FOCUS-AFRICA
Full-value chain Optimised Climate User-centric Services for Southern Africa

# FOCUS-Africa activities in Mozambique

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PLAN INTERNATIONAL

This project has received funding from the European Commission's Horizon 2020 Research and Innovation programme under grant agreement n°869575. The content of this presentation reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

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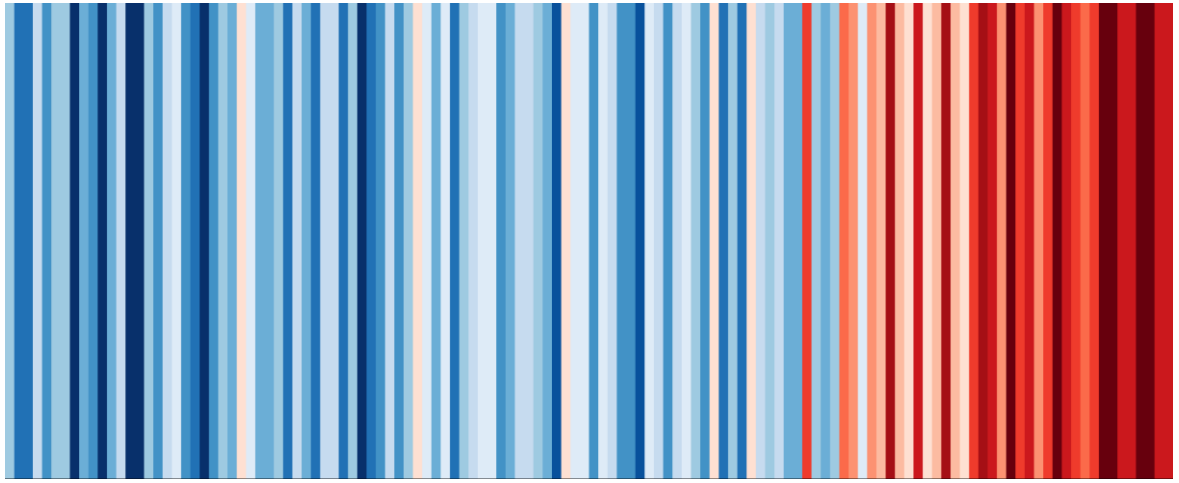
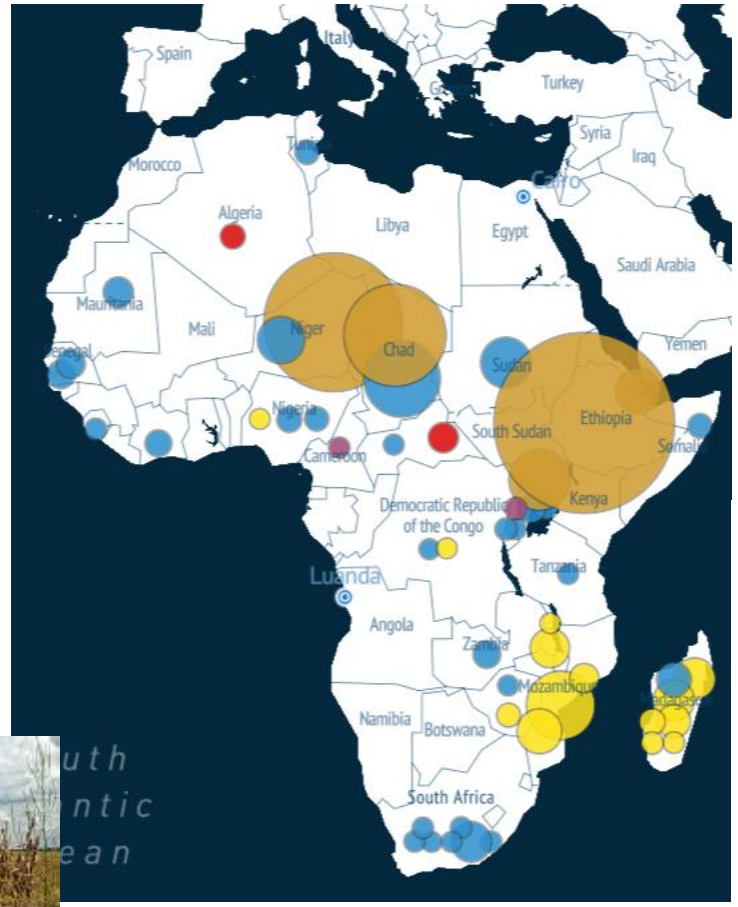
# The climate crisis impacts agriculture

## Agriculture needs to adapt to a changed climate






Extreme weather events in Africa in January-October 2022. Data source: Emergency Events Database (EM-DAT).

- Drought
- Wildfire
- Storm
- Landslide
- Flood

↑ *More people affected*

*Less people affected* ↓

# Need for innovation

There is an estimated 570 million smallholder farmers providing the livelihoods of 2 Bn people, many in SSA

Experimental agriculture must be interpreted as a process based on development of *products*

- A new crop variety
- A new climate service for agriculture
- A new management practice
- …

- Innovation is to be directed to improvement of farming for the benefit of farmers, consumers, and environment
- The end users are **farmers**
- Product profiling (i.e. design) is a key issue to achieve impact

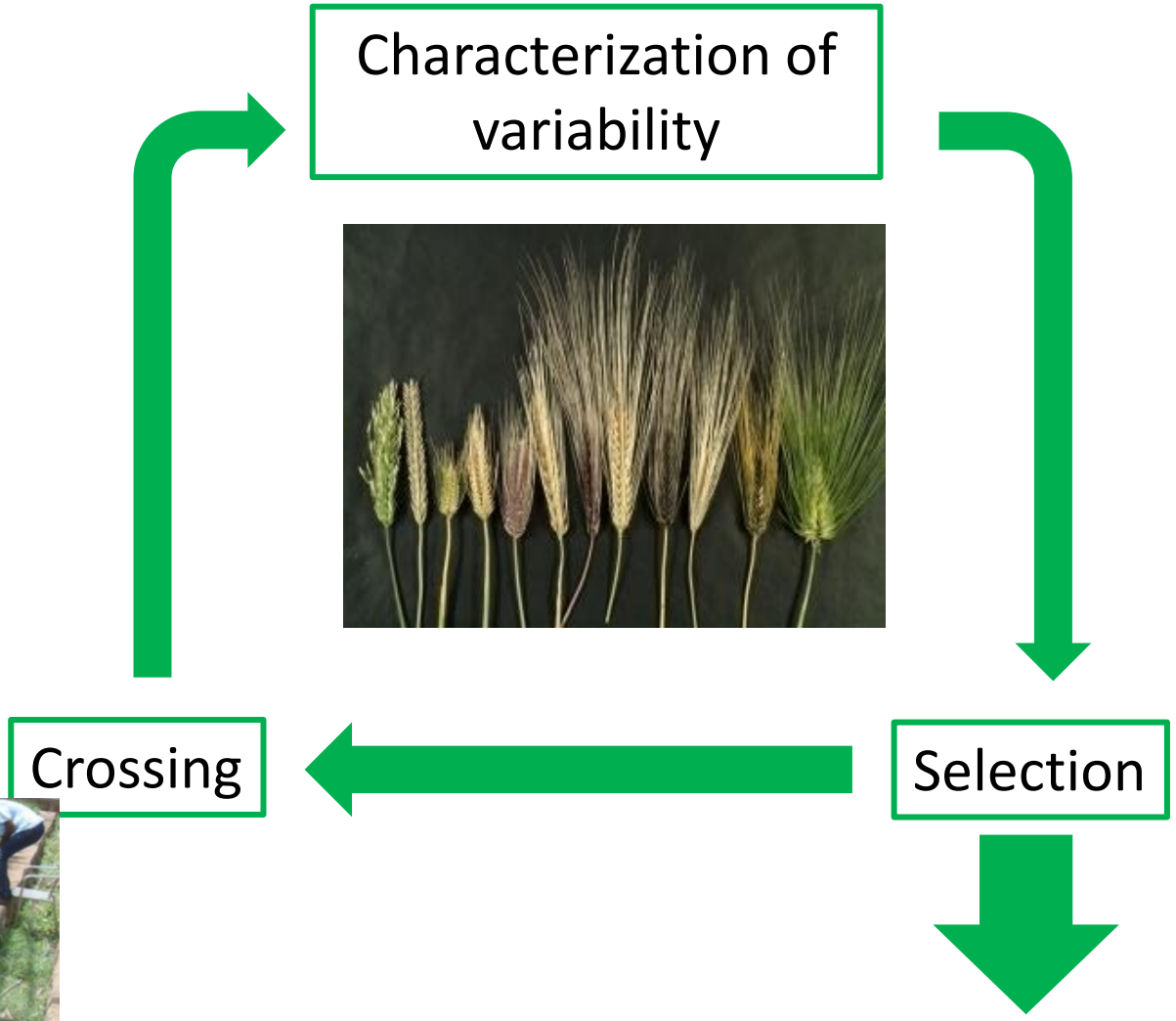
From a designers' textbook:

1. Consider the product's goal
2. Consider who will be using it
3. Consider what the users intend to do with it
4. Is it clear how to use it?
5. Is it engaging to your users?

# Success of modern breeding

The role of breeding is the production of new crop varieties with valuable trait combinations

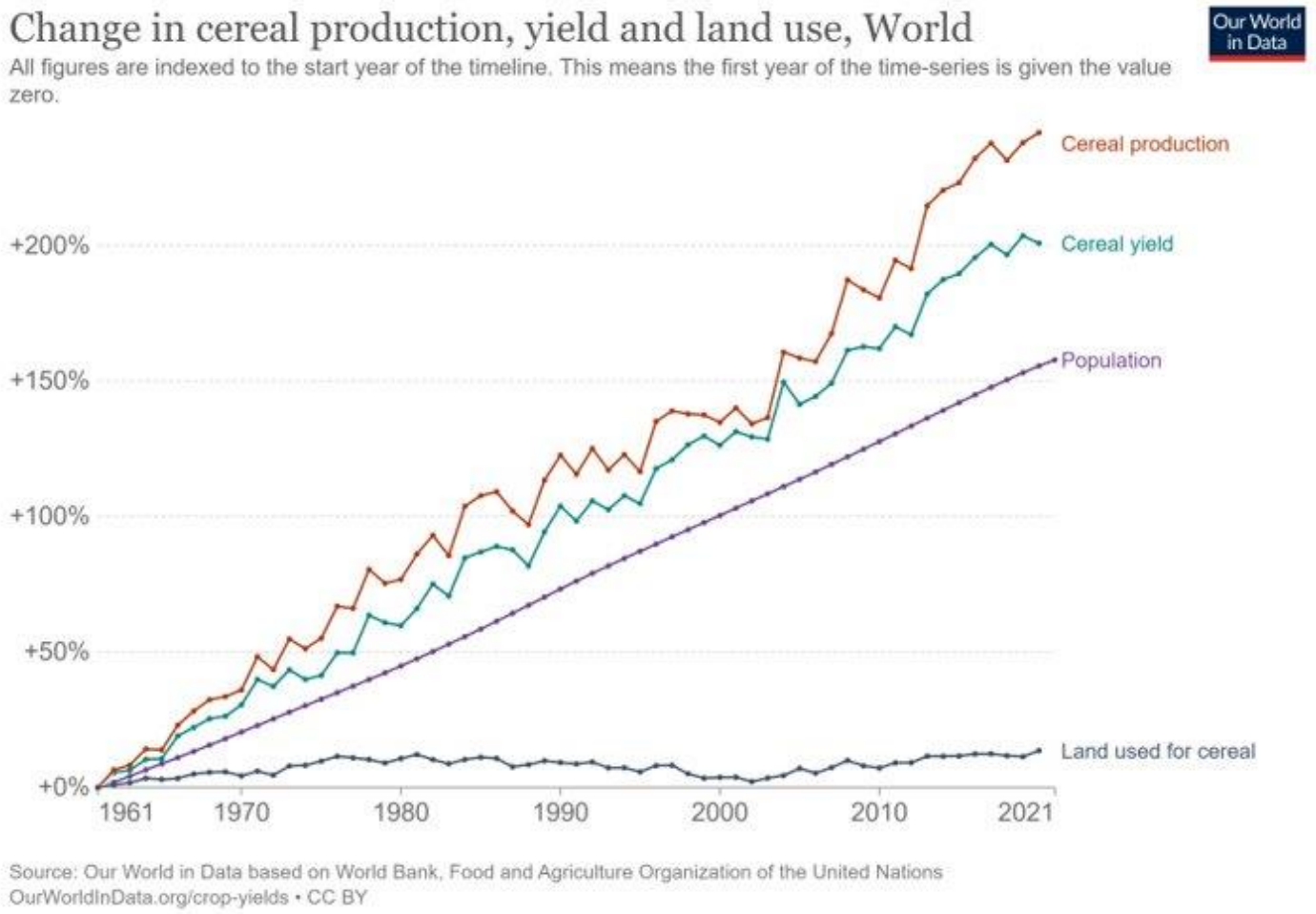
- Higher yield
- Higher quality
- Resistance to pests
- Resilience to abiotic stresses



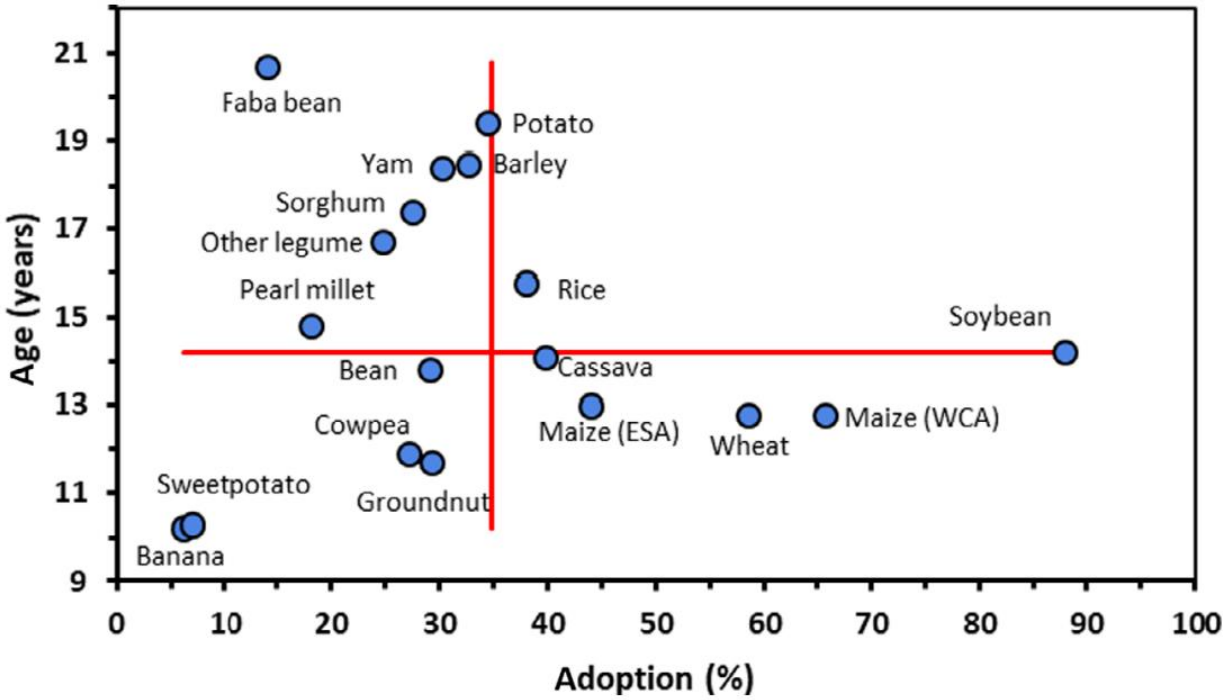

Production of improved varieties

# Achievements of modern breeding

**Norman Borlaugh**
Nobel laureate

# Breeding uptake in Africa is limited




Thiele et al. (2020) Int. J. Food Sci. doi:10.1111/ijfs.14684

**Table 3.2. Adoption of improved crop varieties over time in SSA**

| | 1998 | | 2009 | |
|---|---|---|---|---|
| | Total hectares under crop | Percent of land under improved varieties | Total hectares under crop | Percent of land under improved varieties |
| Ethiopia | | | | |
| Barley | 897,360 | 11.0 | 913,863 | 33.8 |
| Maize | 1,881,000 | 8.5 | 1,768,120 | 27.9 |
| Durum wheat | 797,998 | 80.0 | 1,163,056 | 77.8 |
| Malawi | | | | |
| Maize | 1,243,000 | 13.8 | 1,609,000 | 43.0 |
| Groundnuts | 170,517 | 10.0 | 266,946 | 58.0 |
| Niger | | | | |
| Millet | - | - | 6,513,140 | 11.5 |
| Sorghum | - | - | 2,544,740 | 15.1 |
| Cowpea | - | - | 5,203,530 | 17.0 |
| Groundnuts | - | - | 588,651 | 11.9 |
| Nigeria | | | | |
| Maize | 4,255,000 | 40.0 | 3,708,000 | 95.0 |
| Cowpea | - | - | 3,768,193 | 39.0 |
| Sorghum | - | - | 4,736,730 | 20.0 |
| Millet | - | - | 3,749,600 | 35.0 |
| Tanzania | | | | |
| Maize | 1,646,000 | 4.2 | 2,961,330 | 35.4 |
| Rice | - | - | 627,600 | 13.0 |
| Sorghum | 622,400 | 2.0 | 874,219 | 37.7 |
| Groundnut | - | - | 535,000 | 32.1 |
| Uganda | | | | |
| Maize | 574,000 | 8.9 | 887,000 | 54.0 |
| Banana | - | - | 915,877 | 6.2 |
| Groundnut | 196,000 | 10.0 | 253,000 | 55.0 |

*Source: Sheahan and Barrett (2014) from CGIAR's DIIVA project http://www.asti.cgiar.org/diiva*

# Product profiling


Lot of functionalities, difficult usability

- A high yielding variety
- A high-tech, complex climate service


Compact design highly accessible

- A climate-ready, resilient variety
- An easy to use, actionable climate service

# A call for shared solutions

Transdisciplinary approach

- Climate science
- Socioeconomics
- Genetics
- Breeding

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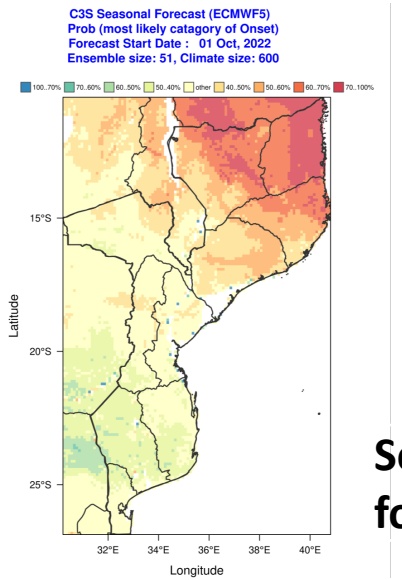
# Our strategy in Mozambique

Climate data


**Seasonal forecast**

Smallholder farmers

Field evaluations

Crop landraces

Genomics

**Better varieties**

# Methodology

- Understand need of climate services supporting cropping of cowpea and rice
- Foster sustainability of innovation

**Strand 1: Engagement of stakeholders**

**Strand 2: Crop genomics**

- Identify agrobiodiversity that can support the developement of climate-ready varieties
- Identify the genetic basis of adaptation in cowpea and rice

- Develop seasonal forecast /climate prediction models tailored to stakeholder needs

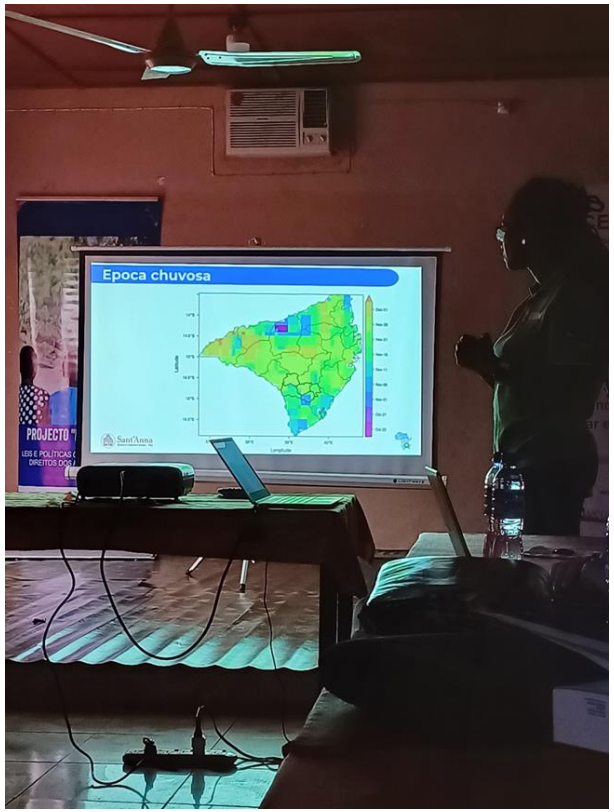
**Strand 3: Climate research**

**Strand 4: Participatory Evaluation**

- Evaluate the performance of climate services in target environments

# Strand 1 – Engagement of stakeholders

- The research area is the **Mogovolas** district, Nametil, Nampula
- A region particularly exposed to extreme events and characterized by low-input agriculture



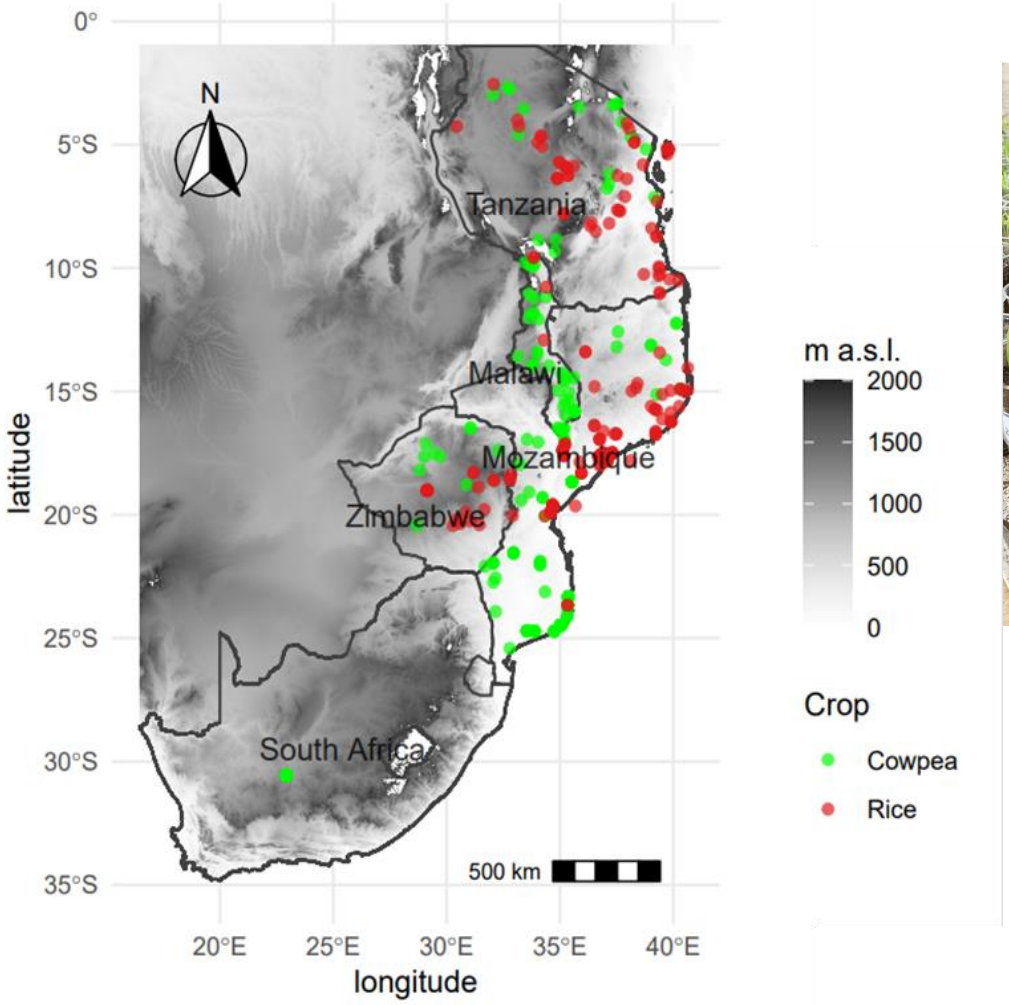

**2021**: Focus group discussions with local farmers, key interviews with local and national stakeholders

**2022**: Survey in 248 households

**2022**: Training at INAM and demonstration with local communities

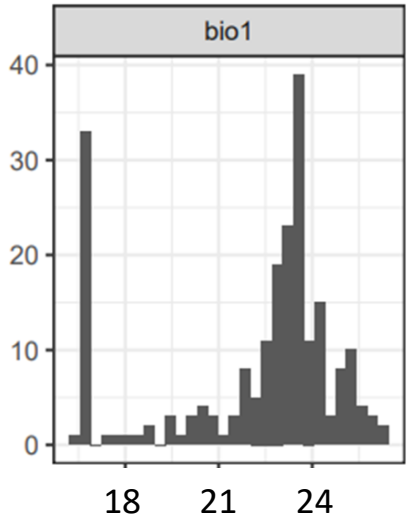
**2023**: Test of the climate service(s) prototype (s) with end users

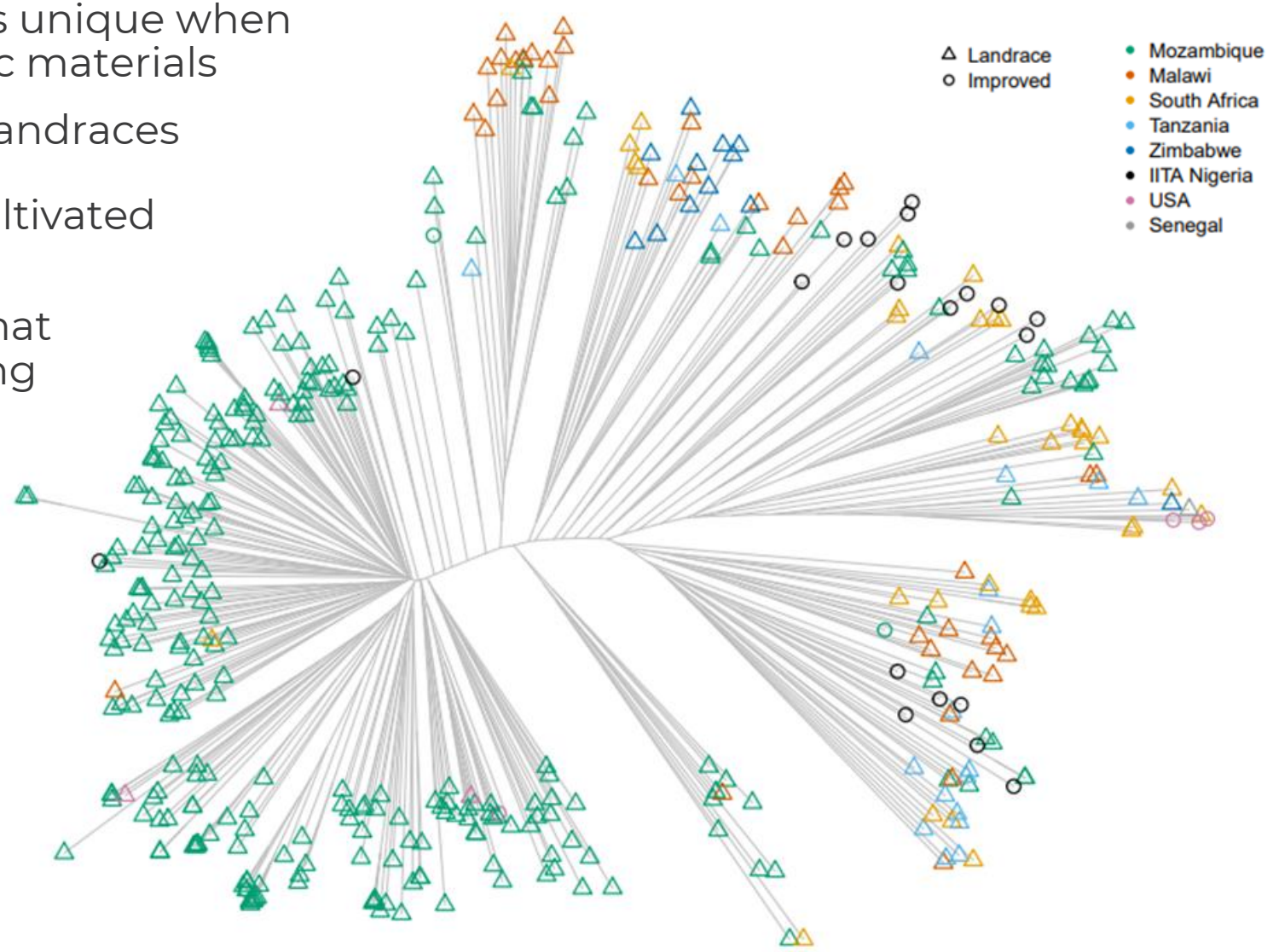
# Strand 2 – Crop genomics




- Selection of a core collection of cowpea and rice traditional varieties from Mozambique and SADC
- 331 rice and 428 cowpea processed at IIAM, and genomic sequencing produced

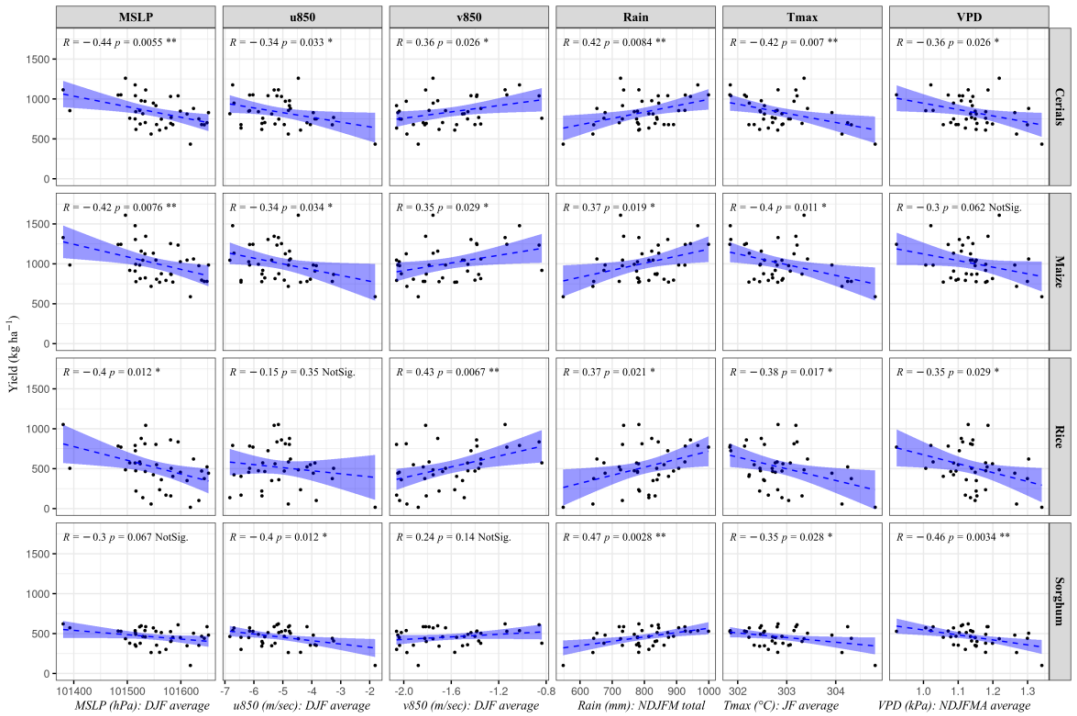
- Cowpea from Mozambique is unique when compared with SADC genetic materials
- High diversity is available in landraces
- Landraces are traditionally cultivated in different climatic niches
- They have adaptation traits that could be exploited by breeding

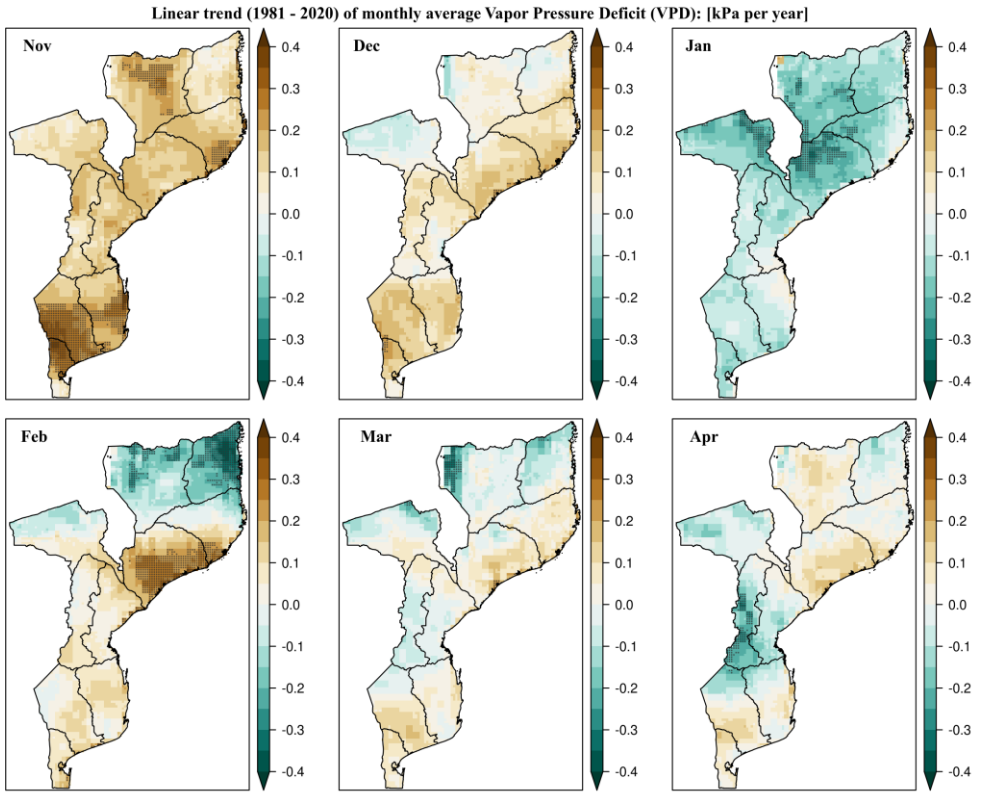


# Strand 3 – Climate analysis

- Climate reconstruction showed a trend of reduction of wet season duration
- Cereal yields in mozambique tend to decrease with increasing maximum temperature (warming) during reproductive stage.
- The increase in growing season average vapour pressure deficit (VPD), also leads to a reduction in yield.



Combining soil data with weather data to derive agroclimatic features of growing season

## Climatic Onset

The first wet day after 01-Sep of a 3-day wet-spell receiving at least *Rw3day*, without grater than 7 dry days in the following 10 days.

## Climatic Cessation

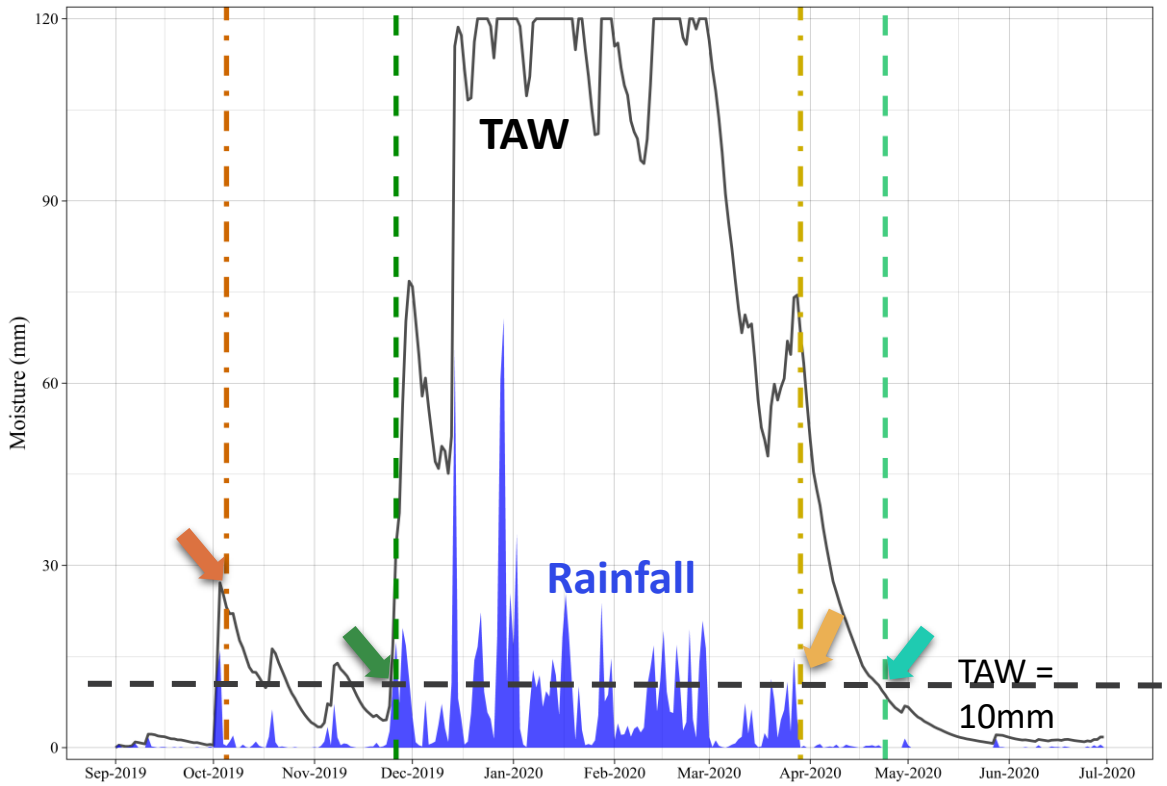
A day after 01-March which, 20-day rainfall amount is less than *Rx20day*.

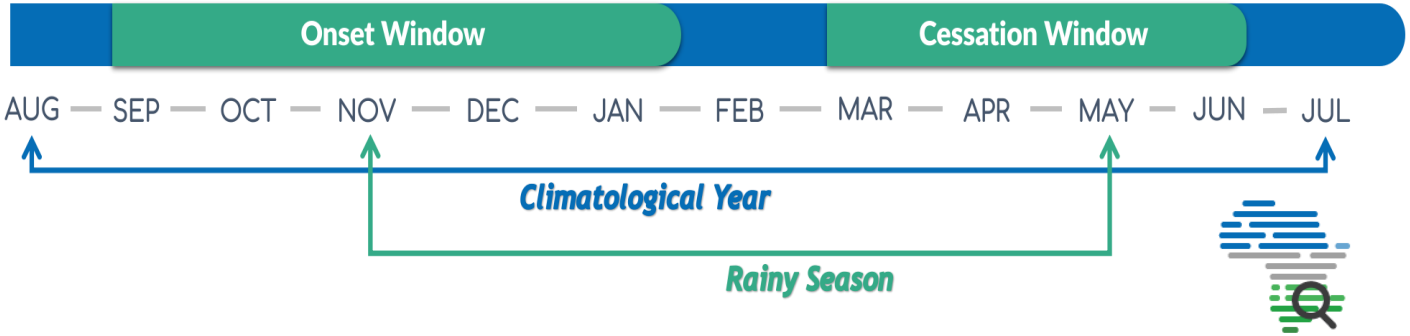
## AgroClimatic Onset

The first day after 01-Sep, when the Eratio (Ea/Ep) > 0.5, followed by a 20-day period in which TAW remains > 10mm.

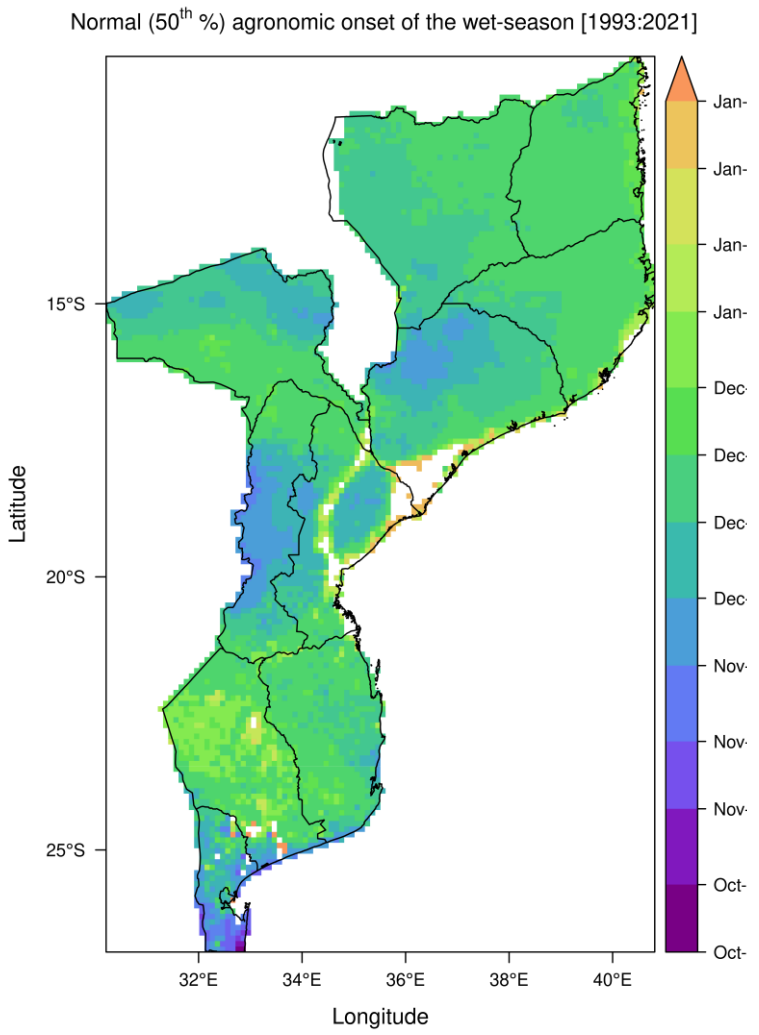
## AgroClimatic Cessation

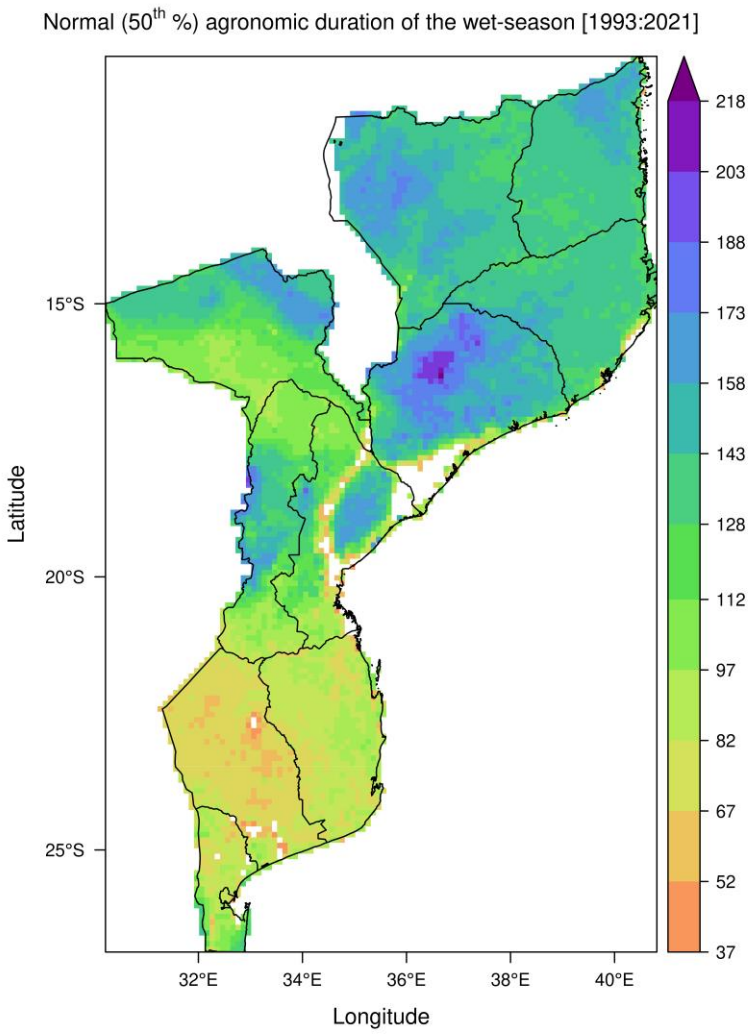
Season has ended at the first day (Eratio<=0.5) after 01-Mar following 12 consecutive non-growing days (TAW<10mm).



# Our product




An R package with graphical user interface has been developed

**Package 'AquaBEHER'**

October 23, 2022

**Type** Package

**Title** Estimation of rainy season calandar and soil water balance for agriculture

**Version** 0.1.0

**Author** Robel Takele <takelerobel@gmail.com>
Matteo Dell'Acqua <matteo.dellacqua@santannapisa.it>

**Maintainer** Robel Takele <takelerobel@gmail.com>

**Description** This R package computes and integrates daily reference evapotranspiration (Eto) into FAO56 water balance model. The AquaBEHER package can estimate daily parameters of crop and soil water balances parameters for agricultural crops. The package can also estimate rainy season calandar (Onset, Cessation and Duration) based on agroclimatic approach.

**License** GPL (>= 3)

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.2.1

**Roxygen** list(markdown = TRUE)

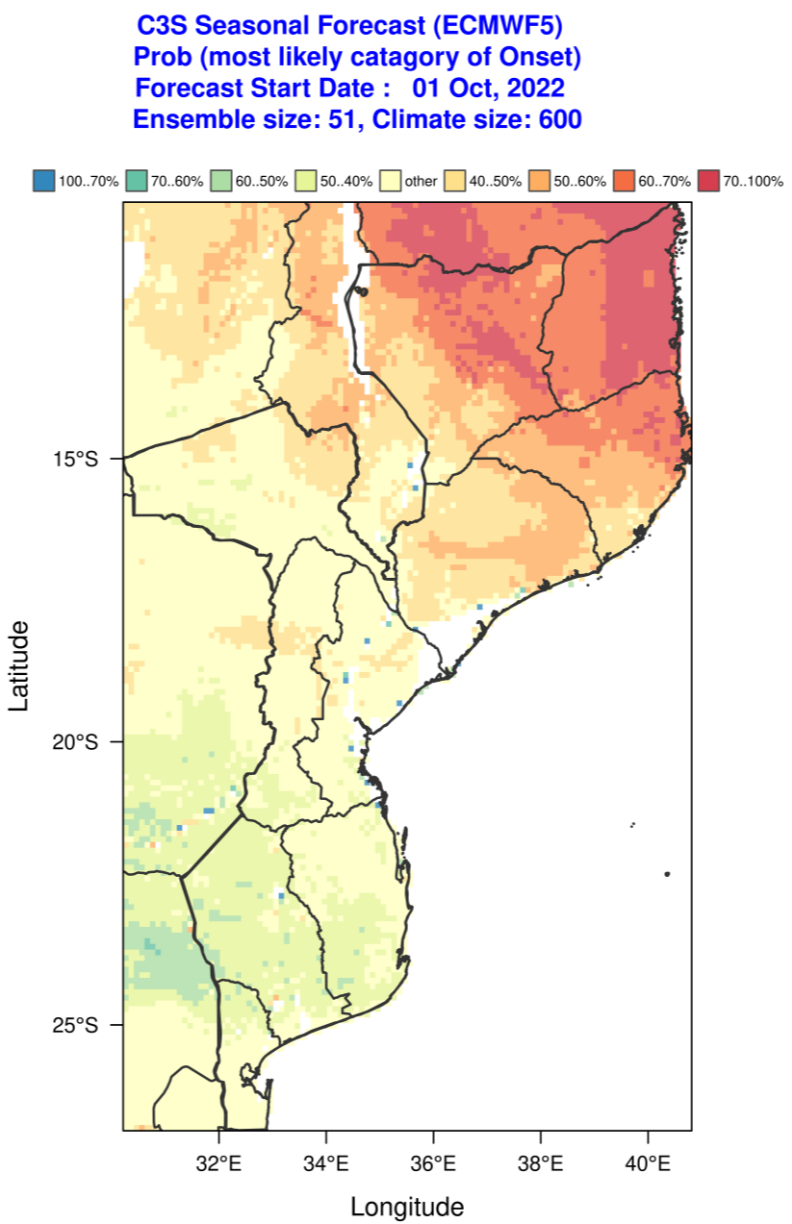
**Suggests** knitr,
rmarkdown,
ggplot2

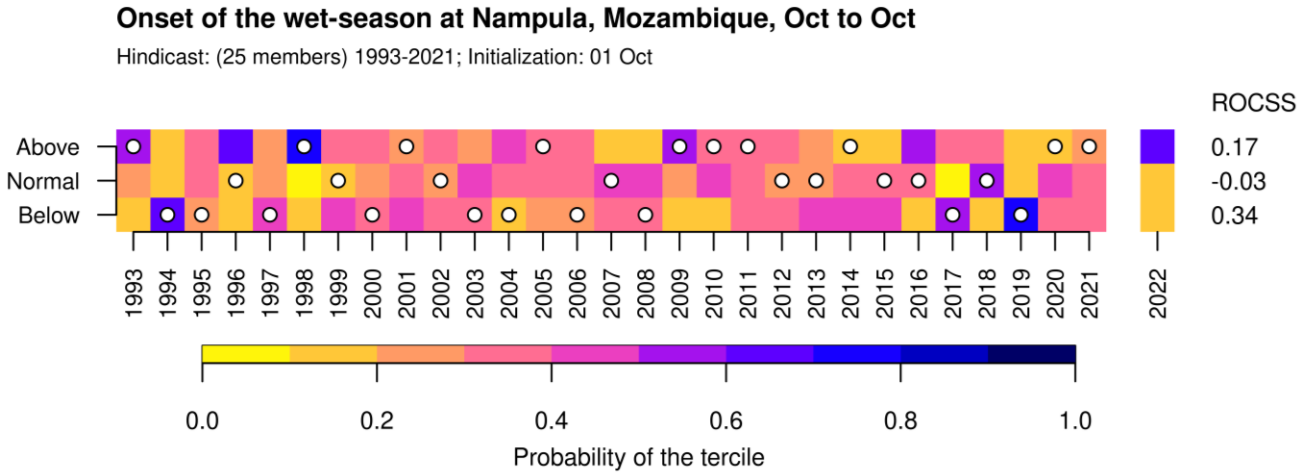
**VignetteBuilder** knitr

**Depends** R (>= 2.10)

# Strand 4 – Participatory evaluation

- Participatory approaches are being used to test climate service(s) prototytpes with intended users
- Crop variaties are being grown in large characterization fields in Nampula and Chokwe; agronomic perfromance is measured
- Farmers are invited on field to evalutate genetic materials according to their preference; the endopoint is to select most promising varieties for further use and characterization




The seasonal forecasting tool based on AquaBEHER is used in training sessions with INAM and other stakeholders

# Way ahead

Maps/bullettins will be presented to extension workers and tailored in field in Mogovolas in May 12-15

### ACTORS INVOLVED

- **Providers/intermediate users** (INAM, IIAM)
- **Extensionists** (SDAE)
- **Supporting actors** (WFP, PLAN)
- **Political actors** (MADER, SDAE…)
- **End-users** (smallholders)

### OBJECTIVES

1. Evaluating the **actionability of the prototype** and the **preferred visualization forms**
2. Understanding the **use and impact of the climate information developed**

### METHODOLOGICAL TOOLS

- A **participatory assessment** of the draft prototype **with local stakeholders**;
- A **simulation** exercise **in-field**

We plan to test preferred varieties with forecast in selected Mogovolas communities during the rainy season of 2023-2024

# Ambition

**Objective**: improve farmers' capacity in decision making in relation to varietal choice and management practices

- To tailor the service to INAM needs and ensure its sustainability after the project ends
- To contribute in streamlining of information between providers and users in Mogovolas
- To scale up the use of the service beyond Mozambique

- To identify approx. 20 climate-ready, farmer-preferred cowpea and rice varities for cultivation in Nampula
- To move towards the developement of new varities

# Acknowledgements


- Roberto Buizza
- Valentina D'Amico
- Mercy Macharia Wairimu
- Marta Solemanegy (IIAM)
- Robel Takele

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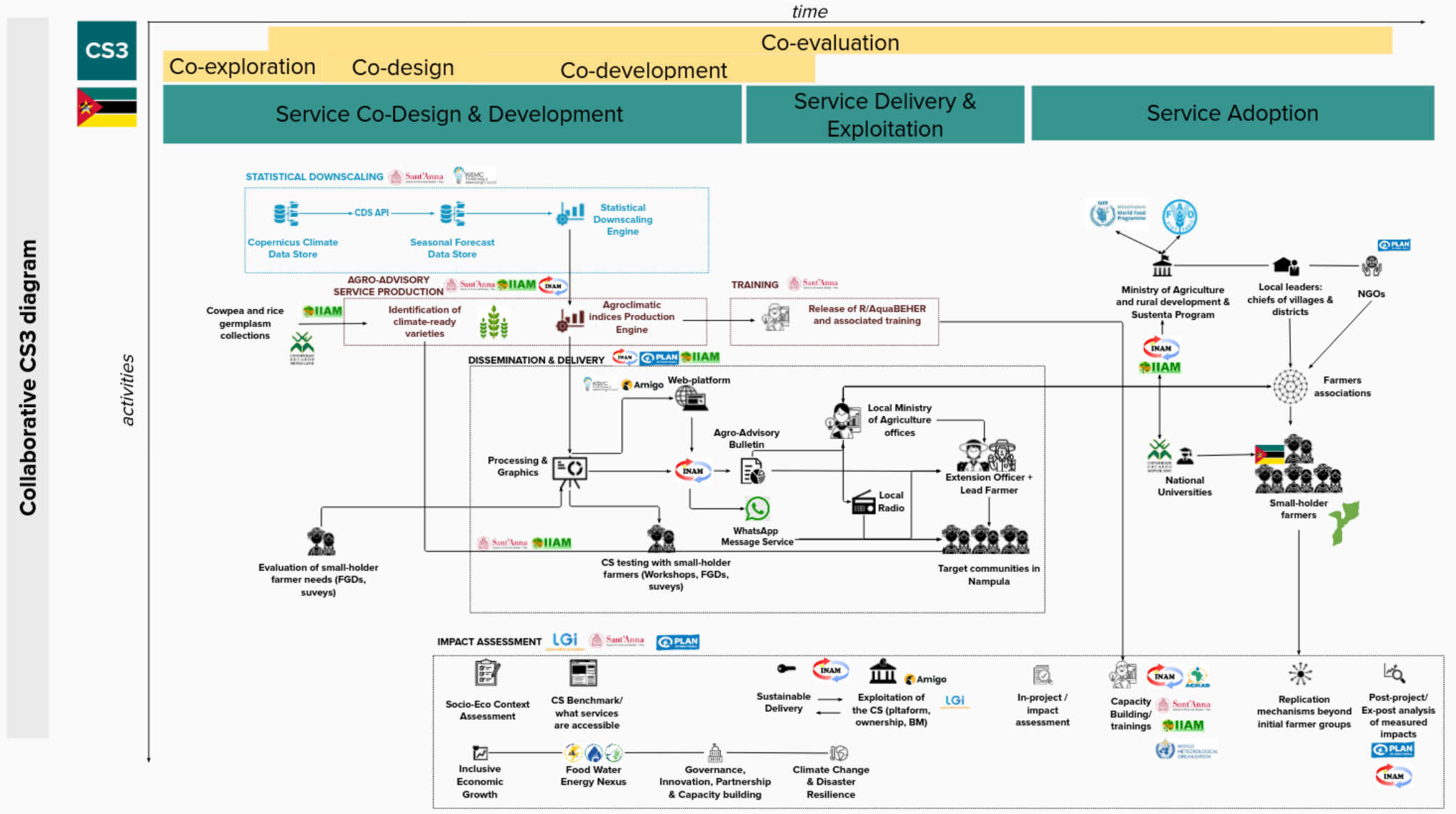
- Joao Chaque
- Rosaria Mabica

- Aderito Celso
- Mussa Mustafa
- Jonas Zucule

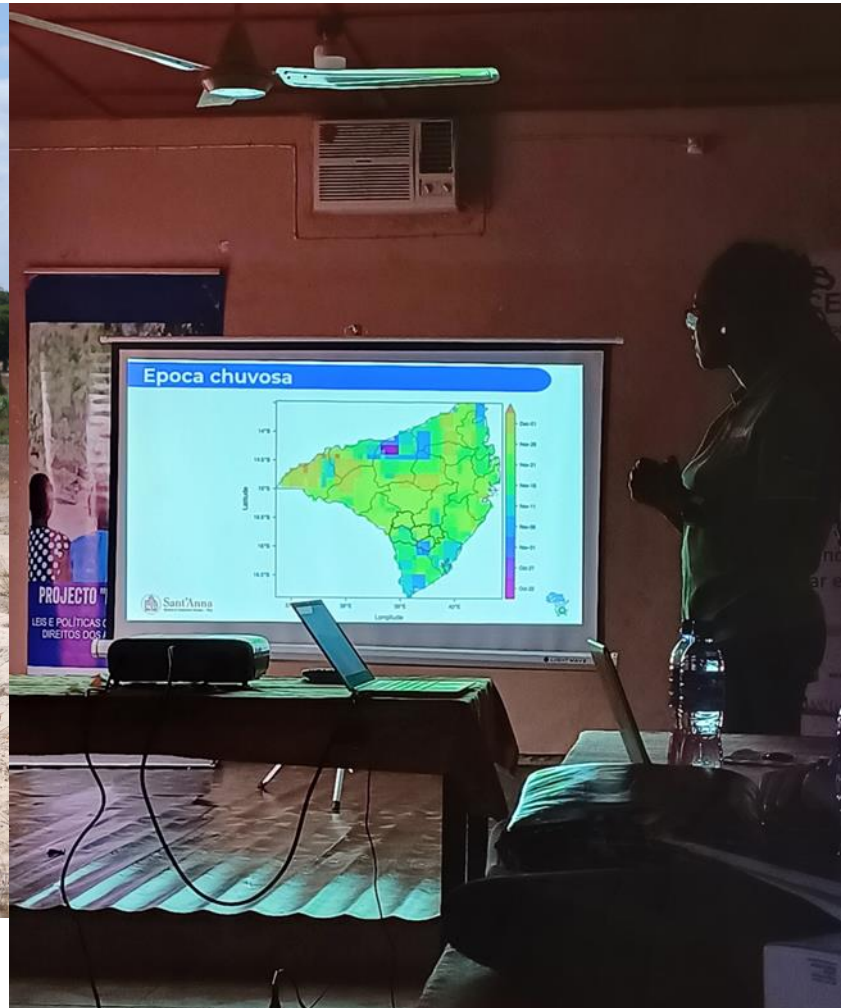
- Eduardo Mondlane University, Rogerio Chiulele and Benedito Cunguara
- The Mogovolas district extension workers
- The communities in Rieque and Nampachepa and in all the other field locations

# Obrigado
# Kushukurru

# CS3 Mozambique at a glance

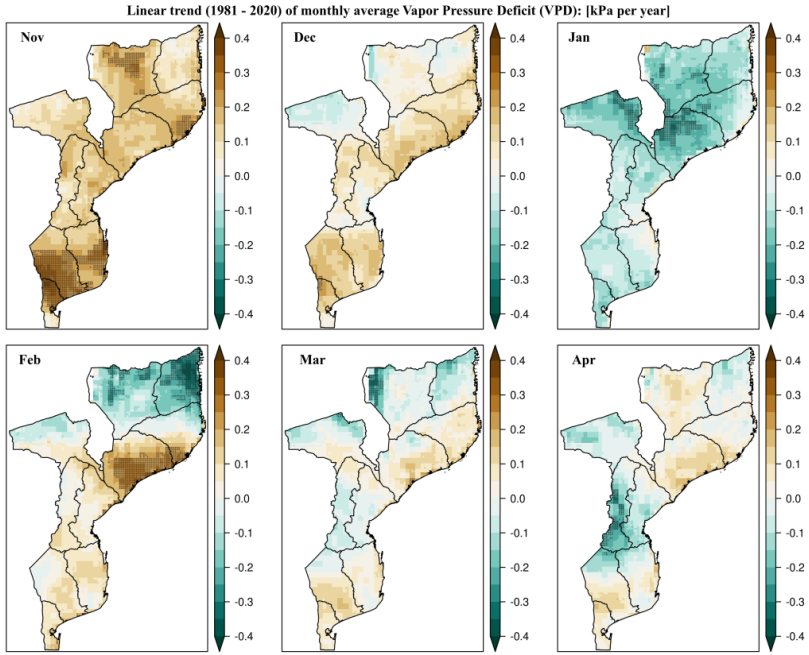



NAMACHEPA


Epoca chuvosa
PROJECTO
Sant'Anna

# Strand 4 – climate analysis

- Reconstruction of climate trends is completed
- Drying November and December (Planting months) and Febrary and March (reproductive stage)
- January is getting wetter

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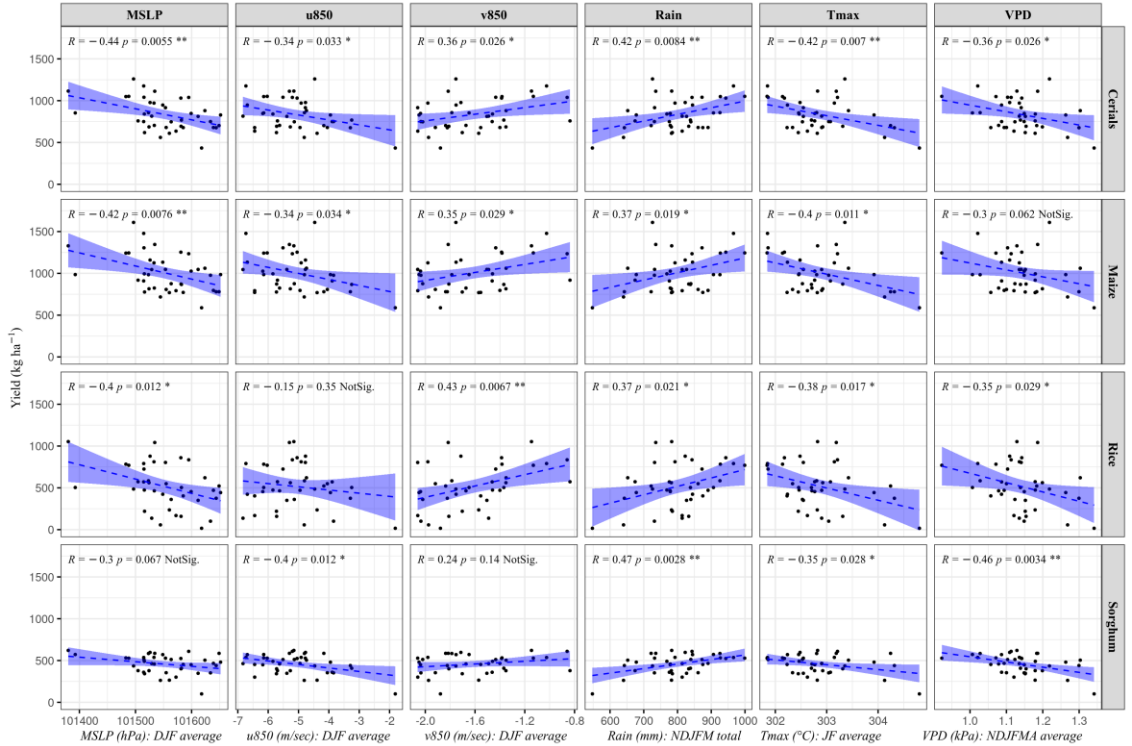


# Enhancing climate adaptation for crop production

**The contribution of modern (molecular) breeding**

- Opportunity to use **integrated approaches** to develop climate-resilient crops
- Identify important traits (genetic factors) and speed up production of new varieties

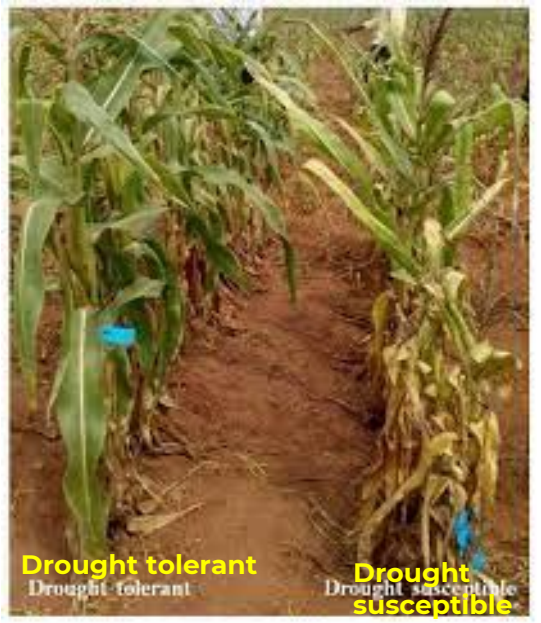
**Genetic resources**
- Landraces
- Wild varieties
- Cultivars

**Genomics & Phenomics**
- Phenotyping
- Computational
- Functional

**Climate resilient Crops**
High yield, drought tolerant, High nutritional value, Disease resistance etc…

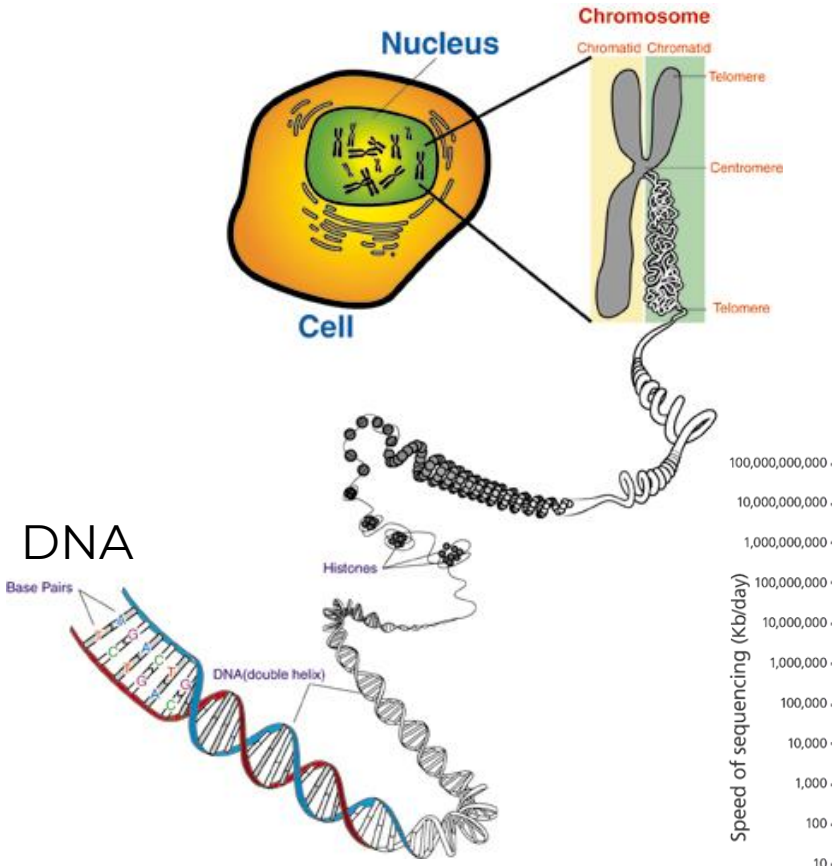
Evaluate existing agrobiodiversity

Pre-breeding activities



# Genomics is a robust tool for harnessing existing agrobiodiversity

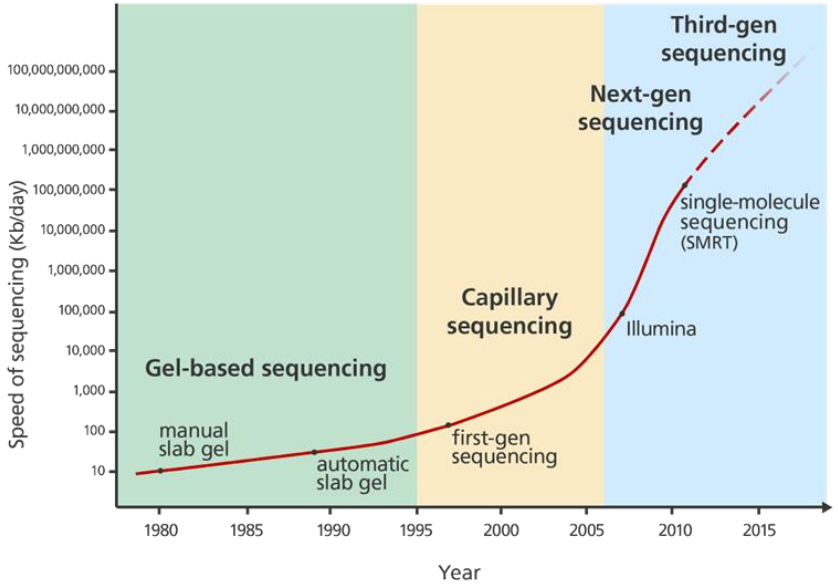
- New untapped genetic agrobiodiversity can be sourced from crop seed banks and traditional farmer fields
- **Genomics** can **speed up** screening and assess value of plant genetic resources

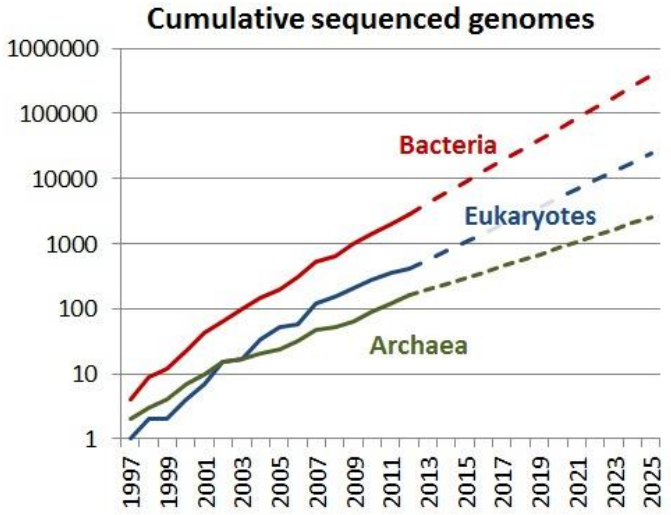



- **Genome**: the whole **GENETIC MATERIAL - DNA** - In a cell, in an organism, or in a species

It is the **POTENTIAL** In terms of functionality of organisms

- Genomic technology has evolved rapidly the last 20+years making DNA sequencing an everyday task

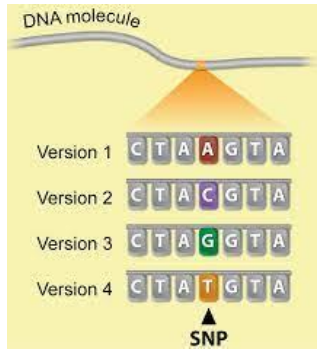


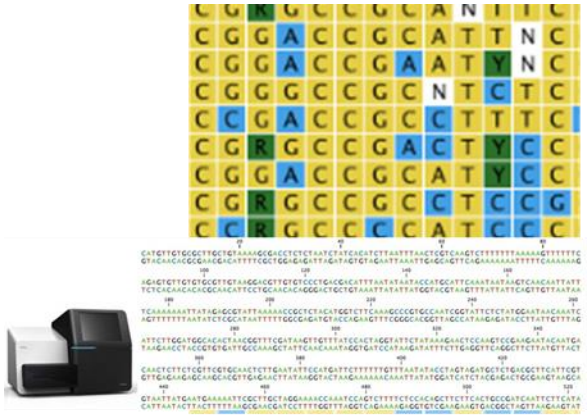
# Genetics of important plant traits

- **SNPs** are single nucleotide polymorphisms in DNA that have different alleles in different individuals. SNPs are used to distinguish segments of DNA

- Current genomic technology can sequence hundreds of thousands of SNP's in each individual

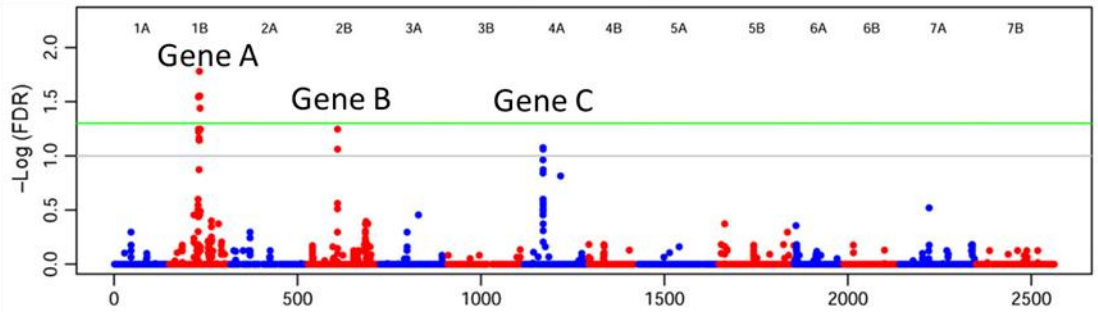



## 1. Genomic SNP data



## 2. Collection of agronomic traits of interest

**3.** Association analysis




## 4. Genomic regions of Breeding interest