urgent adaptation to climate changes**
- **Prices volatility**
- **Food security and nutritional security**



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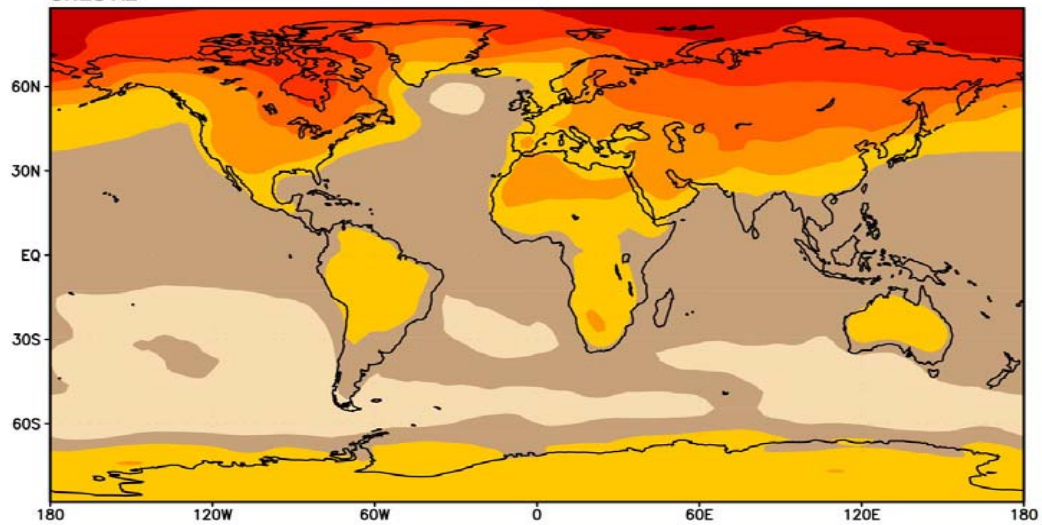




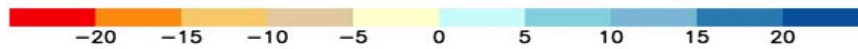
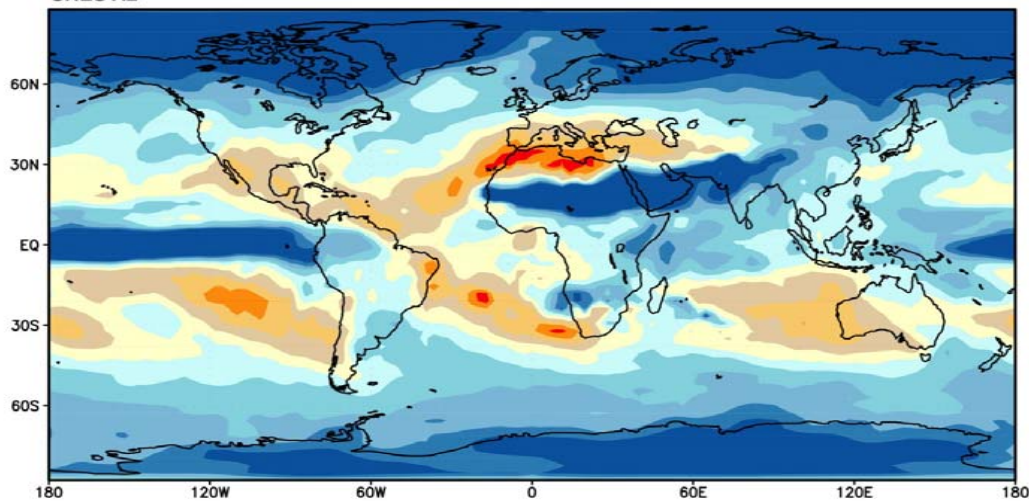
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SRES A2



SRES A2



# Fast and deep evolution of economic, scientific and social contexts

- **Market globalisation**
- **High throughput biology and ecology**
- **Obvious and strong citizens implication in agricultural research agenda**
- **More legal constraints and conflicts**
- **Reduced attractiveness of agricultural jobs**

# Four main challenges

- **Increase efficiency of predictive biology**
- **Increase scientific basis of agroecology**
- **Reduce number of human beings under or over nourished**
- **Develop open data basis for more meta-analysis**

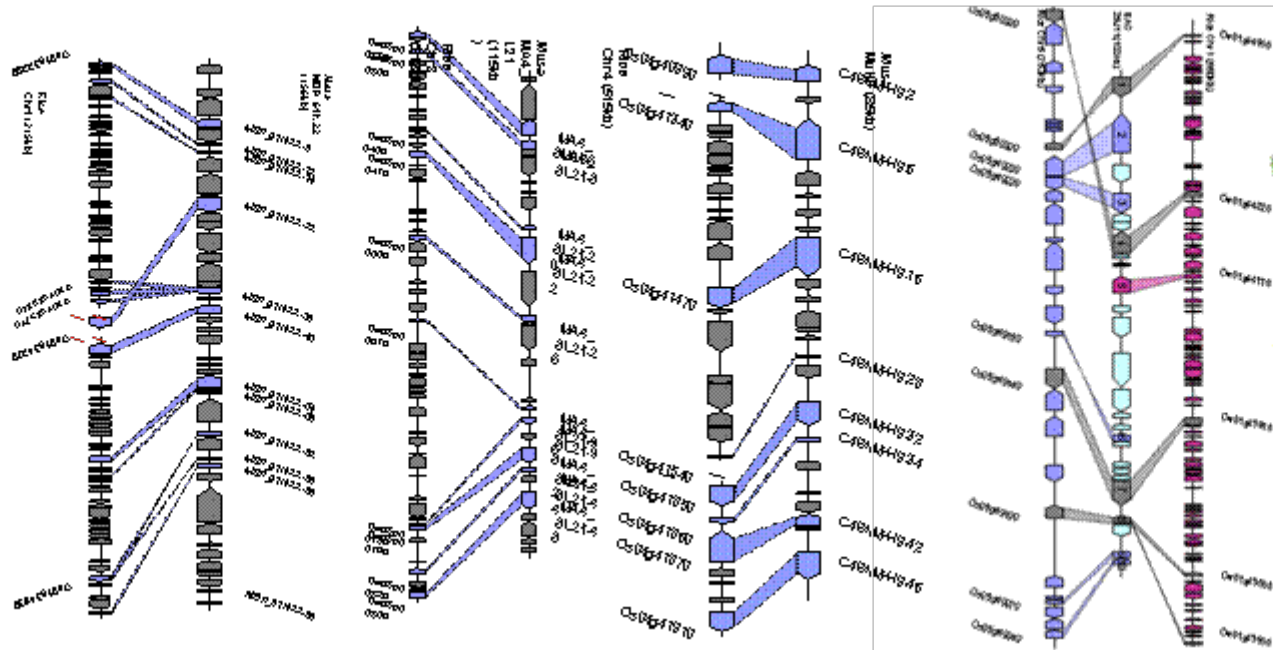
# Genomic breeding

- **High throughput genotyping of germplasms**
- **Coupled with high throughput phenotyping**
- **Valorized by high throughput bioinformatics**
- **Organise large worldwide network within public research**

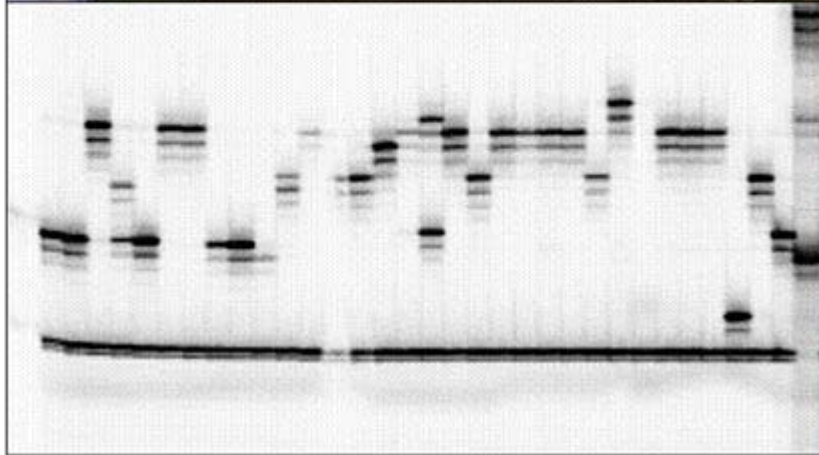
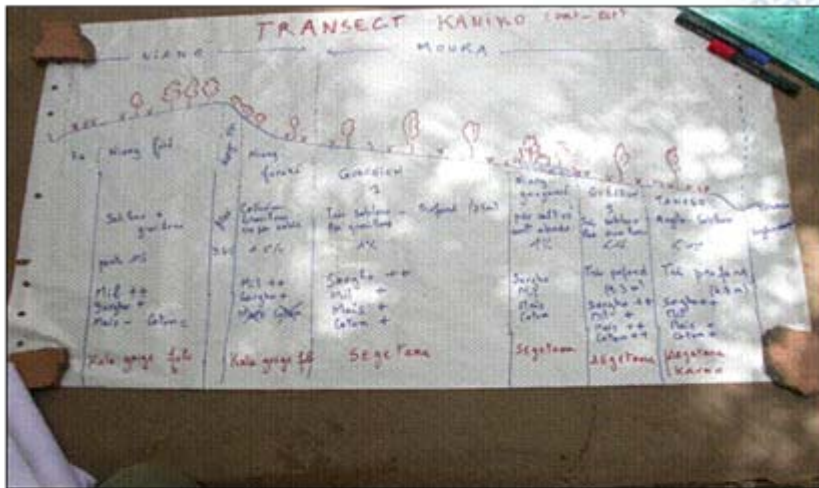
# New avenues

from model to (other) crops

## Genomic sequence comparison between rice and Musa



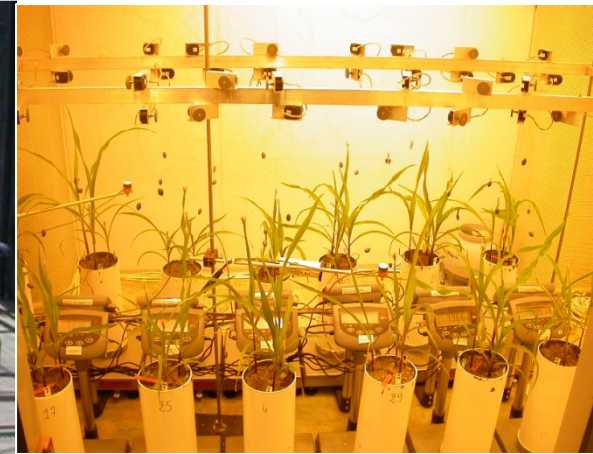




**Phenodyn : suivre la vitesse d'élongation foliaire et la transpiration au pas de temps de 15 min sur 450 plantes conjointement avec les conditions environnementales** *Sadok et al. 2007 PCE 30, 135–146*



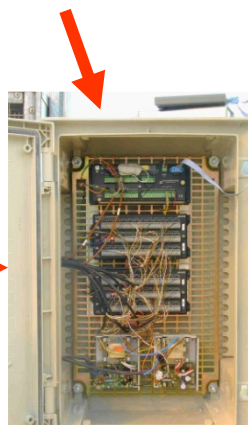
400 plants



50 plants

meristem  
temperature

Soil water status  
transpiration rate



data logger

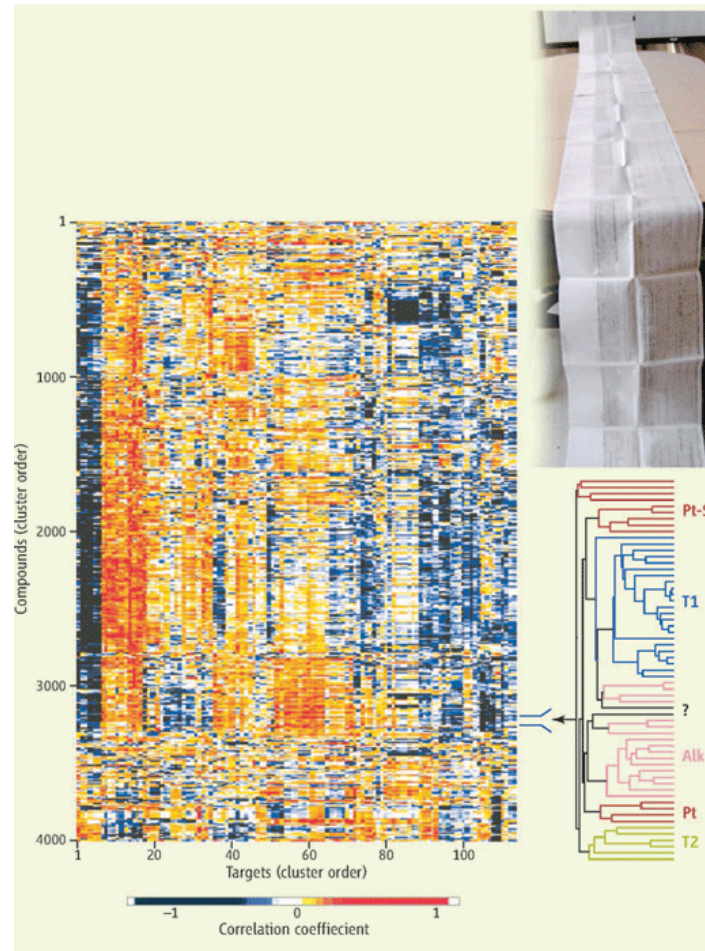


evaporative  
demand

light

**Postgenomic motivation.** Before the clustered heat map, long scrolls of computer paper were needed to list large data sets. Shown is an 8.3-m scroll of data on the molecular pharmacology of cancer cells that was later depicted as a one-page clustered heat map of 4000 lines. The clustered heat map shows relationships between the growth-inhibitory activity of chemical compounds (i.e., potential drugs) and molecular characteristics (including gene expression) of 60 cancer cell types (*1*).

PHOTO CREDIT: GENOMICS & BIOINFORMATICS GROUP



In : A Postgenomic Visual Icon  
John N. Weinstein  
*Science* 28 March 2008: 1772-1773.

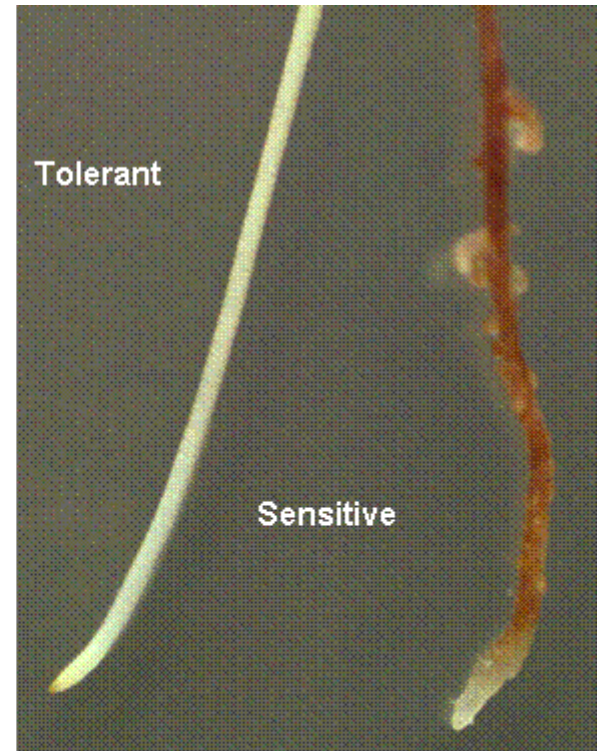
# Develop reverse genetics

- **From trans to cis-genesis**
- **Targeted and controlled insertional events**
- **Valorisation of epigenesis**
- **Exploration of glycobiology potential**
- **Synergy between white and green technologies**

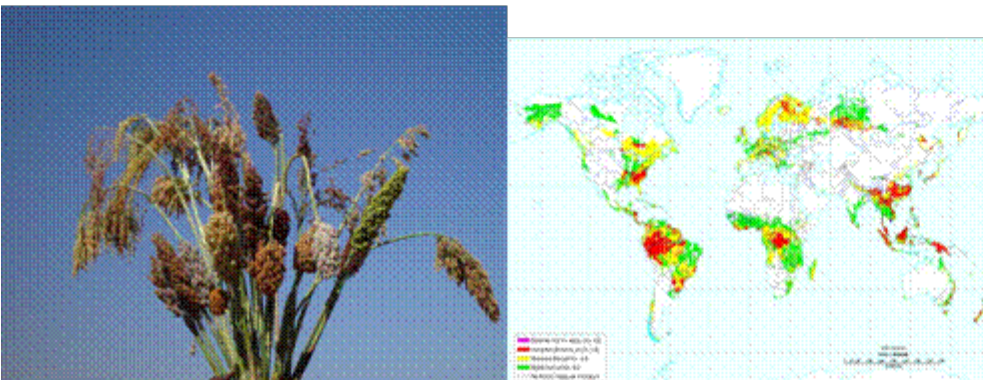
## A major gene for aluminum tolerance in sorghum

AltSB,  
cloned by chromosome walking,  
a transporter in the plasma membrane,  
activated by Al,  
promoting the efflux of citrate  
to the rhizosphere.

Citrate binds Al thus providing tolerance.



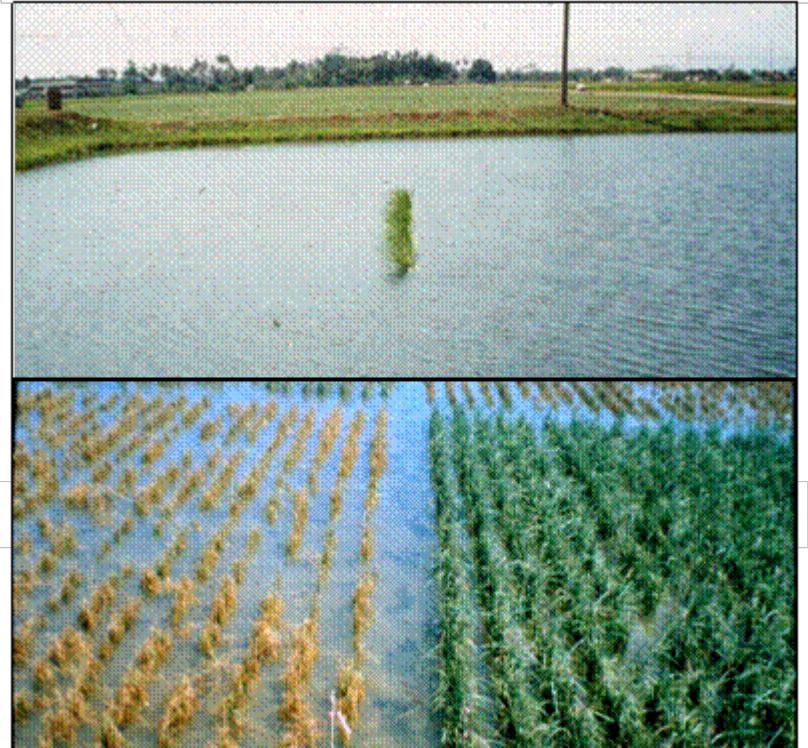
courtesy of J Magalhaes, Embrapa



## A major gene for submergence tolerance in rice

FR13A,  
a highly submergence tolerant landrace

Sub1,  
gene for submergence tolerance,  
was cloned by chromosome walking,  
is an ethylene-response-factor-like gene



Courtesy of Gurdev S Khush, Irri

# Translation initiation factors: key targets for plant resistance to viruses

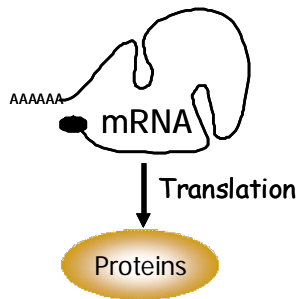
Viruses require host factors to perform their infectious cycle

Recessive genes are prevalent for resistance to viruses

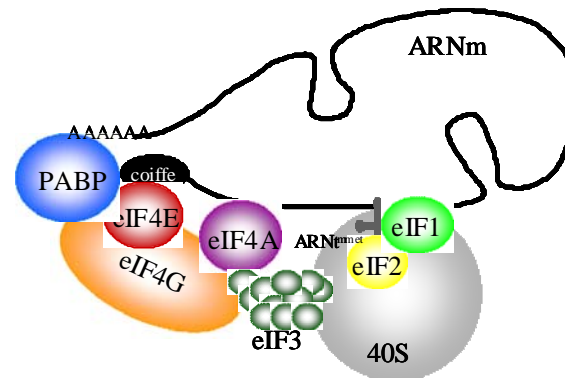
Molecular cloning of recessive resistance genes



Characterization of *A. thaliana* mutant lines

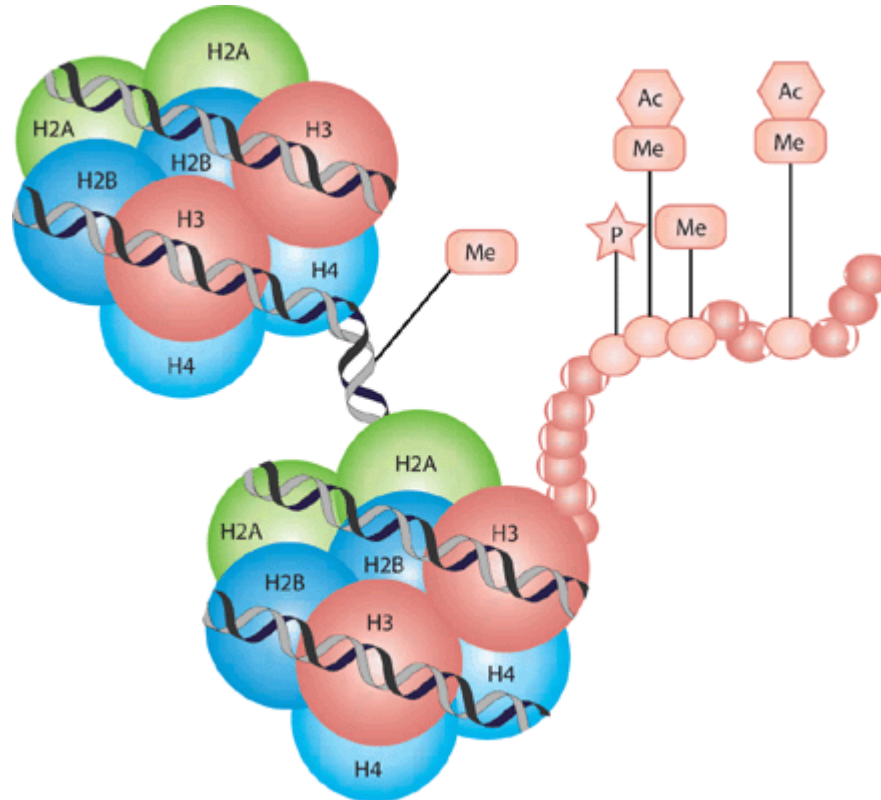


Translation initiation factors eIF4E & eIF4G  
- kingpin in plant resistance to RNA viruses  
- host factors required for viral cycle



**Turnoffs and turn-ons.** Chemical modifications of DNA or histone proteins (H), particularly their tails, affect nearby gene activity.

CREDIT: SCIENCE SIGNALING, A. M. BODE, Z. DONG, INDUCIBLE COVALENT POSTTRANSITIONAL MODIFICATION OF HISTONE H3. SCI.STKE 2005, RE4 (2005)



In : Are Epigeneticists Ready for Big Science?

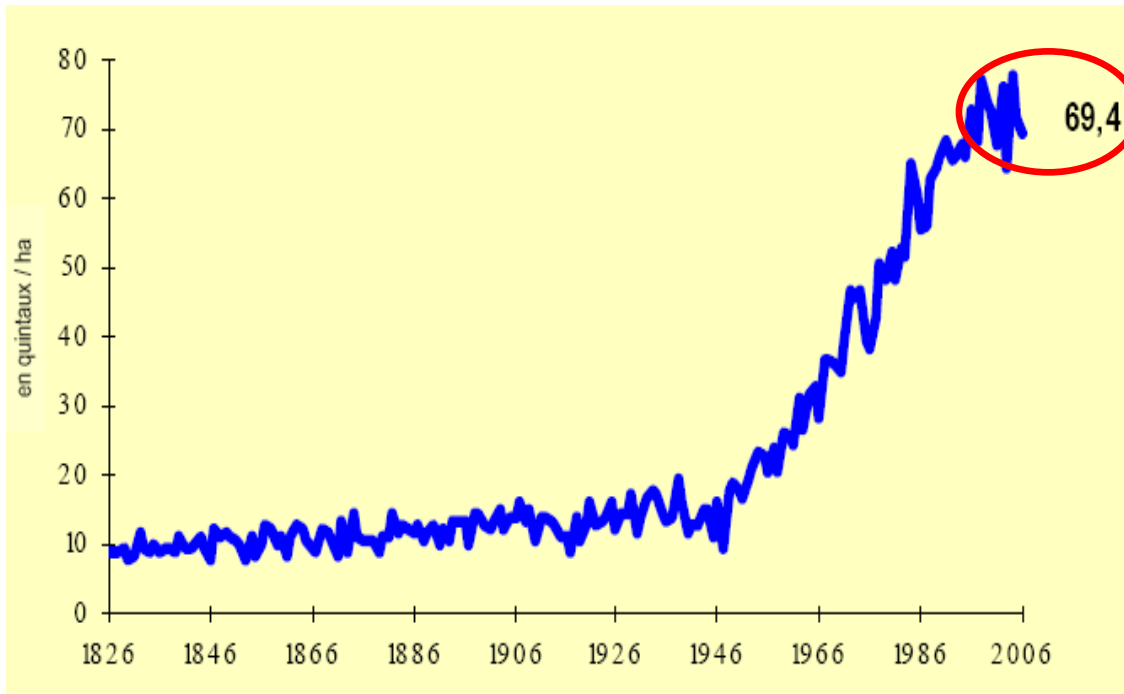
Elizabeth Pennisi

*Science* 29 February 2008: 1177.



# L'agro-ecology

- **Conceive and integrate innovations**
- **Develop faster and practical diagnosis kits**
- **Conceive new agronomic systems**
- **Assess positive and negative agricultural impacts on environnement**
- **Assess economic and social consequences of those new practices on farm and value chain.**



**Evolution des rendements du blé tendre en  
France sur longue période 1826-2006**  
(source APCA-Etudes économiques d'après INSEE-ONIGC)

# Irrigation system

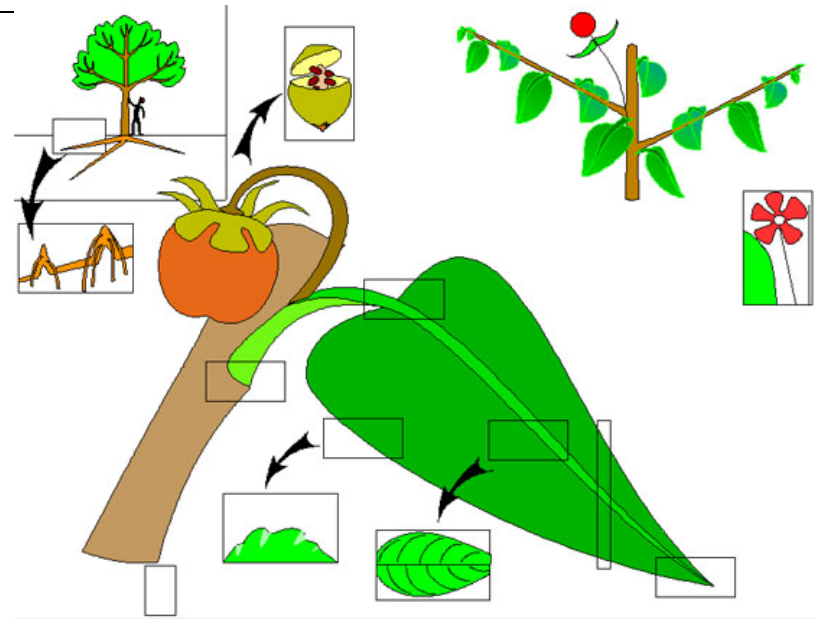


*Courtesy of B Sine et al, Ceraas, Senegal*

# Diagnosis : easier, faster and more precise

- Weeds, pests and diseases identification
- Intraspecific molecular characterization
- Nutrients, water and soils status
- Integrated resistance management
- Development of estimating models

# Taxonomic identification tool



**An informatic tool using graphic interface for species identification**



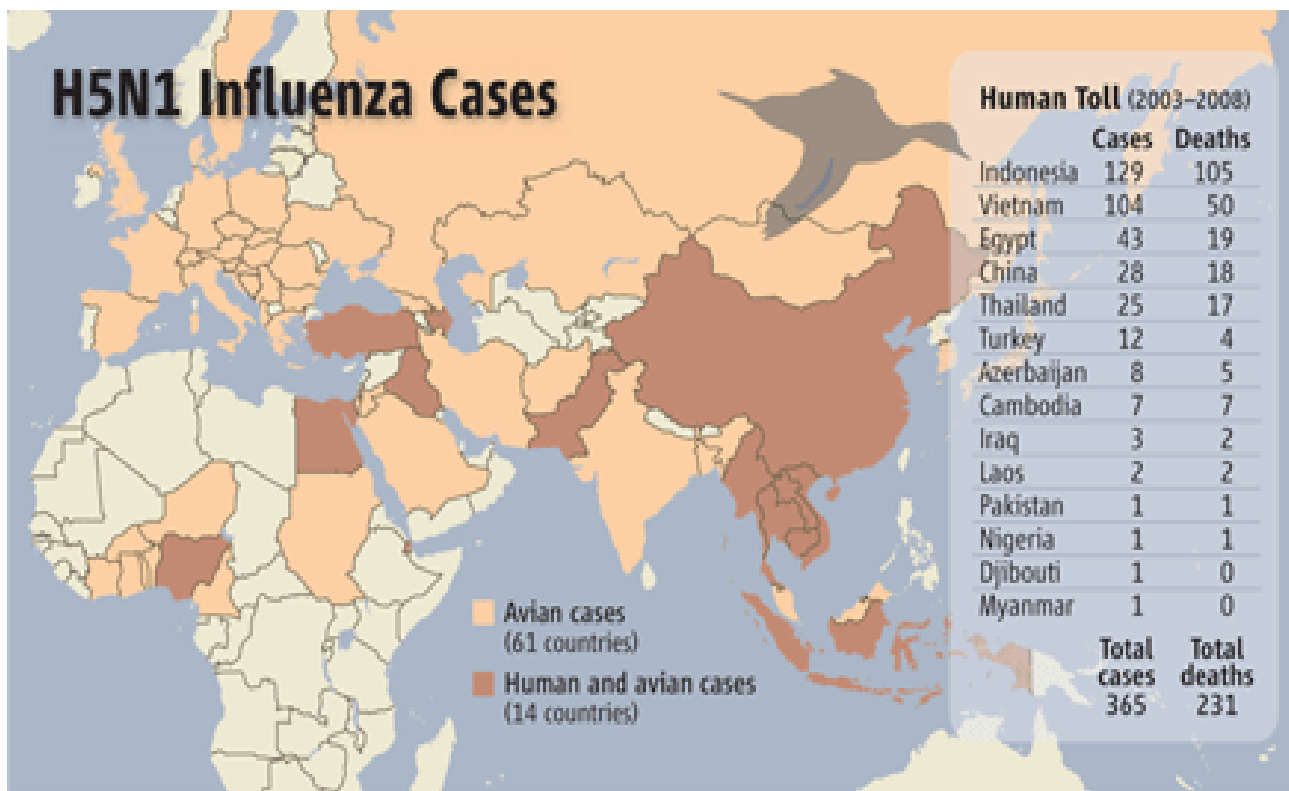
Centre de Coopération Internationale en  
Recherche Agronomique pour le  
Développement



UMR botANique et bioinforMatique  
de l'Architecture des Plantes

**Still on the move.** Although not headline news, in 2007 the H5N1 virus spread to poultry flocks in eight new countries and returned in 23 others stretching from Japan to the United Kingdom while human cases continued to mount.

SOURCE: WHO AND OIE (WORLD ORGANISATION FOR ANIMAL HEALTH), 21 FEBRUARY 2008



**In :** Flu Virus Research Yields Results but No Magic Bullet for Pandemic

Dennis Normile

*Science* 29 February 2008: 1178-1179.

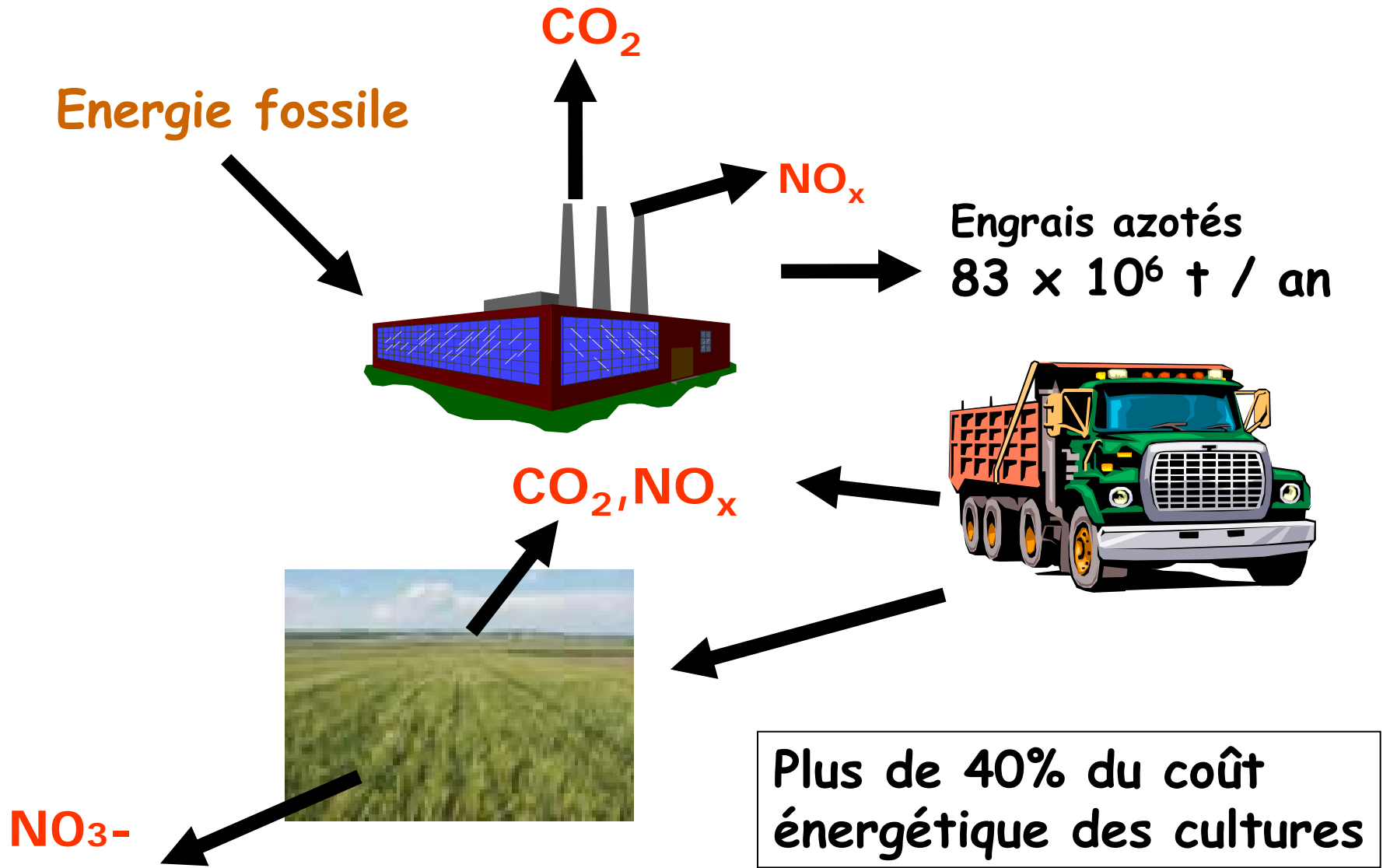
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# New practices and more agroinformatics

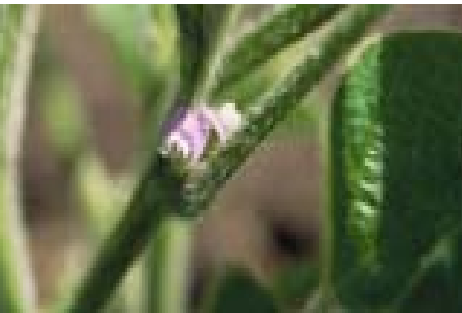
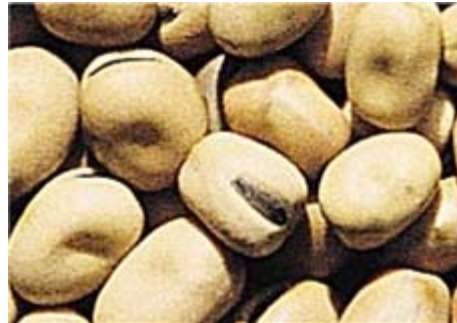
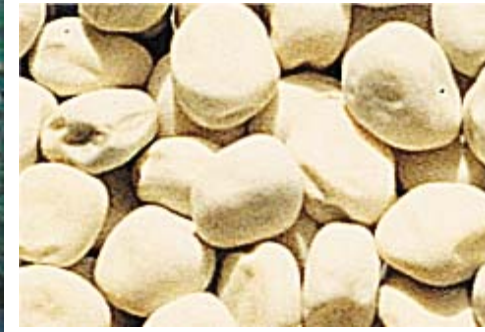
- **ICT in farming practices : jubile, fertimieux, Farm Star,**
- **Develop alternative practices**
- **Develop new agronomic systems**
- **Develop eco-balance approaches**

# Effets environnementaux de l'utilisation des engrais azotés chimiques

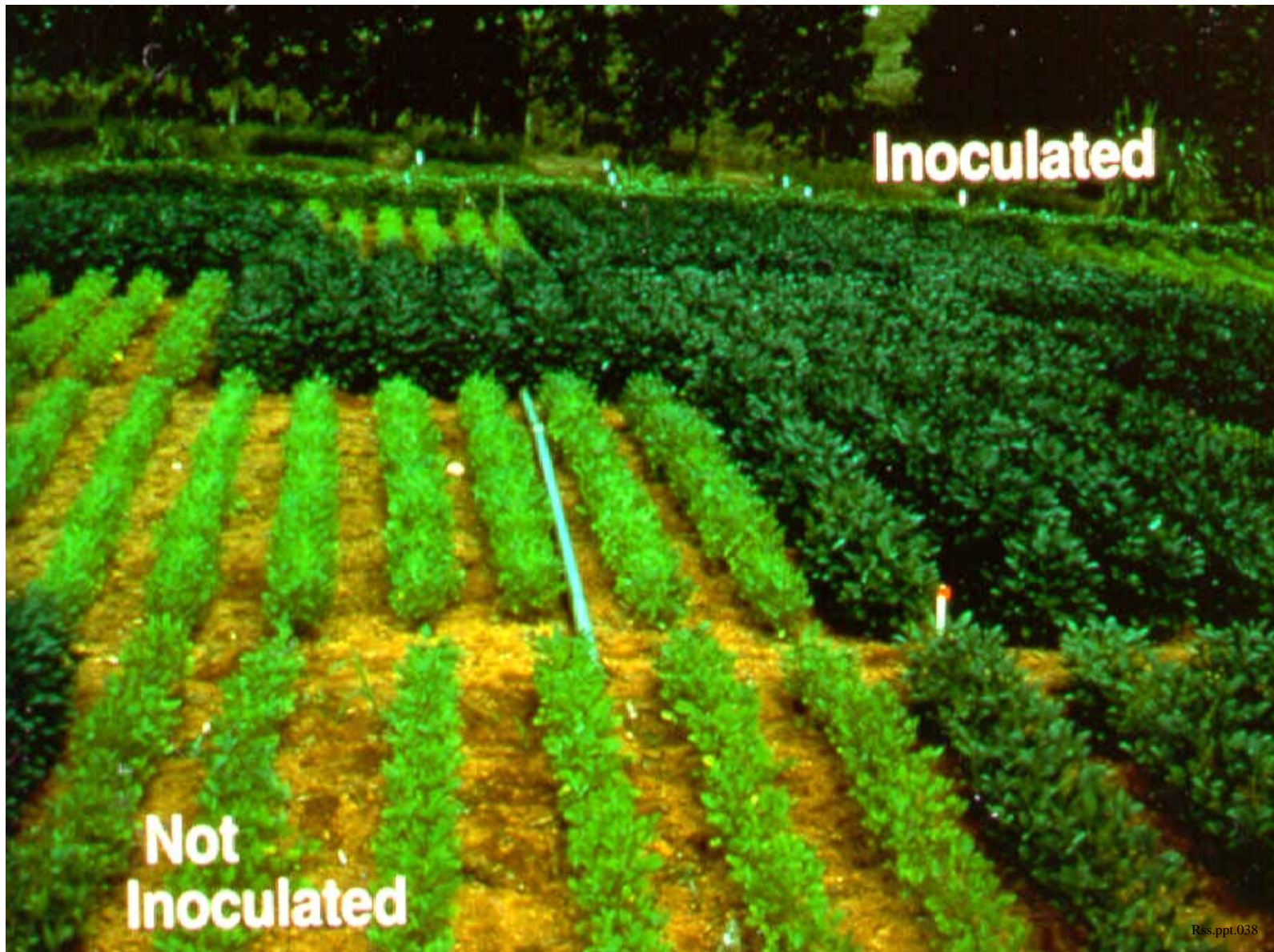




**Les légumineuses représentent  
35% des protéines végétales  
consommées dans le monde**



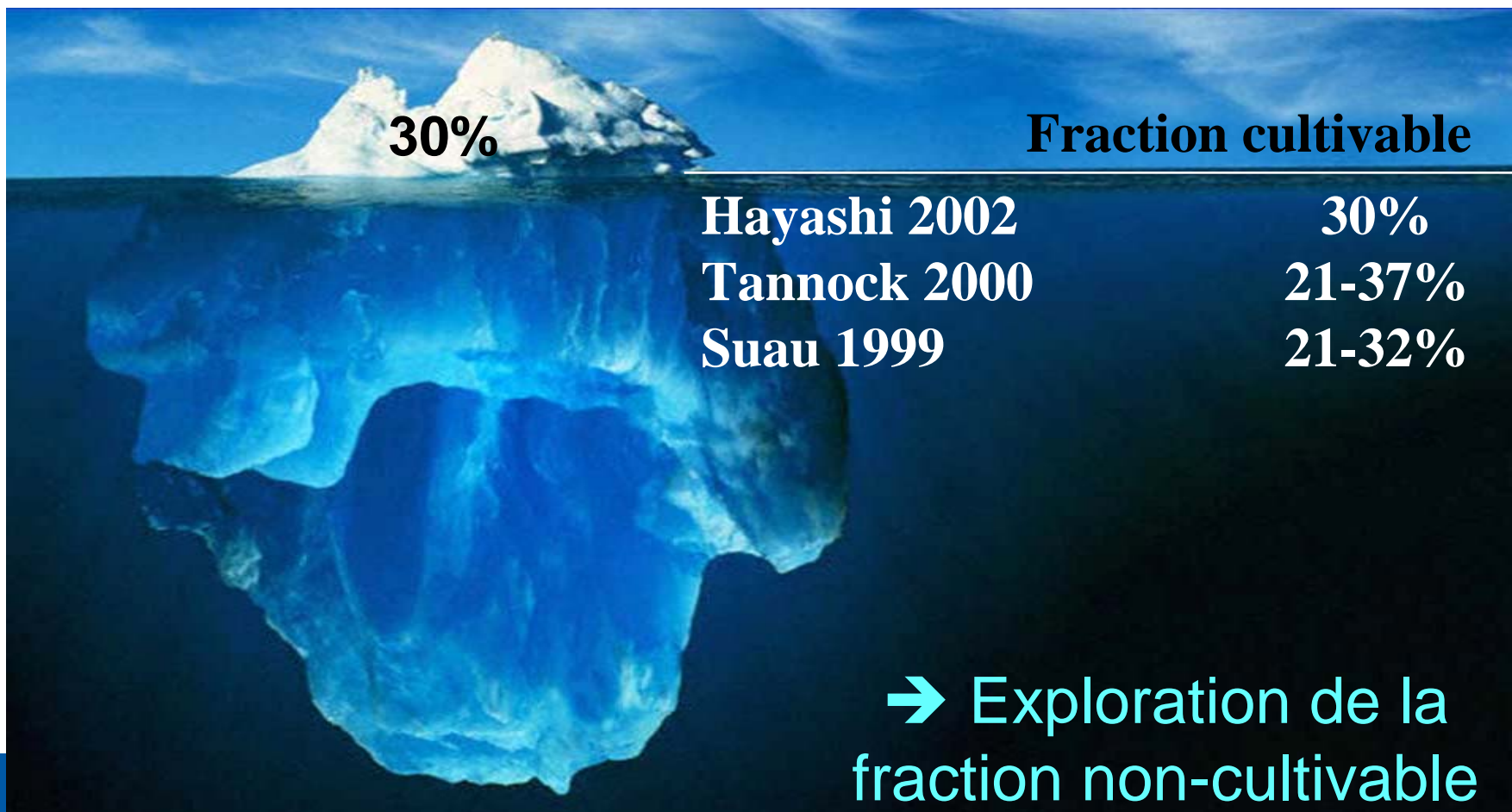
# *Essais d'inoculation de soja par Rhizobium*



# More need for meta-analyses

- **Metagenomics**
  - of Human gut microflora
  - of rumen microflora
  - of soils microbes
- **Develop data basis**
  - Farms
  - Soils
  - Agronomic practices
  - Phytosanitary practices
  - Baby and adult Human nutrition

# Le microbiote intestinal dominant : fraction cultivable ~ 30%

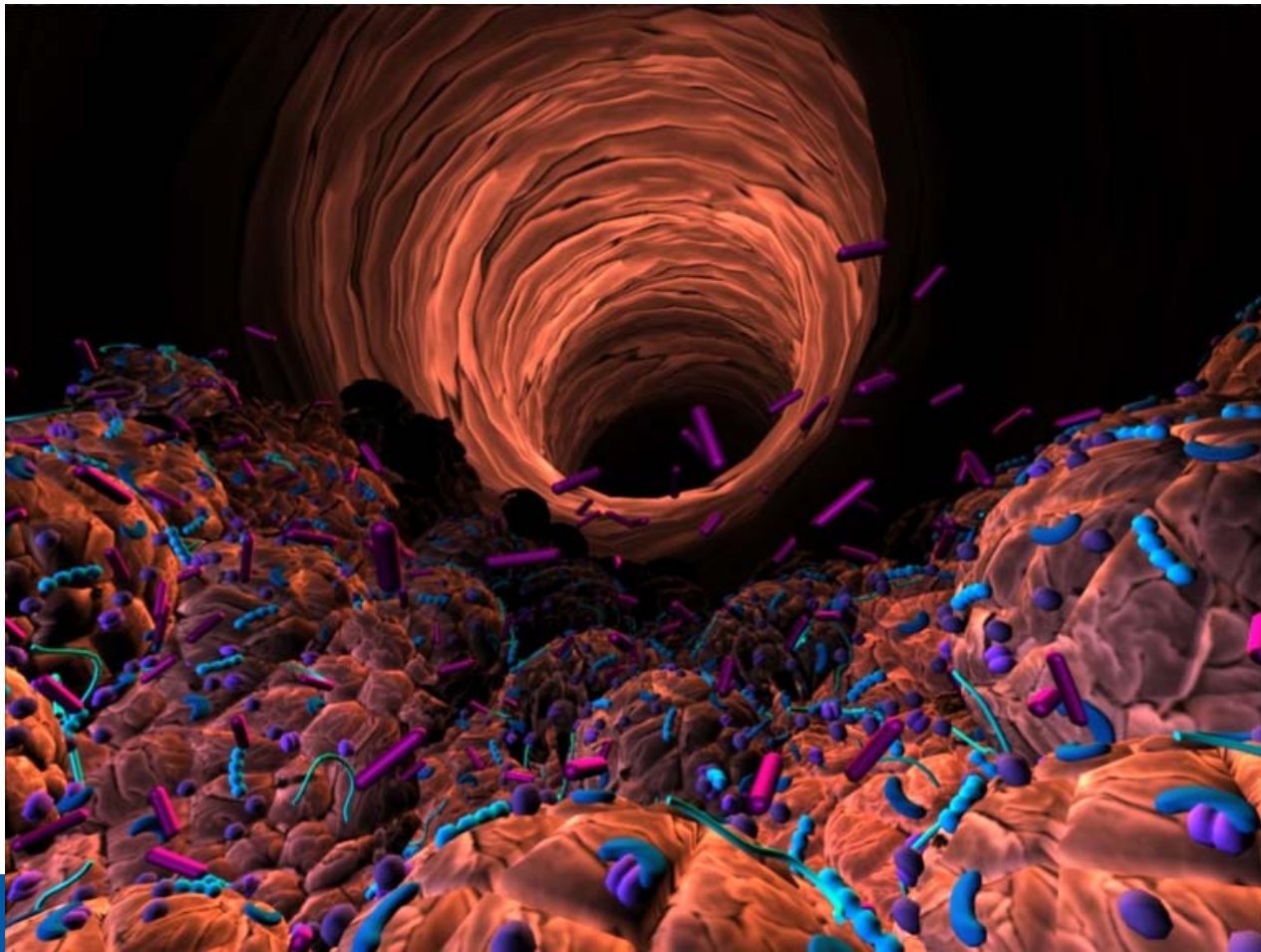


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# Strategic investments to share

- **Germplams**
- **Experimentation and experimental units**
- **Environment and food observatories**
- **Technological platforms**

# From globalization of problematics to worldwide programs

- **Transdisciplinary programs:**
  - *genomics breeding,*
  - *adaptation to climate changes,*
  - *predictive biology,*
  - *monitoring of plant and animal health,*
- **Adapt solutions towards agrobusiness as well as familiar farming**