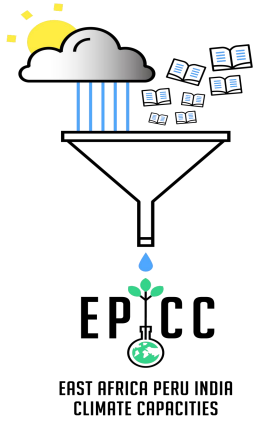# Suitability analysis for major food crops in Ethiopia

Brazil East Africa Peru India Climate Capacities (B-EPICC)
Strengthening Resilience Against Climate Change in Ethiopia.
Project workshop 2023

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Addis Ababa, Ethiopia

Climatic and topographic conditions over Ethiopia

- Annual rainfall amount varies from **2400mm** (southwest) to **500mm** (northeast).

- Mean temperature varies from **–15°C** over the highlands, to above **25°C** in the lowlands.

- A highly complex and ragged terrain elevation changes from **116m** below m.s.l to **4600m** above m.s.l.

Made with QGIS and GMTED2010 DEM from USGS

Elev (meters)
4.420
-121
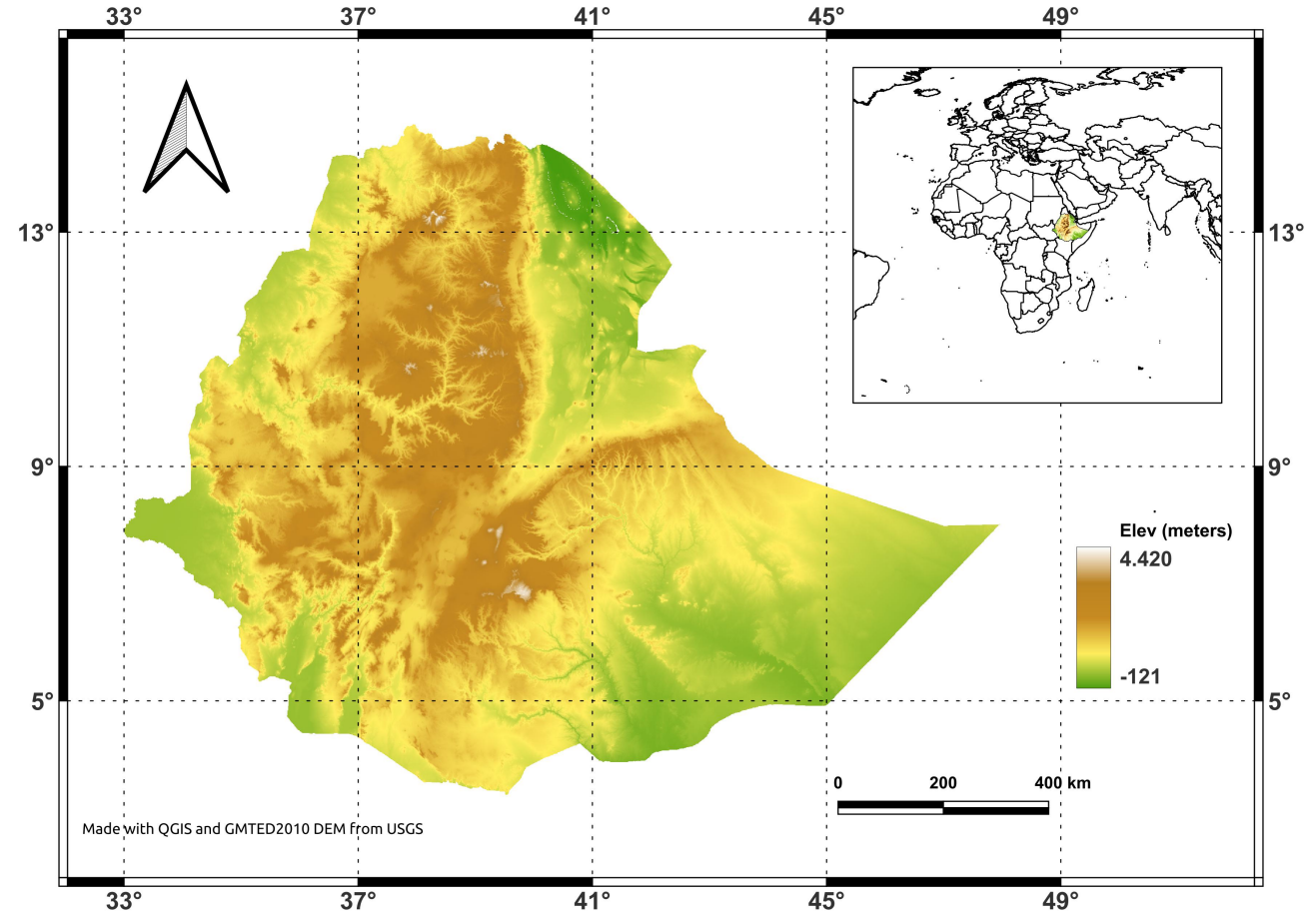
Rainfall and agricultural practices

- The two main rainy seasons are: the short rain **Belg** (MAM) and long rain **Kirmet** (JJAS).

- The **Kiremt** rainfall accounts for **50-90%** of the annual precipitation in the country (Gliexiner et al., 2017; Viste and Sorteberg, 2013; Korecha and Barnston, 2007).

- Agriculture industry is the backbone of the Ethiopian economy and it contributes **52%** of the Gross Domestic Product (GDP)(CSA, 2005).

- About **80%** of the population depend on it for sustenance and livelihood.

- Rainfall variability is the fundamental cause of crop failure and drought in northern Ethiopia (Araya and Stroosnijder, 2011).

Major crops for food in Ethiopia

Apart from other crops utilized for food in Ethiopia, the following are the major crop types supporting the dietary complements:

- Teff

- Maize

- Barley

- Wheat (common)

Crop types used for suitability analysis

Crop name	Scientific name	Genus	Species
Teff	Eragrostis tef (Zucc.) Trot	Eragrostis	Eragrostis tef
Maize	Zea mays L. s. mays	Zea	Zea mays
Barley	Hordeum vulgare L.	Hordeum	Hordeum vulgare
Wheat (common)	Triticum aestivum L.	Triticum	Triticum aestivum

Eragrostis tef: out of 100 gram of teff flour, one can get:
- Protein: 12.2 g,
- Fat: 3.7 g,
- Carbs: 70.7 g,
- Fiber: 12.2 g,
- Iron: 37%, and Calcium: 11% of the Daily Value (DV).
- it is also gluten-free.

(Tadel and Hibistu., 2021)

Climate and soil PH datasets used

Data type	Historical	Future
Precipitation[1]	1970-2000	2041-2060 (ssp370)
Average temperature[1]	1970-2000	2041-2060 (ssp370)
Soil PH[2]	2015	2015 (0.0, 0.5, 1.0, 1.5)

[1] Worldclim V2.1
[2] ISRIC - World Soil Information

Shared Socioeconomic Pathways (SSPs)

Future crop environmental requirements for suitability analysis have been conducted using the Shared Socioeconomic Pathways (SSPs) scenarios of projected socioeconomic global changes up to 2100 datasets. The scenarios are: *Source: Wikipedia*

SSP	Scenario	Estimated warming (2041–2060)
SSP1-1.9	**very low GHG emissions:** CO_2 emissions cut to net zero around 2050	1.6 °C
SSP1-2.6	**low GHG emissions:** CO_2 emissions cut to net zero around 2075	1.7 °C
SSP2-4.5	**intermediate GHG emissions:** CO_2 emissions around current levels until 2050, then falling but not reaching net zero by 2100	2.0 °C
SSP3-7.0	**high GHG emissions:** CO_2 emissions double by 2100	2.1 °C
SSP5-8.5	**very high GHG emissions:** CO_2 emissions triple by 2075	2.4 °C

https://www.carbonbrief.org/

Climate models employed in the analysis

| Climate models	Model descriptions
CanESM5	Canadian Earth System Model, Earth System Model.
MPI-ESM1-2-HR	Max Planck Institute for Meteorology, Earth System Model.
MRI-ESM2-0	Meteorological Research Institute (MRI) of Japan, Earth System Model.
UKESM1-0-LL	UK Earth System Model.

These models' datasets are downloaded from the Worldclim data archive derived from the CMIP6 future projections on Shared-Socioeconomic Projection **SSP3-7.0** for **2050**s.

Crop suitability analysis model

- FAO's process-based crop model "**Ecocrop**" is applied.

  - Ecocrop assesses the adequacy of climatic conditions (i.e., temperature and rainfall) within a growing season, besides soil PH information for crops. It evaluates the climatic suitability based on rainfall and temperature marginal and optimal ranges. https://gaez.fao.org/pages/ecocrop

- Model validation is determined from the **GBIF** (Global Biodiversity Information Facility) datasets.

  - GBIF is an international network and data infrastructure that freely shares biodiversity data and information about where and when species have been recorded. https://www.gbif.org/

Overview of current rainfall and temperature climatology (1980's)

Rainfall (mm/month)
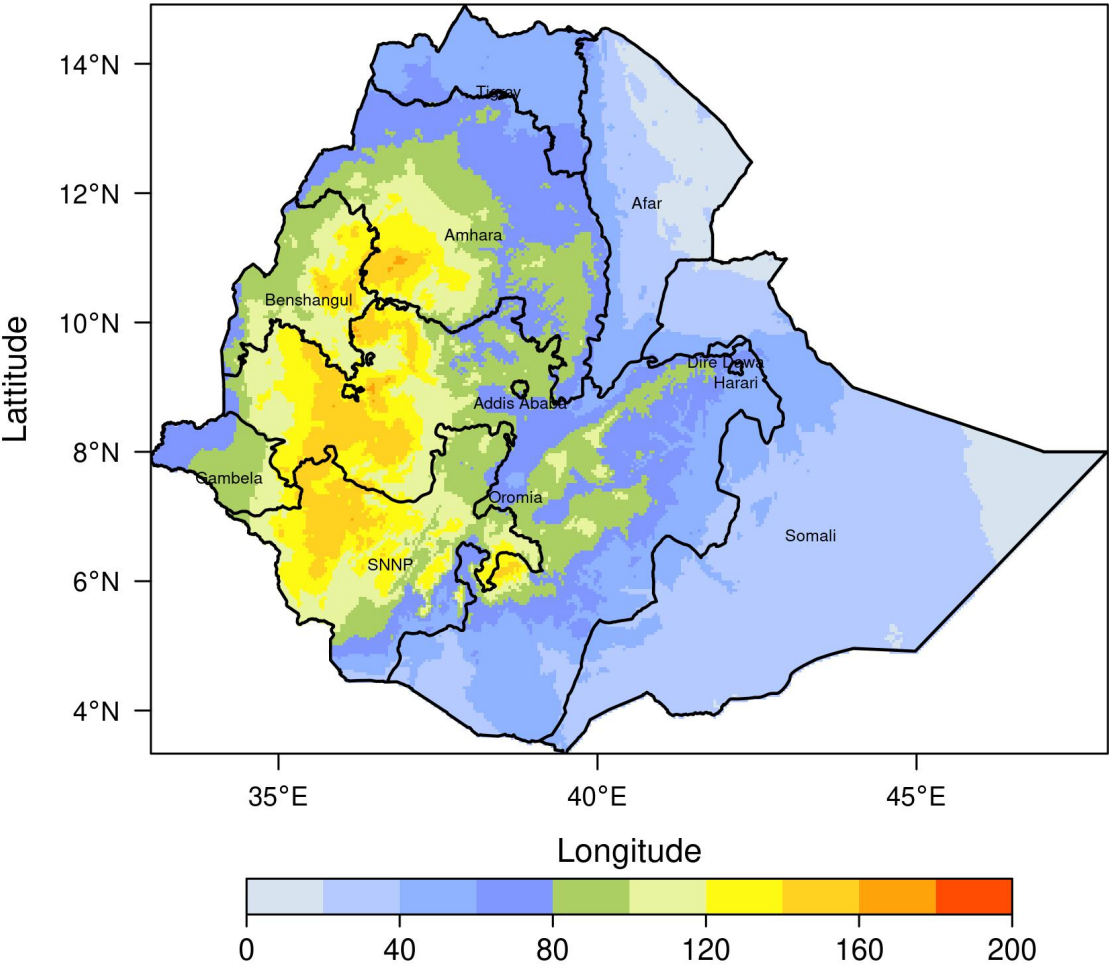
Temperature (degC)
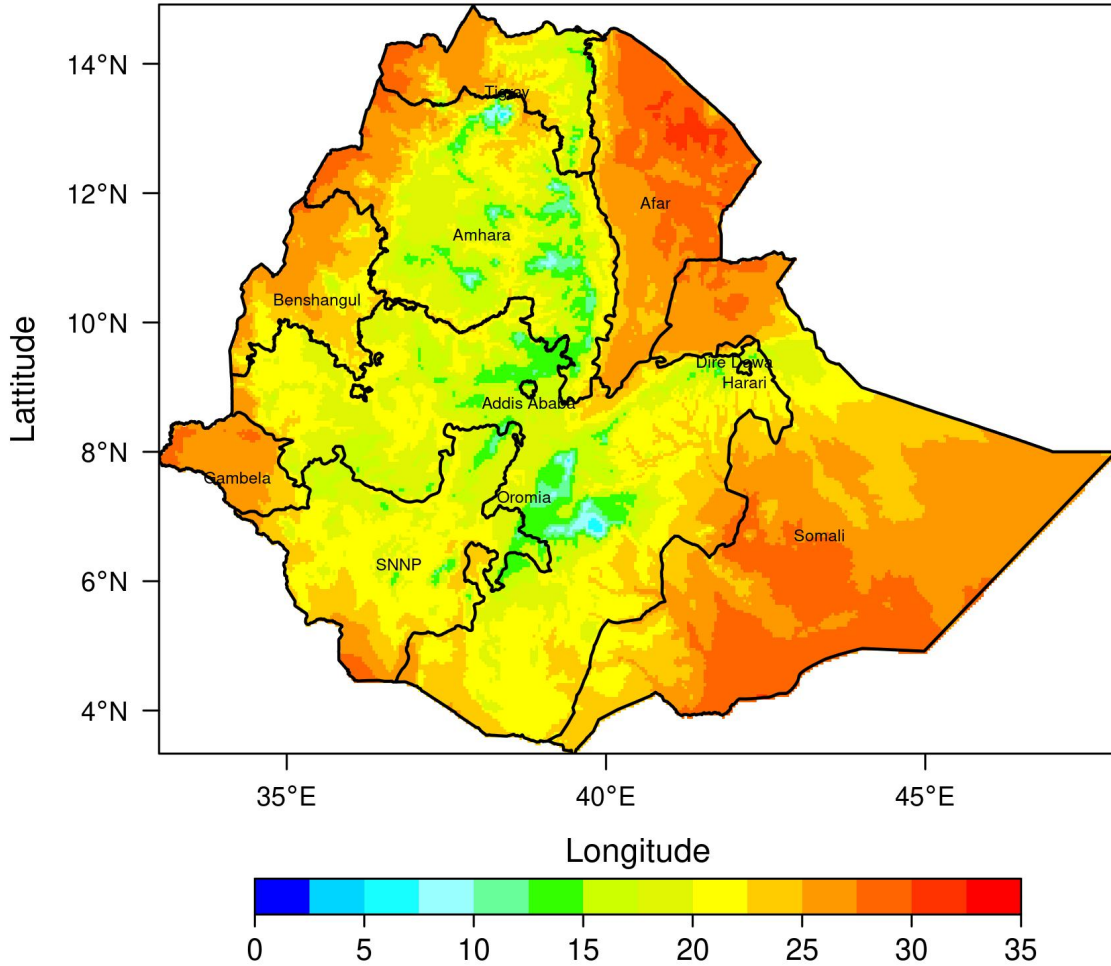
Overview of Soil PH
(Now)

- Current soil PH value distribution over the country.

Soil PH
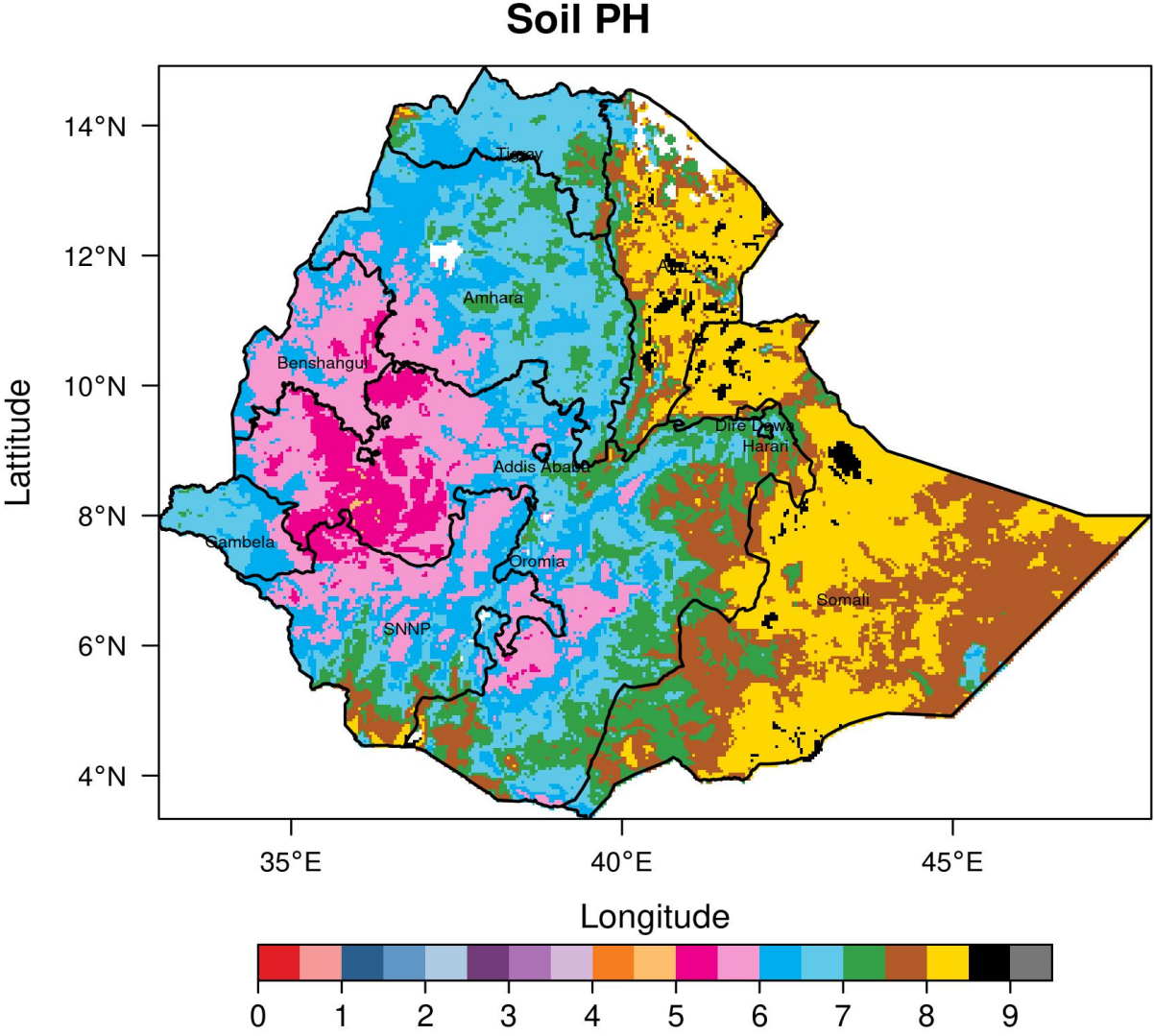
Suitability results
(current)

Current crops suitability
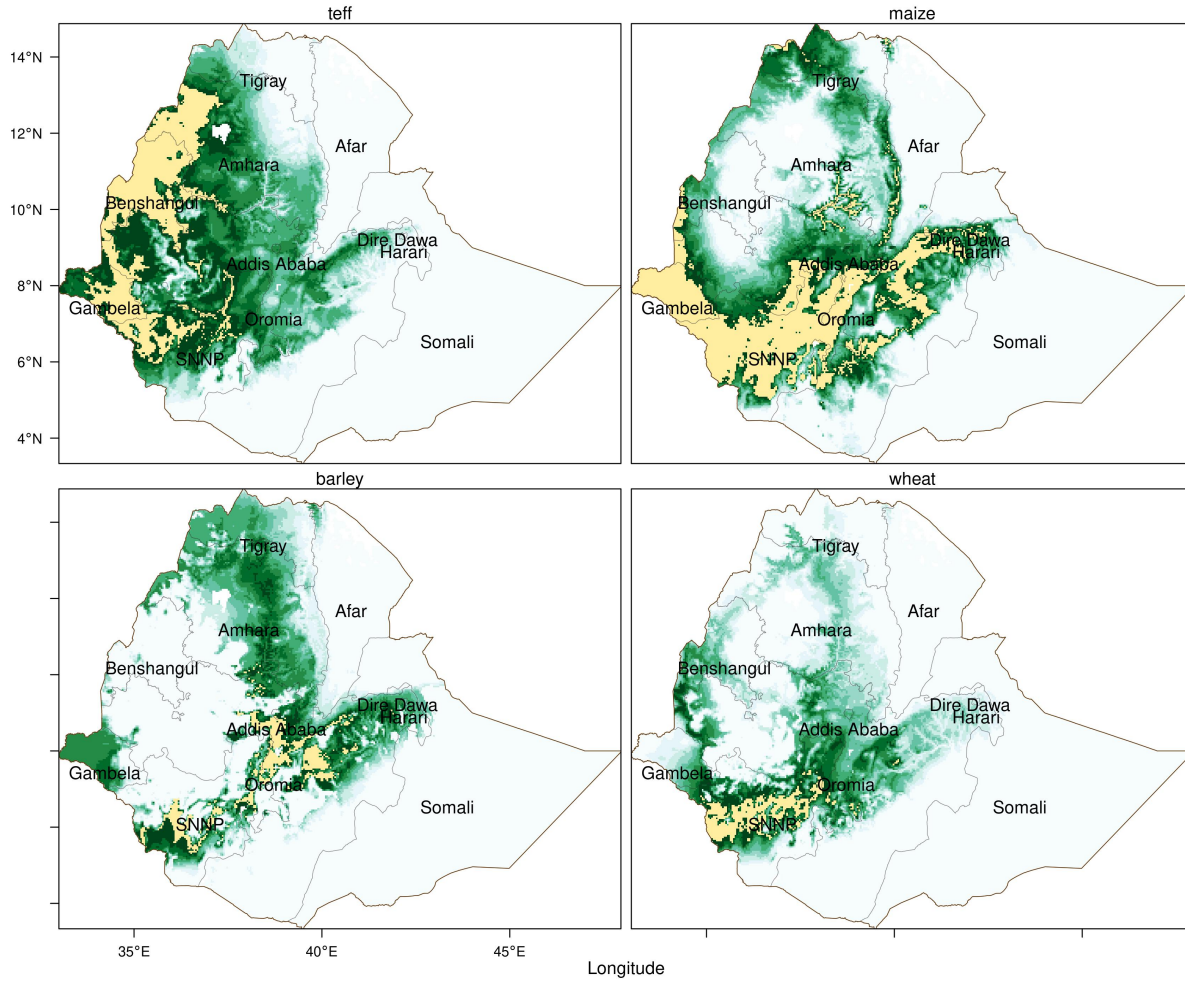
Current crops suitability based on GBIF validation
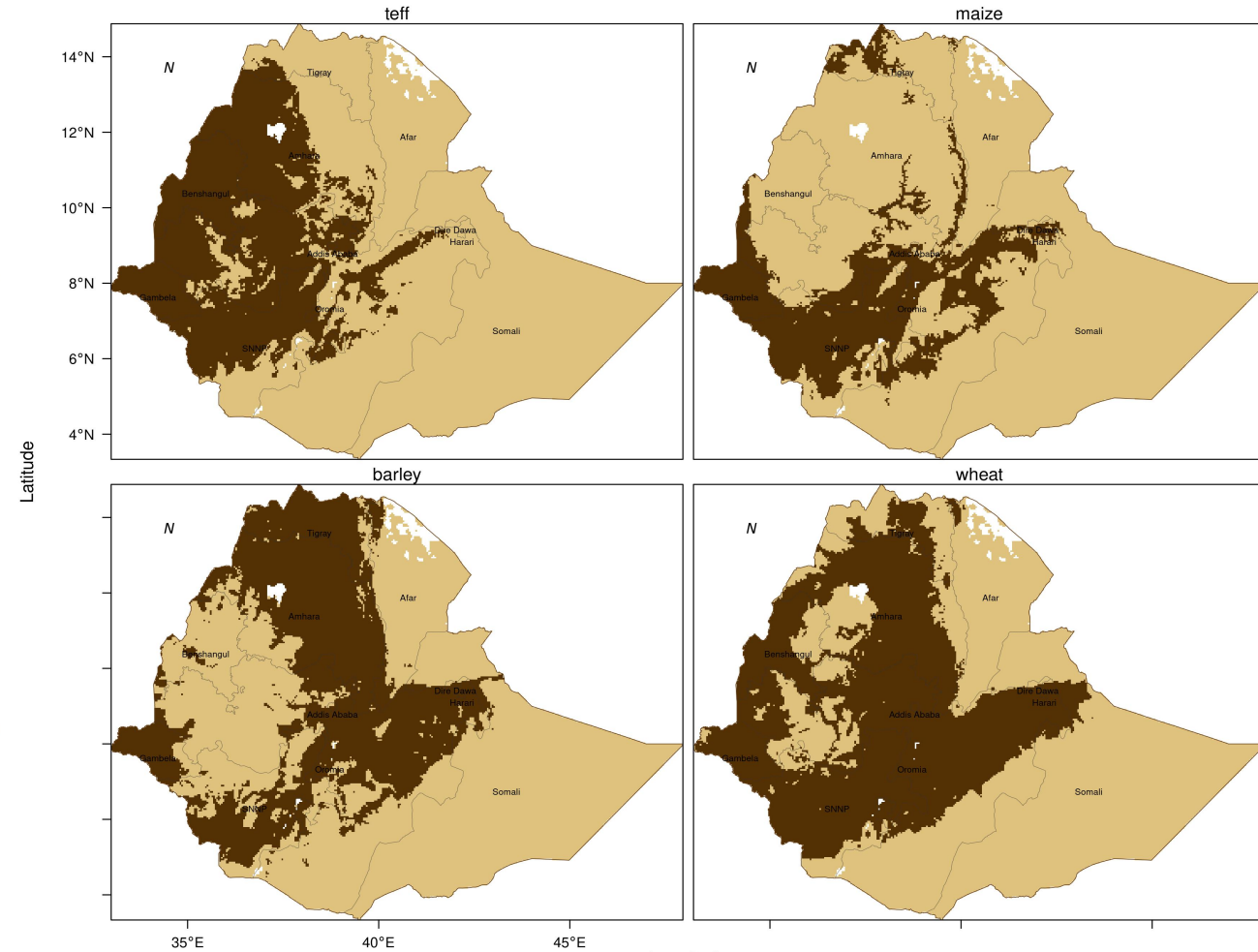
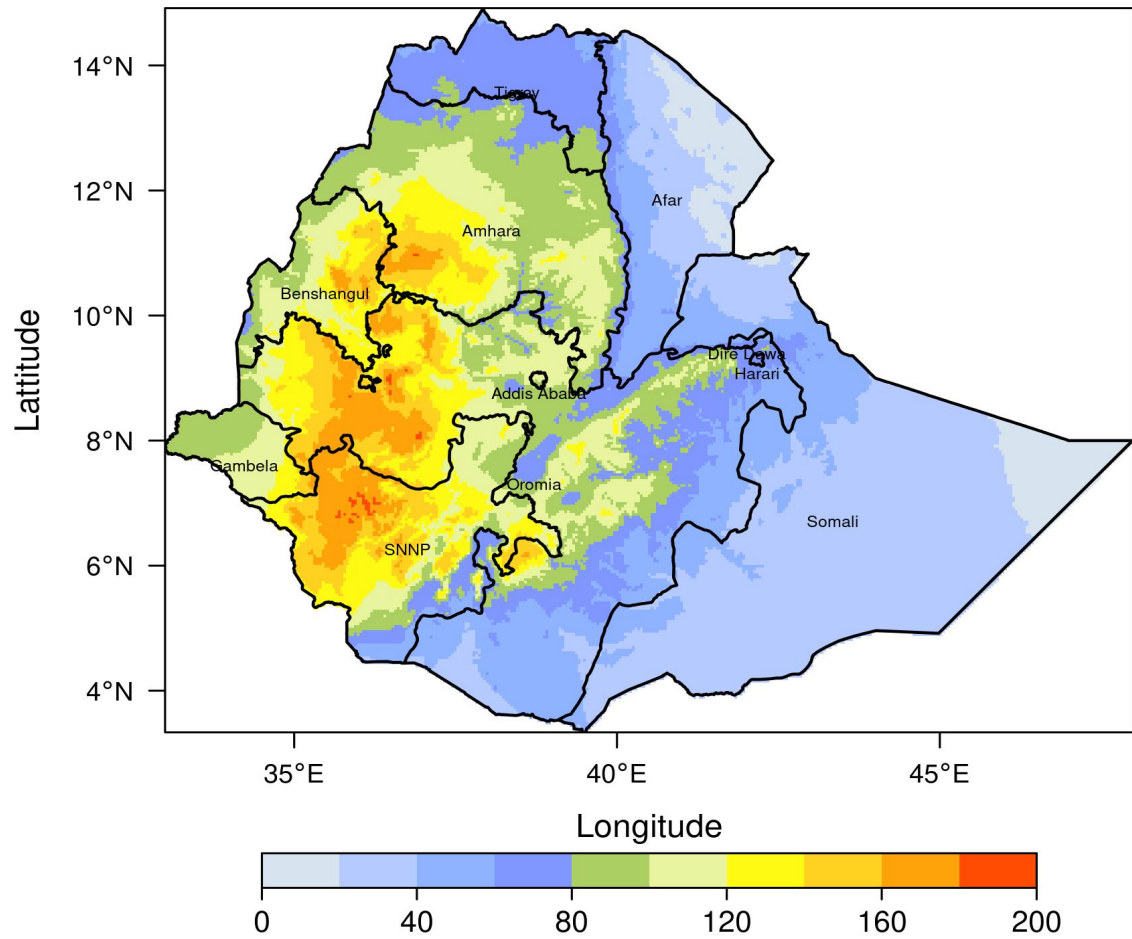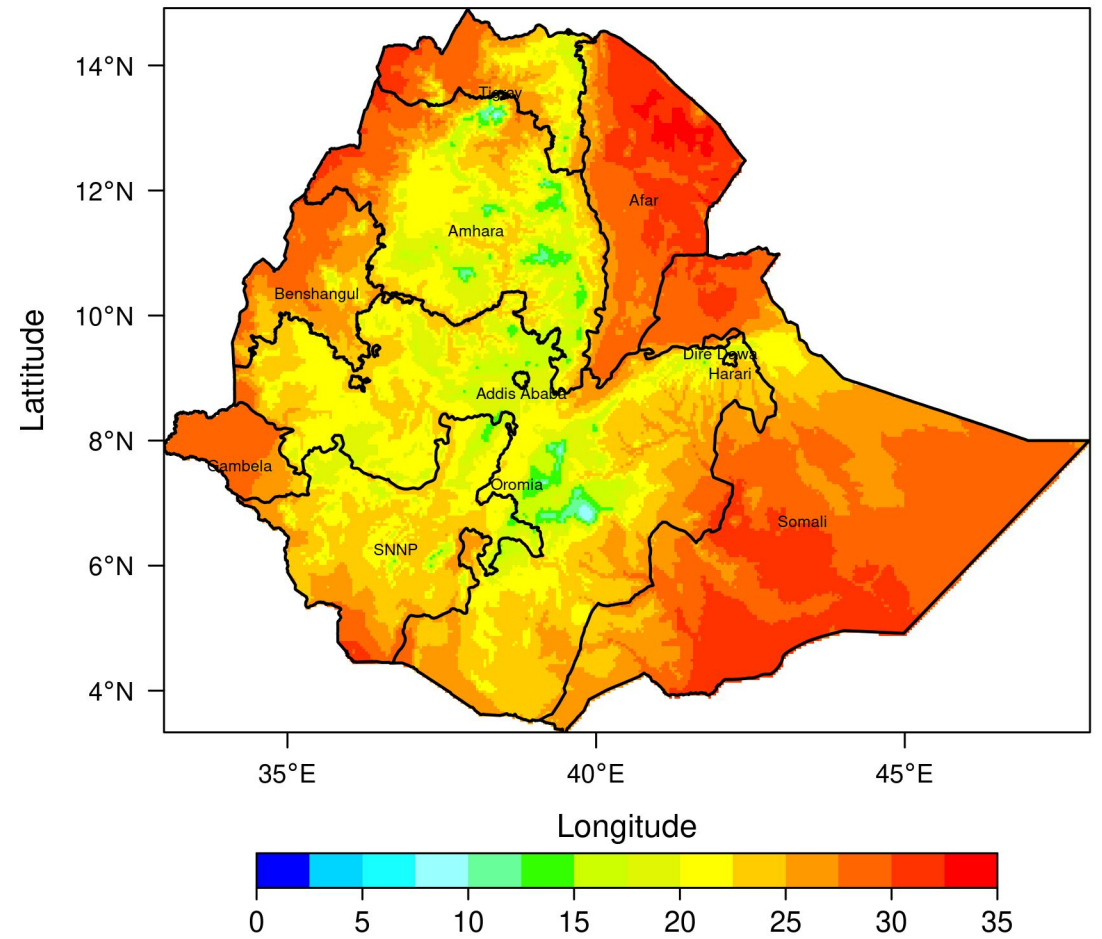# Suitable area for crops results
(current)
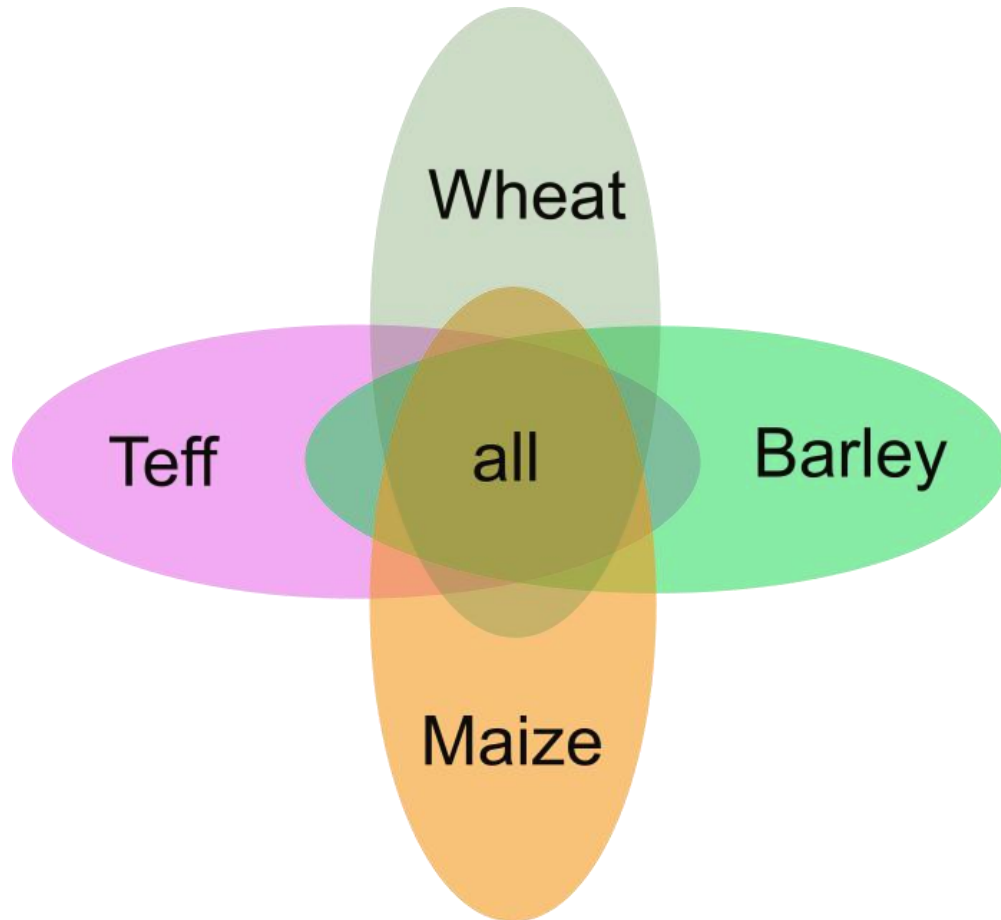
Suitable area for crops
(percent)

- Teff: 32%
- Maize: 21%
- Barley: 36%
- Wheat: 44%

Future rainfall and temperature climatology
(2050s)

Rainfall (mm/month)
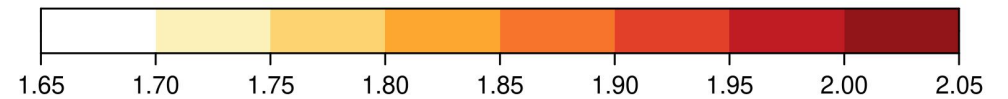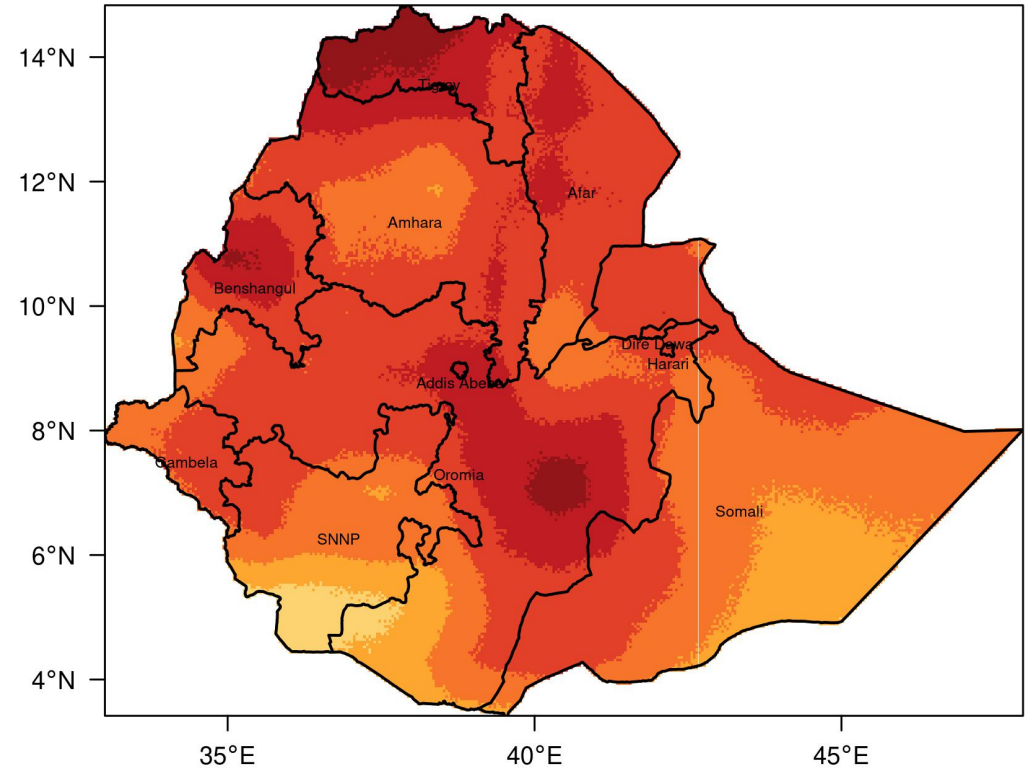
Temperature (degC)

Rainfall and temperature anomalies
Future (2050s) minus Current (1980s)

Future - Current
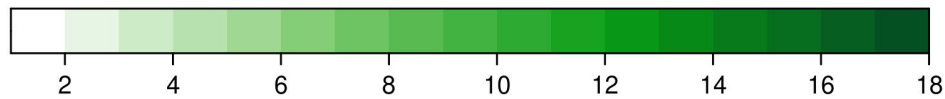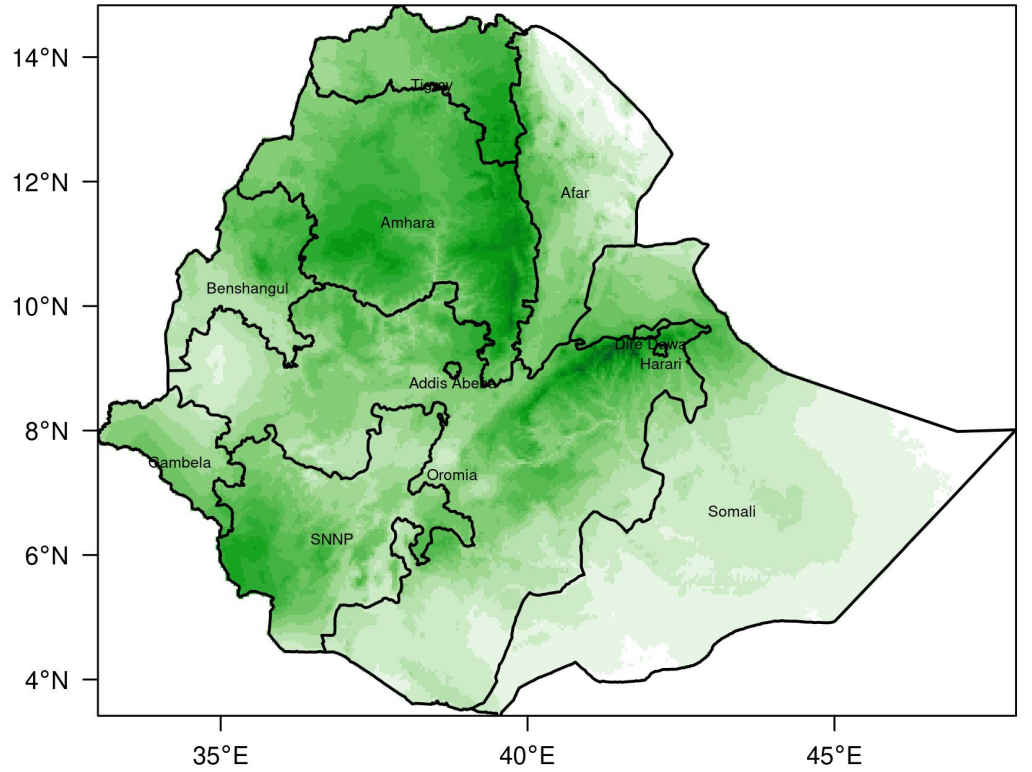
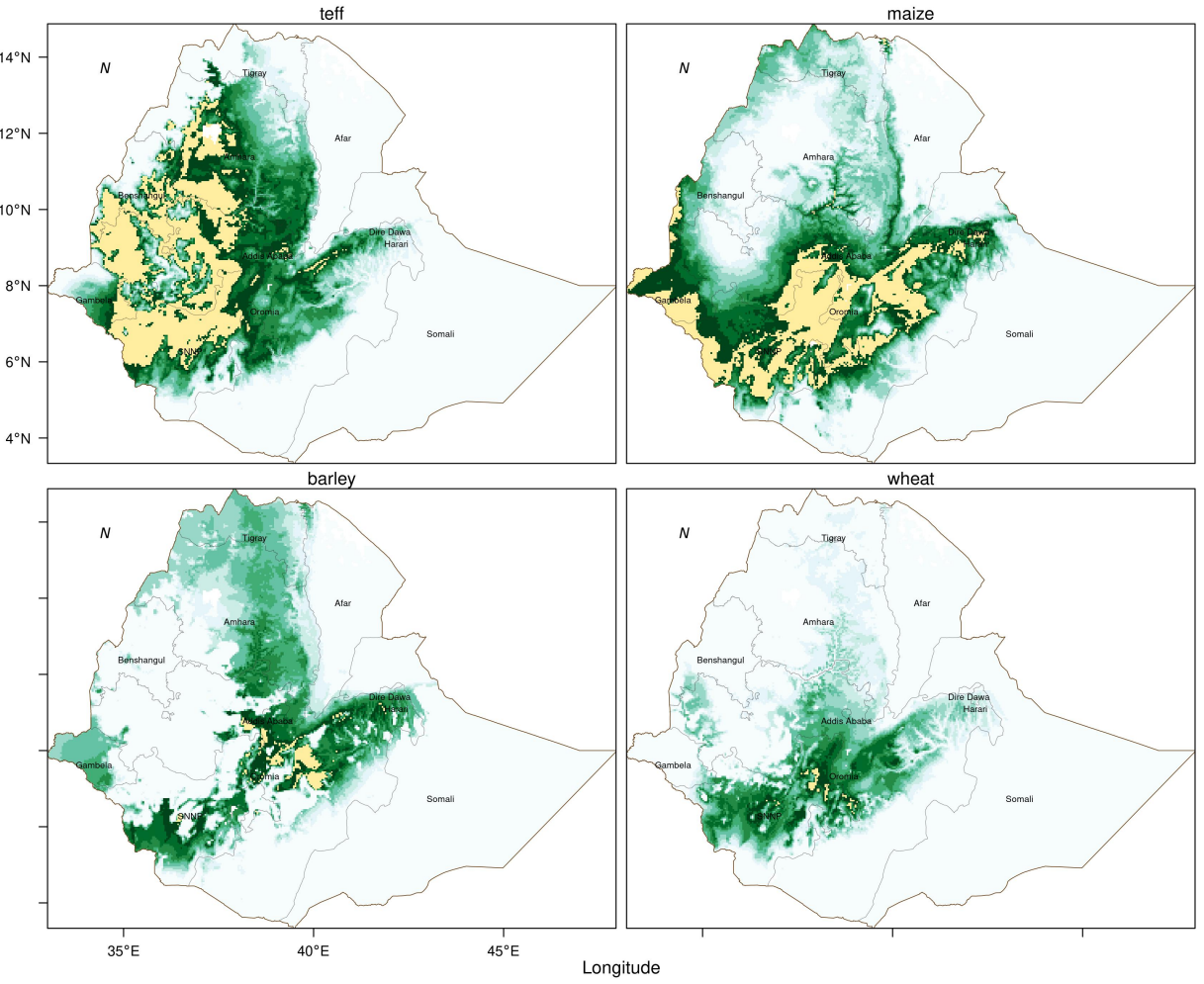rainfall (mm/month)

Future - Current

temperature (degC)

Suitability results
(current and future)

Current crops suitability

teff

maize

barley

wheat

models average future crops suitability ssp370 at 0.0 PH

teff

maize

barley

wheat
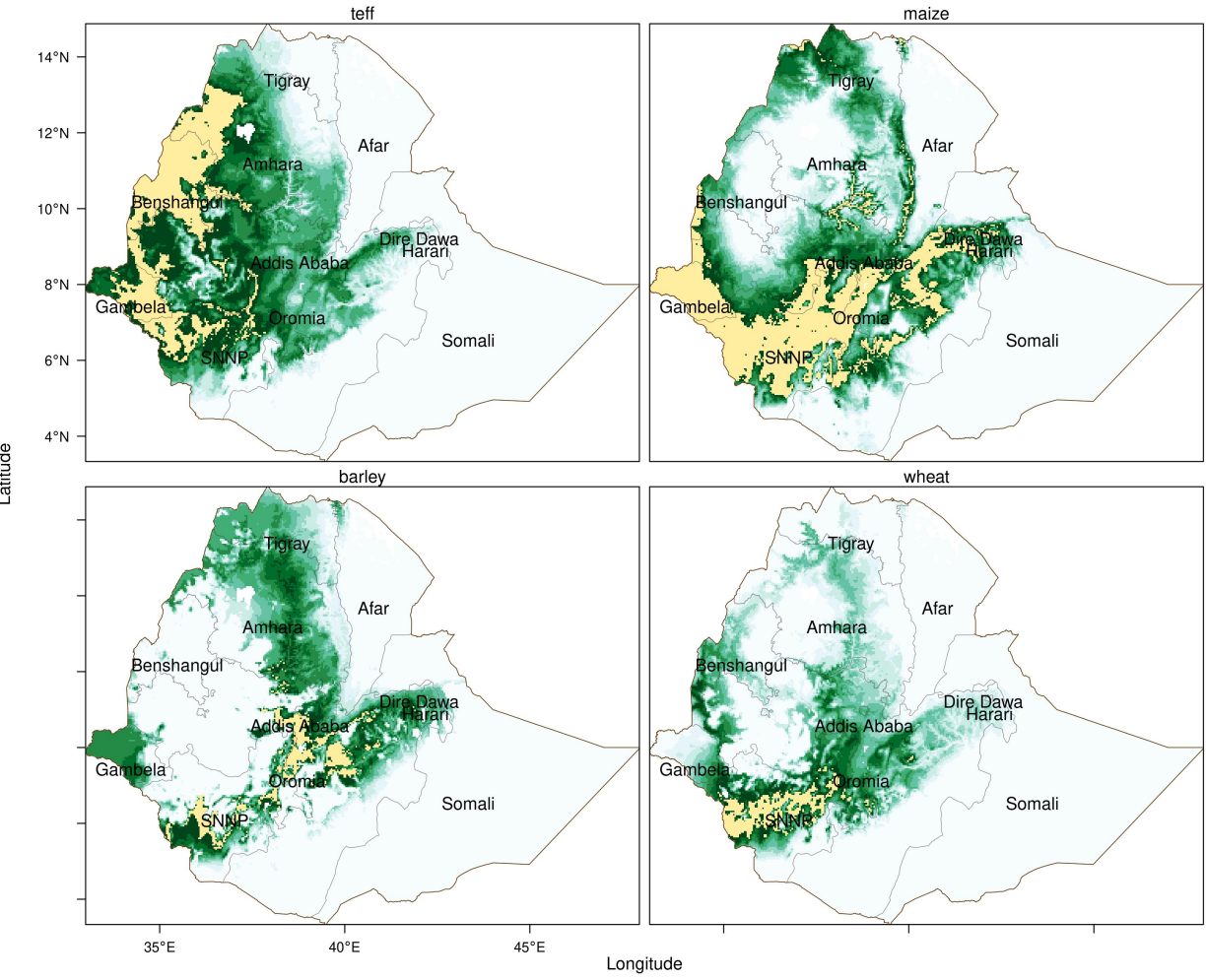
Suitability results
(future change in soil PH)

ensmean future crops suitability ssp370 at 0.5

teff   maize

barley   wheat

unsuitable   suitable

ensmean future crops suitability ssp370 at 1.5

teff   maize

barley   wheat

unsuitable   suitable
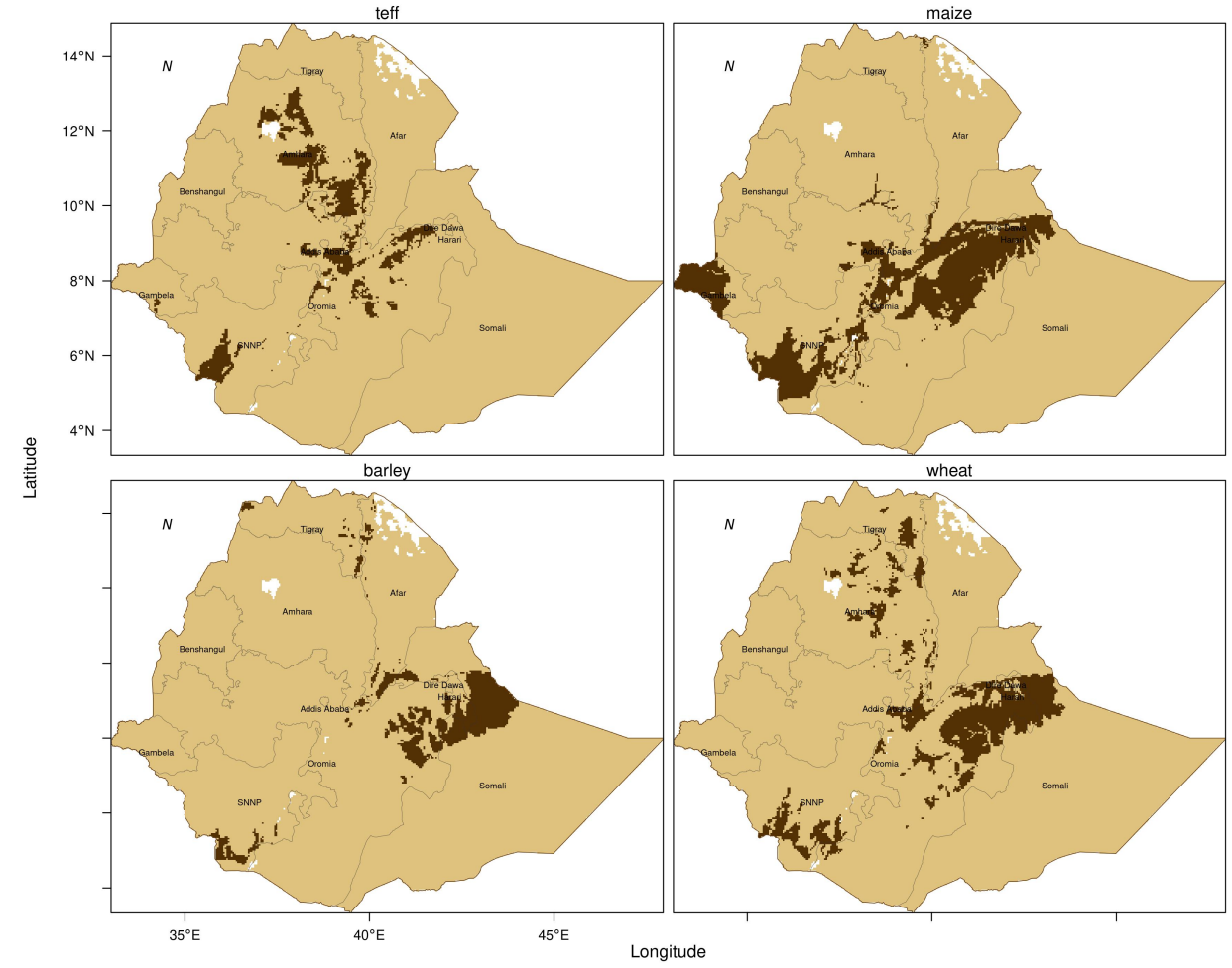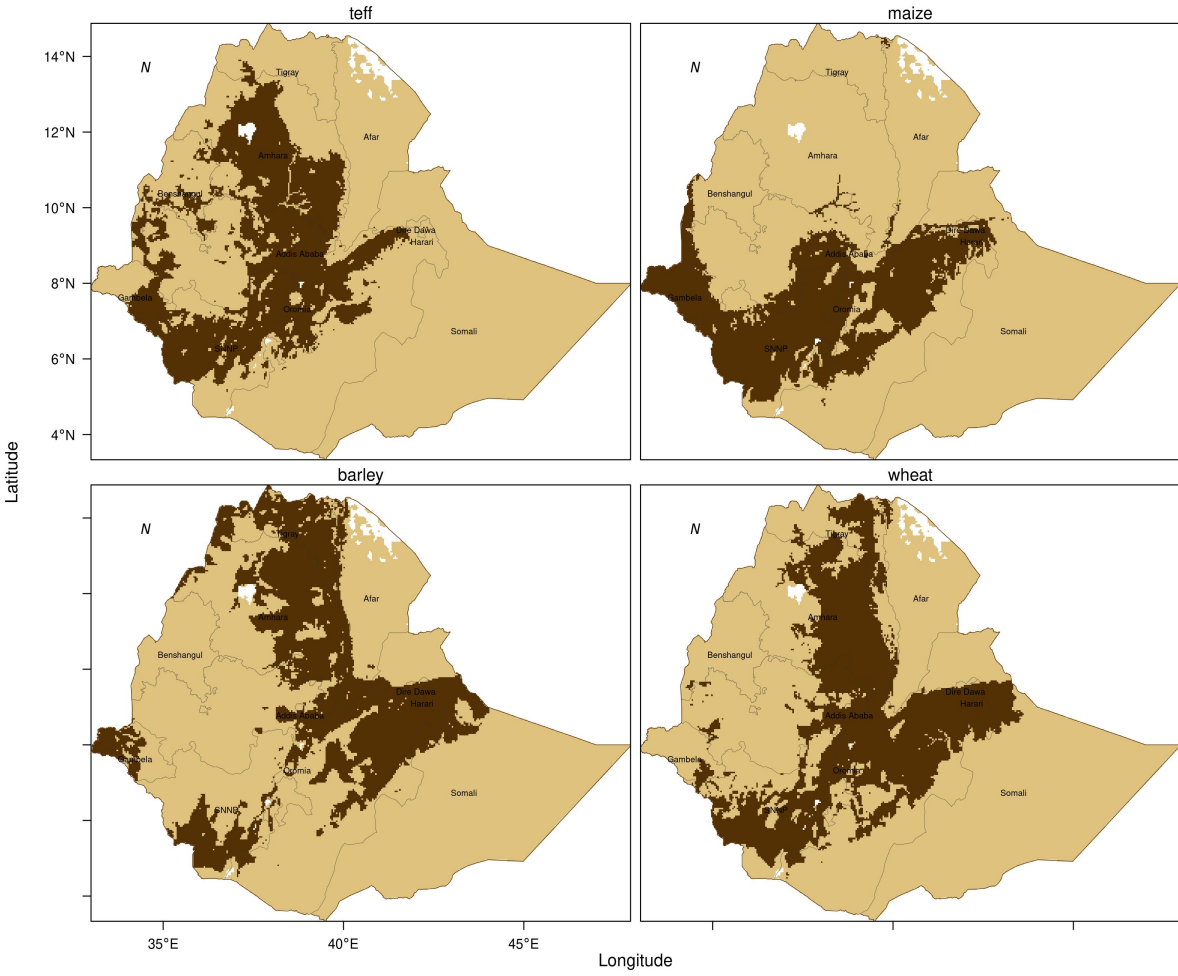
Suitability difference analysis
(future - current)

- Future crop suitable area changes concerning a changing soil acidity.

- The hypothetical decline of soil PH value by 0.0 (**no change**), 0.5, 1.0, and 1.5.

Thank you!