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Article | Open Access | Published: 04 April 2022

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Scientific Reports **12**, Article number: 5590 (2022) | Cite this article

Outline

- *Context*
- *Data and methods*
- *Main findings*
- *Take home*

Context

- Orphan crops play an important role in smallholder farmers' food systems (*multipurpose staple crops with high nutritional and economic values, largely grown in marginal areas*)

- Unfortunately, *they are neglected in the mainstream research agenda* and data are scarce about the potential of those crops to withstand current and future climate variations.

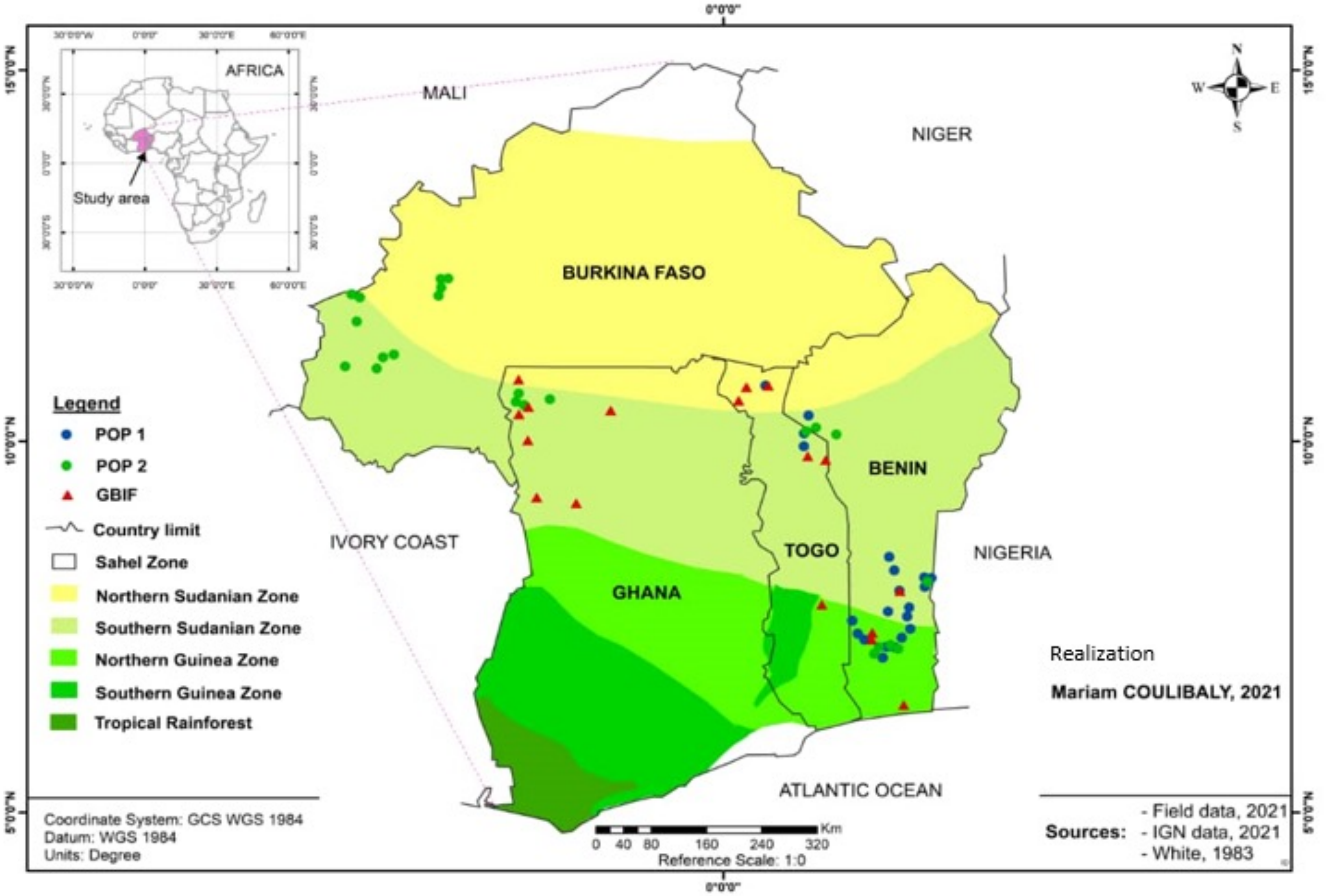
- Defining how and where those species will adequately respond to environmental variations is a central topic in plant science research

- This study uses Kersting groundnut (*Macrotyloma geocarpum)* as case study and examines the response to future climates by using genetic information and niche modeling approach

Kersting's groundnut counts six landraces (a domesticated, locally adapted, often traditional cultivar of a species) within agroclimatic zones in West Africa

Figure 1. Kersting's groundnut seed coat colors.

Data and methods



- A total of 361 accessions of KG collected from Benin, Burkina Faso, Ghana and Togo were used.
- The DNA of each sample was extracted from young leaves and lab manipulations
- The program Structure 2.3.4 was used to assign individuals to different genetic cluster
- Genetic analysis (*AMOVA and pairwise Fst test, etc.*)
- Occurrence data collection (*field, labs and online database*)
- Data processed and models run with maximum entropy method
- Schoener's niche equivalency (identity) and similarity test (D), *ntbox package* *R software*
- MOP analysis (to describe possible changes in distribution patterns under current and future climatic conditions)

Main Findings

- Despite low levels of diversity (He = 0.28 and Ho = 0.023, p.value = < 0.001), Kersting's groundnut populations remained genetically well differentiated (Fig.1) with a Diversity of landraces (Fig. 0).
- 2 distinct populations were identified: Pop1 and Pop2
- A random distribution of landraces within population was observed

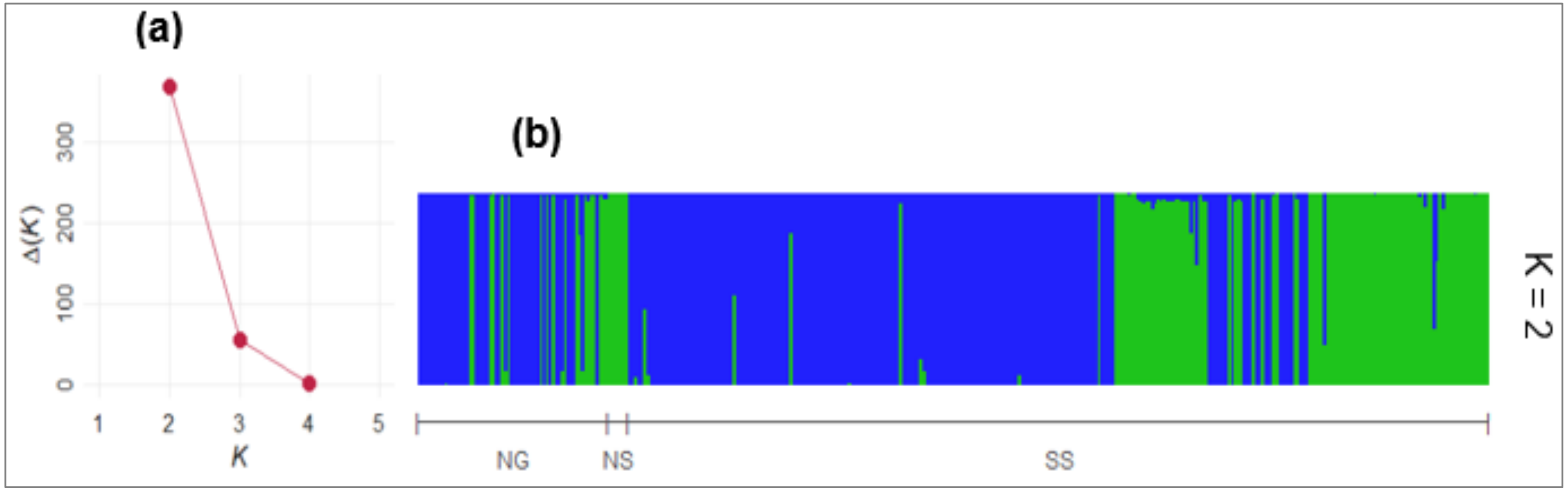
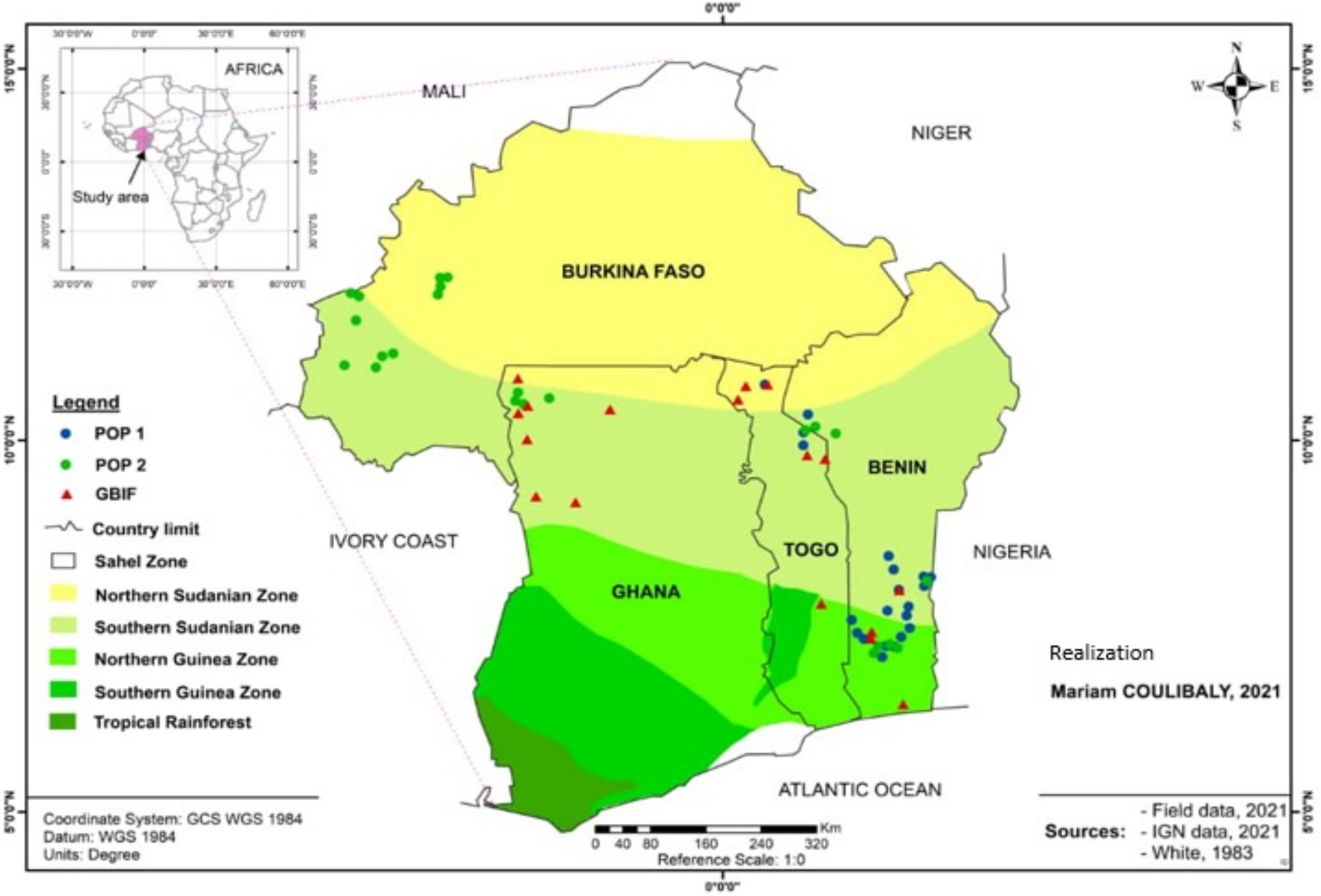
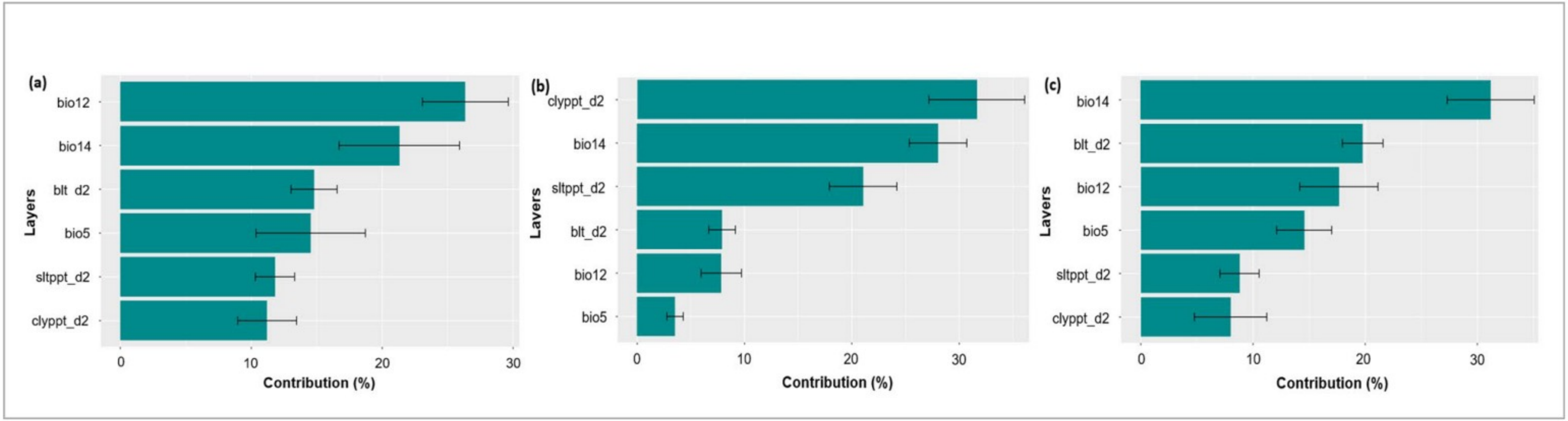


Figure 1. Structure diagram showing the delineation of Kersting's groundnut individuals into two genetic populations (K = 2), Pop1 (Blue) and Pop2 (Green). Vertical lines represent individuals within populations and those with more than one color share genetic information with other populations.


AFRICA
Study area
MALI
NIGER
BURKINA FASO
BENIN
TOGO
GHANA
IVORY COAST
NIGERIA
ATLANTIC OCEAN
Legend
POP 1
POP 2
GBIF
Country limit
Sahel Zone
Northern Sudanian Zone
Southern Sudanian Zone
Northern Guinea Zone
Southern Guinea Zone
Tropical Rainforest
Realization
Mariam COULIBALY, 2021
Coordinate System: GCS WGS 1984
Datum: WGS 1984
Units: Degree
0 40 80 160 240 320 Km
Reference Scale: 1:0
Sources: - Field data, 2021
- IGN data, 2021
- White, 1983
0°0'0"
15°0'0"N
10°0'0"N
5°0'0"N
N
S
E
W

Main Findings

- Climate and soil layers were important in running the models



Main Findings

- Niches between the species and genetic Pops were not identical ($P < 0.01$), but they were similar (Fig 3).

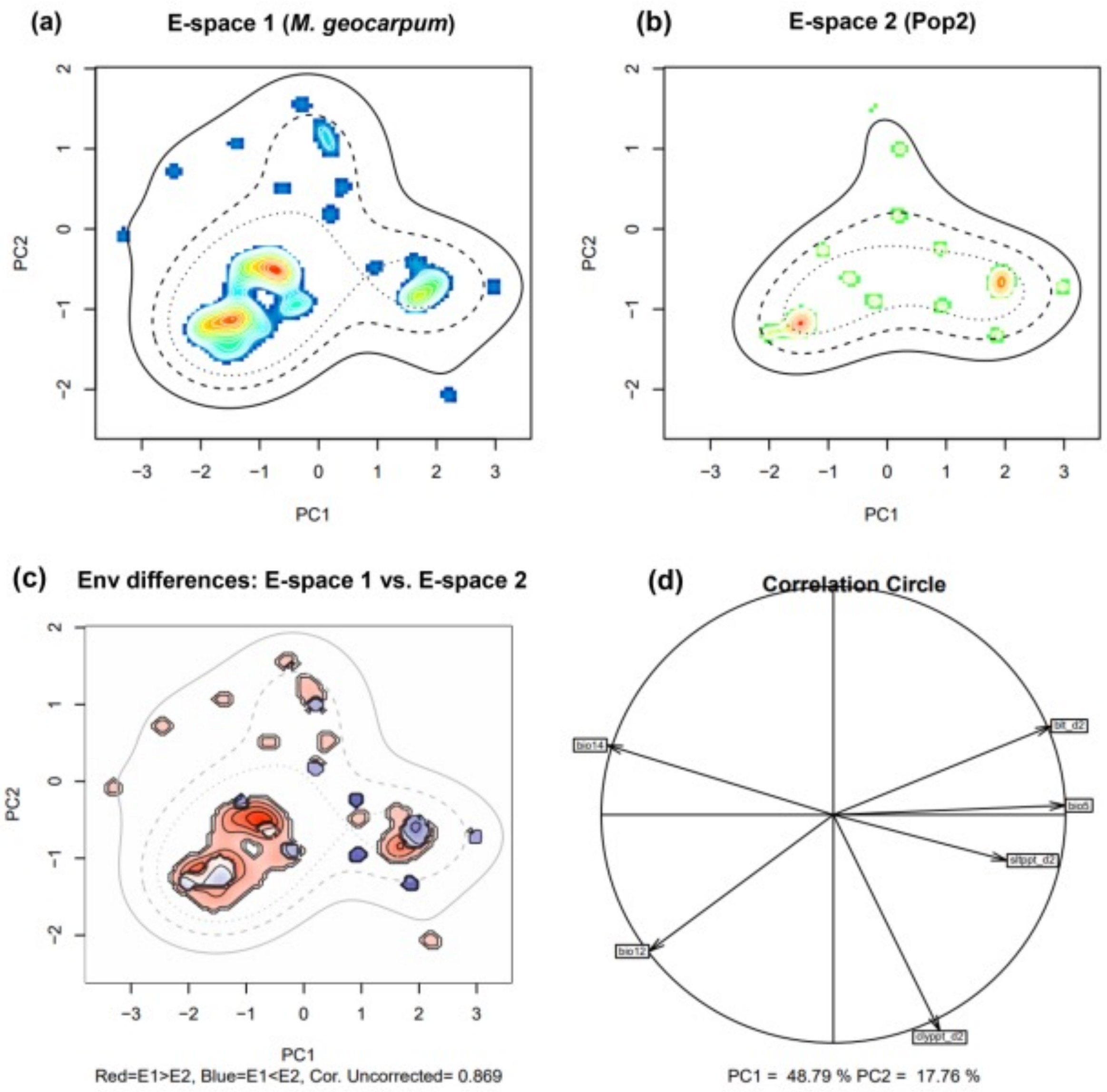


Figure 3. Niches of the two compared groups (*M. geocarpum* and genetic Pop2) in two dimensional E-space. Graphs (a) and (b) represent the niches of species and Pop2, respectively along the first two axes of the PCA. (c): is the diference in the E-space of the two groups, and Niche E-space; (d) is the correlation circle based on the two principal components of the environmental input data.

Main Findings

Models revealed

- Large areas with suitable conditions for the cultivation of KG and genetic populations in the present day with some extension in the future (Fig.4a&b).

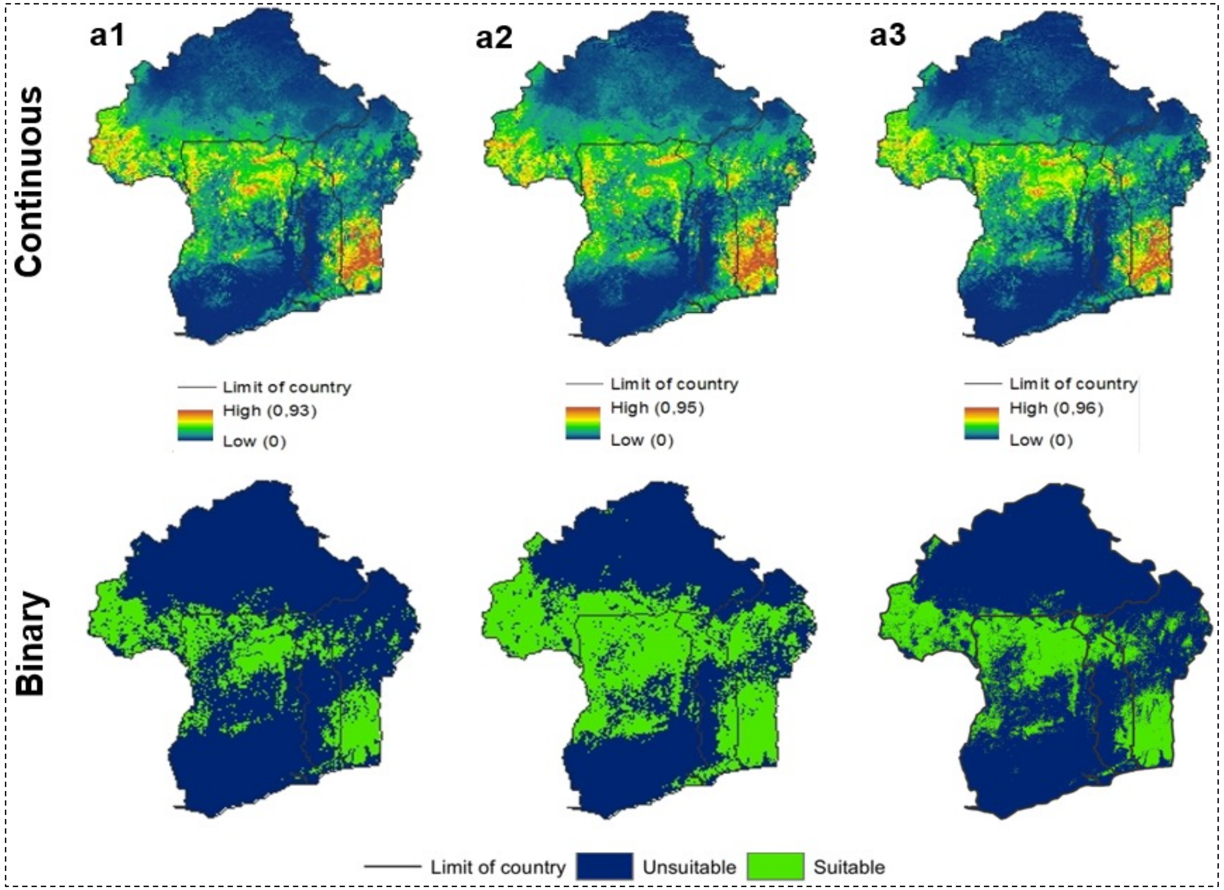
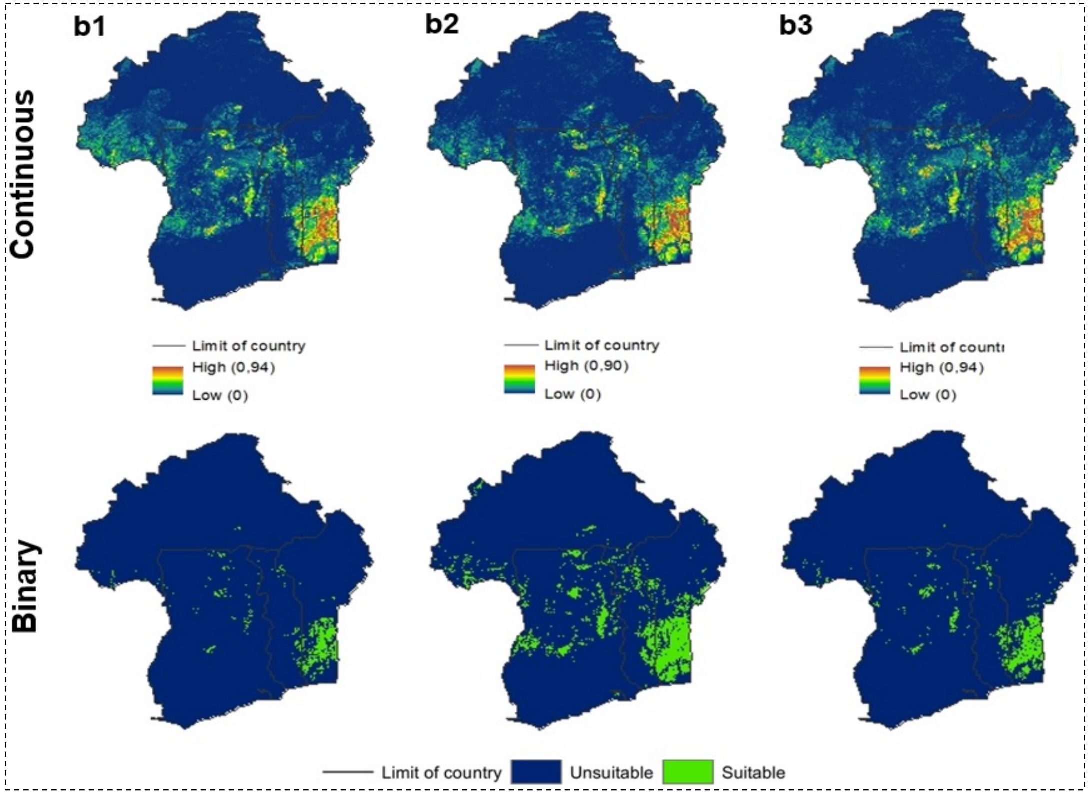


Figure 4a. Binary and continuous maps showing the spatial distribution of M. geocarpum (a1–a3) and genetic Pop1 (b1–b3) and Pop2 (c1–c3) in present and the future days. Each model was set to thresholds with the 10 percentile training presence values to produce continuous and binary raster maps for current and future scenarios in ArcGIS v. 10.7.1.



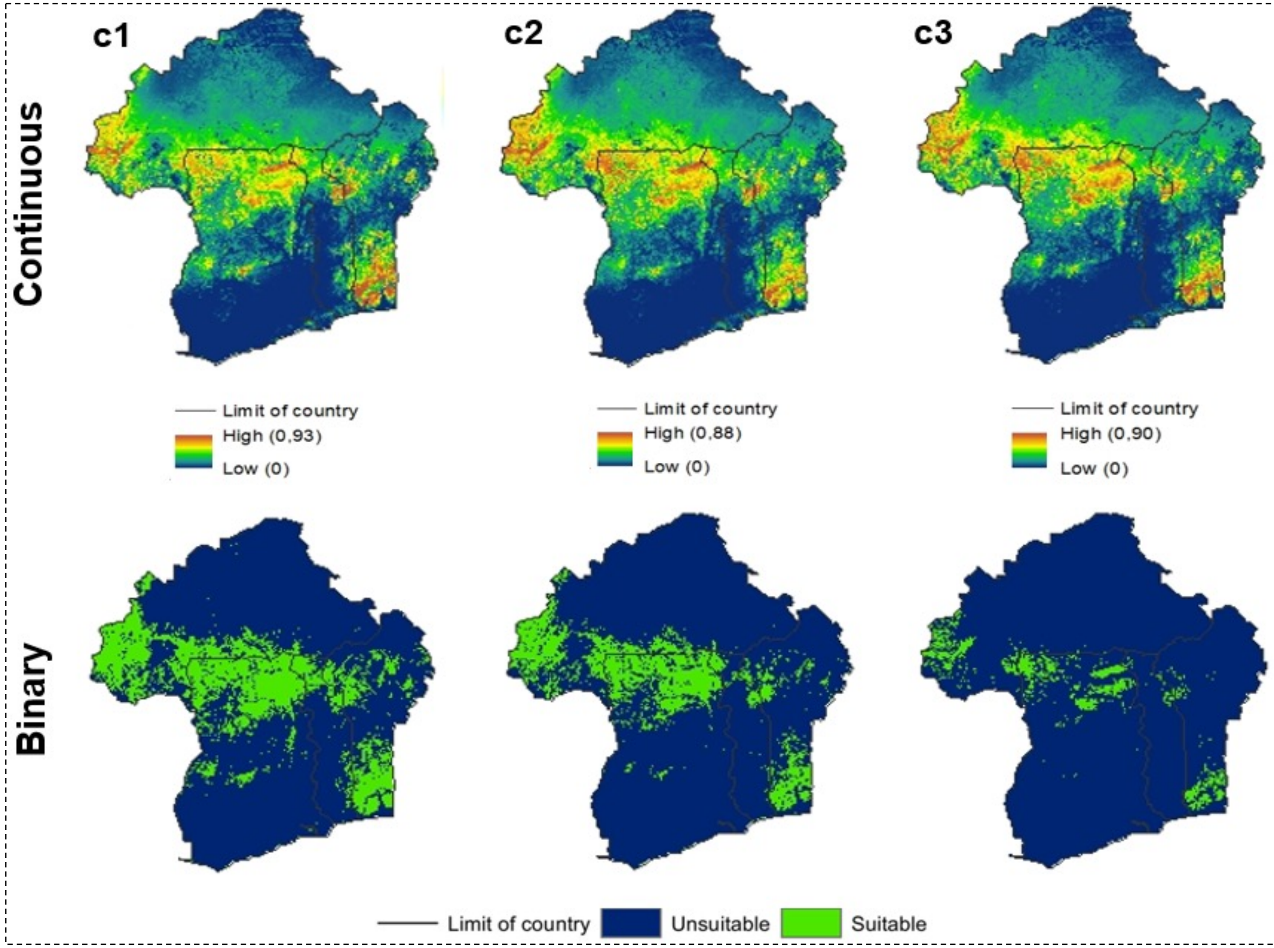


Figure 4b. Binary and continuous maps showing the spatial distribution of genetic Pop1 (b1–b3) and Pop2 (c1–c3) in present and the future days. Each model was set to thresholds with the 10 percentile training presence values to produce continuous and binary raster maps for current and future scenarios in ArcGIS v. 10.7.1.

Main Findings

The MOP results indicated dissimilarity from the extrapolative conditions in the two future scenarios of 2055

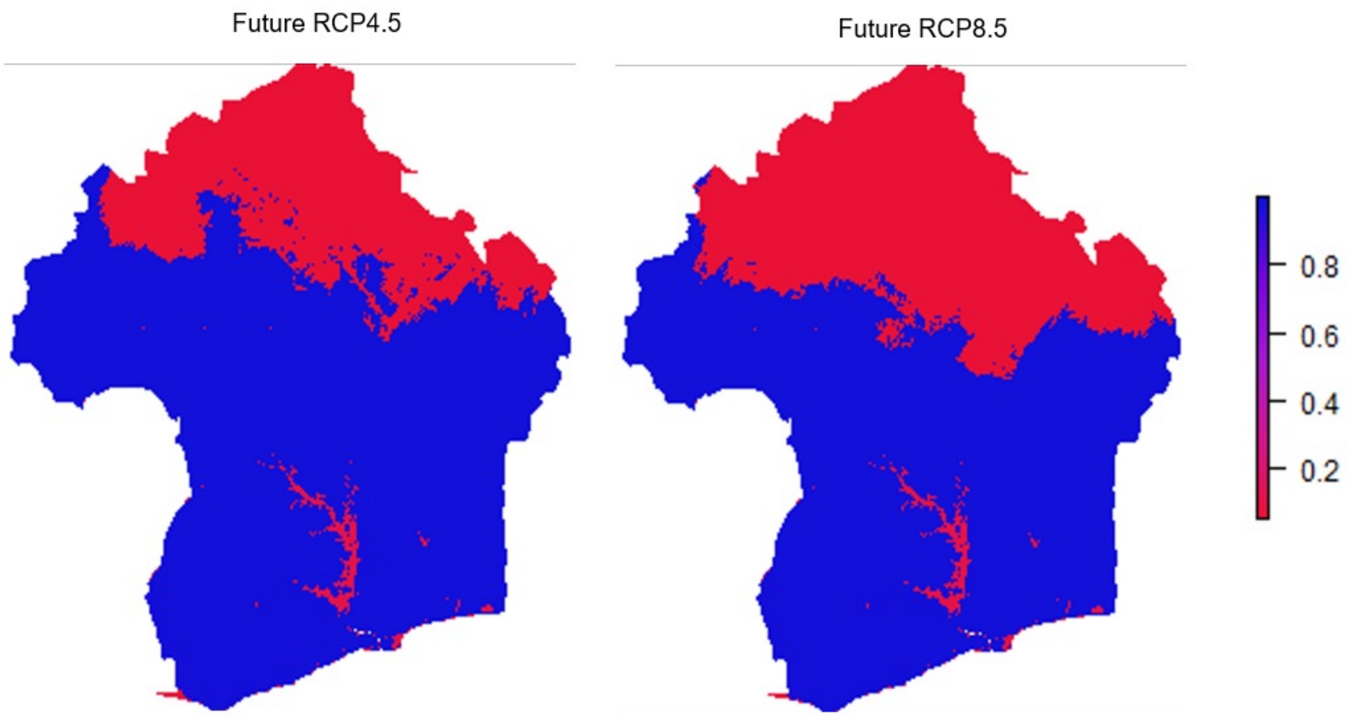


Figure 5. Output of the mobility-oriented parity analysis of KG from 'ntbox'; 0 (Red) represents strict extrapolation areas meaning complete dissimilarity between calibration environments and extrapolation regions in the future; 1 (Blue) area similar to areas where the models have been calibrated.

Software used: ArcGIS v. 10.7.1.

Take home

Using our approach, we identified genetic populations, and cultivable areas for further germplasm collecting to enhance available germplasm and better direct Kersting's groundnut breeding priorities in the future.

This study highlights the importance of incorporating genetic data into Ecological Niche Modeling (ENM) approaches to obtain a finer information of species' future distribution, and explores the implications for agricultural adaptation, with a particular focus on identifying priority actions in orphan crops conservation and breeding.

The overall trend shown by our results indicates an increase in climate suitability for the species cultivation in West Africa thank you