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FRANCE 2030 — PROGRAMME DE RECHERCHE CARBONE ET ÉCOSYSTÈMES CONTINENTAUX

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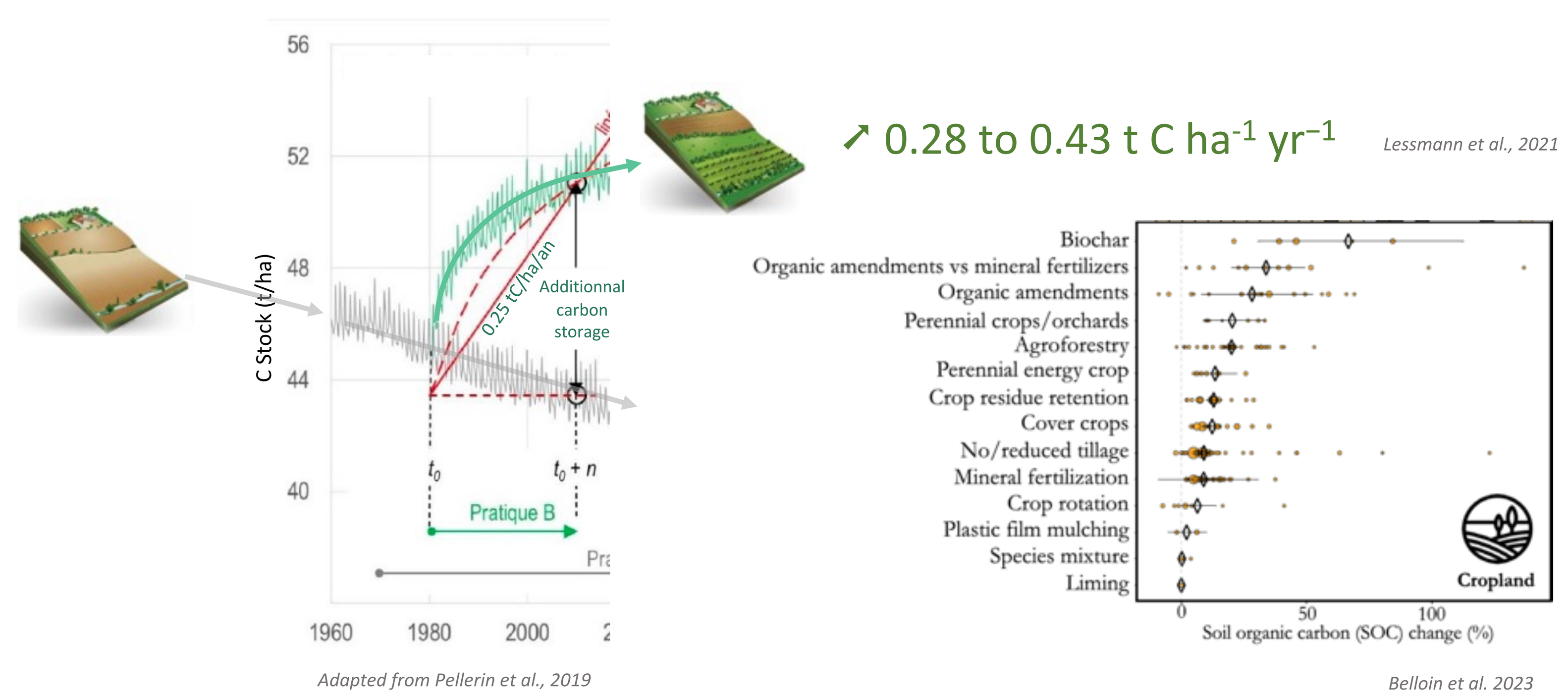
PROGRAMME DE RECHERCHE
CARBONE ET ÉCOSYSTÈMES CONTINENTAUX
FairCarboN

RhizoSeqC
Optimizing rhizodeposition to increase carbon sequestration in agrosystems

Context : Land management and C stocks



Objectives of RhizoSeqC

General objective : to **develop cropping systems** capable of combining an **increase of direct soil C inputs** and a **promotion of soil OM stabilization** while maintaining **economically attractive production** in contrasted climates

Plant level
1. to identify **the genotypes and genomic regions that promote C inputs** via rhizodeposition
2. to **understand the mechanisms** of C transfer within the plant-microbiome-soil continuum

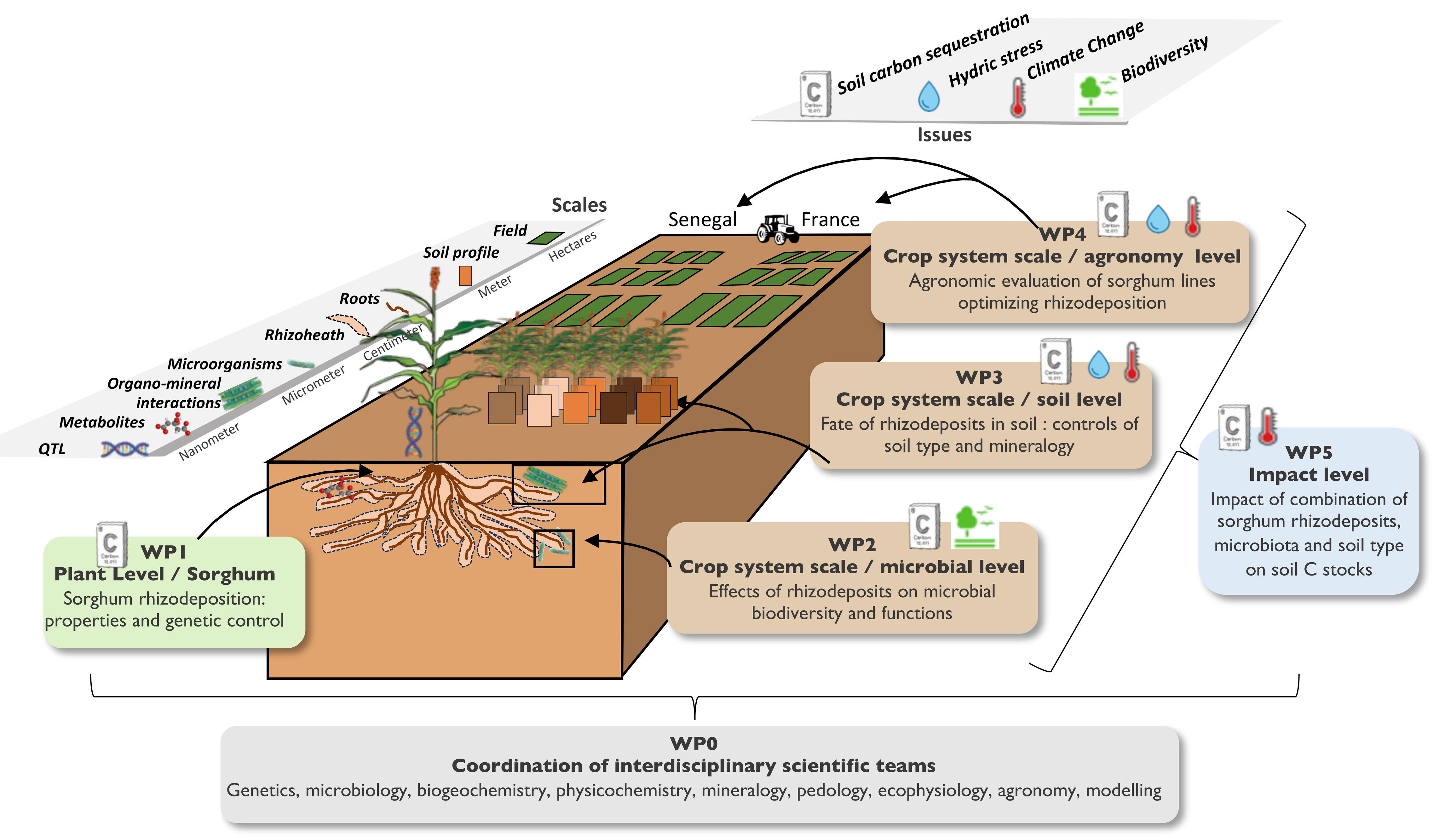
Agrosystem level
3. to **identify minerals that promote OM stabilization** by organomineral interactions.
4. to **estimate the feasibility** of implementing such cropping systems in contrasted climates

Impact level
5. to quantify additional soil carbon storage to **assess the sequestration trends in the long term**
6. to structure, on a national and international scale, a **community of multidisciplinary scientists**

Hypothesis of RhizoSeqC

Rhizodeposition through root exudation, mucilage deposition, or degeneration of root cells represents a major input of organic matter that feeds into the stable soil carbon pool by **associating with mineral phases**.

HYPOTHESIS : Genotypes selection towards increased rhizodeposition may enhance root C inputs to the soil and could therefore be a promising easy-to-implement management option for potentially increasing C sequestration



Experimental choices : sorghum

- **5th cereal** at the worldwide level
- **High biomass production** for livestock fodder / also used for food (staple food for 300 M°)
- **Mainly produced in Africa** (27 Mha), but sorghum value chains are also **developed in Europe**
- **High water deficit tolerance** : plant of major agricultural interest in a context of climate change
- **Relevant « Elite » genetic materials** : backcross-nested association mapping (BCNAM) populations *(Garin et al., 2024), public-private collaborations*
- **A first study** showed plasticity of root hair and rhizosheath traits (only for for 2 genotypes) *(Adu et al. 2023)*
- **Large variability of rhizosheath traits expected** according to results achieved in pearl millet *(Ndour et al., 2017, 2020, 2021, 2022)*

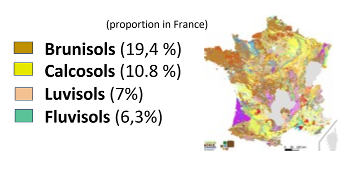
Sorghum BCNAM trial established in 2014

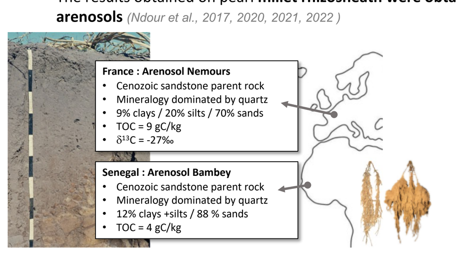
BCNAM Populations and trials in Garin et al., 2024
2,000 individuals developed in the framework of the Biomass For the Future (BFF, PIA4) program

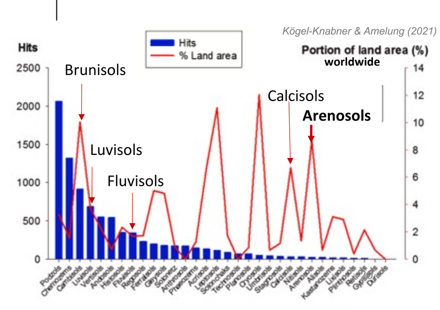
Experimental choices : soils

Arenosols :

- **4th major soil type** (8.5% of land area), notably African areas under high food pressure *(FAO-GIS, 1998)*
- Surprisingly, **poorly studied** *(Kögel-Knabner & Amelung, 2021)*
- Low C content / C stocks highly impacted by land-use change / correlated with **high C deficit** *(FAO-GIS, 1998) (Quero et al. 2022)*
- Arenosols (not aggregative and C poor) are relevant precisely because they are **favourable conditions for revealing (1) the differential aggregative** behaviour of sorghum lines and **(2) the capacity for C stabilisation** by added mineral phases.
- **Expertise** of the teams on arenosols (Senegal, France)
- The results obtained on pearl **millet rhizosheath were obtained on arenosols** *(Ndour et al., 2017, 2020, 2021, 2022)*







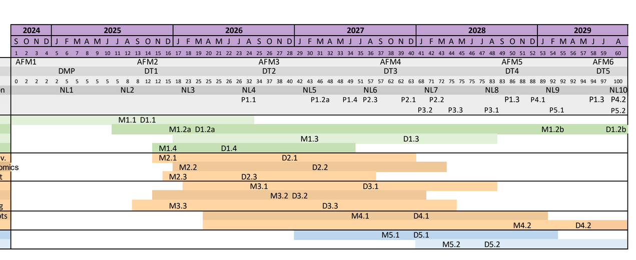
Organization of the partnership

BIAM *(W. Achouak WP2)* — WP1, WP2, WP0
- *rhizosheath phenotyping*
- *rhizosphere microbiota*
- *plant microbe interaction*
- *phenotyping labeling with stable isotopes*

DIADE + ISRA & CERAAS *(L. Laplaze WP1, WP4)* — WP1, WP4, WP0
- *ecophysiology*
- *field phenotyping*
- *root development interaction with soil microorganisms*

ECO&SOL + INRAE APC *(L. Cournac WP4)* — WP1, WP3, WP4, WP0
- *Rhizosheath phenotyping*
- *composition and function of rhizosphere microbiome*
- *field trials in Senegal*
- *development of low-tech indicators*

CEREGE *(I. Basile-Doelsch WP3)* — WP3, WP0
- *C dynamics in soils*
- *mineralogy*
- *physicochemistry*
- *micro and nano-scales*



AGAP *(D. Pot)* — WP1, WP4
- *Population genomics of sorghum*
- *sorghum phenotyping*
- *quantitative genetics*
- *Genetics and ecophysiological modelling*

ECOSYS *(F. Rees)* — WP1
- *measurements of rhizodeposition*
- *root architecture*
- *mechanistic plant-soil modelling*

ENS-PARIS + ECOTRON *(S. Abiven)* — WP3
- *dynamics of organic matter*
- *isotope labelling*
- *radiocarbon*

BEF *(D. Derrien WP5)* — WP5, WP0
- *soil C dynamics modeling*
- *priming effect mechanisms*
- *C turnover*
- *prospective approaches for ecosystem services*

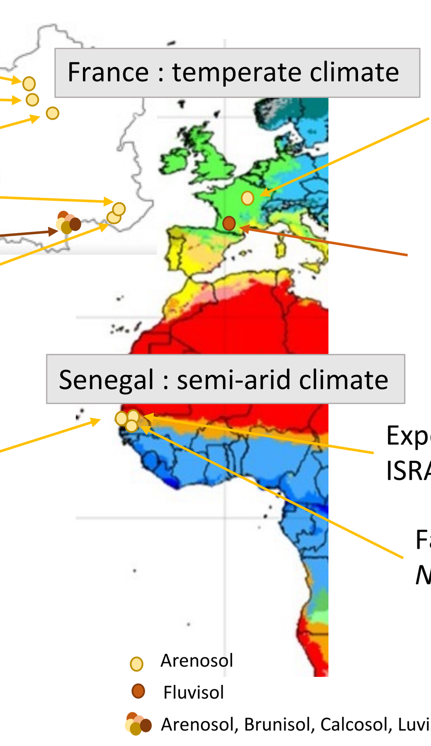
ECODIV (L. Henneron) — WP2, WP5
- *field experiments*
- *combinations of $^{13}C/^{14}C$*
- *priming effect mechanisms*
- *isotopic pool dilution (IPD)*
- *soil N cycling processes*

LSCE *(C. Hatté)* — WP5
- *isotopic geochemistry ^{13}C ^{14}C*
- *method of cross-calculation of isotopic ^{13}C and ^{14}C mass*
- *quantify C stocks and priming effect*

North / South experiments

Lab experiments WP1, WP2, WP3

Field experiments WP4, WP5



Experimental site : CEREEP ECOTRON, *Nemours*

Experimental site : INRAE UE APC, *Auzeville*

Experimental site : ISRA- *Bambey*

Farmers *Niakhar*

Sorghum BCNAM trial established in 2014