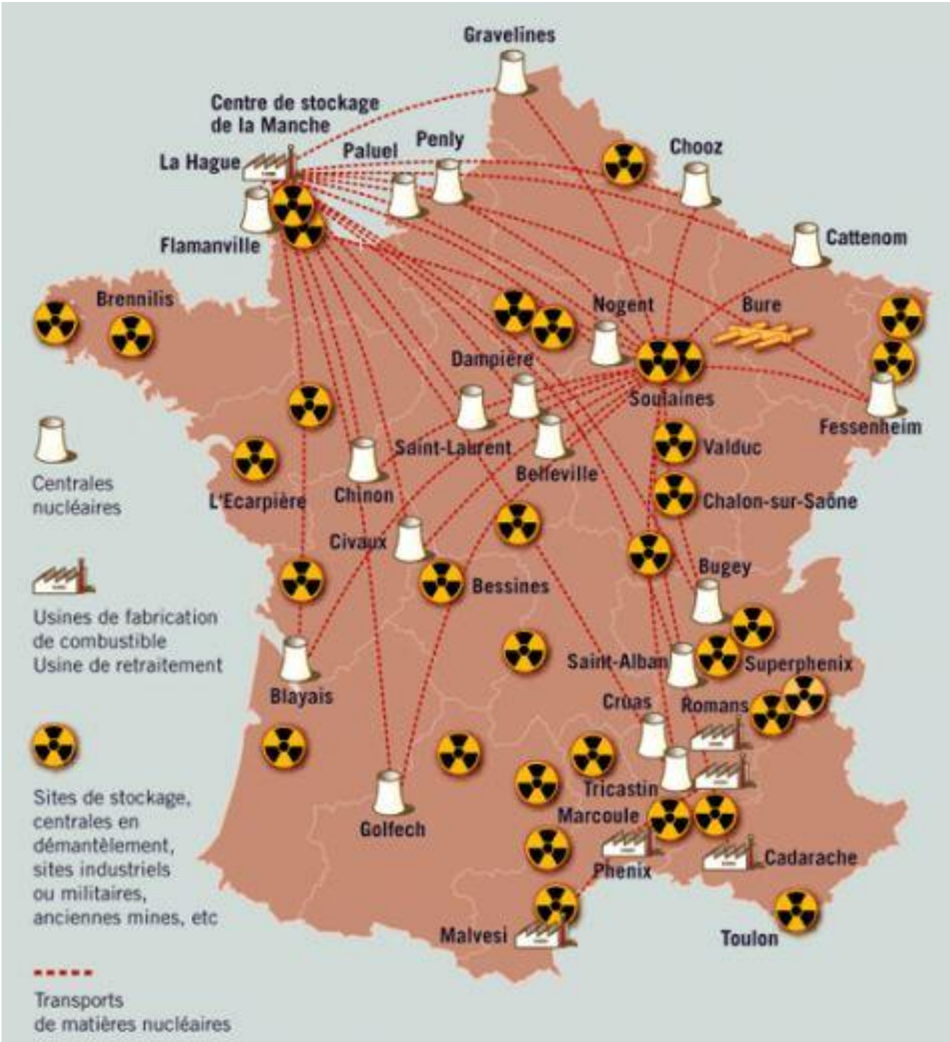




58 units on 19 sites
Covering 80% of French electricity consumption

# Architecture of the DEMETERRES program

**Water Treatment**

**Soil Treatment**

**Phyto-Remediation**

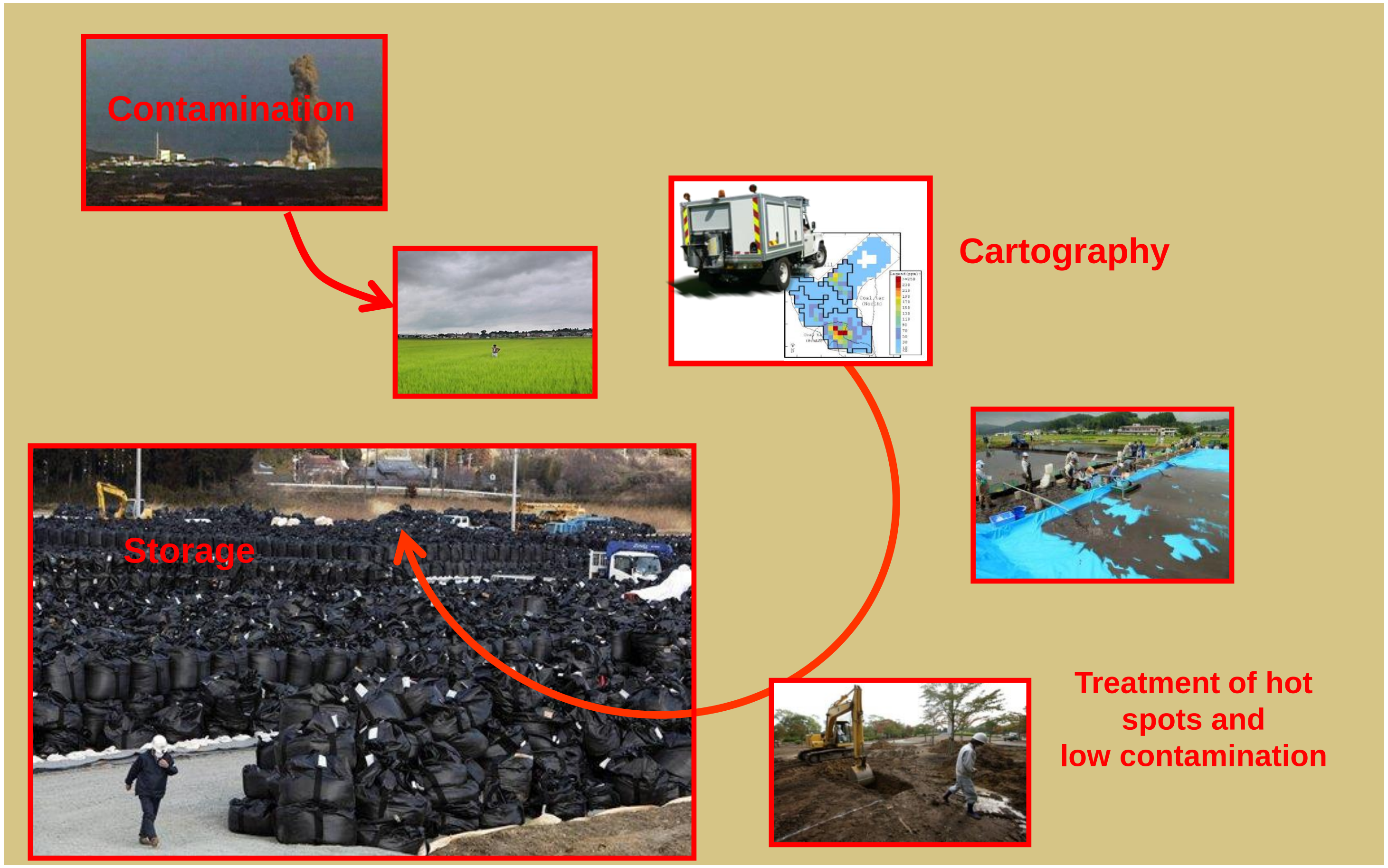
**« Safe-Food »**

**Soil Characterization**

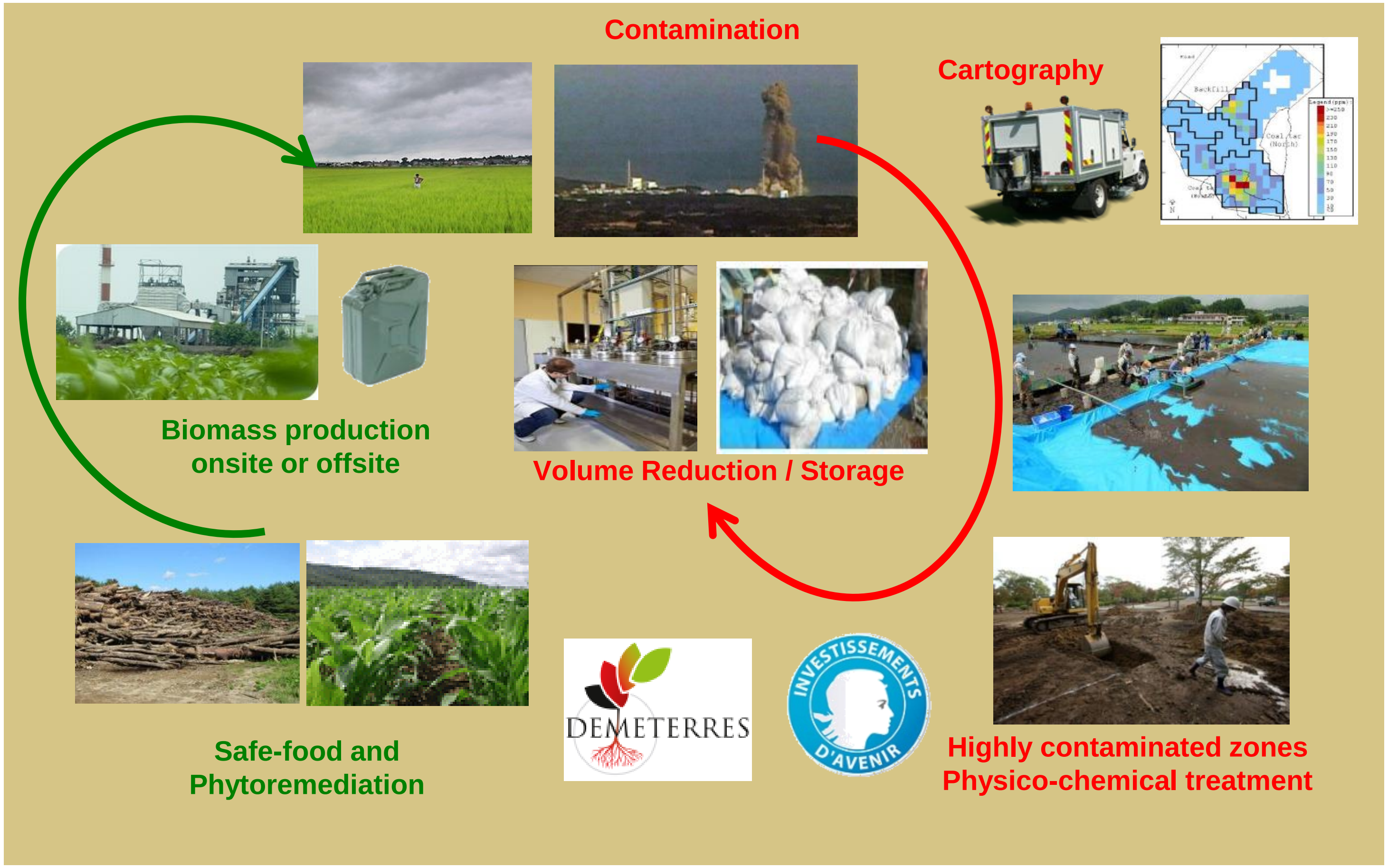
**Guide of Intervention**

## New Post-accidental Remediation Strategies

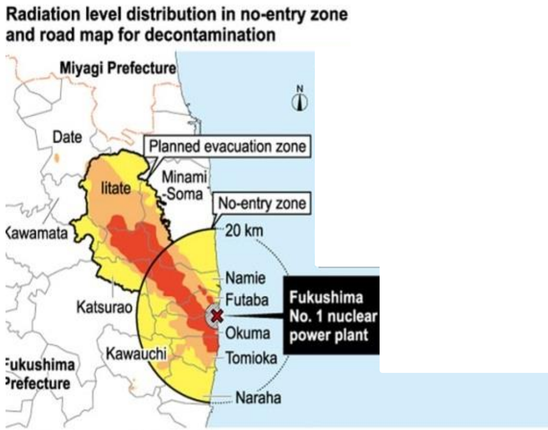
# Towards a mixed technology of (bio)remediation



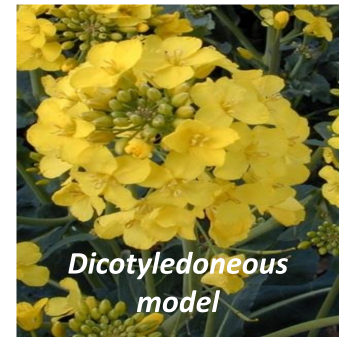
# Towards a mixed technology of remediation



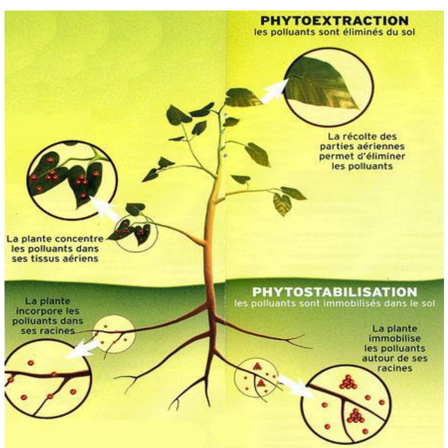
## Safe-Food








## Phytoextraction




## Safe-Food

**OBJECTIVES**

Decrease by 50% Cs contamination in seeds

Dicotyledonous (Arabidopsis) decrease by 50% leaves contamination

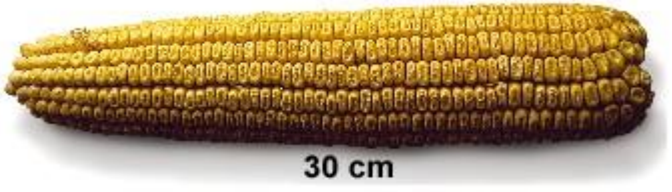
## Phytoextraction

**OBJECTIVE**

Increase by 200% Cs content in aerial parts

# Using Genetics approaches


*Balsas teosinte*




*Zea Mays*

# Cs strongly interacts with clay in soil

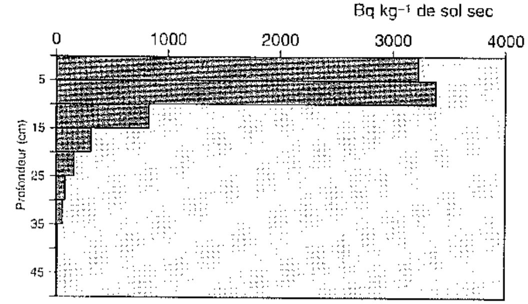
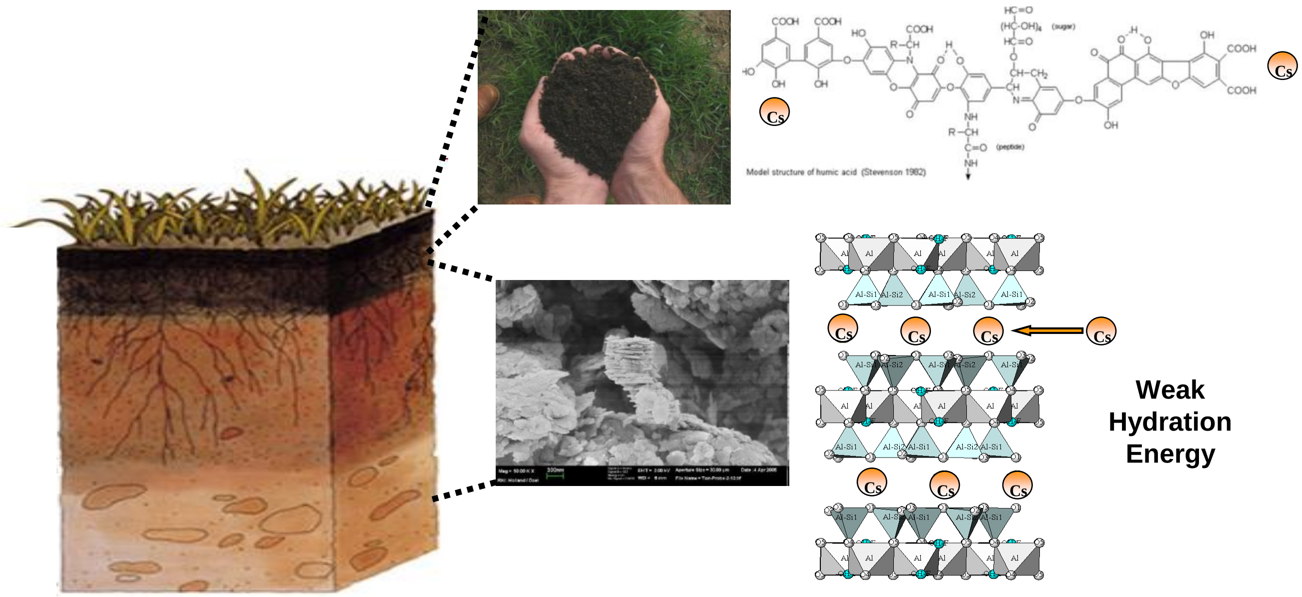



Figure 5.3. Répartition en profondeur du $^{137}Cs$ dans un sol de vigne 30 ans après son apport dans les 10 premiers centimètres de la couche de surface (Grauby, 1993).



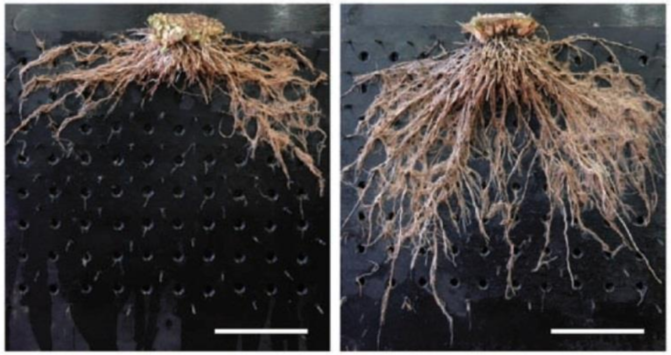
# Molecular approaches to modify

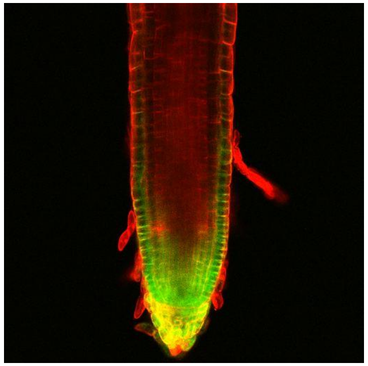
**1- Root architecture to optimize or decrease Cs contamination**

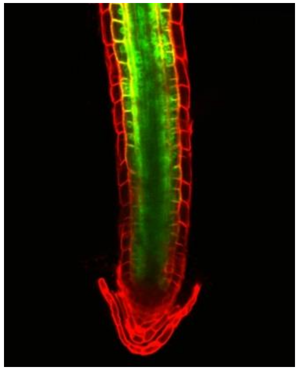
**2- Decrease / Increase Cs biodisponibility in the rhizosphere by modifying proton and organic acid excretion**

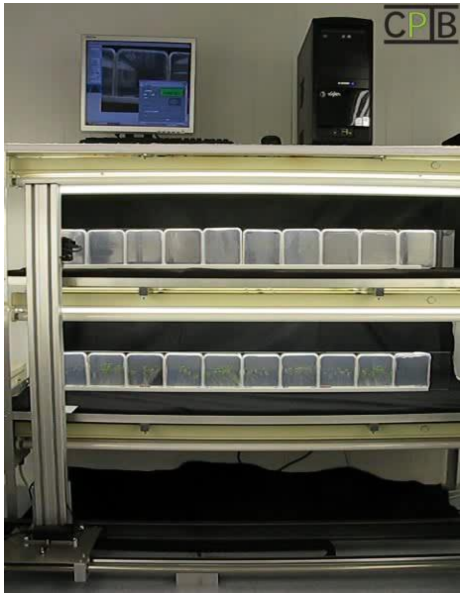
**3- Decrease / Increase Cs transport *in planta***

# 1- Change in Root Architecture

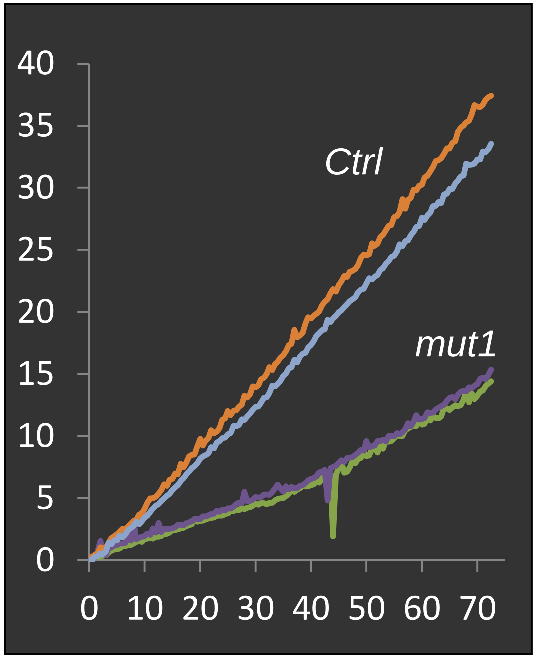


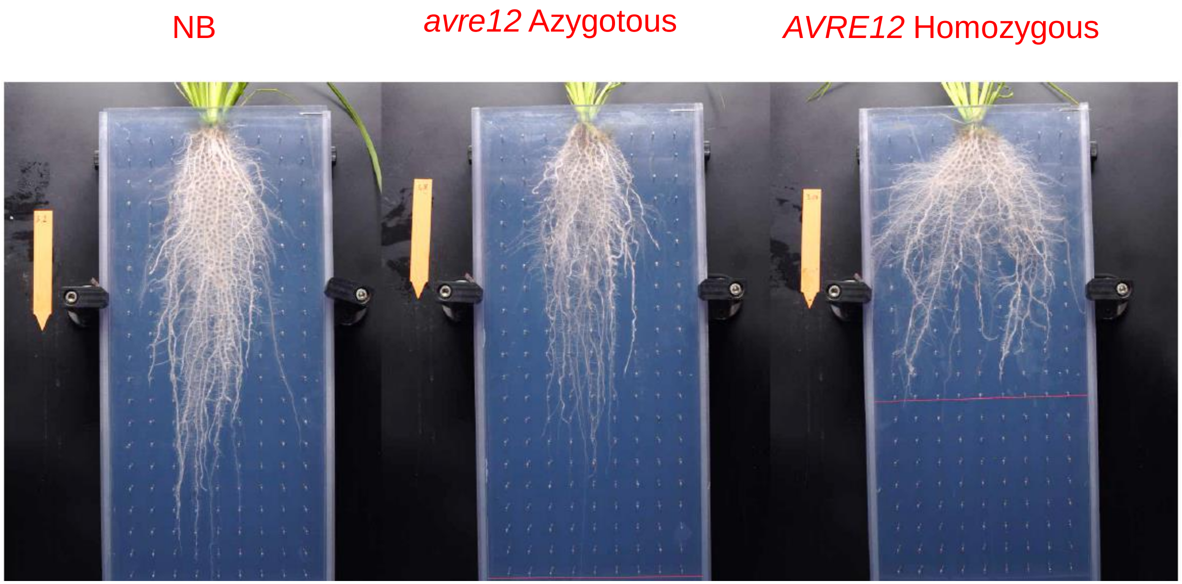


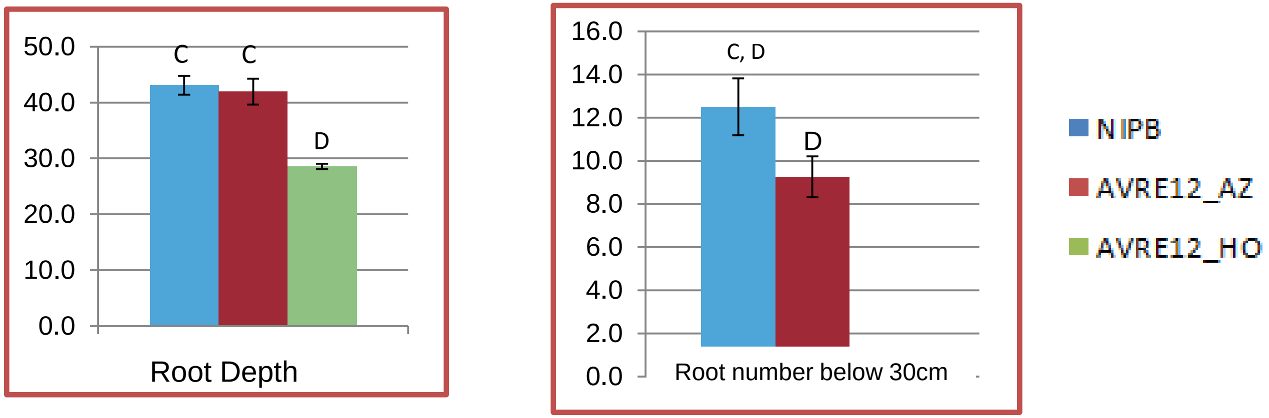



**Software : RootTrace**



# 1- Change in Root Architecture



# 2- Decrease / Increase Cs biodisponibility in the rhizosphere

**AHA ($H^+$) family**

| | |
|---|---|
| *AHA1* | roots |
| *AHA2* | roots |

11 family members

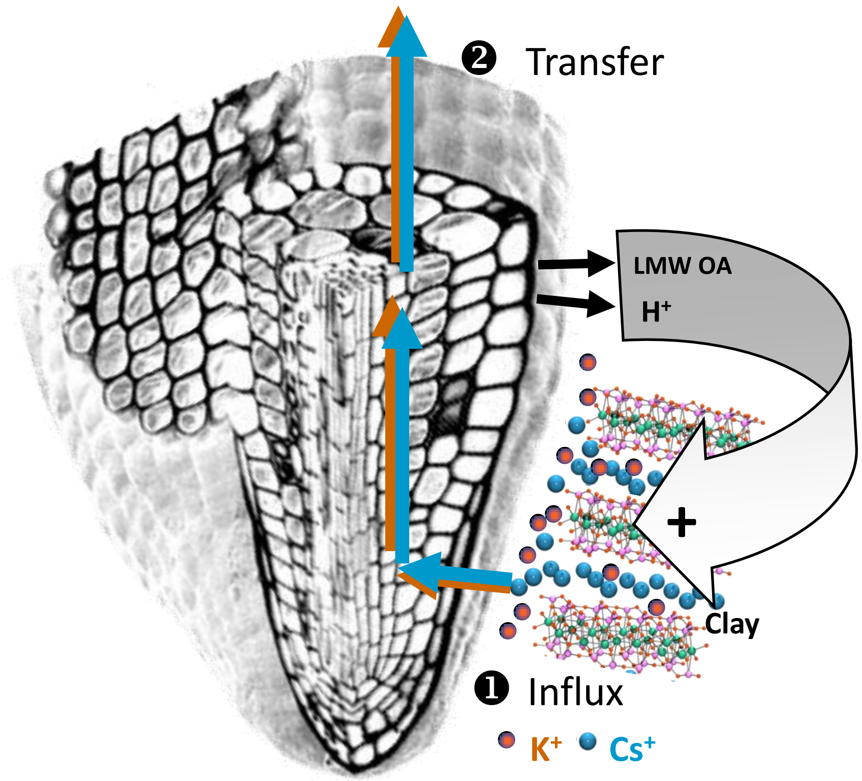
**organic Ac.**

*ALMT*

*MATE*

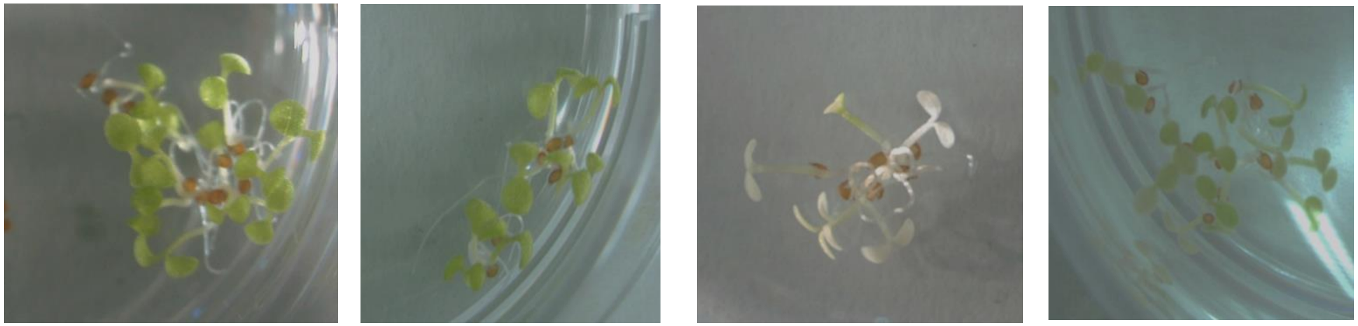
*FRD3*

...

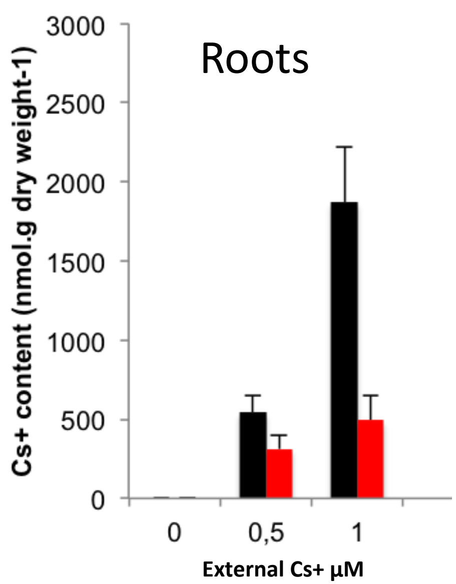


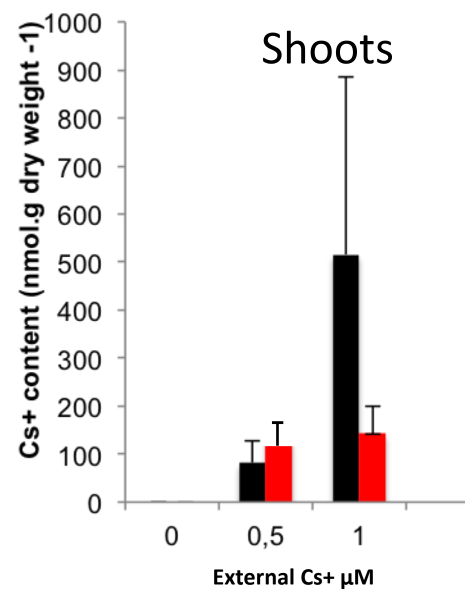
# Strategy

Col | *aha-x* | Col | *aha-x*

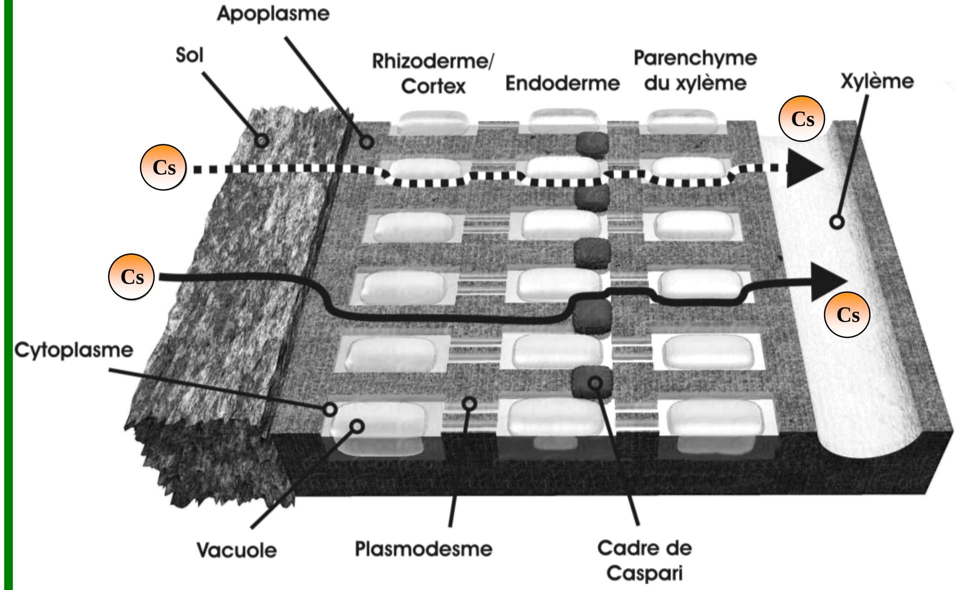


no $Cs^+$ | 500µM $Cs^+$

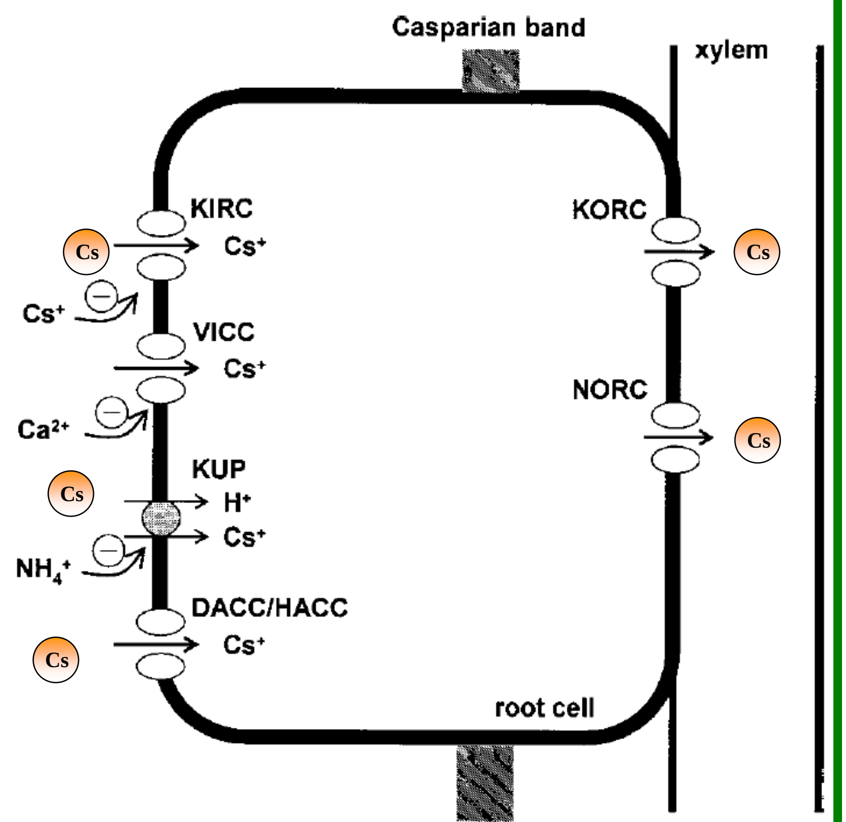


# 3- Decrease / Increase Cs transport *in planta*




From White & Broadley (2000)
New Phytol. 147, 241-256



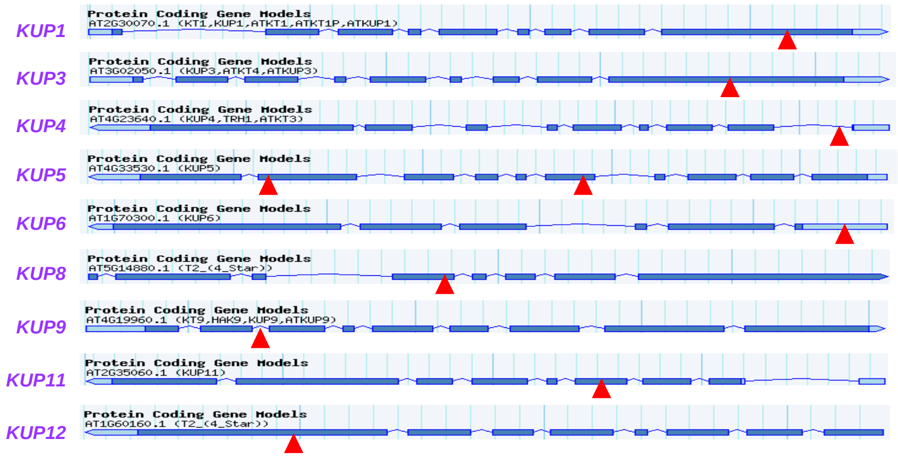

## Cs shares K transporters

*Arabidopsis thaliana* genome
(White 2003, *Encyclopaedia of Applied Plant Science*)

| | |
|---|---|
| KIRC (*AKT* & *KAT* families) | 7 genes |
| KORC (*SKOR* & *GORK*) | 2 genes |
| VICC (*GLR* & *CNGC* families) | 40 genes |
| KUP (*KUP/HAK/POT* family) | 13 genes |
| CHX | 26 genes |
| KEA | 6 genes |
| | 94 genes ! + NHX etc… |

# Strategy

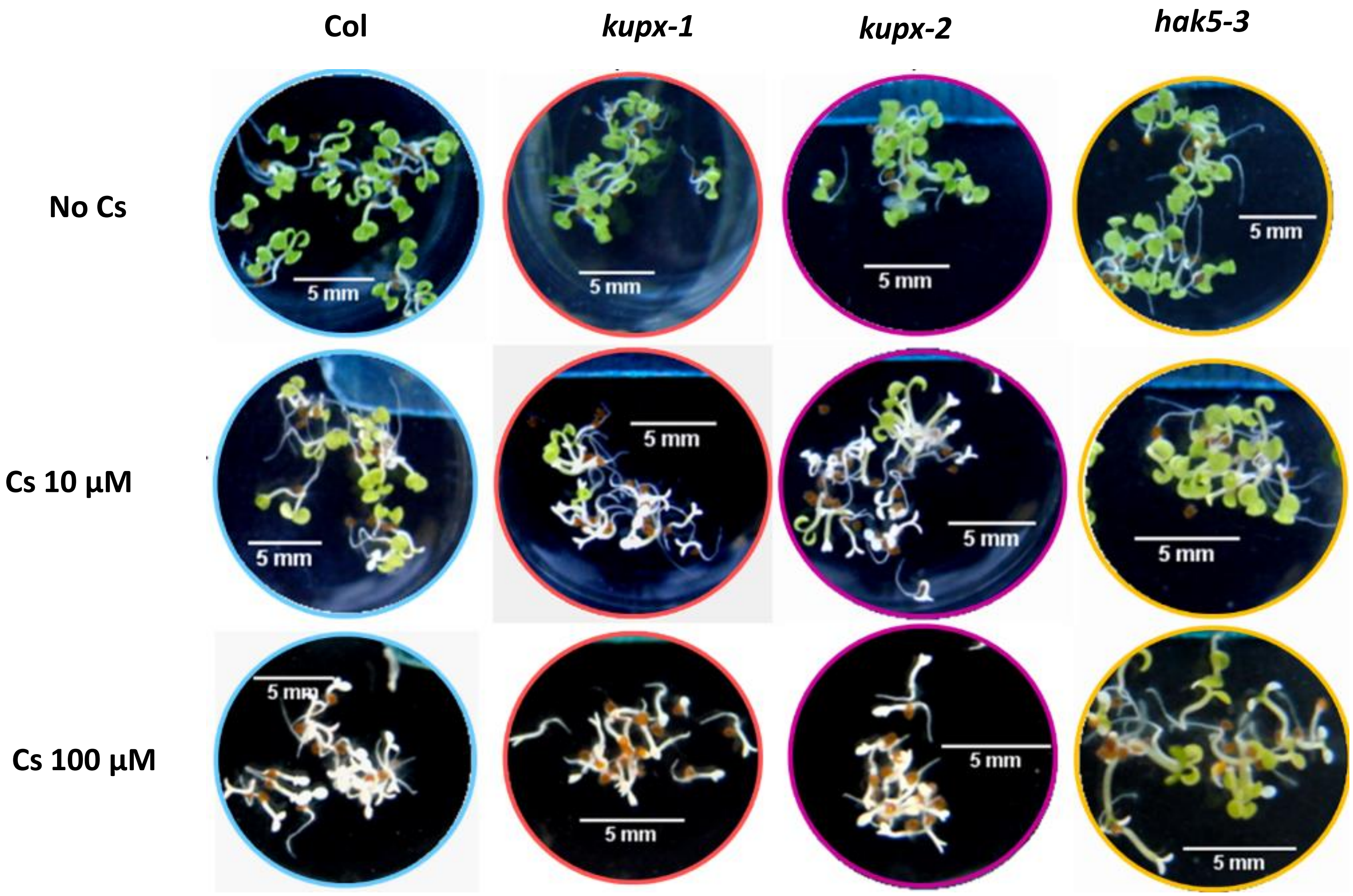
## Identification of disrupted mutants (Shakers, KUP, KEA, CHX, NHX, HKT…)




## Characterization of invalidated mutants:

- ✓ On agar plate: root lengh measurements, biomass production, chlorophyll contents…under low or high $K^+$ with/without Cs ,
- ✓ In hydroponic conditions: analyses of Cs uptake by tracer experiments, determination of $Cs^+$ and $K^+$ contents (ICP)…,
- ✓ Construction of Arabidopsis plants more efficient in Cs transport

# Strategy

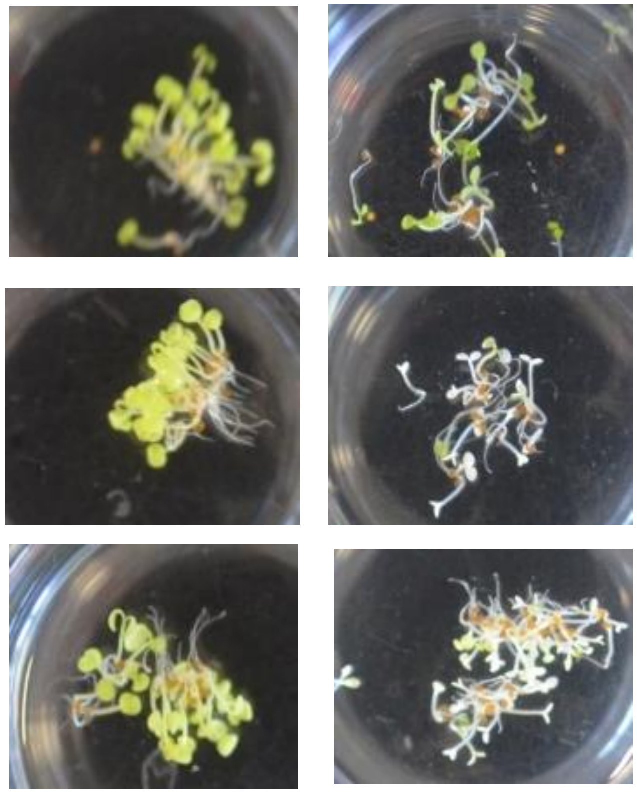


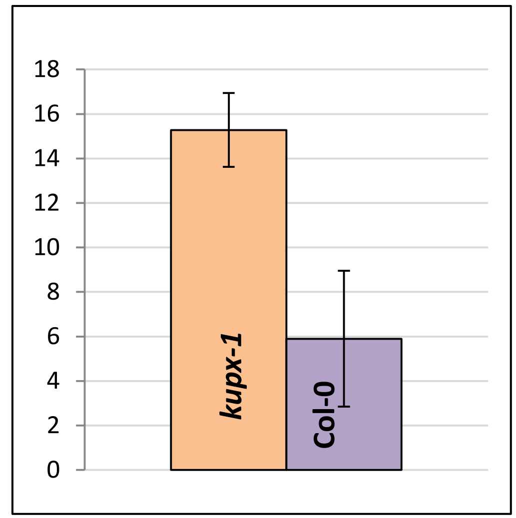
# Strategy

Col-0

*kupx-1*

*kupx-2*





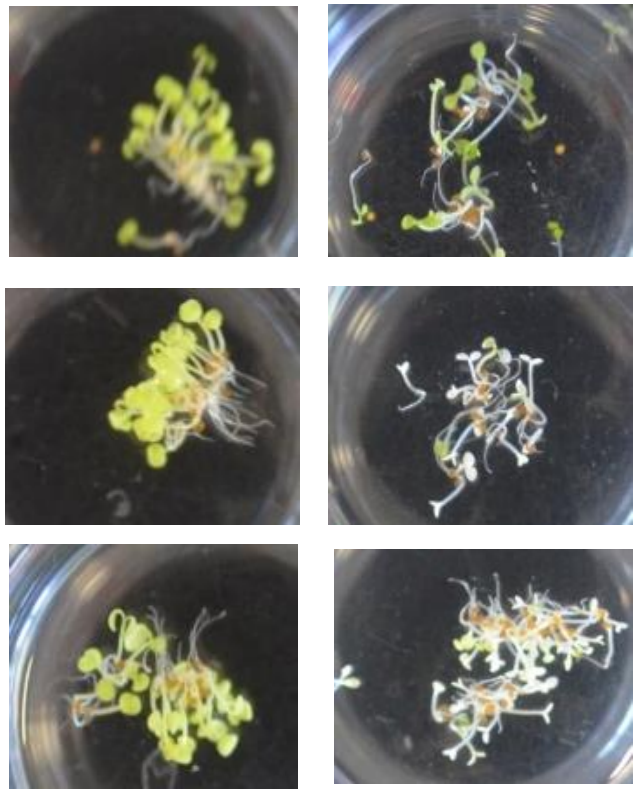

**Cs absorption**
**(nmol/g Roots FW)**

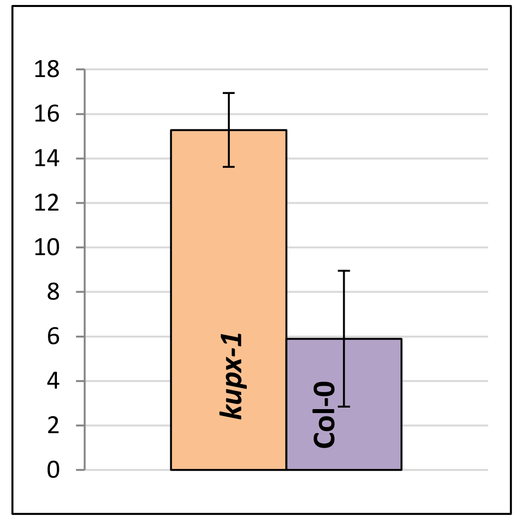
# Strategy

Col-0

*kupx-1*

*kupx-2*



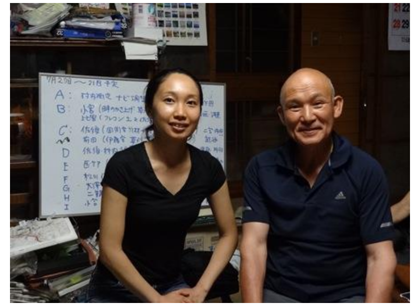



Cs absorption
(nmol/g Roots FW)

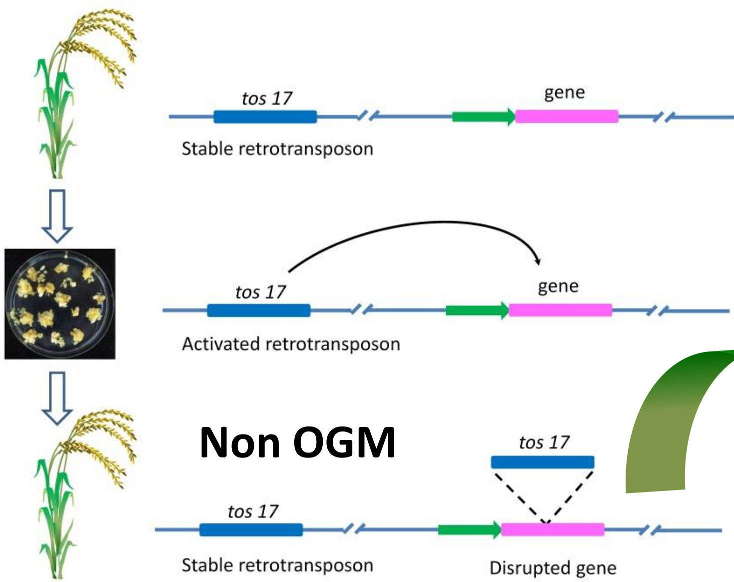
# Tests on contaminated soils

SCHOOL OF SCIENCE
THE UNIVERSITY OF TOKYO


cirad

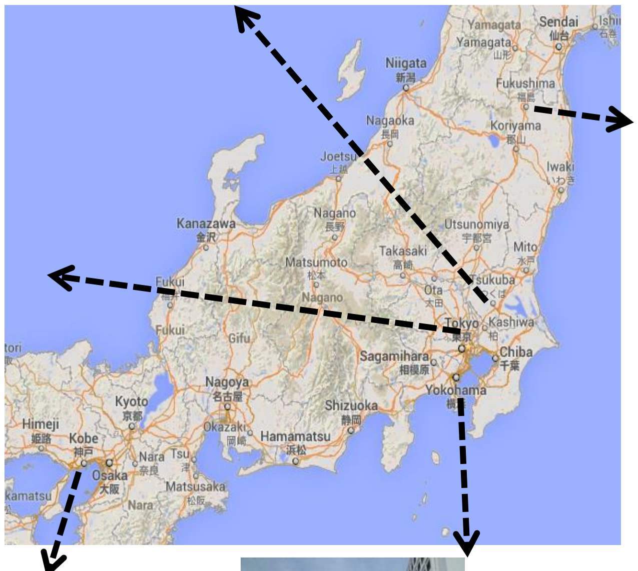


Soils from Fukushima




**National Institute of Agronomy & Environmental Sciences** (NIAES)
Dr Tomohito ARAO


**Forests & Forestry Products Reseach Institute** (FFPRI) Dr M. Taoka




**Institute of Environmental Research**
at Fukushima University

Pr Tsukada and colleagues

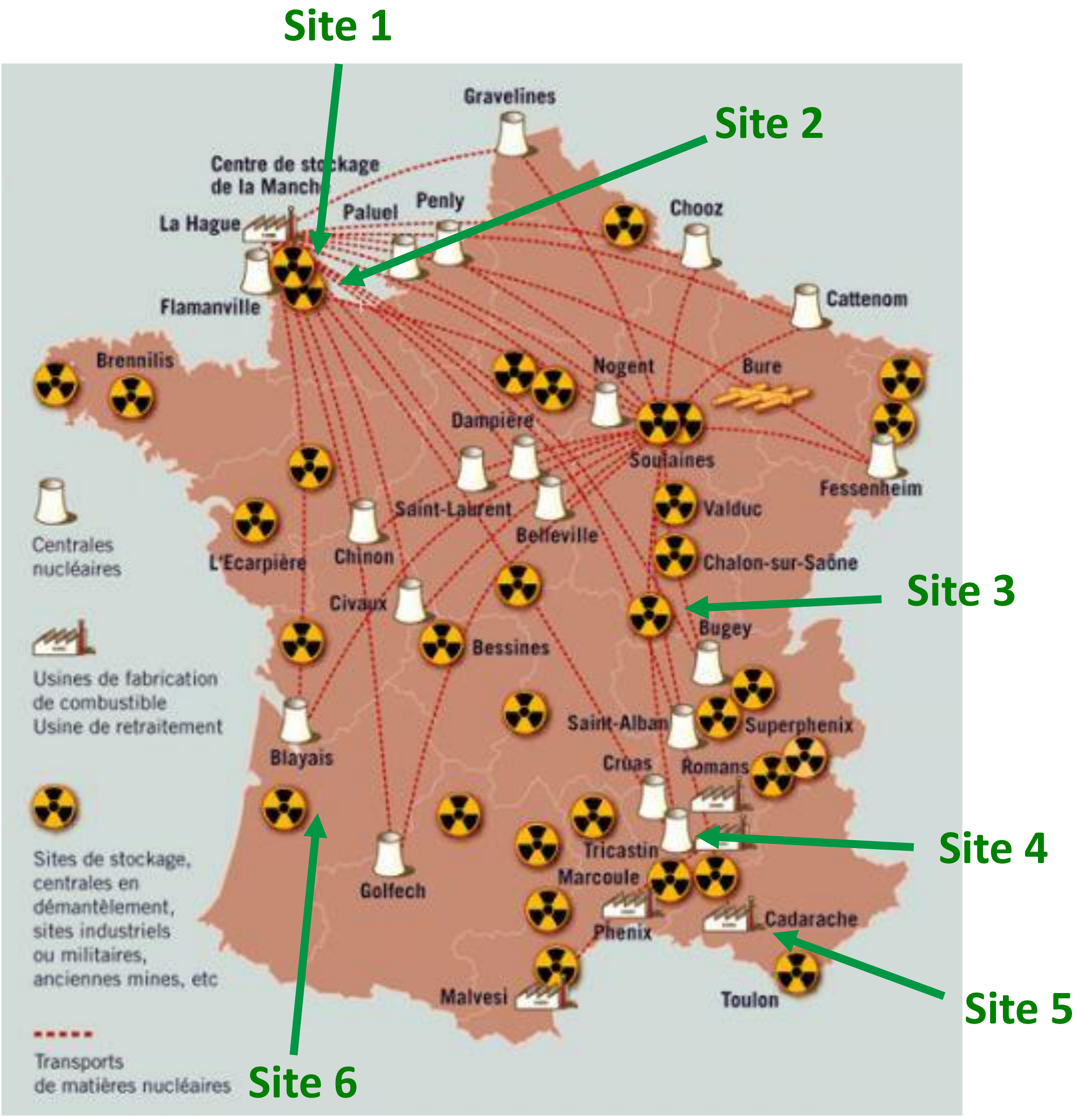
New Institute under construction


**University of Tokyo**
Pr Tomoko Nakanishi

Pr Mimura, **Kobe University**

**Riken Institute Yokohama**,
Dr Ryoung Shin

**Visit of Japanese institutes in October 2014**




# Soil Characterization

We are developing a soil collection typical of the diversity of the different nuclear sites in France, from sandy soils to those rich in clay to test the efficiency of the technologies developed in the frame of the Demeterres program

Many thanks to the French program “investment for the future”, all the contributors to the program from the different Institutes and to our partners in Japan

Many thanks for you attention, it’s so difficult after the lunch !!