

Tailoring Superior Alleles for Abiotic Stress Genes for Deployment into Breeding Programs: A Case Study Based on Association Analysis of *Alt_{SB}*, a Major Aluminum Tolerance Gene in Sorghum (ALTSORGHUM)

Embrapa Maize and Sorghum
- Brazil -

INRAN
- Niger -

IGD (Cornell Univ.)
- US -

USPSNL (USDA - ARS)
- US -



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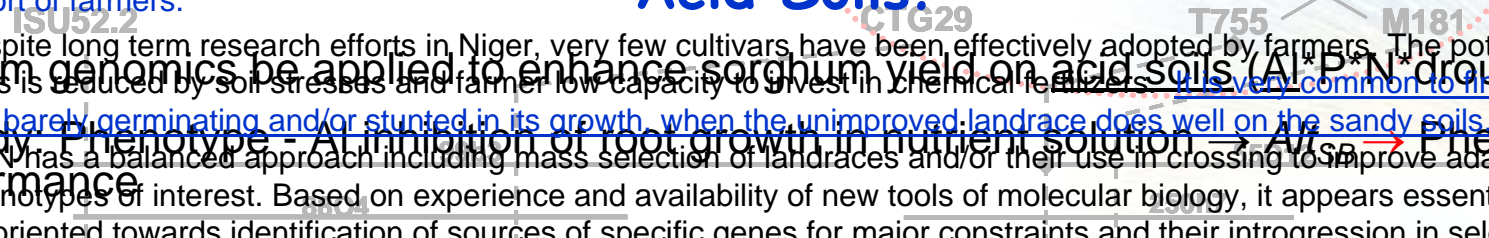
Can the Deployment of Superior Alleles for Al^{3+} Tolerance, a Major Aluminum Tolerance Gene in Sorghum Impact Yield in Sorghum Cultivated on Acid Soils?

In Niger a significant portion of the Sahelian farmers grow crops with a drought tolerance phenomenon. Soils are usually very sandy and low in nutrients, especially phosphorus. The productivity of sorghum in such systems is very low but most of the alleles are not adopted. Farmers do not have access to modern inputs and use intercropping as a strategy to reduce risks of crop failure. With the level of poverty in these areas, finding more resilient cultivars with enhanced productivity is the major goal for research in support of farmers.

Despite long term research efforts in Niger, very few cultivars have been effectively adopted by farmers. The potential of many improved varieties is reduced by soil stresses and farmer low capacity to invest in chemical fertilizers. It is very common to find on farm an improved cultivar barely germinating and/or stunted in its growth, when the unimproved landrace does well on the sandy soils.

The breeding program at INRAN has a balanced approach including mass selection of landraces and/or their use in crossing to improve adaptation and grain yield for other phenotypes of interest. Based on experience and availability of new tools of molecular biology, it appears essential that cultivar improvement be oriented towards identification of sources of specific genes for major constraints and their introgression in selected landraces or other elite cultivars.

Breeding for sorghum with enhanced tolerance to aluminum (Al) toxicity is likely to improve overall crop performance through better root growth, nutrient acquisition (especially P), and drought tolerance.



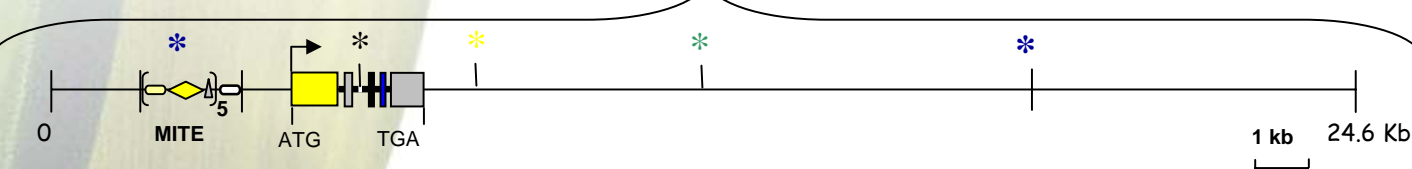
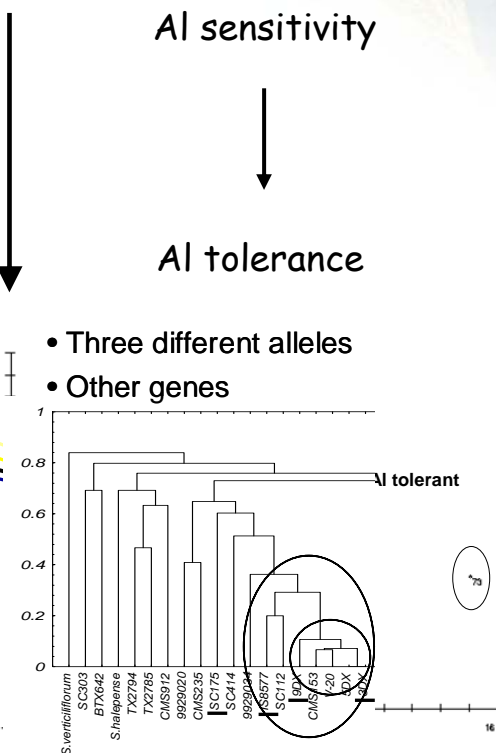
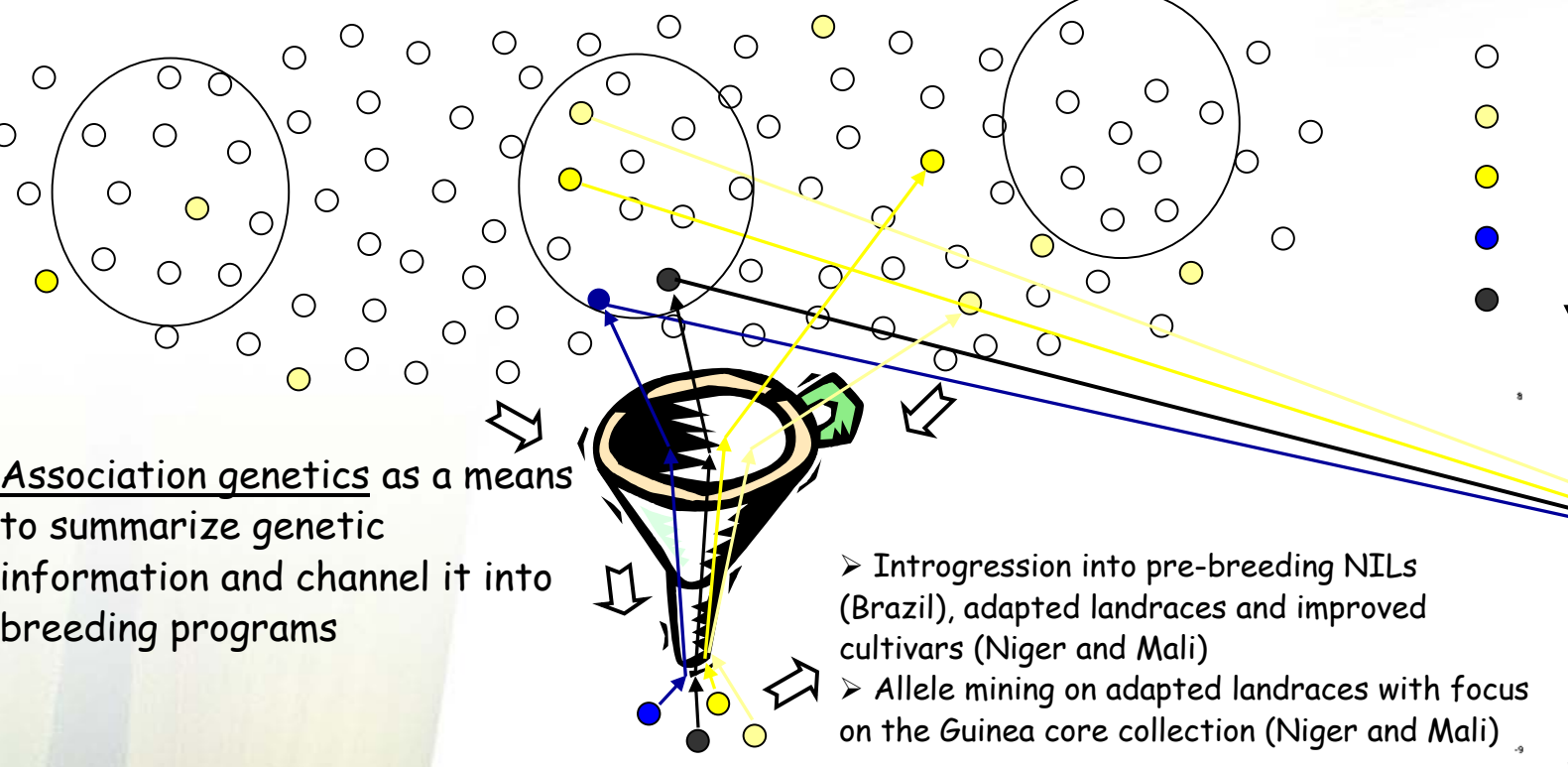
Issoufou Kapran (INRAN)



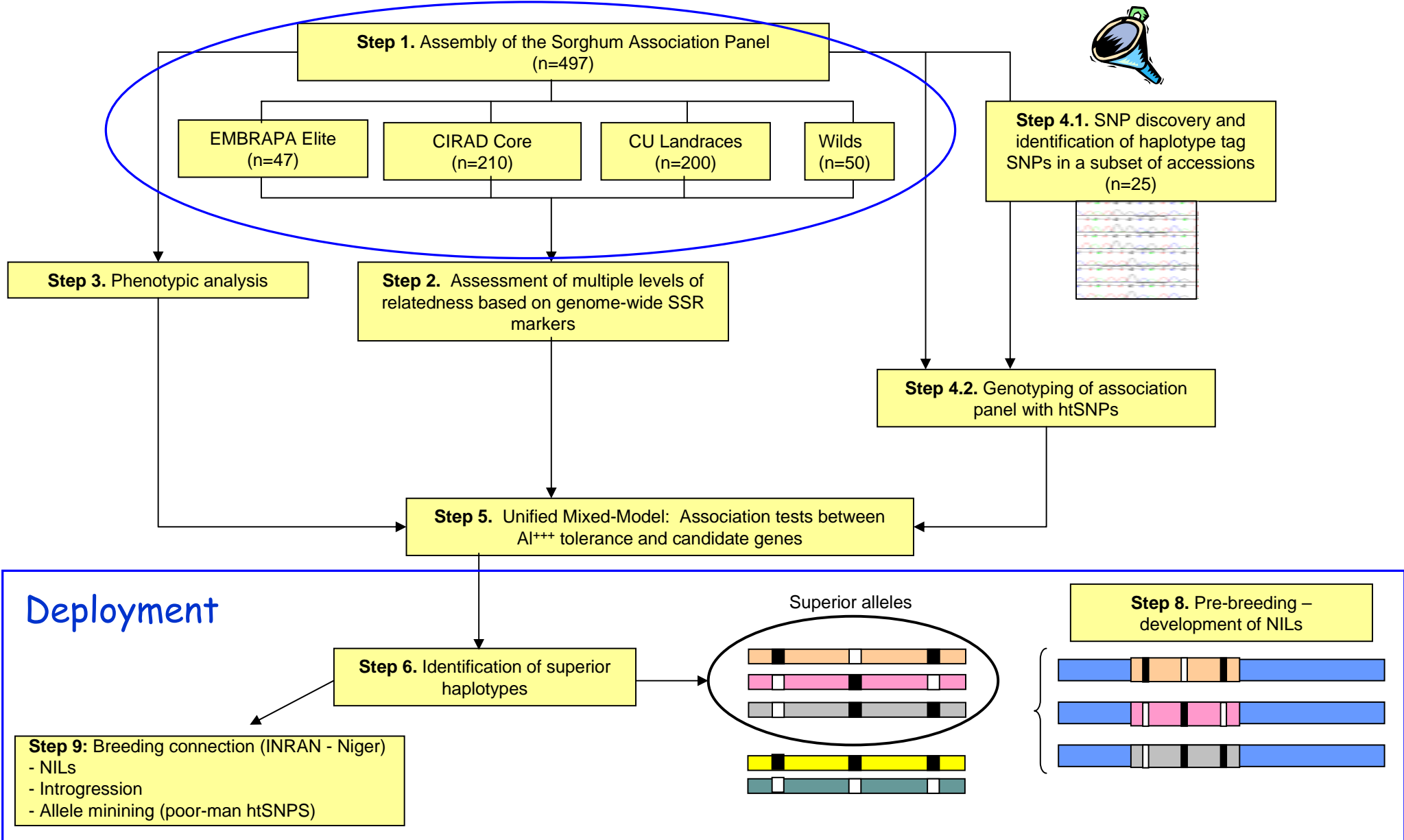
Rationale and Deployment Strategy

Working hypothesis: a thorough scan into the sorghum genetic diversity can be used to identify 'superior' Alt_{SB} haplotypes ('molecular versions' in different lines) to find breeding ideotypes

- Association analysis can be used to define the molecular make-up of these ideotypes,
- Ideotypes can be tagged by an easy-to-use marker system and introgressed into pre-breeding NILs
- The breeding value of these ideotypes can be assessed in acid soil conditions by an adequate strategy
- Field-validated ideotypes can be efficiently deployed into sorghum breeding programs

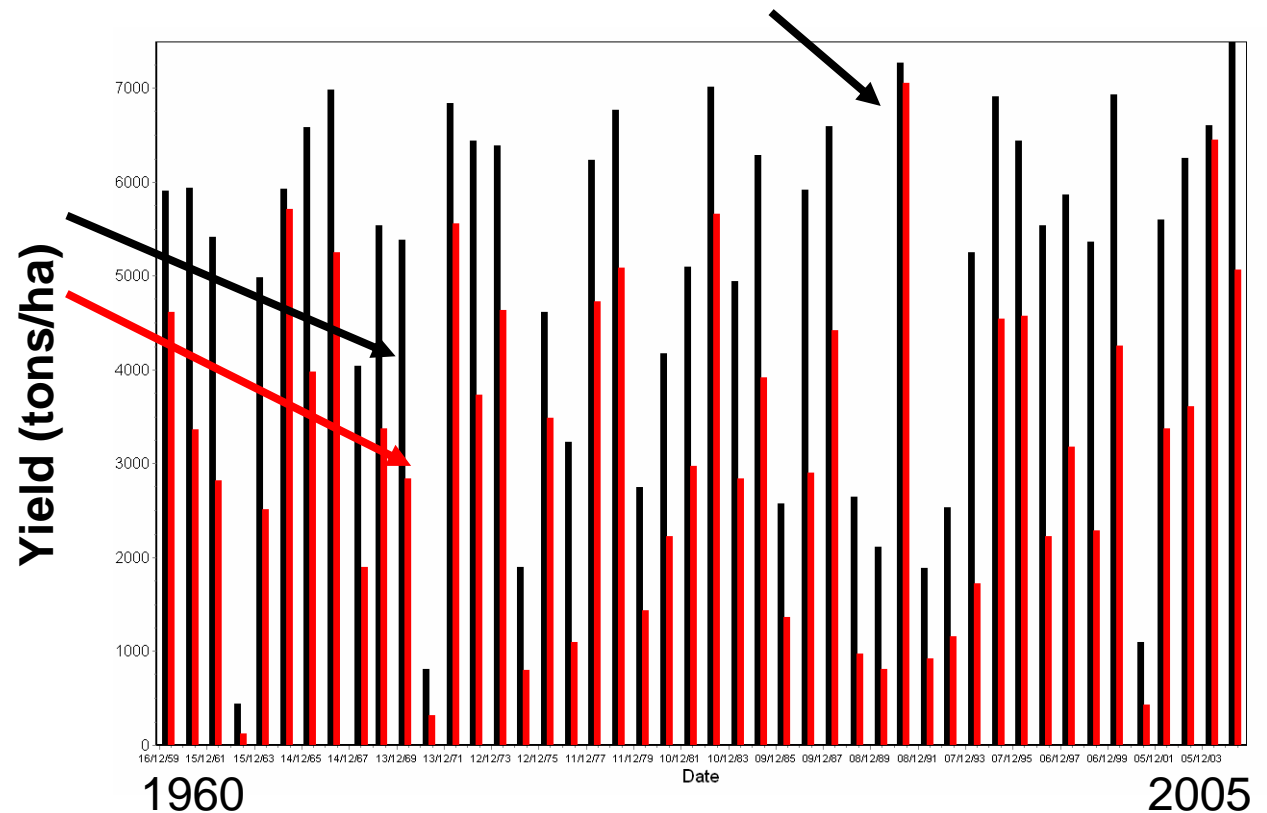


ALTSORGHUM Activities



Simulated Sorghum Yields in Safrinha Season (Scott Chapman – CSIRO)

- 40 years of weather data for Sete Lagoas
- Al-tolerant (90 cm roots) vs. sensitive (30 cm)
- Similar yields in 'good rainfall' years (1991)
- Drought stress in average years
 - 5000 kg/ha tolerant
 - 2500 kg/ha sensitive
- Shows interaction of rainfall amount and distribution on yield



Link with Other Projects

- **Concept Note** (Assessment of the breeding value of superior haplotypes for Alt_{SB} , a major Al tolerance gene in sorghum: linking upstream genomics to acid soil breeding in Niger and Mali (ALTFIELD) – Bob Schaffert (PI)
- **Fred van Eeuwijk and Scott Chapman:**
 - multi-trait (exploring genetic correlations between traits) and multi-environment (Africa and Brazil) analysis for performance of selected Alt_{SB} haplotypes (haplotypexE).
 - multi-trait analysis to assess the impact of Al tolerance on acid soil performance (drought: 1 dryland site vs 2 irrigated sites).
 - Spatial Analysis to account for fertility heterogeneity within field testing sites.
 - 'phenotypic integration' of different association panels into one unified set.

Data Format and Release

- Public database for sharing molecular marker information, including summary statistics tables and matrices of population structure and relatedness.
- Aluminum tolerance data for the association panels and related material (tables)
- Detailed physiological and molecular data for selected haplotypes (tables, charts etc)
- Sequence data (FASTA) for selected haplotypes and haplotype tagging-markers
- Field performance data for NILs and converted germplasm.
- Information related to the field testing sites (semi-variograms, etc).

Release: IGD database provisionally (<http://cbsuss03.cs.cornell.edu/sorghum/index.html>), then PANZEA database, and GCP database

