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

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

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**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/)

**How to improve crop production?**

(Source: World Food Programme)
Staple Food Import in Africa

World Rice Export in 2020

Legend
- Thailand Rice Export in 2020
- India Rice Export in 2020
- Vitenan Rice Export in 2020
- Pakistan Rice Export in 2020
- United States 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. Elijah Phiri
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Dr. Jose Bofana
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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

\[ \text{Production}_{ij} = F \left( \text{Area, Agri - climatic, Agronomic, Irrigation, LAI, NPP, Soil, DEM}_{ij} \right) \]

\[ \varepsilon = \frac{\text{StasArea}_{\text{tar}}}{\text{Area}_{\text{ref}}} \]

\[ \text{StasArea}_{\text{tar}} = \text{Area}_{\text{ref}} \times \varepsilon \]

\[ \text{StasPro}_{\text{tar}} = \text{PreProduction}_{\text{tar}} \times \omega \]

\[ \omega = \frac{\text{StasPro}_{\text{tar}}}{\sum_{i=1}^{n} \text{PreProduction}_{\text{tar}}} \]
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

Data accessing address https://essd.copernicus.org/preprints/essd-2023-346/
Crop Production data Sharing On Harvard Database

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

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
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 the last decades, the yield of maize, wheat, rice, and soybean has shown a significant upward trend in almost all regions, but the average yield of these crops is still below the world average.

- Maize: 2.12 tons
- Rice: 2.11 tons
- Wheat: 2.78 tons
- Soybean: 1.13 tons

Increase Ratio:
- Maize: 64.6%
- Rice: 75.1%
- Wheat: 65.4%
- Soybean: 53.2%
Method of Crop Yield Gap Assessment

Attainable Yield Gap = Actual Yield – Potential Yield

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

Spatial Analysis

Actual Yield

Potential Yield (90th)

Yield GAP = PY - AY
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]

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

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