中国科学院空天信息创新研究院

Aerospace Information Research Institute (AIR)
Chinese Academy of Sciences (CAS)

Crop production, crop yield dataset and Attainable yield gap analysis in Africa

Dr. Hongwei Zeng

Email: zenghw@aircas.ac.cn

Workshop on advancing satellite-based crop monitoring to increase resilience in the face of global food insecurity

July 2, 2024, Abuja, Nigeria

Food Insecure Issues in Africa

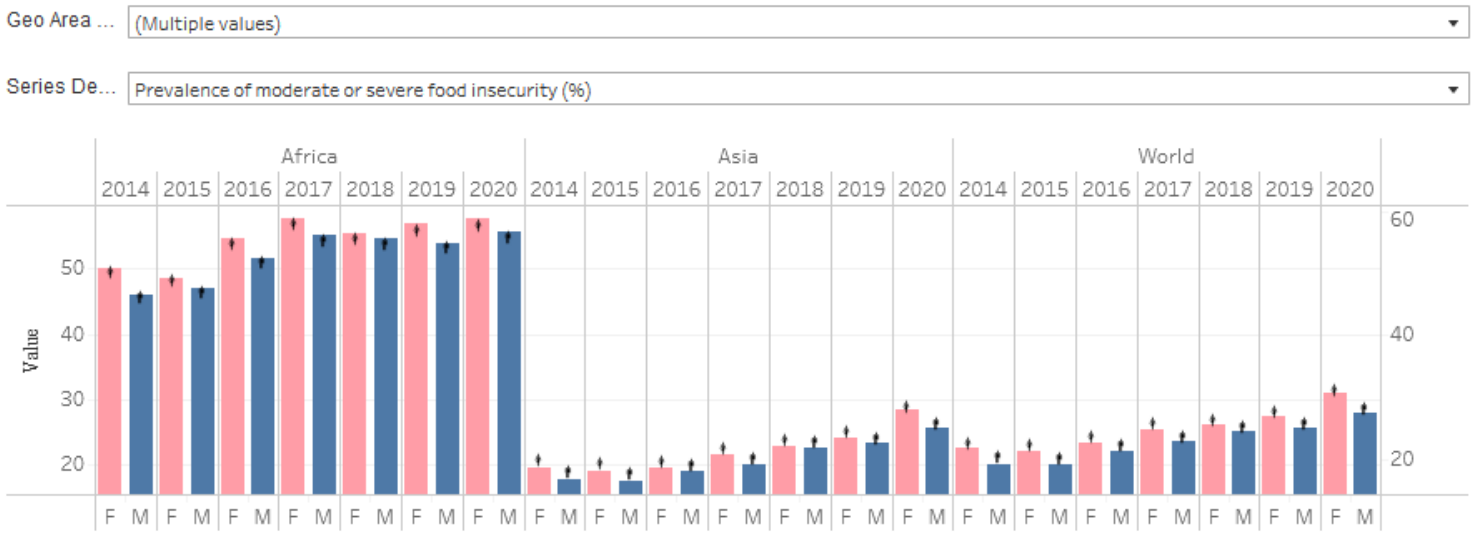
SDG2 Goal: creating a world without hunger

- ✓ 2.1 By 2030, end hunger and ensure access by all people to safe, nutritious, and sufficient food all year round.

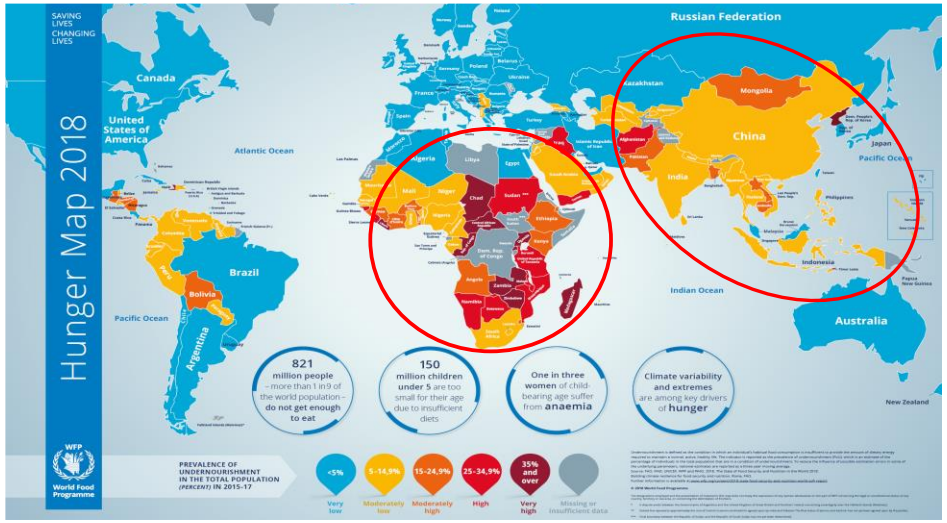
There is a long way to go to achieve the SDG2 goals

- ✓ 720-811 million persons were suffering from hunger
- ✓ Above 30% world's population were moderately or severely food-insecure

Africa has the highest proportion of moderately to severely food-insecure people: more than half of males and females were moderately or severely food-insecure



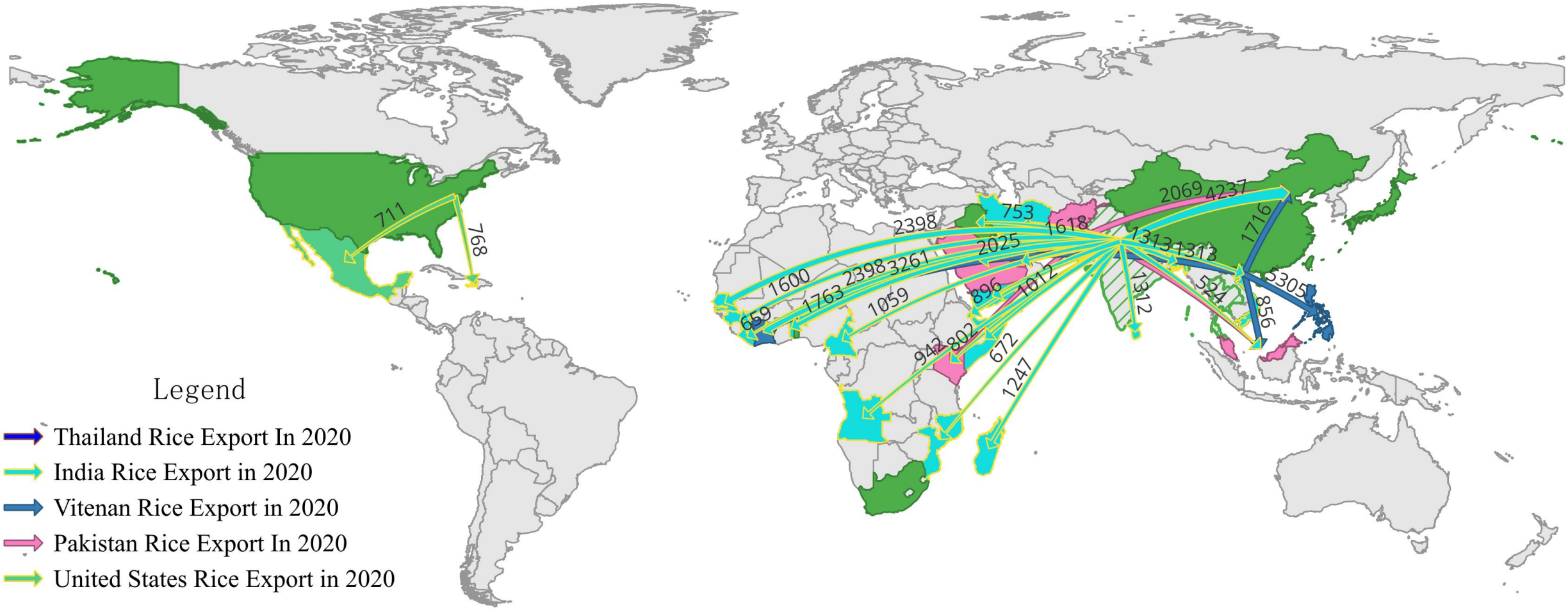
(Source: https://www.fao.org/sustainable-development-goals/indicators/2.1.2/en/)



Source: World Food Programme

How to improve crop production?

Staple Food Import in Africa



World Rice Export in 2020

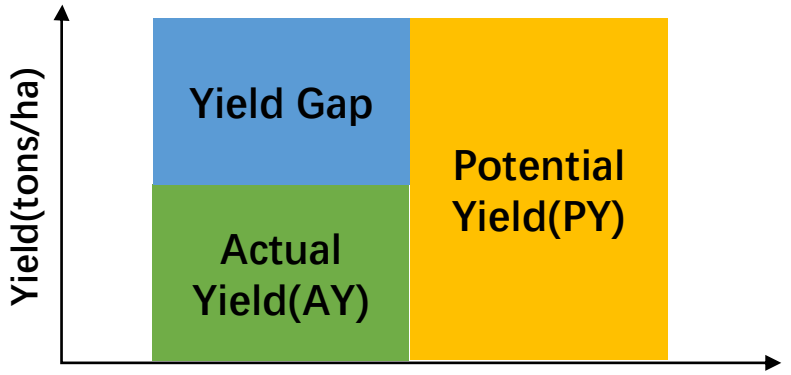
The challenge for SDG2 in Africa

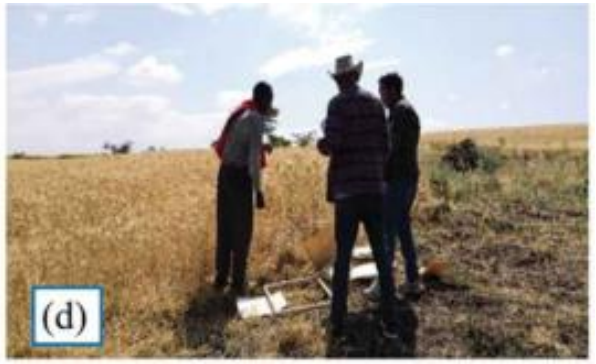
Data lack is the big challenge for African countries to assess SDG2

- Long term crop production data
- Long term crop yield data

A feasible way to achieve SDG2 in Africa: reduce the gap between potential yield and actual yield

- Quantify the actual crop yield
- Quantify the potential crop yield
- Identify the limiting factors affecting the yield gap
- Policy recommendation to achieve SDGs2





Working networks in Africa

- Built a working network with partners from Egypt, Mozambique, Zambia, South Africa, Nigeria, Ethiopia
- Built the Lusaka International Research Center at the University of Zambia for agriculture in southern Africa

Prof. Walter Musakwa

Johannesburg University

Dr. Jose Bofana

Catholic University of Mozambique

Dr. Mohsen Nabil

National Authority for Remote Sensing and Space Sciences, Egypt

Dr. Elijah Phiri

University of Zambia

Dr.Hiten Jantilal

Mozambique National Directorate of Agriculture

Prof. Emmanuel Mashonjowa

University of Zimbabwe

Mr. Awetahegn Niguse Beyene

Tigray Agricultural Research Institute, Ethiopia

Dr. Abdelrazek Elnashar

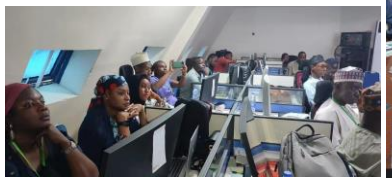
Cairo University, Egypt

Dr. Tesfay Gebretsadkan Gebremicael

Tigray Agricultural Research Institute, Ethiopia

Activities Implemented

Workshop in Beijing(Oct 2023)



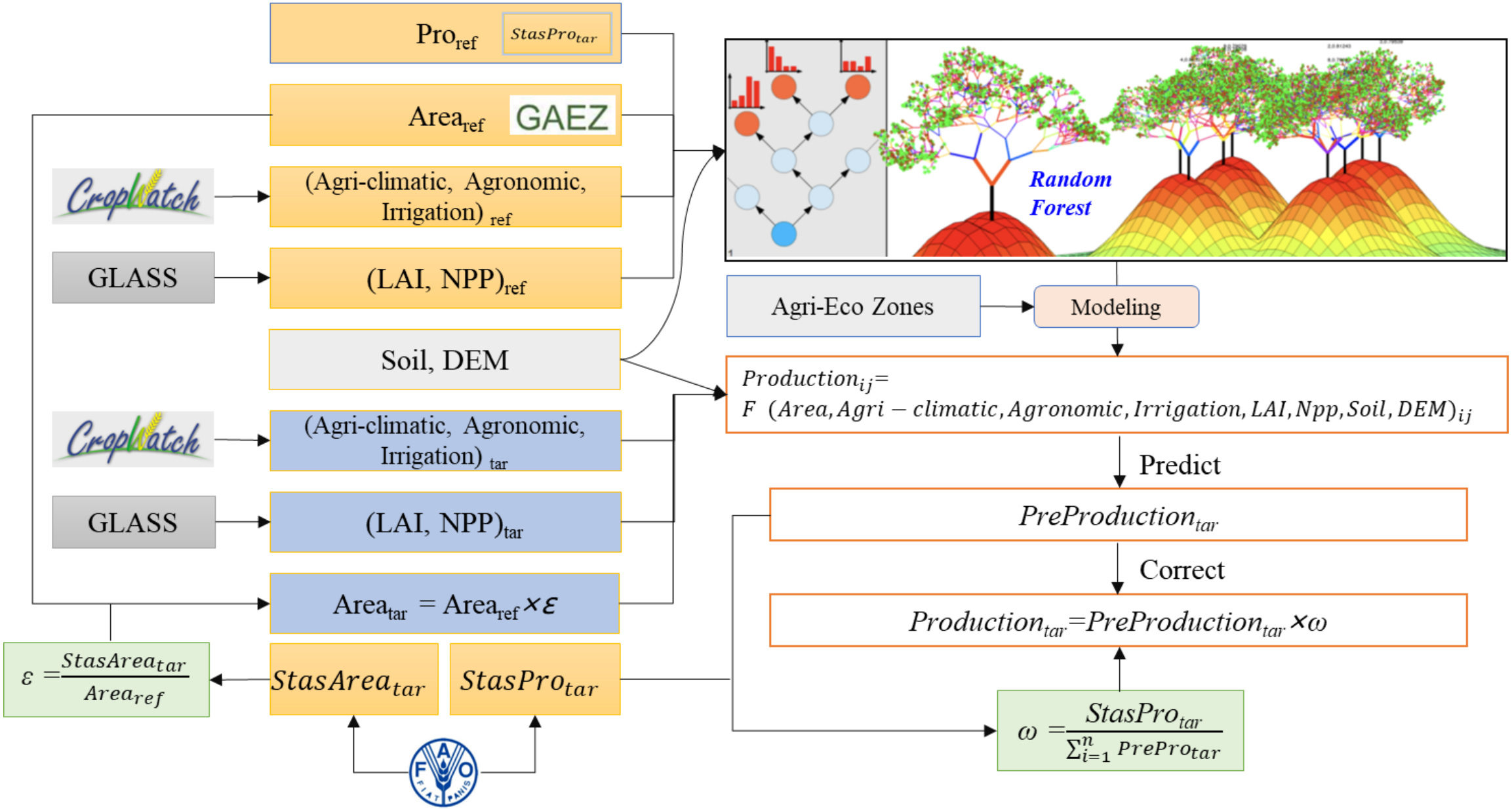
Workshop in NARSA of Nigeria (Aug 2023)

Workshop in Beijing(Oct 2023)

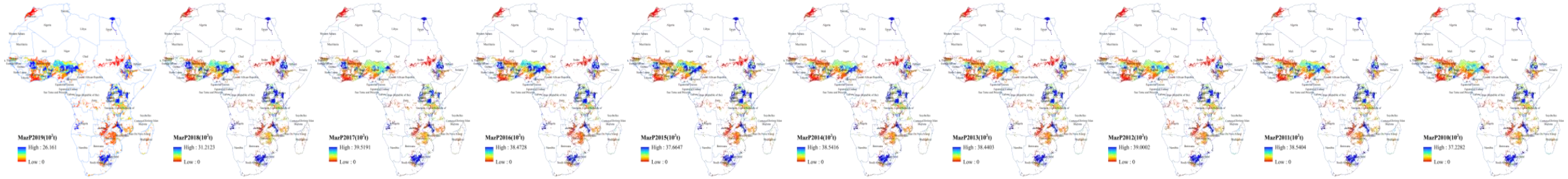
Regional Workshop in Mauritius(Aug 2023)

Activities Implemented

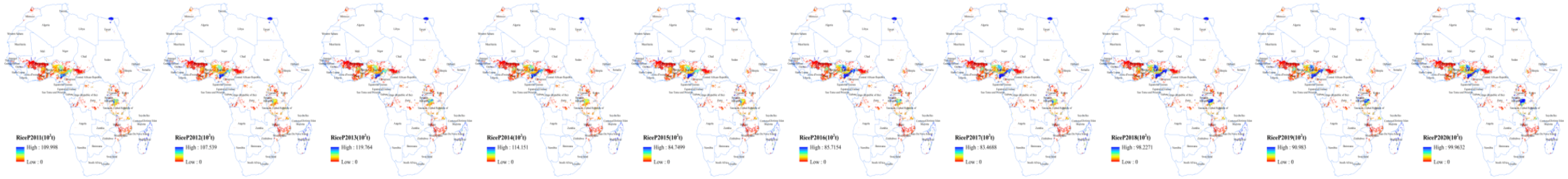
Data driven model for African crop production



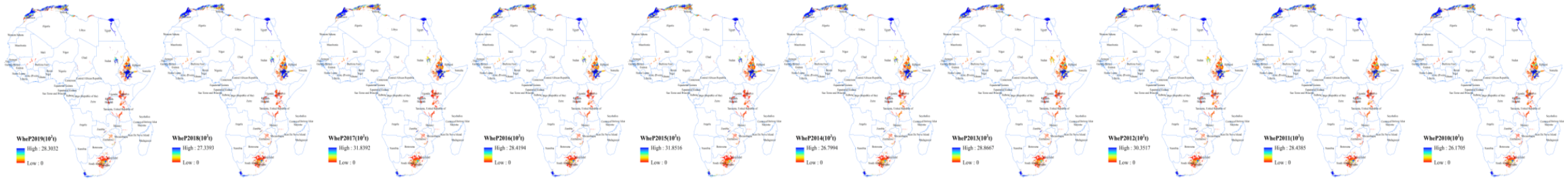
GeoCropPro4Africa Products: maize, rice, wheat, soybean



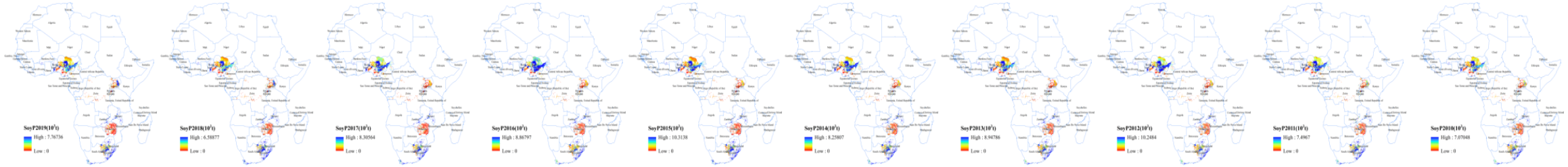
Maize Production and Yield data 2000-2022



Rice Production and Yield data 2000-2022

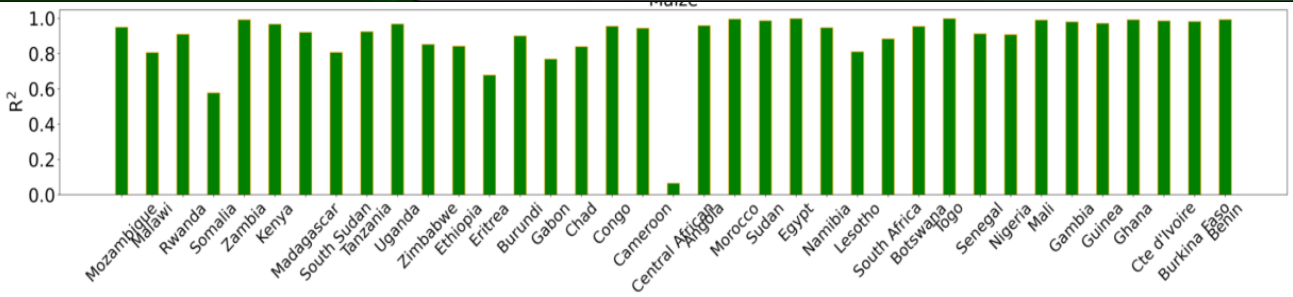


Wheat Production and Yield data 2000-2022



Rice Production and Yield Data 2000-2022

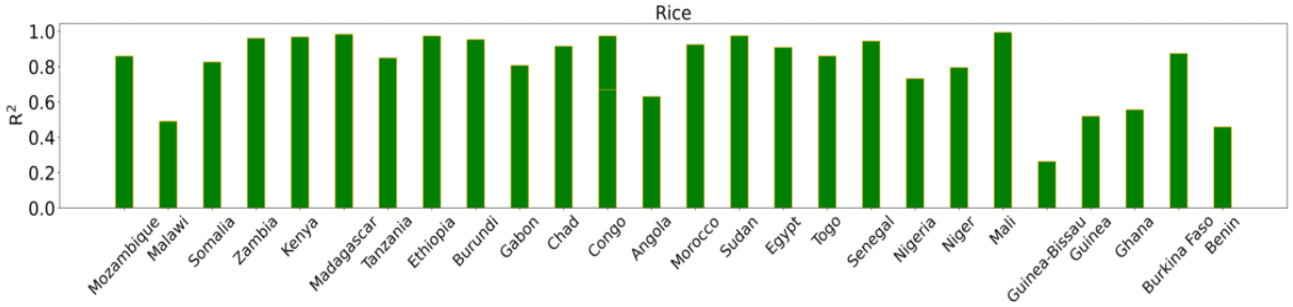
Prediction Performance Assessment



Maize

Average R^2 = 0.891

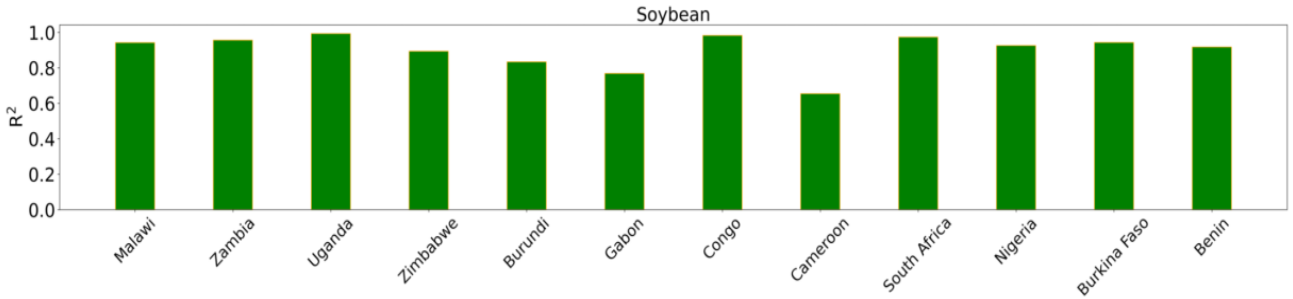
RMSE = 0.211 Kt



Rice

Average R^2 = 0.852

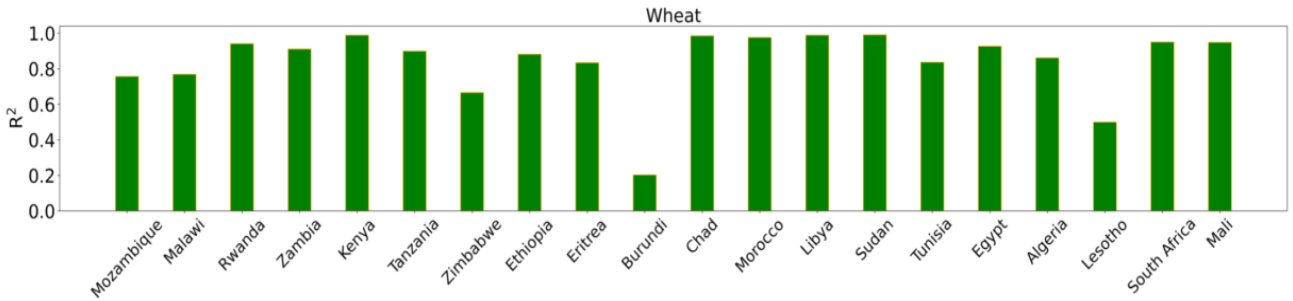
RMSE = 0.254 Kt



Soybean

Average R^2 = 0.896

RMSE = 0.367 Kt

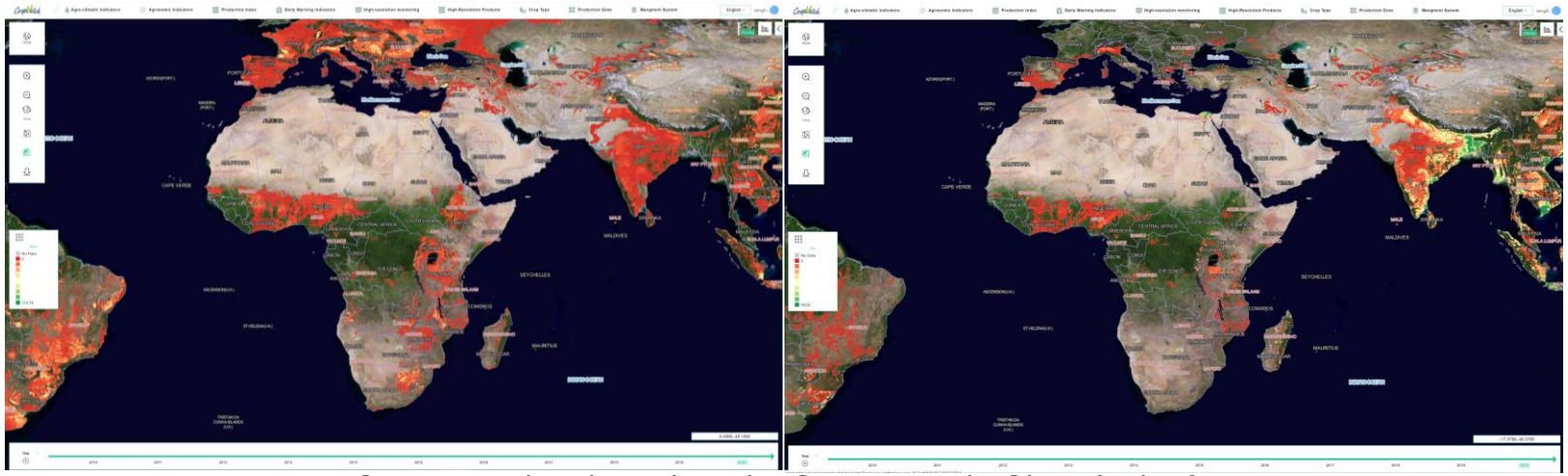


Wheat

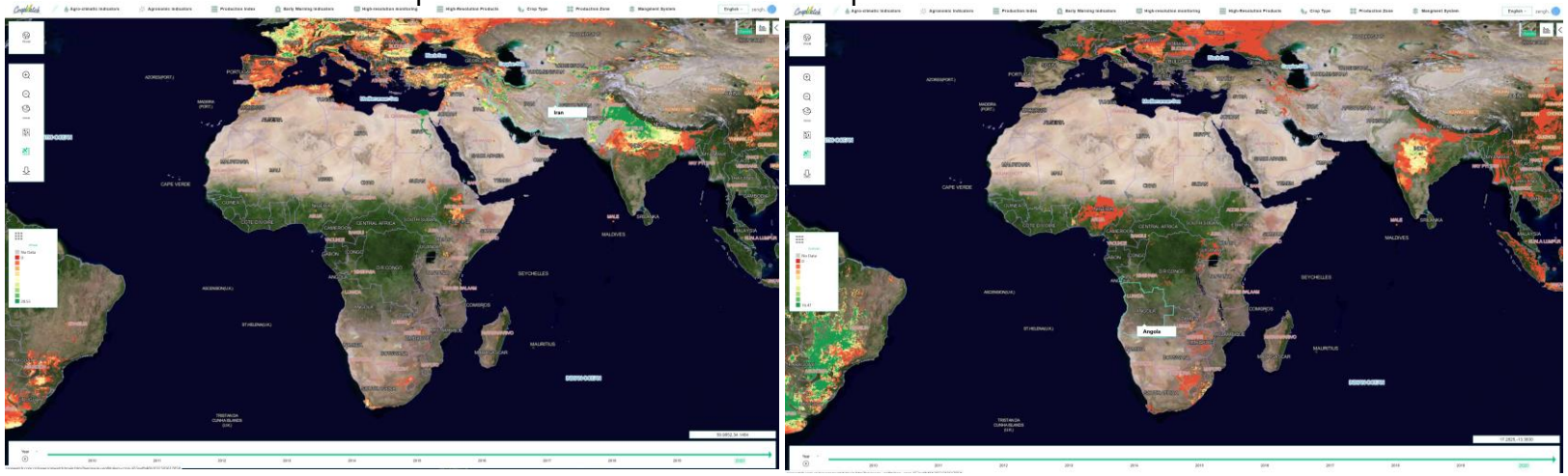
Average R^2 = 0.897

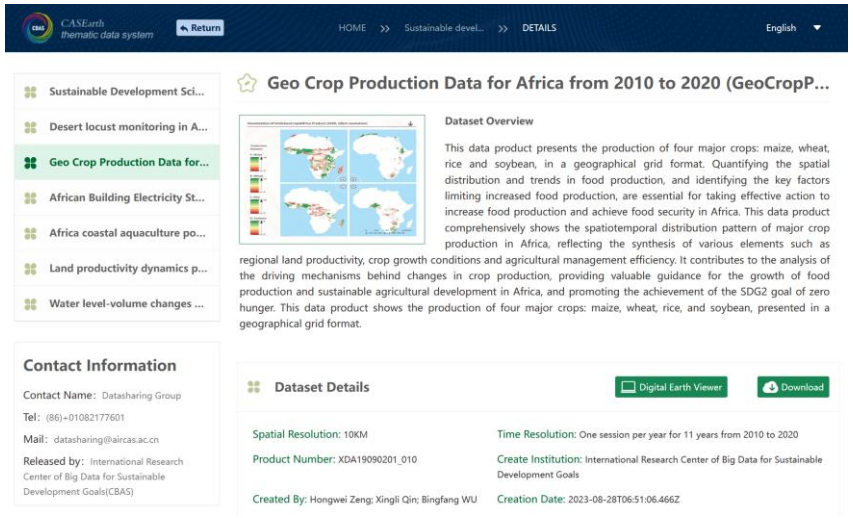
RMSE = 0.074 Kt

Crop Production data Sharing On CropWatch and CBAS



Crop Production data in CropWatch Cloud Platform





Crop Production data in CBAS platform

Data accessing address https://essd.copernicus.org/preprints/essd-2023-346/

Crop Production data Sharing On Harvard Database

HARVARD Dataverse

Add Data | Search | About | User Guide | Support | Sign Up | Log In

Harvard Dataverse >

GGCP10: A Global Gridded Crop Production Dataset at 10km Resolution from 2010 to 2020

Version 1.0

Qin, Xingli; Wu, Bingfang; Zeng, Hongwei; Zhang, Miao; Tian, Fuyou, 2023, "GGCP10: A Global Gridded Crop Production Dataset at 10km Resolution from 2010 to 2020", https://doi.org/10.7910/DVN/G1HBNK, Harvard Dataverse, V1

Cite Dataset | Learn about Data Citation Standards.

Access Dataset | Contact Owner | Share

Dataset Metrics

4,689 Downloads

Description GGCP10 uses the WGS84 coordinate system, longitude, and latitude projection (EPSG:4326). The file format of GGCP10 is GeoTIFF. The GGCP10 for each crop per year is represented as a single-band image. The pixel value of the GGCP10 corresponds to the crop production data of the respective spatial grid, with the unit being kiloton。 The data products cover 11 years, from 2010 to 2020. There are four crop types: maize, wheat, rice and soybean. The data product has a total of 44 tif images. The pixel value of the image represents the crop yield for that space grid, and the unit is kilotons. (2023-08-21)

Subject Earth and Environmental Sciences; Agricultural Sciences

Keyword Crop Production; Time Series Data; Gridded Data; Agricultural Remote Sensing

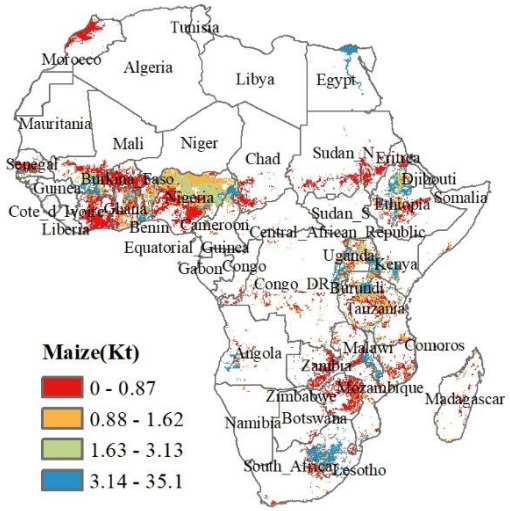
Notes The GGCP10 dataset reveals the spatio-temporal distribution patterns of global crop production and helps to uncover the mechanisms driving changes in crop production. It provides essential data support for research on global food security and sustainable agricultural development.

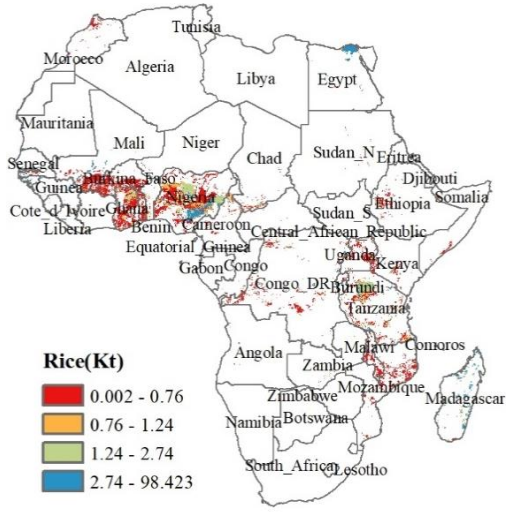
Qin, Xingli; Wu, Bingfang; Zeng, Hongwei; Zhang, Miao; Tian, Fuyou, 2023, "GGCP10: A Global Gridded Crop Production Dataset at 10km Resolution from 2010 to 2020", https://doi.org/10.7910/DVN/G1HBNK, Harvard Dataverse, V1

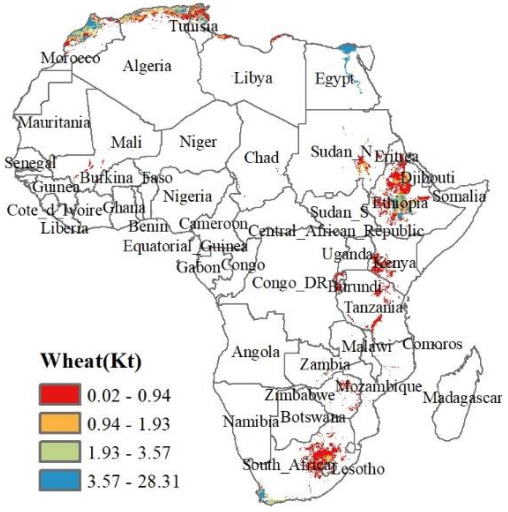
Download address: https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/G1HBNK

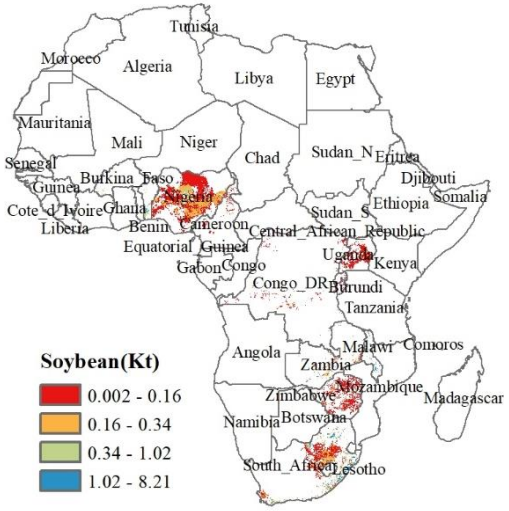
Crop Production Change Trends

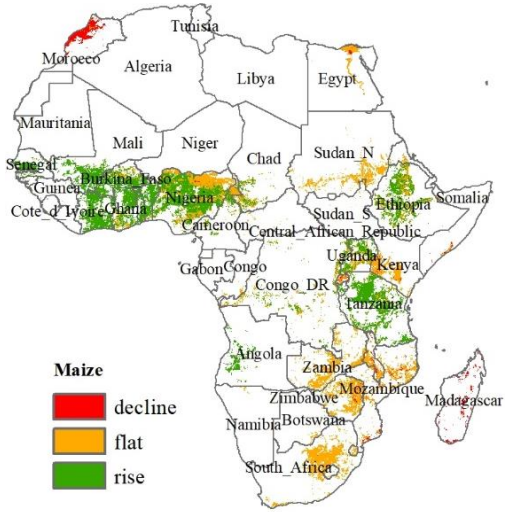
In last decades, Africa made a great achievement in improving crop production, and the maize, wheat, rice and soybean shown a significant up-trend, such as the maize and rice in west Africa, wheat in east Africa.

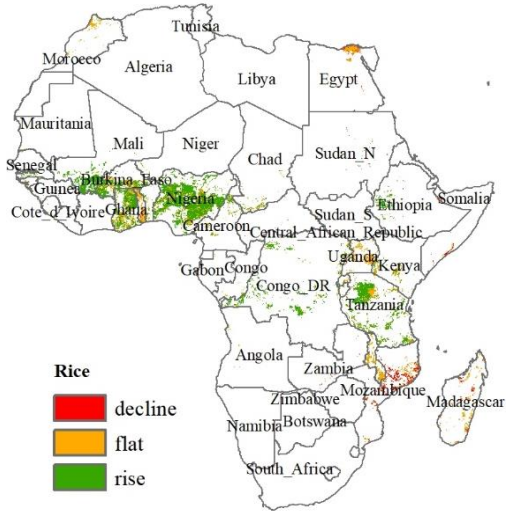


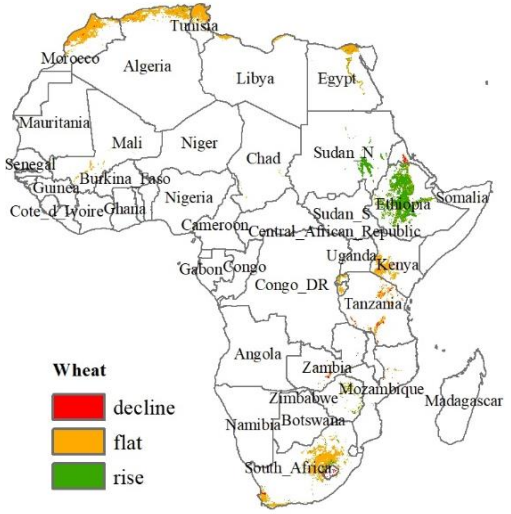


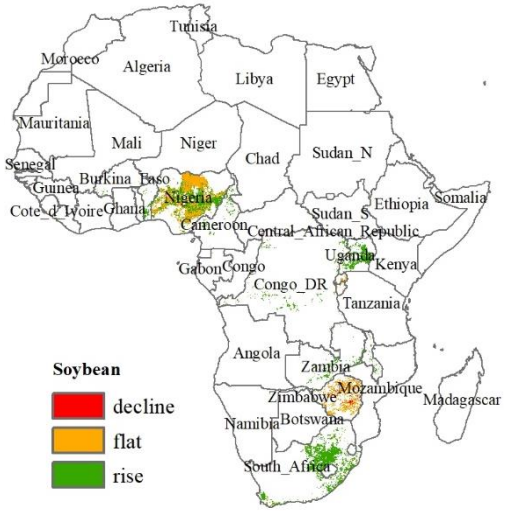






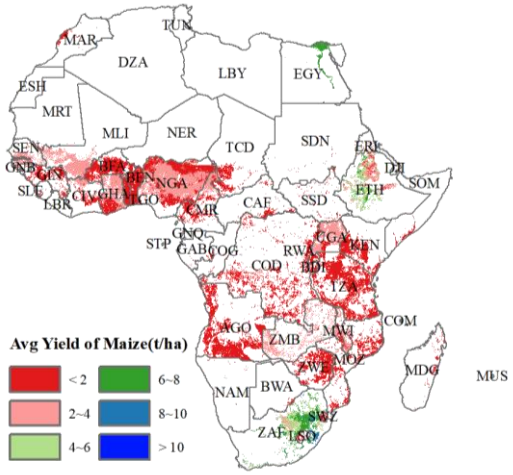




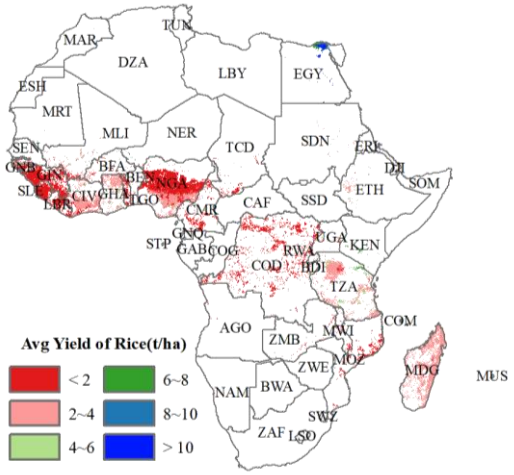


Crop Yield Change Trends

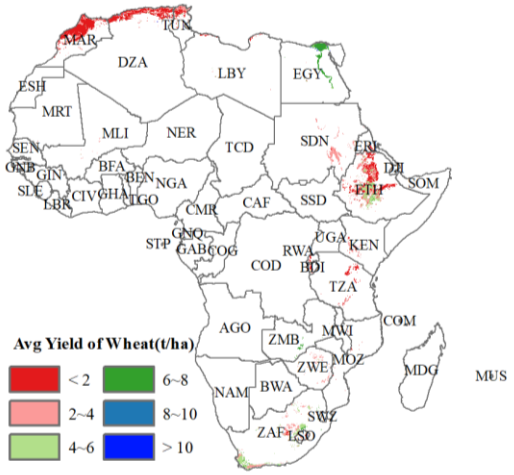
In last decades, the yield of maize, wheat, rice and soybean shown a significant up-trend in almost region, but the average yield of them is still below the world average.



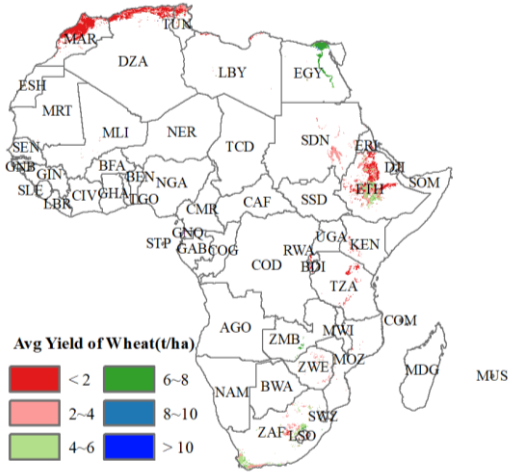
Maize[2.12tons]



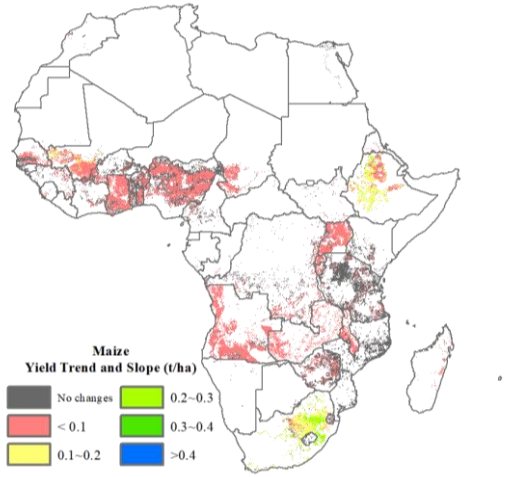
Rice[2.11tons]



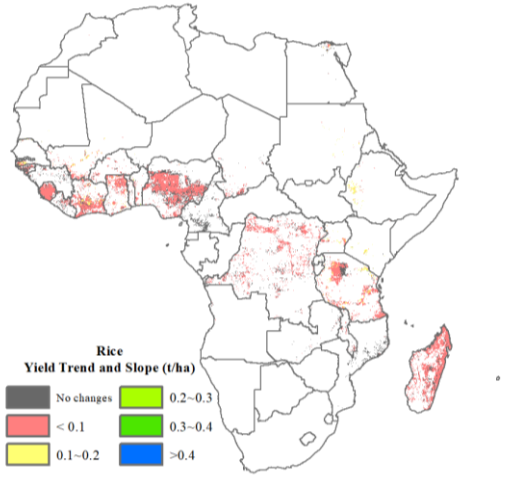
Wheat[2.78tons]



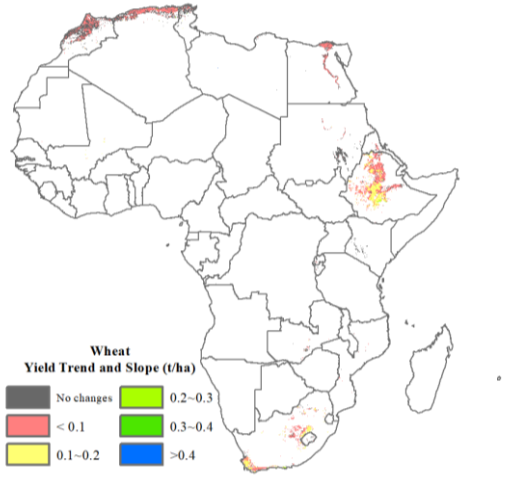
Soybean[1.13tons]



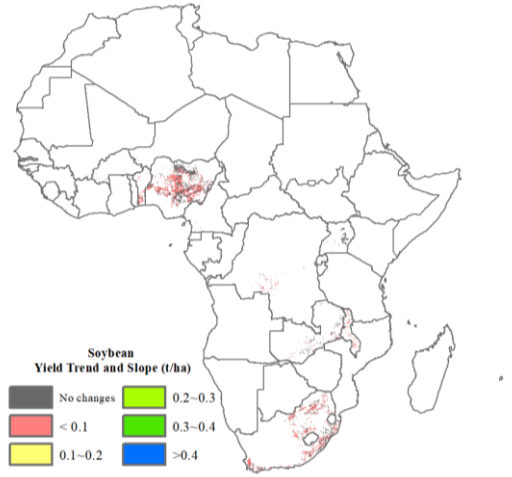
Increase Ratio:64.6%



Increase Ratio :75.1%



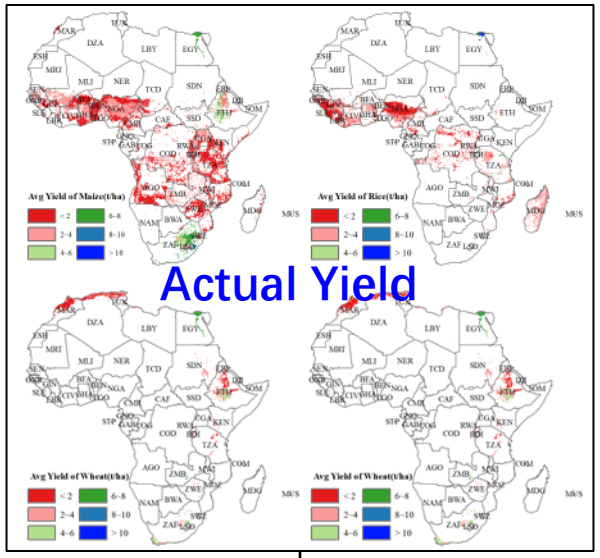
Increase Ratio :65.4%

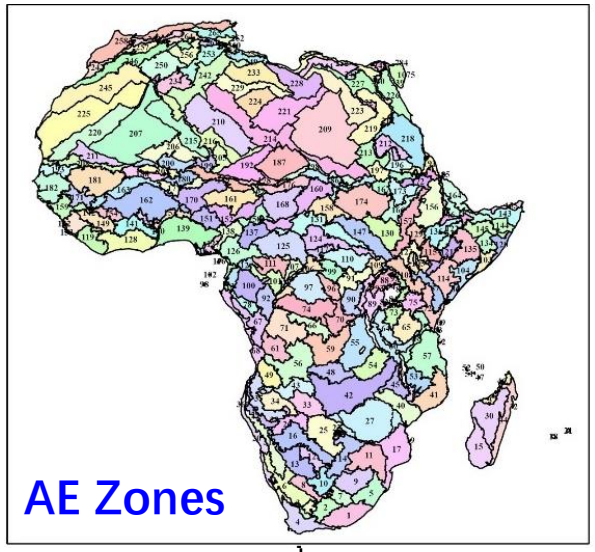


Increase Ratio :53.2%

Method of Crop Yield Gap Assessment

Attainable Yield Gap = Actual Yield – Potential Yield





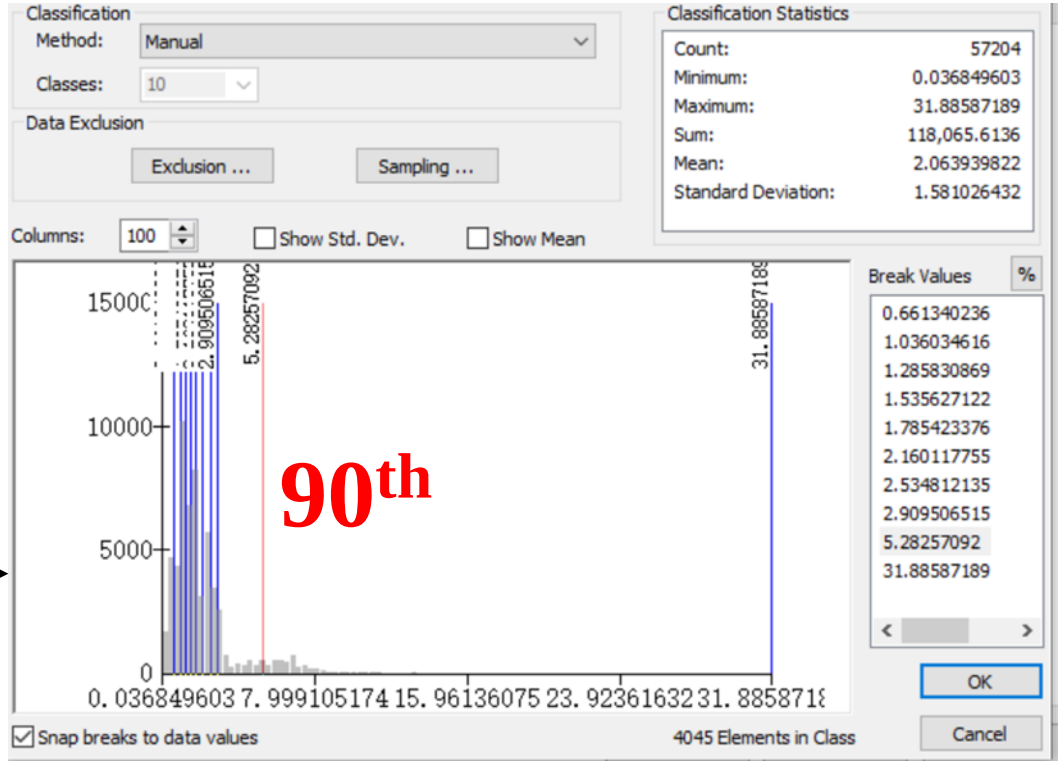
Spatial Analysis

Actual Yield

Potential Yield (90th)

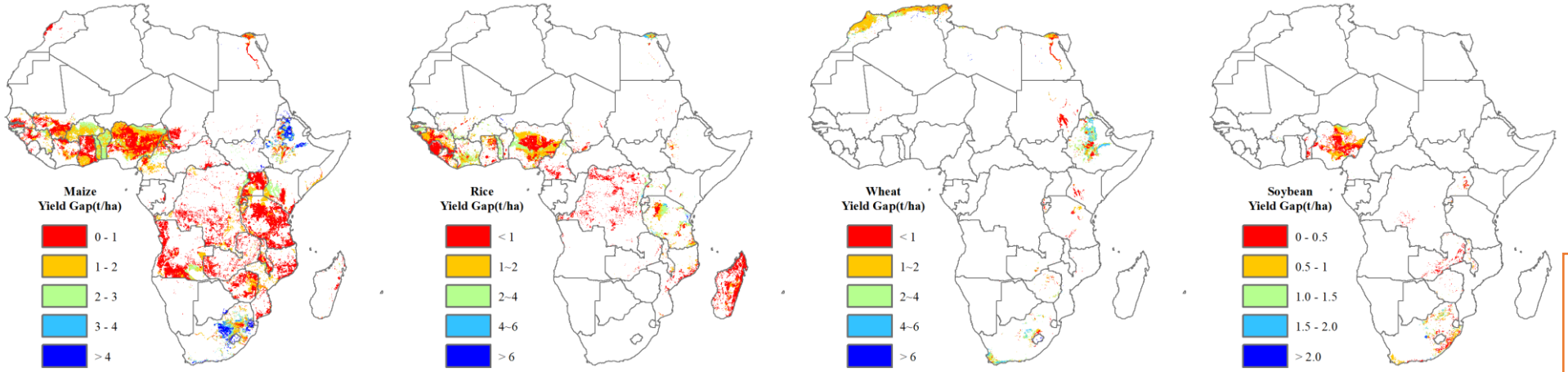
Yield GAP = PY - AY

Potential Yield: The actual yield at 90th percentiles within a agri-ecological zone where has the similar climate, terrain, soil.



Crop Yield Gap between 2018 and 2022

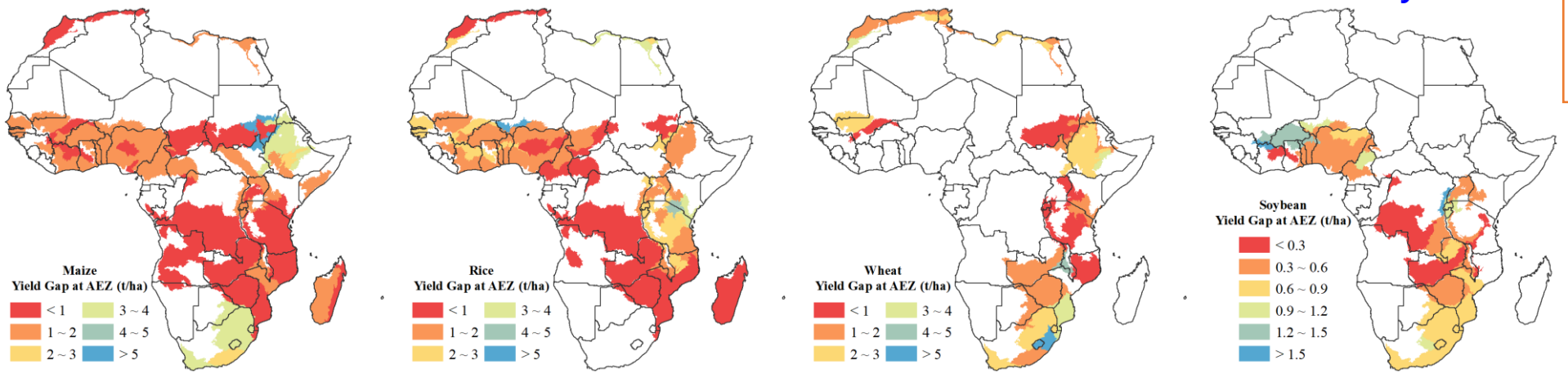
- **Actual Yield**: Maize[**2.12tons**], Rice[**2.11tons**], Wheat[**2.78tons**], Soybean[**1.13tons**]
- **Potential Yield**: Maize[**3.24tons**], Rice[**3.30tons**], Wheat[**4.83tons**], Soybean[**1.67tons**]
- **Yield Gap**: Maize[**1.12tons**], Rice[**1.19tons**], Wheat[**2.05tons**], Soybean[**0.54tons**]



Maize Rice Wheat Soybean

Yield Gap at Pixel Level

If reduce 50% yield gap, the production of maize, rice, wheat, and soybean can increase 26%, 28%, 37% and 24%.



Yield Gap at Agri-ecological zone Level

Challenge to close gap

- Extreme event caused by climate change: flooding, drought, heat wave
- Pest and disease: such as the locust in East Africa
- Management: nutrition, water, pest control, fertilize
- Infrastructure: irrigation









Summary

- We proposed an effective way to generate crop production and yield data, and generate the long term crop production and crop yield data from 2000 to 2022.
- Africa made a significant improvement in increasing crop production and crop yield in last decades, but the average crop yield is still below the average.
- There is a certain potential in maize, rice, wheat, and soybean, close the crop yield gap between actual yield and potential yield, Africa can improve 30%~ 40% crop production.

THANKS!

- **ANSO project(No. ANSO-SBA-2022-02)**
- **Geo Annual Report of China in 2024**
- **CropWatch4GEOGLAM(No.2019YFE0126900)**

Contact: Dr. Zeng Hongwei

Email: zenghw@aircas.ac.cn