AgMIP The Agricultural Model Intercomparison and Improvement Project

An Integrated Assessment of Climate Change Impact on West African Agriculture

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Introduction

Climate Change threatens many aspects of human lives globally.

Africa is particularly vulnerable because (Hoffman and Vogel, 2010):

(i) there is a very high dependence on rain-fed agriculture (60%) and on climate-sensitive natural resources for livelihoods,

(ii) there is extreme poverty in many African countries with little or no insurance against environmental stressors, and

(iii) there is an increasing rate of degradation of natural resources leading to low resilience to the impact of rising temperatures and more variable rainfall.

(iv) Despite many climate change studies, not many have conducted integrated assessments that link biophysical and socioeconomic impacts on agriculture productivity.

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AIMS

(i) Determine how climate is likely to change in the near future in West Africa, and

(ii) to demonstrate the application of the AgMIP methodology (socio-economic, climate and crop modelling) for an integrated assessment of near future (2040 – 2069) climate change impact on West African Agriculture.

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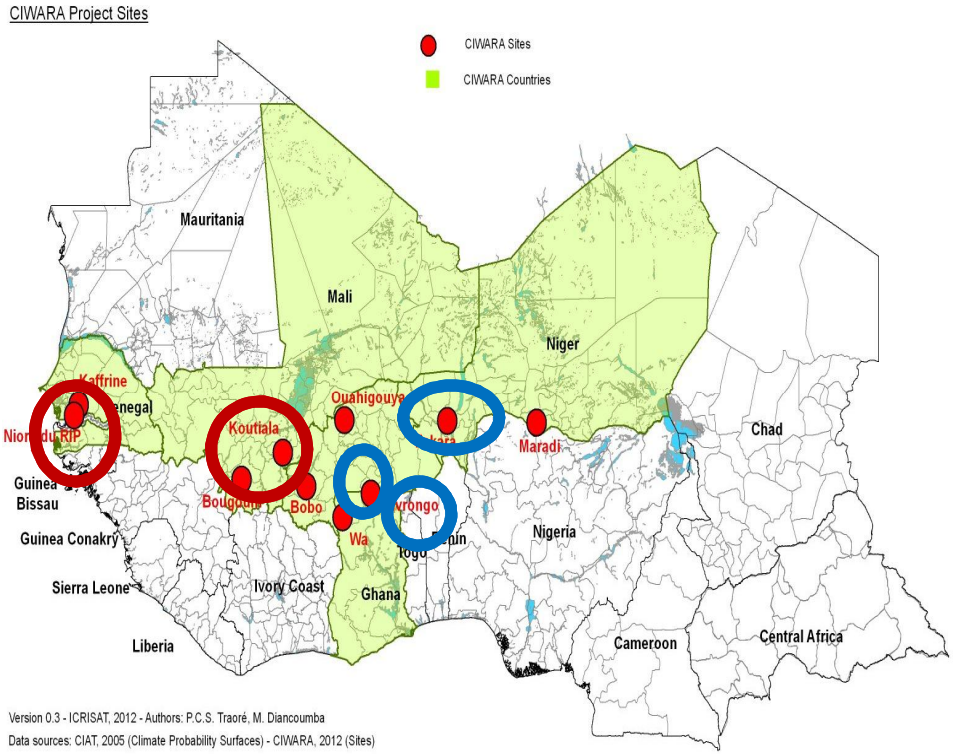
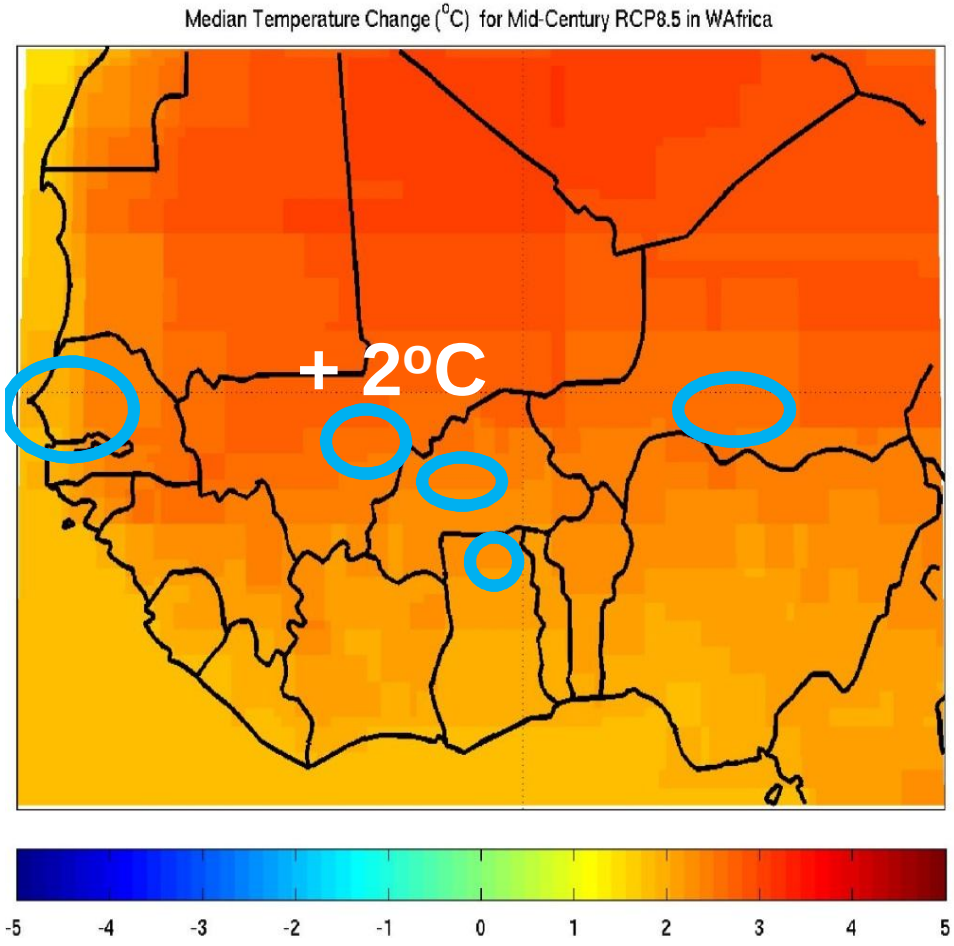
CIWARA Sites

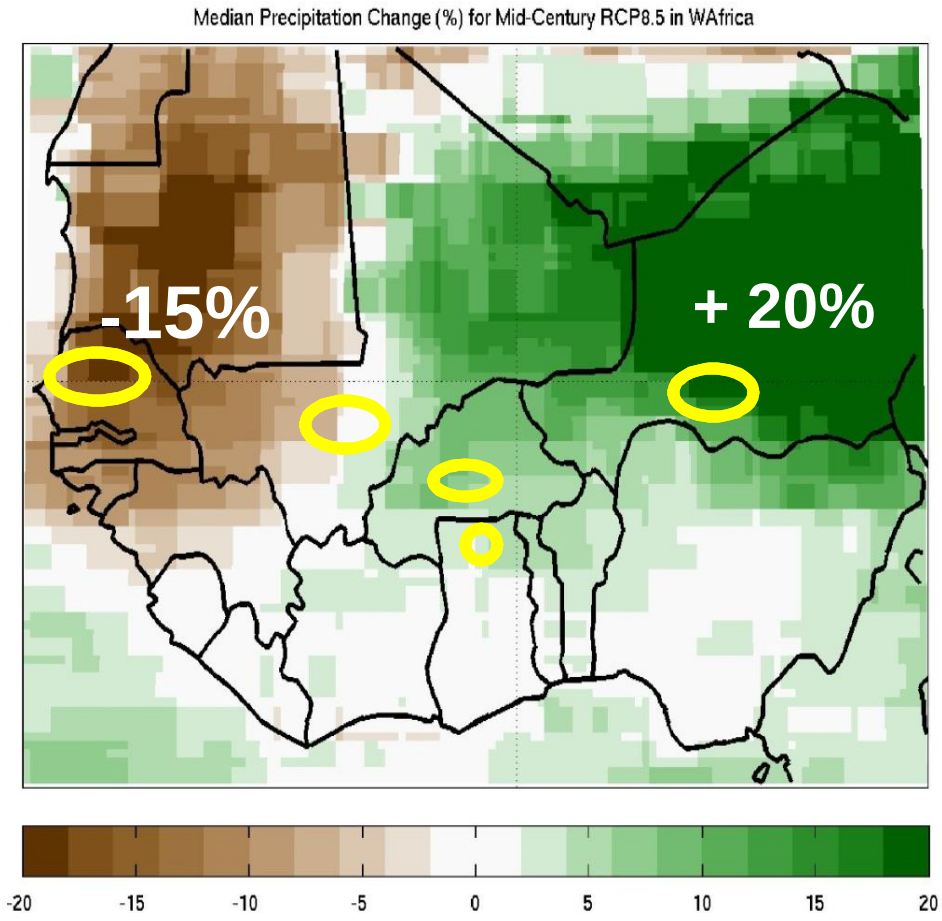


Study Sites:

Senegal
Mali
Niger
Burkina Faso
Ghana

Objective 1: Projected Difference in Mean Temperature and Rainfall for Future Climate (2040-2069)

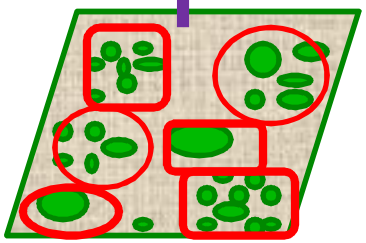




INTEGRATED ASSESSMENT FRAMEWORK

CROP MODELS VALIDATION

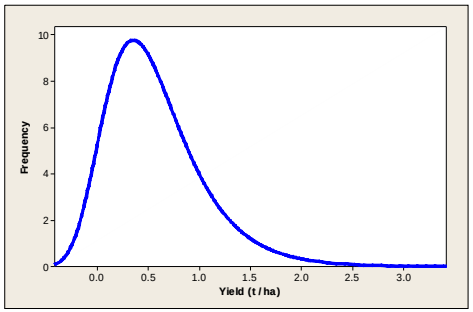
BASE YEAR



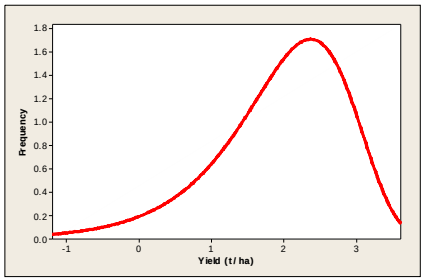
Typology Strata

10
20
70

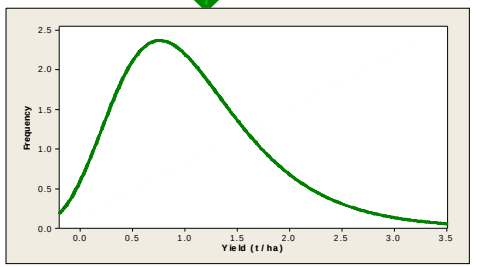
Current Technology + CROP MODELS + Current Climate (1980-2010)



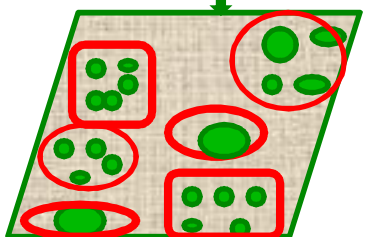
Current Technology + CROP MODELS + Future Climate (2040-2069)



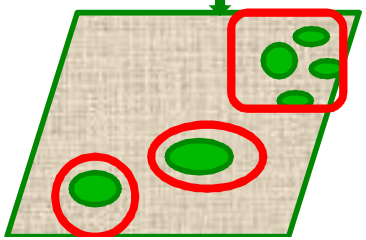
RAPs + ADAPTATION (Future Technology) + CROP MODELS + Future Climate (2040-2069)



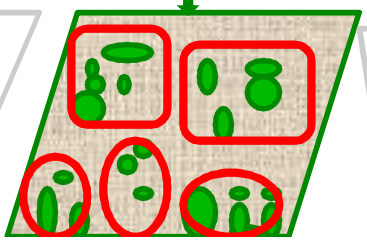
SOCIO-ECONOMIC MODEL (Income): GAINERS vs. LOSERS



50
30
20



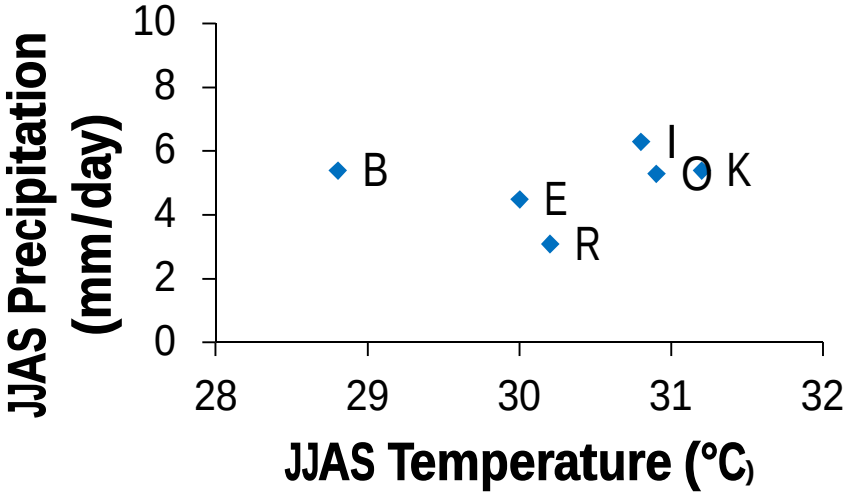
30
30
40

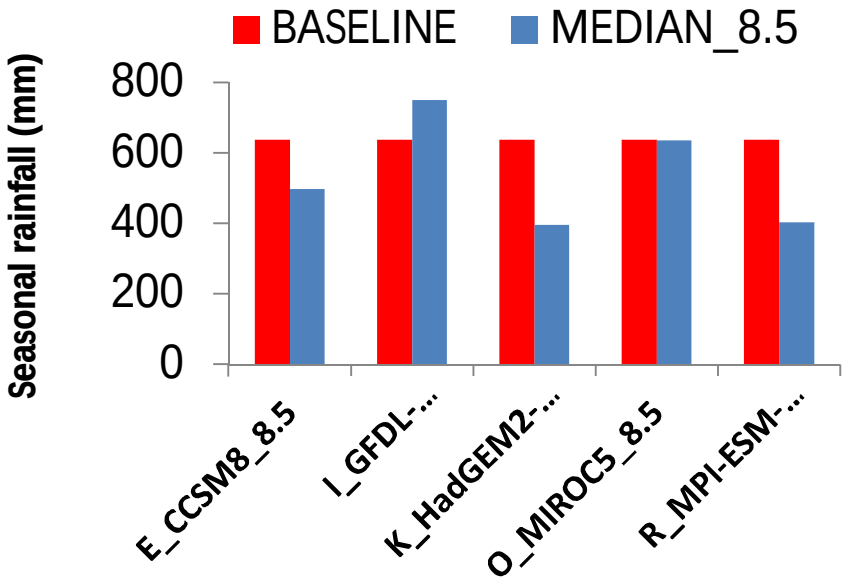


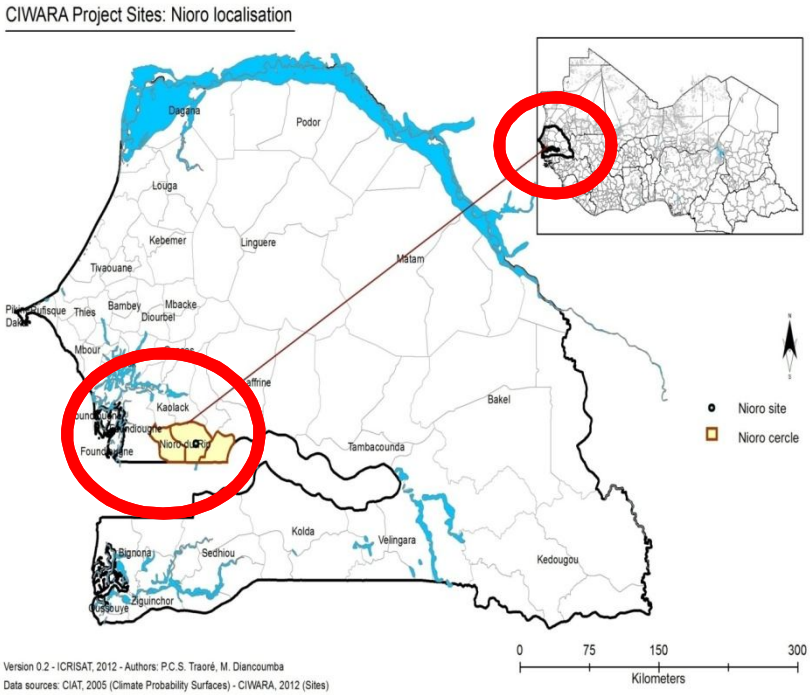
Adapting to Future Climate: Possible Strategies

Entry point	1. Production system / policy	2. Plant technology	3. Agronomy / management
Adaptation package components	**Increase share of irrigated, higher-value crops in the system: irrigated maize as a precursor to higher value crops (vegetables)**	**Improved genotypes heat and drought tolerant (cereals and legumes)**	**Improved water Management & climate information Services**
Realization	**TOA-MD & crop models**	**crop models only** **- Increase lifecycle** **- Heat tolerance** **- Altered root distribution**	**crop models only**
Relevance to climate scenarios (GCMs x RCPs)	- Water supplementation during dry spells - Off-season cropping	- Retain LGP fitness under elevated temperatures	- No loss option under generally rainfall limiting conditions - Bridging across more frequent, longer dry spells
Relevance to socio-economic scenarios (Trends x RAPs)	- meet growing urban / livestock demand - Poultry sector, feed - Expansion of peri-urban agriculture	- Increased presence of commercial seed sector - Larger choice of germplasm at the farm gate	- Less labor constraints under mechanization - Opportunities for contour ridge tillage

Case Study: Nioro du Rip, Senegal







Rainfall Projections by 5 GCMs

Applying AgMIP Methodology: Case Study Nioro (Senegal)

Household survey; 226 farmers in 2007

3 crops, and 2 strata:
Stratum: i = non-maize based;
Stratum ii =maize-based system

2 crop models, and validation

Simulation of yields under:
Current climate (1980-2010)
Future climate (5 GCMs, 30 yrs)

With and without Adaptation,

Economic impacts on household income.

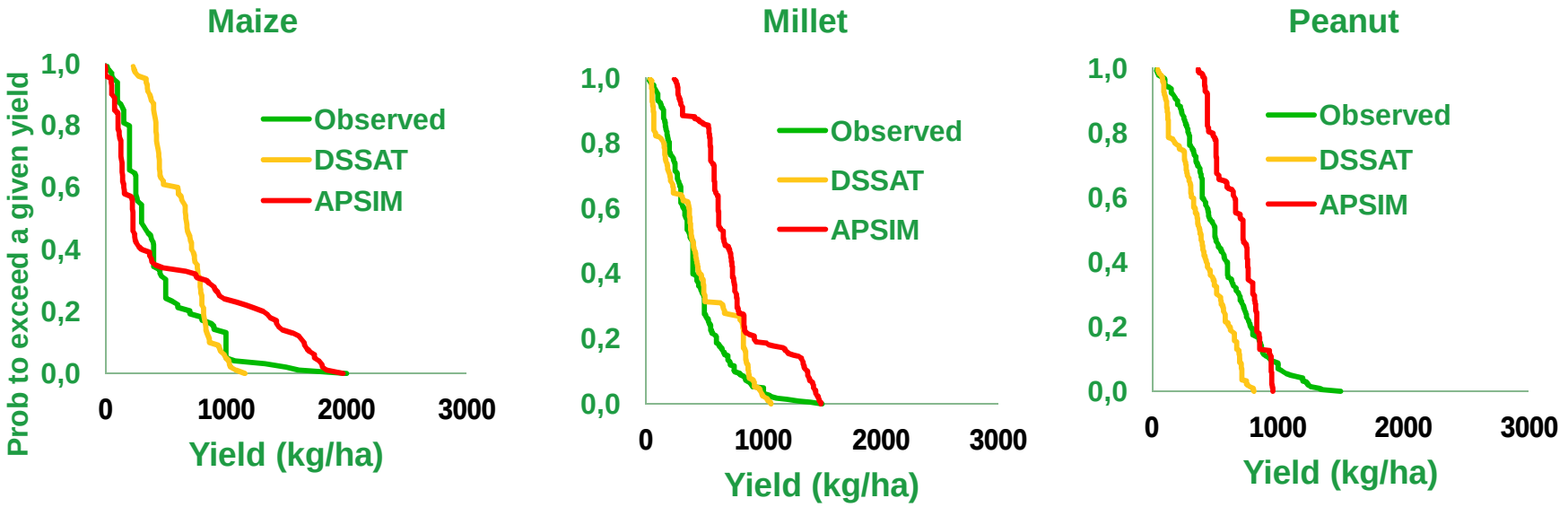
Crop	Models	Calibration data sources
Millet (*CIVT*)	DSSAT, APSIM	Akponikpe (2008); Akponikpe et al (2010)
Maize (*TZEEY*)	DSSAT, APSIM,	Dzotsi et al (2002)
Groundnut/ Peanut (*Chinese*)	DSSAT, APSIM	Naab et al (2004)

Validation of Crop Models

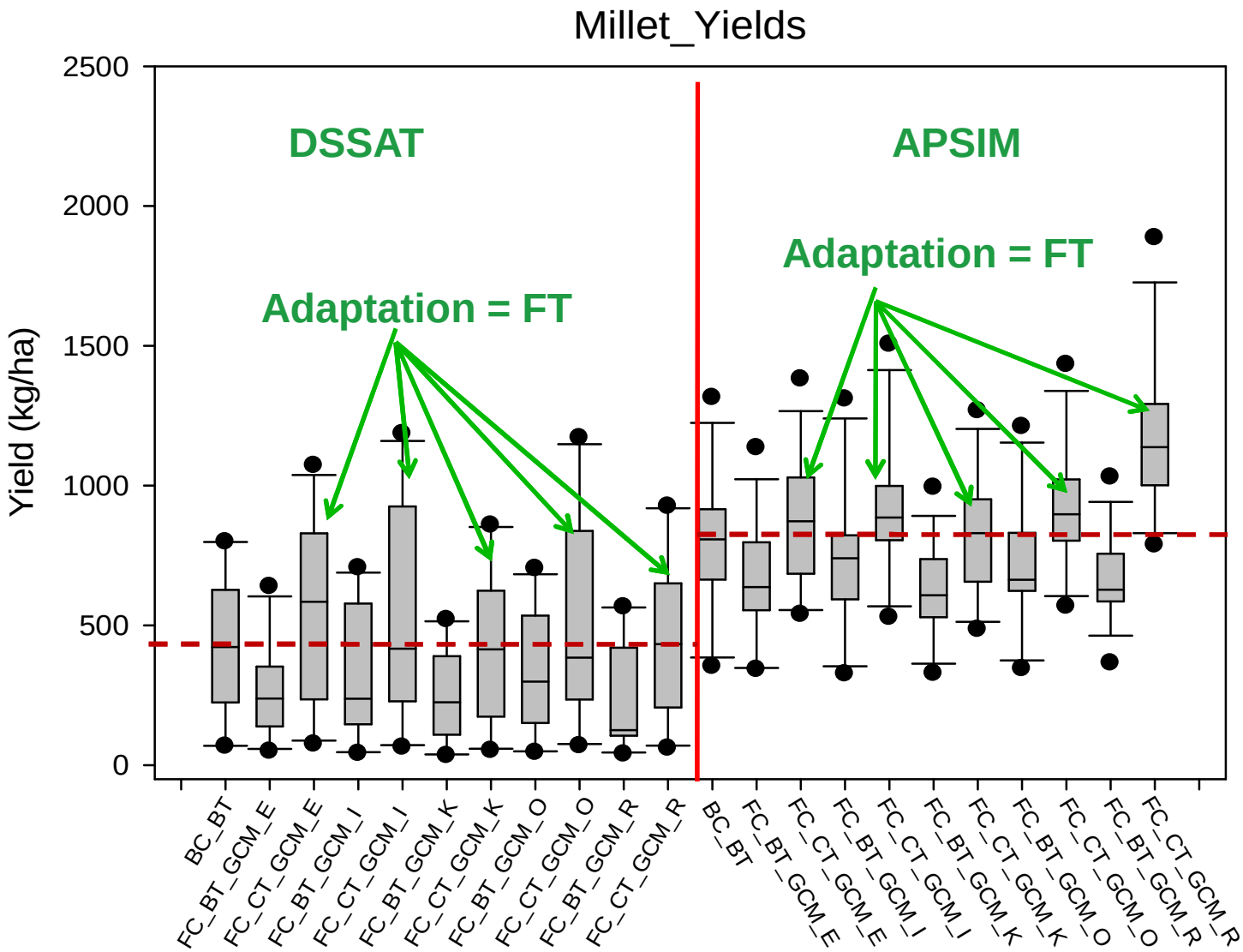
Data: socio-economic (e.g. farm size, income, farm labour, crops cultivated); agronomic (sowing date, manure + fertilizer cost, yield, etc.), GPS location, etc.

Soil data obtained from survey manuals, adjusted for degradation due to long time cropping.

Weather data from Meteorological Station.



Simulated Future Millet Yields with and without Adaptation



BT = Current Technology (i.e. current cultivars)

FT = Future Technology (i.e. new cultivars)

BC = Current climate

FC = Future climate

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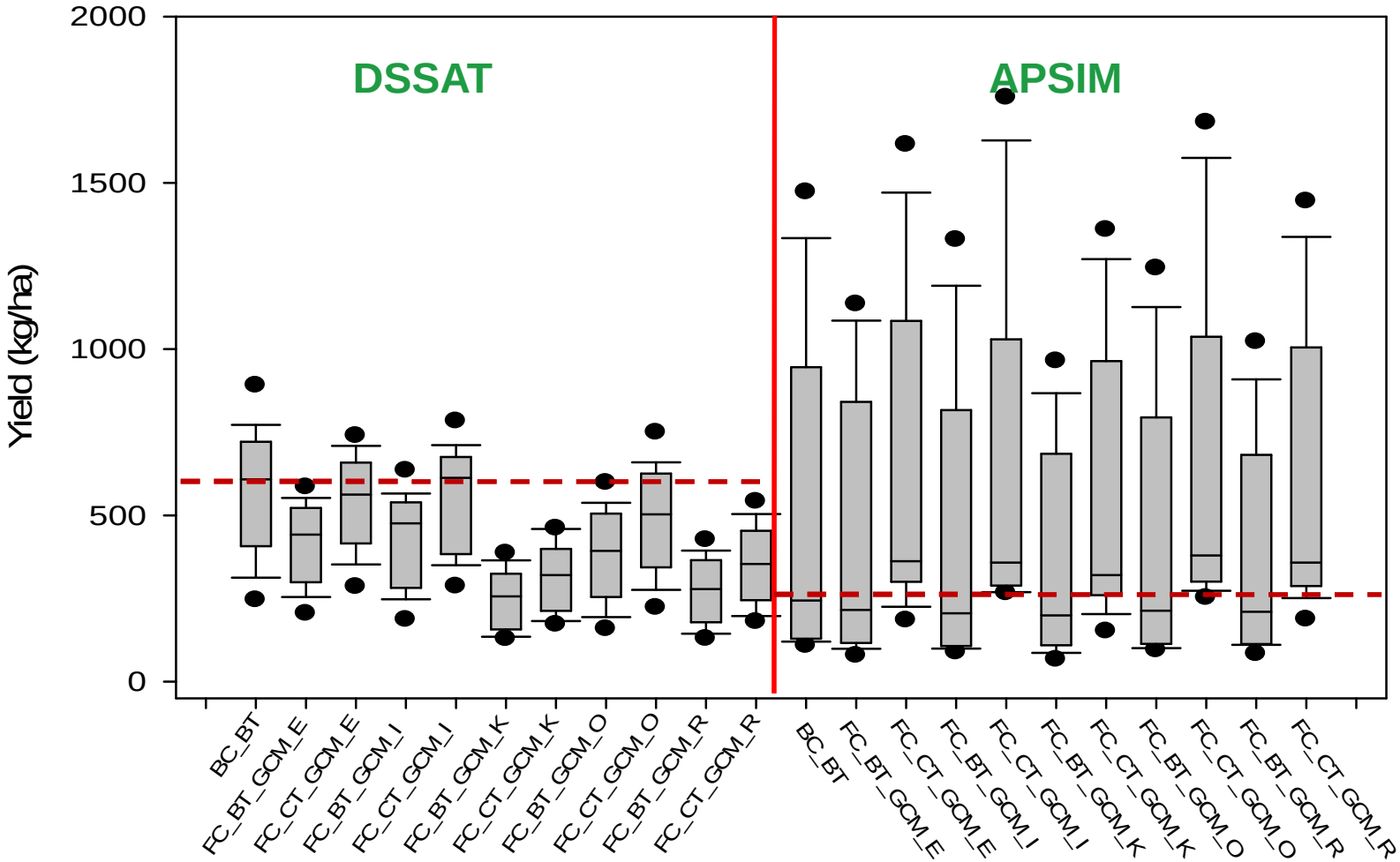
Maize



Who Gains and Who Loses under Climate Change?

Strata	Climate scenario	DSSAT	APSIM
		Net Loss (%)	Net Loss (%)
Non maize farms	GCM E	-7.14	12.02
maize farms		-7.16	8.36
All farmers		-7.15	9.94
Non maize farms	GCM I	0.91	7.64
maize farms		9.33	2.40
All farmers		5.70	4.66
Non maize farms	GCM K	15.59	14.06
maize farms		30.38	12.42
All farmers		24.01	13.13
Non maize farms	GCM O	11.46	9.90
maize farms		16.35	6.37
All farmers		14.24	7.89
Non maize farms	GCM R	15.35	12.11
maize farms		26.99	10.59
All farmers		21.97	11.25

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Conclusions

The Integrated Assessment of climate change impact on agricultural productivity in West Africa (example Nioro, Senegal) indicated that:

1.Western Sahel (Senegal) would experience increased temperature and drying in future.

2. Climate change would adversely impact on crop yields without adaptation; Heat and drought tolerant varieties would perform better under future climate

4. All the crop models and GCMs (except GCM E) project that ALL farmers would experience Net income losses under future climate, but maize-based cropping systems are likely to be more adversely affected.

4. All Crop Models and GCMs do NOT agree on the extent to which climate change would impact on household incomes. Ensemble modeling preferred.

5. The AgMIP methodology and tools are appropriate for Integrated Assessments of climate change on West African Agriculture.

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Thank You