IMPROVING DROUGHT TOLERANCE IN SORGHUM IN AFRICA

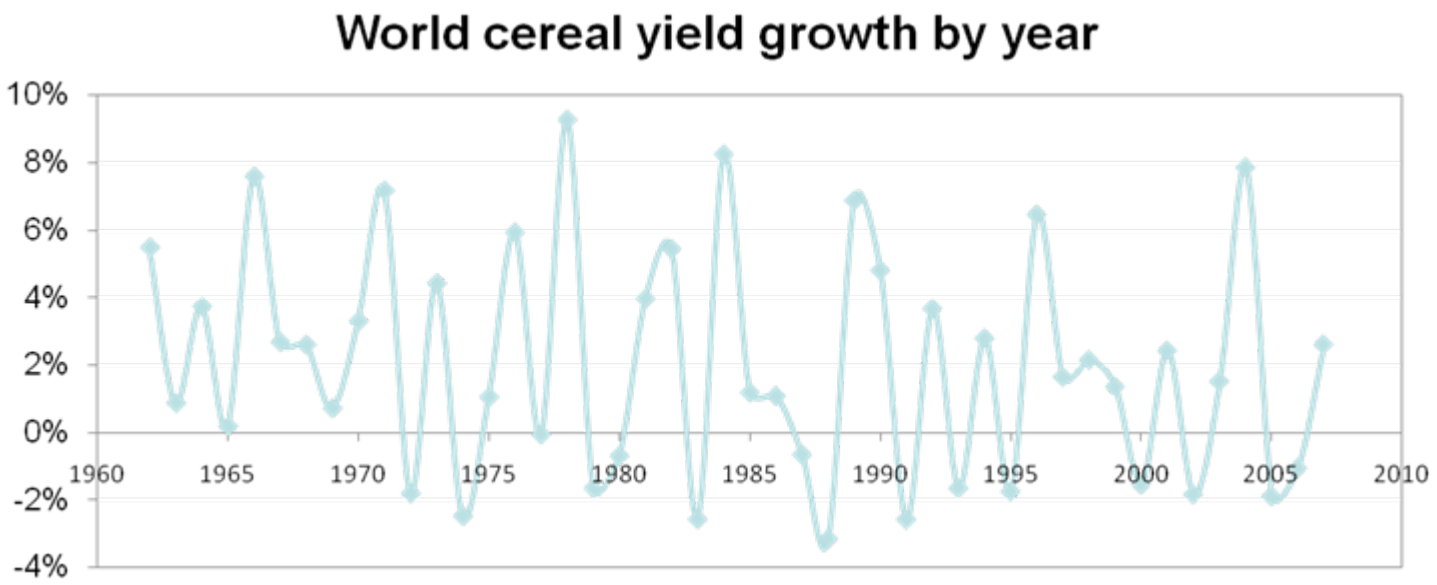
ARM 2009

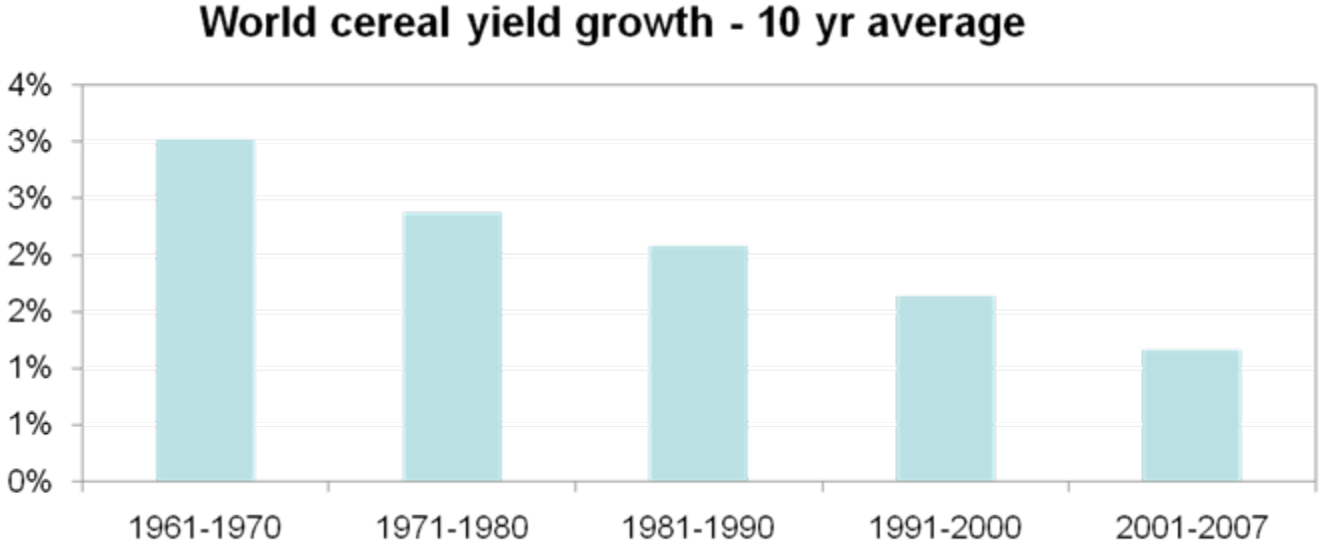
CHALLENGE INITIATIVE: SORGHUM CI

SEPTEMBRE 2008

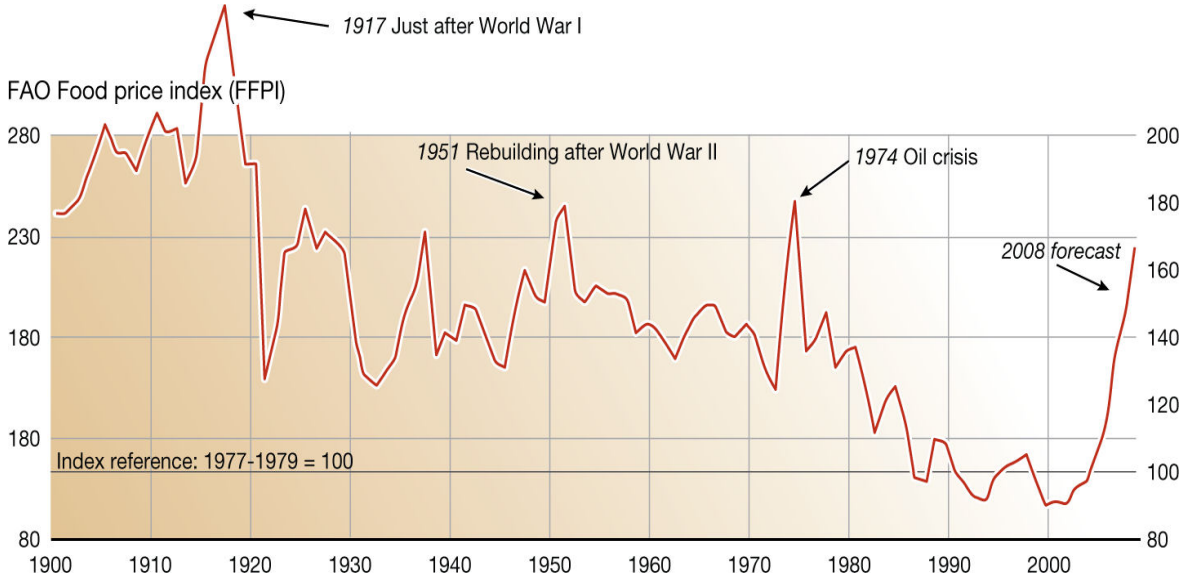
Dr Oumar NIANGADO, PDC/SORGHUM CI

Challenge, opportunity (I): Growing food

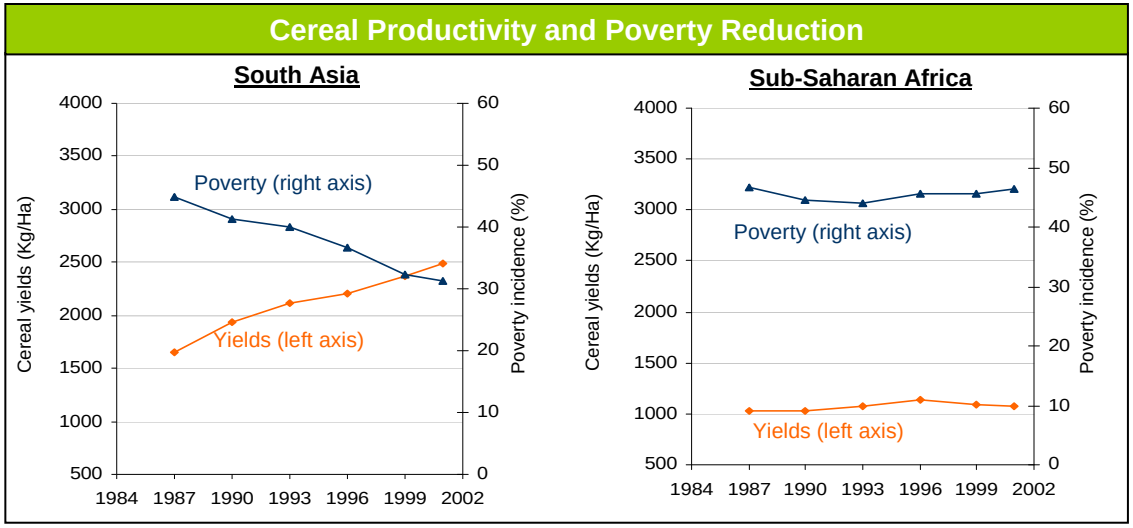




Challenge, opportunity (II): Improving food security



Fulfil consumer aspiration of cheap food.



Reduce poverty through agricultural productivity growth.

The DT tolerance in Sorghum for Africa CI

A balanced portfolio of activities:

•Discovery and development of alleles contributing to sorghum drought tolerance

•Phenotyping sorghum reference set for drought tolerance

•Improve sorghum productivity in semi-arid environments of Mali through integrated MARS

•Development and evaluation of drought-adapted sorghum germplasm for Africa and Australia

A new integrated project developped in March 2009 during CI workshop:

Development of drought tolerant sorghum for Africa by a Backcross-NAM approach

An integrated program for development of improved sorghum germplasm that balances local agronomic and grain quality preferences with incorporation of well-characterized drought adaptations and exploration for cryptic valuable alleles

Development of drought tolerant sorghum for Africa by a Backcross-NAM approaches

3 Components:

COMPONENT 1: the population development

➢**Objectives**: to produce experimental materiel with enlarged genetic basis in a farmer preferred adapted background, identify key genomic regions that accounts

COMPONENT 2:the genotyping component

➢ **objectives**: identify key genomic regions that accounts for performance in target environments in the genetic background of the adapted parent

COMPONENT 3: the phenotyping component

➢**Objectives**: to characterize the environment (climate and soils) of the target region, to phenotype parental lines and reference set in key target environments within each country; to evaluate BCNAM lines develped in each target country, ti enhance irrigation facities where appropriate

TARGET COUNTRIES

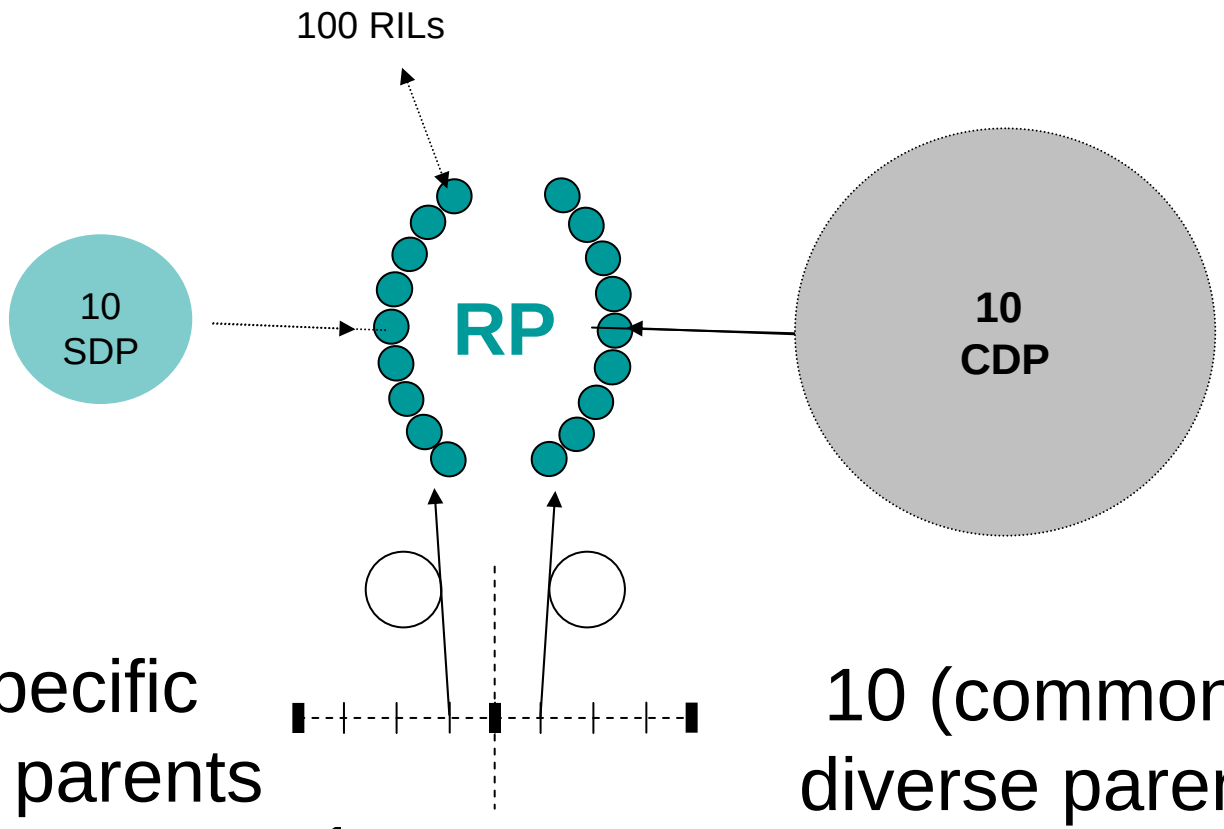
WEST AFRICA:

Mali : 2 Sites:

- In the sahelian zone: Bema station or Cinzana research station
- In the savannah zone: Sotuba research station

EST AFRICA:

- **Ethiopia**: sites and activities not yet precise



10 specific donor parents

1 recurrent parent

10 (common) diverse parents

Back-Cross Nested Association Mapping population

RP	x (10 SDP	+	10 CDP)
a	x (Sa1 … Sa10	+	C1 … C10)
b	x (Sb1 … Sb10	+	C1 … C10)
c	x (Sc1 … Sc10	+	C1 … C10)
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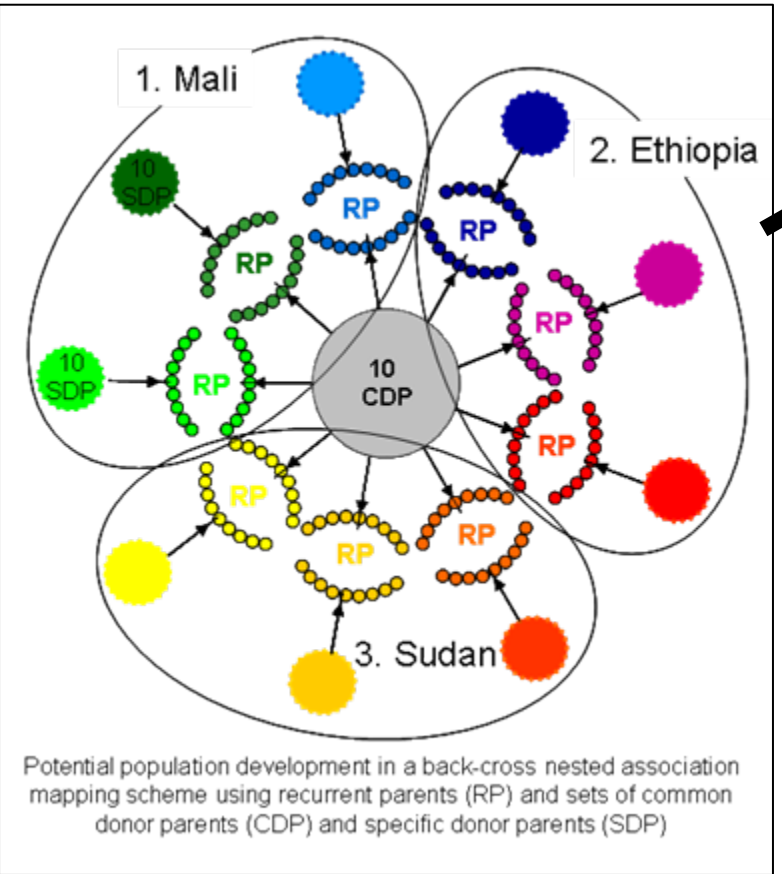
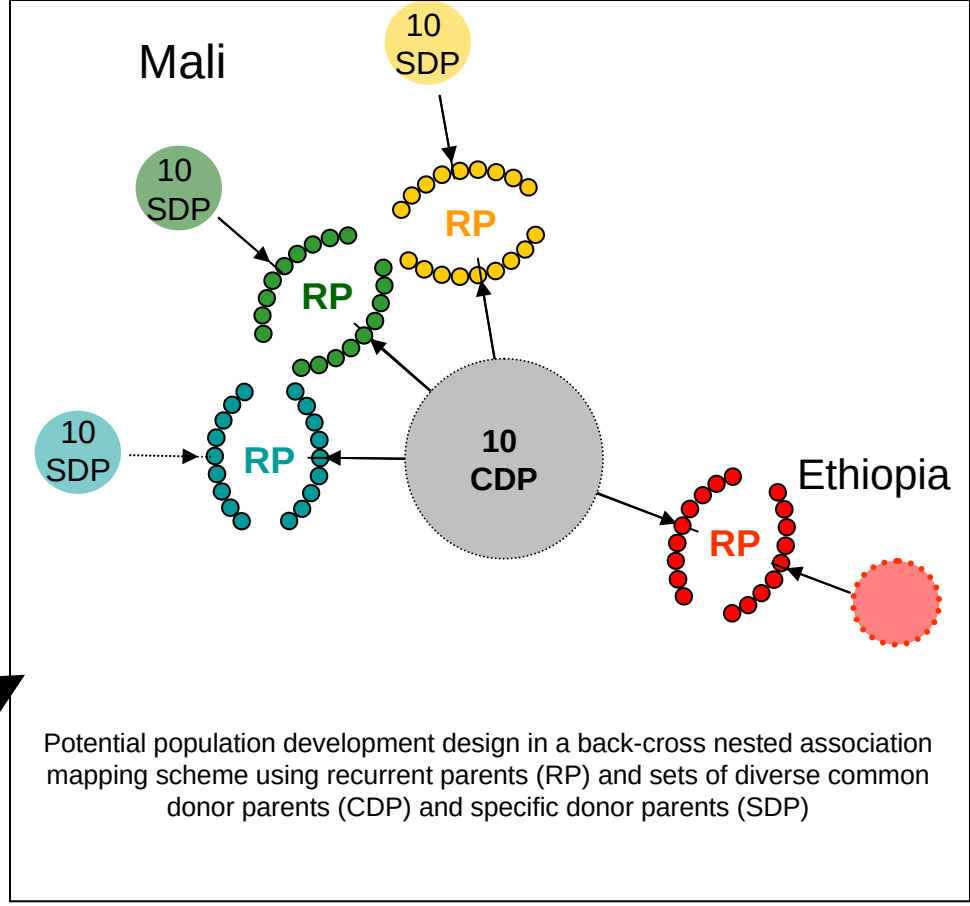
9 RP	**90 SDP**		**10 CDP**



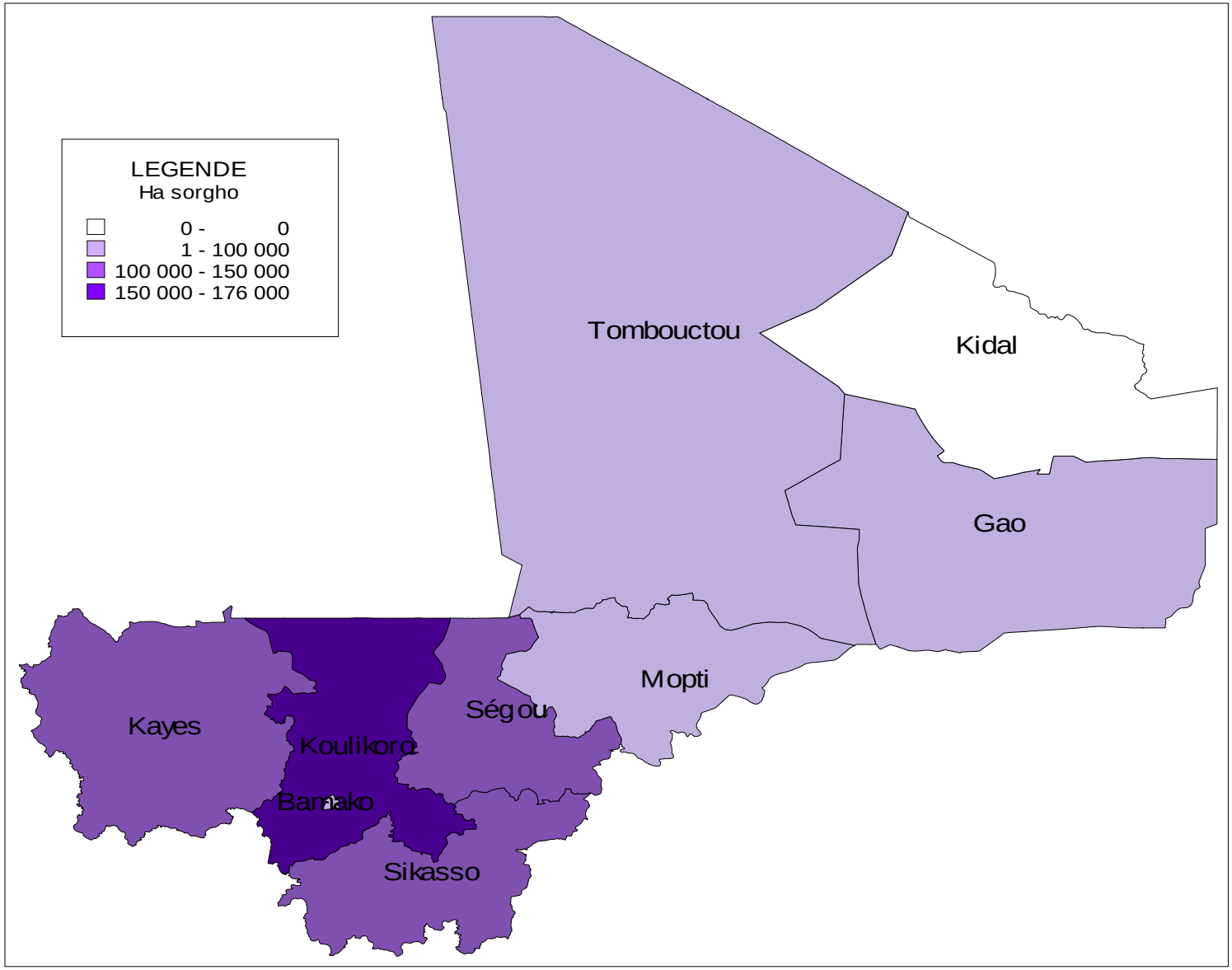
Potential population development in a back-cross nested association mapping scheme using recurrent parents (RP) and sets of common donor parents (CDP) and specific donor parents (SDP)



Potential population development design in a back-cross nested association mapping scheme using recurrent parents (RP) and sets of diverse common donor parents (CDP) and specific donor parents (SDP)

Necessity to focus and adjust the budget

SORGHUM PRODUCTION BASSIN IN MALI



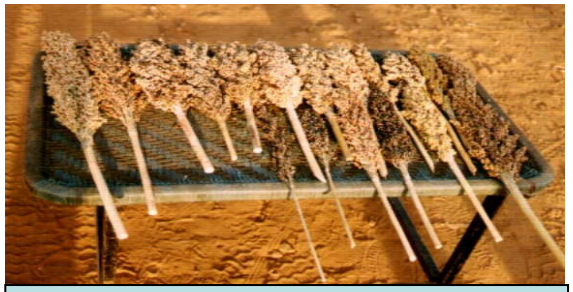
Cultivated sorghum diversity in Mali

Race guinea

- Most important race founded every where highly in the savannah and guinea zone
- Loose panicle with small grain, vitreous to soft, good for making a tô (most important meal in the savannah and Guinea rural area)
- Mostly photoperiod sensitive, with some early accessions in the sahelian zone
- Good adaptation, generally grown without any mineral fertilizer (only farm manure is used)

Race dura

- Most important race in the sahelian zone
- compact panicle, big grain size, good to make a "couscous" most important meal in the sahelian zone
- Mostly photoperiod sensitive, well adapted to the sahelian zone , generally grown without any mineral fertilizer (only farm manure is used)
- Tested in the savannah zone durra race varieties are highly infested by head bug, grain mold

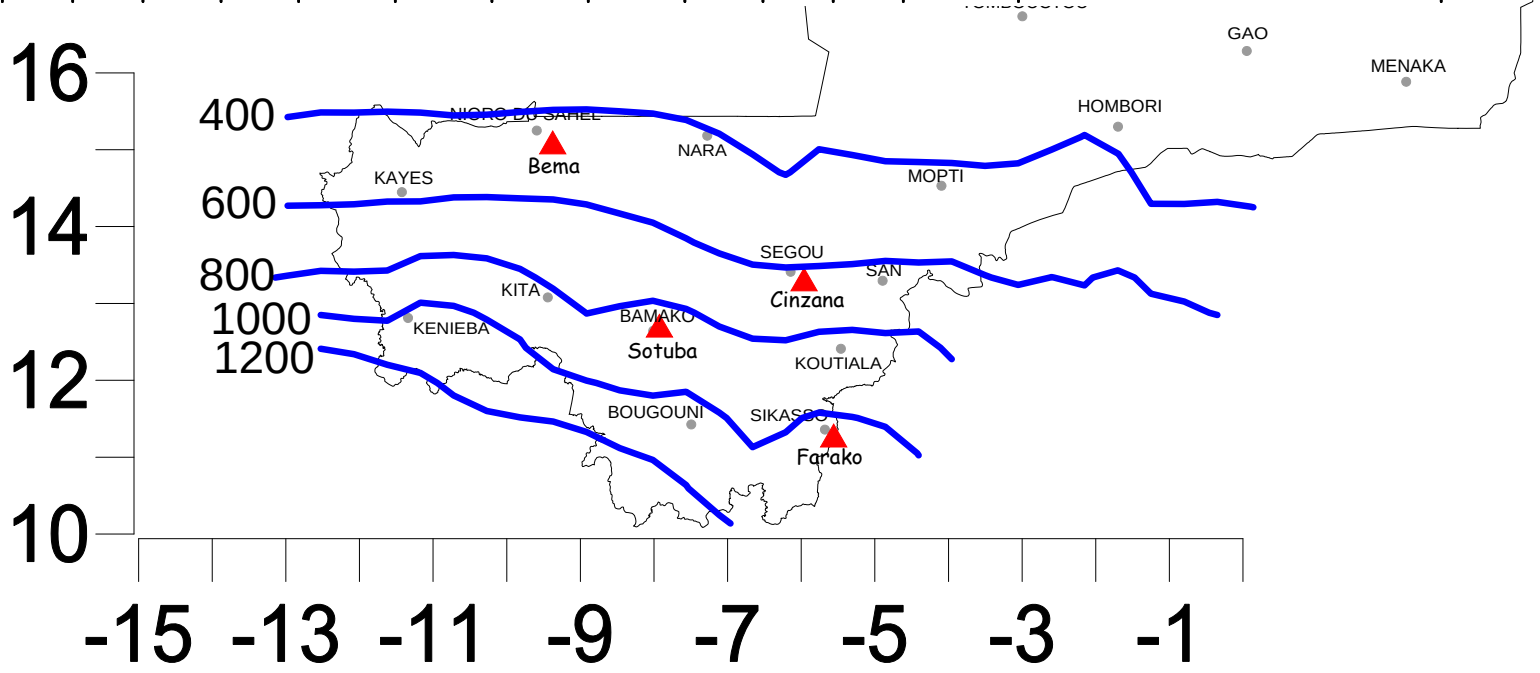


Race caudatum

- Race introduced in some area in the sahelian zone in the sixties
- Important race in many breeding programmes for his high yield potential
- semi-compact panicle, grain with medium size
- Mostly photoperiod insensitive, parent for many breeding Some time infested by head bug, grain mold

Climatology of the studied locations

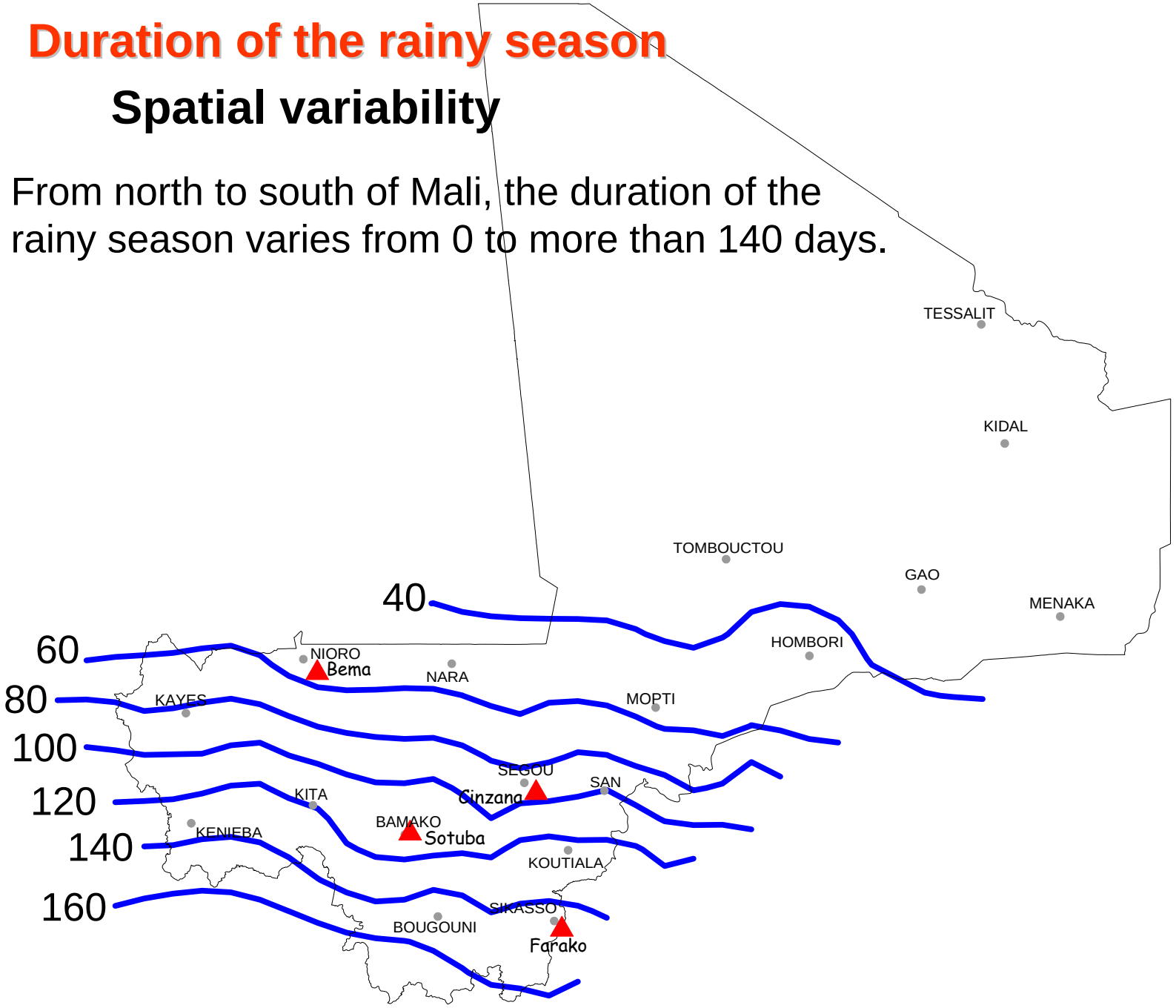
Location	J	F	M	A	M	J	J	A	S	O	N	D	rain	rainy season Onset	rainy season End	rainy season Duration
NIORO	0	0	0	2	8	41	104	150	84	23	1	1	417	26/07	12/09	48
CINZANA	1	0	2	13	37	91	188	204	115	29	1	0	681	23/06	26/09	95
SOTUBA	1	1	2	17	51	120	215	275	151	51	1	0	884	07/06	08/10	124
SIKASSO	2	3	8	40	97	149	228	286	197	78	8	0	1089	17/05	15/10	151



Duration of the rainy season

Spatial variability

From north to south of Mali, the duration of the rainy season varies from 0 to more than 140 days.



PRINCIPAL INVESTIGATOR AND LEADING INSTITITUONS

➢**MALI**

✓**component 1:**

- Principal investigator: Michel Vaksmann (CIRAD/IER)
- collaborating scientists and institutions: C.Tom Hash (IC/India), Jean François Rami (CIRAD), Abdoulaye Diallo (IER/Sotuba), Aly Aboubacar (IER/cinzana), David Jordan (QDPI/Australia) , Niaba Témé (IER/Souba)

✓**Component 2**

-Principal investigator: Andy Paterson (Univ GA); S. Kresovich (cornell); Co-PI: C. Tom Hash (IC/India), D. Pot (Cirad/France)
-Collaborating scientist and institutions: idem component 1)

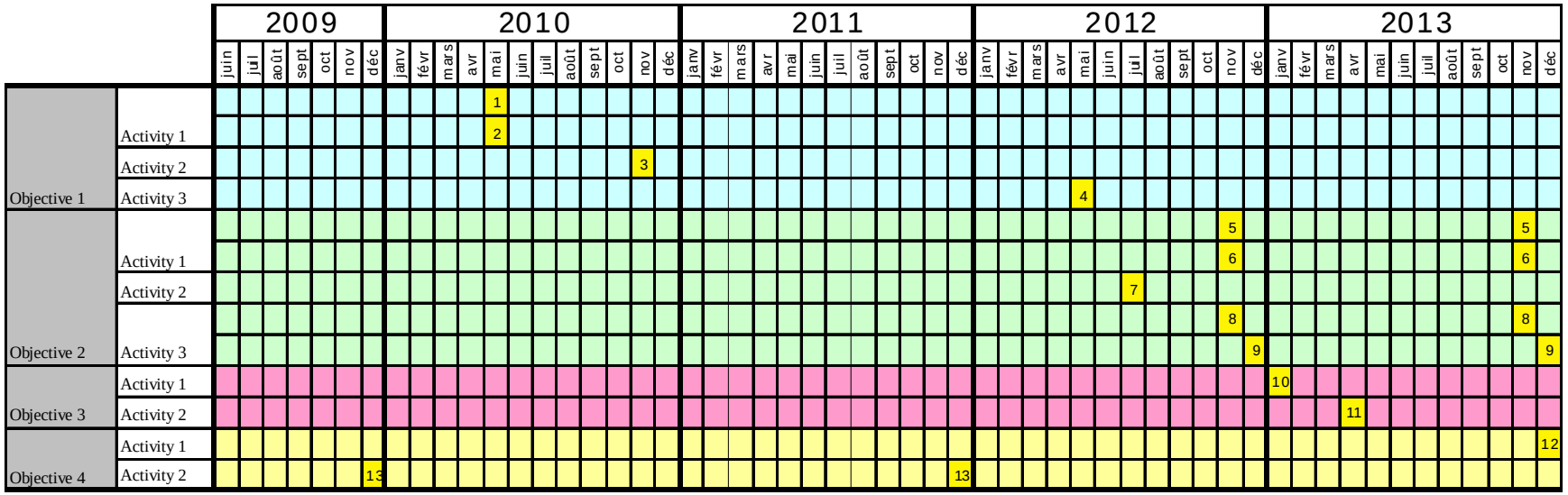
✓**Component 3**

-Principal investigator: Niaba Témé (IER/Sotuba)
-Collaborating scientists and institutions: Hari Upadhyaya (IC/India) Michel Vaksmann(IRAD/IER), Mary Mgonja (IC/Kenya), Joshua Saranga (HUJ/Israel), Andy Borrell (QDPI/Australia)

➢**ETHIOPIA**

Activities and Sites not yet defined

1. Population development



Quantifiable Outputs (cut and paste from Appendix A):

1. A set of 4 Elite RP and 10 CMP well genetically characterized and stabilized.
2. A set of 40 documented SMP, genetically stabilized
3. *ms3* versions of 4 Elite parents targeting a specific environment
4. 80 BC1F4 populations of 100 individuals selected for local adaptation
5. Multi environmental dataset for standard breeding characterization (yield components, maturity, height, etc.)
6. Specific phenotyping dataset on key secondary traits
7. Genotypic dataset for 8000 individuals
8. High performing lines (yield, drought adaptation) identified in each populations to be involved in advanced evaluation programs for further multi site evaluation.
9. Key genomic regions involved in yield components and drought adaptation identified
10. A set of high performing lines identified as parents for a multi-allelic MARS design
11. F1 seeds available for MARS design
12. 3 PhD students trained
13. 40 regional scientists trained

ACTIVITIES & MILESTONES FOR THE POPULATION DEVELOPMENT

2. Phenotyping

		2009							2010											2011											2012											2013						
		Jul	Jui	Ao	Sep	Oc	No	De	Jan	Fe	Ma	Av	Ma	Jui	Jui	Ao	Se	Oc	No	De	Jan	Fe	Ma	Av	Ma	Jui	Jui	Ao	Se	Oc	No	De	Jan	Fe	Ma	Av	Ma	Jui	Jui	Ao	Se	Oc	No	De	Jan	Fe	Ma	Av	Ma	Jui	Jui
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Objectives1	1.3																															3																	
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	4.2																																															
Objective 4	4.3																																															

Quantifiable Outputs

1. Environmental data and knowledge of key target environments are collected in each target region
2. Soil analysis information and water balance for each target area are available
3. Genotype simulations for each area are established
4. Morphological, physiological and yield components are known
5. Post flowering drought responses of selected lines under stress and non stress conditions are identified
6. Germplasm lines with post-flowering drought adaptation are identified
7. Identification of 3-4 best lines for drought tolerance with enhanced yield components for each environment
8. Irrigation facility is available
9. Three graduate students are trained for drought response phenotyping
10. Adequate human resources are acquired to undertake the project

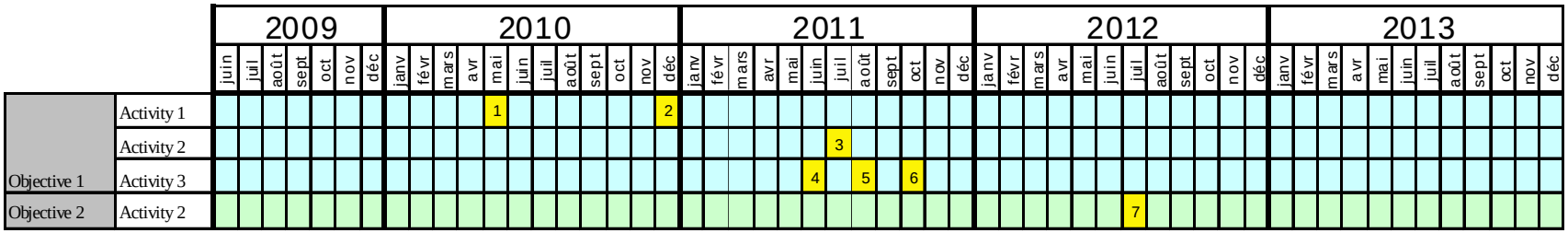
3. Genotyping

(1) **Objective 1: Discovering** SNP in a diverse sample of the sorghum gene pool and testing for economical genotyping.

Activities	Quantifiable Outputs
G1. Discovery of informative DNA polymorphism	G1. Identification of 'features' (nucleotides) in the sorghum genome that are particularly informative (polymorphic) for use as a 'universal' genotyping resource
G2. Genotyping platform development	G2. Database of SNP data G3 Development of a high-throughput SNP genotyping platform based on appropriate technology by year 3 (near the time of availability of the 8,000 segregants)
G3. Platform assessment	G4. SNP-based characterization of representative germplasm G5. DArT characterization of representative germplasm G6. Genetic resolution and cost efficiency comparison

(2) **Objective 2:** Genotyping of 100 segregants per population (8,000 total), requiring economical genotyping.

G4. Platform implementation	G7. Application of the genotyping platform to provide genome-wide genotyping of the 8,000 segregants (about 300 informative markers per segregant)



Quantifiable Outputs (cut and paste from Appendix A):

G1. Identification of 'features' (nucleotides) in the sorghum genome that are particularly informative (polymorphic) for use as a 'universal' genotyping resource
G2. Database of SNP data
G3. High throughput SNP universal genotyping resource
G4. SNP-based characterization of representative germplasm
G5. DArT-based characterization of representative germplasm
G6. Choice of sorghum CI platform
G7. Genome-wide genotypes of the 8,000 segregants

THE PENDING ACTIONS

Selection of the materials (RP, SDP and CDP

It is important that the working group finalize the list of materials during the ARM before leaving

Roles of the participants

It is important to keep the multidisciplinary team

Selection of the sites in Mali

Based on the observations of the MT, the group is in process to select during the ARM the main sites for the project

THANK YOU FOR YOUR ATTENTION