Africa Agriculture Watch

By AKADEMIYA2063

Artificial Intelligence and Satellite Remote Sensing Data for Decision-making in the African Agricultural Sector

AKADEMIYA

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Harnessing Cutting-edge Predictive Modeling Technologies for Evidence-based Decision-making

Africa's food production systems are constantly battling numerous threats, including climate shocks, plant disease and pest outbreaks, further exacerbated by the COVID-19 pandemic and the Ukraine crisis, among other shocks. Furthermore, the disruptions engendered by such crises require accurate and timely data generation to predict and inform agricultural production for better preparedness.

The lack of information about growing conditions can be overcome by using today's digital technologies. For instance, remotely sensed data enables real-time tracking of changes in vegetation cover, climate data, and other parameters related to cropping activities. In addition, recent developments in machine learning and computer modeling make it possible to track and predict crop production using remotely sensed data. The weaknesses that hamper access to quality agricultural statistics can also be overcome by employing digital technologies, from measuring arable land, planted areas, crop yields to the spatial distribution of harvested quantities.

In response to this agricultural data gap, Africa Agriculture Watch (AAgWa), developed by AKADEMIYA2063's scientists, and launched in 2021, is a web-based platform that employs cutting-edge machine learning techniques and remotely sensed data to predict agricultural yields and production levels of several crops across Africa to support crisis management, monitoring, and mitigation efforts in local communities.

5 FACTS

2021

AKADEMIYA2063 established Africa Agriculture Watch (AAgWa) in 2021 to contribute to Africa's efforts toward sharpening the continent's preparedness for and resilience to shocks for more sustainable food systems.

47

AAgWa's scope of intervention covers 47 African countries.

AAgWa forecasts crop production for 9 crops, namely beans, cassava, maize, millet, rice, groundnut, sorghum, wheat and yam.

AAgWa is featured on the Global Alliance for Food Security (**GAFS**) dashboard. The web-based platform is included in the **Focus Area** menu, in Advice, under "**Crops Monitor**".

Its mission is aligned with the African Union Agenda 2063.
AAgWa contributes to the first aspiration of Agenda 2063 of a prosperous Africa based on inclusive growth and sustainable development, especially the aspiration for a modern and productive African agriculture using science, technology, innovation and indigenous knowledge.

Top AAgWa Features

Africa Crop Production (AfCP) Model

The AfCP model provides forecasts on food crop production across Africa. The estimations are based on a combination of remotely sensed biophysical parameters retrieved from satellite images, historical production maps, and machine learning techniques.

Predictions Calendar

Since its inception in 2021, AAgWa periodically releases prediction calendars covering various harvesting seasons for the nine crops.

Accessible Web-based Tool

AAgWa facilitates the access and use of remote sensing products and forecast maps by embedding the ready-to-use AAgWa outputs in a web-based tool.

Bridging the Agricultural Data Gap

AAgWa is bridging the agricultural statistics data gap in Africa by collecting remote sensing data through satellite images to better inform and drive agricultural productivity.

Featured on the Global Alliance for Food Security Dashboard

Jointly convened by the World Bank Group and the German G7 Presidency with active engagement and support from humanitarian and development partners, regional organizations and governments, GAFS aims to catalyze an agile, immediate, and coordinated response to the unfolding global food and nutrition security crisis as an act of solidarity in support of those most affected. AAgWa is featured under the “Advice” sub menu, which seeks to support coordinated and regular information exchange among decision-makers and reporting of trends in key indicators to promote awareness regarding ongoing food security crises.

Research

AAgWa is harnessing cutting-edge predictive modeling technologies, such as machine learning techniques, to provide forecasts and reduce uncertainties in decision-making processes in African food production systems. AAgWa's research activities overcome Africa's agricultural statistics data gap by using remote sensing data through satellite images. The research methodology is based on the Africa Crop Production Model (AfCP).

Africa Crop Production Model (AfCP)

The Africa Crop Production (AfCP) model provides forecasts on food crop production for several crops and countries across the African continent. Its spatial resolution is at the community level with a grid cell size of 10 by 10 kilometers. The estimations are based on a combination of three components: (i) remotely sensed biophysical parameters retrieved from satellite images, (ii) historical production maps, and (iii) machine learning techniques.

The AfCP model is built using the machine learning artificial neural network (ANNs) technique. The ANNs are a supervised learning technique that requires explanatory variables as inputs and labels or examples as corresponding outputs. The model's construction corresponds to learning the relationship between the inputs and the labels through an iterative process.

AfCP Model Inputs

The Normalized Difference Vegetation Index (NDVI):

The construction of the AfCP model requires explanatory variables to assess crop conditions through the growing season. The first variable used is the Normalized Difference Vegetation Index (NDVI), which is the ratio between the difference between near-infrared (NIR: 0.7 – 1.1µm) and red (R: 0.6 – 0.7µm) bands of multispectral images reflectance, and their sum. The rationale for using the NDVI as the first input into the AFCPM is justified first by its close relationship with crop yield (Huang and Han, 2014; Liu et al., 2019; Rembold et al., 2013) and second by its capacity to assess the photosynthesis activity intensity of crops' leaves as a proxy to their health (McVeagh et al., 2012).

Daytime Land Surface Temperature (LST):

Several studies have shown that final crop yields are also related to thermal indices (Leroux et al., 2016). We use the MODIS/Terra land surface temperature version 6 product (Wan et al., 2015) at a one-kilometer spatial resolution. The product consists of twelve scientific datasets. Specifically, we used the first layer corresponding to the daytime land surface temperature with pixel values ranging from 150 to 1310.7 degrees Kelvin. Like the NDVI, the quality assurance layer has been used to select reliable daytime land surface temperature pixels.

Rainfall Data:

Most African agriculture is rainfed, and rainfall data from satellite data sources are used to encounter water availability as an explanatory variable in the AfCP model.

Evapotranspiration:

The fourth input parameter to the AfCP model is the evapotranspiration (ET) data which is a proxy to assess crops' water stress.

Crop Calendar:

AAgWa relies on FAO crop calendar to produce timely food crop production and yield forecasts across Africa. Specific computations are performed during crop sowing and growing stages to provide production and yield forecasts before harvesting.

Publications

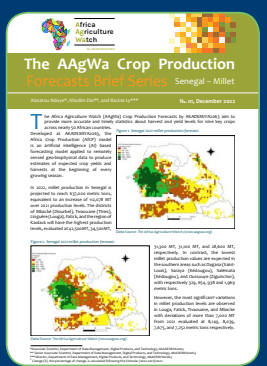
AAgWa scientists are consistently contributing to filling the agricultural data knowledge gap for better crisis preparedness and sustained resilience across Africa. Research from AAgWa scientists includes work on machine learning challenges and opportunities in Africa's agriculture sector, forecasting commodity prices, and remote sensing and machine learning for food crop production data in Africa post-COVID-19.

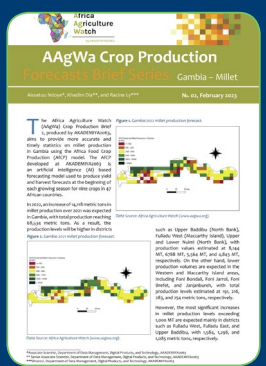
The Ukraine Crisis and African Economies

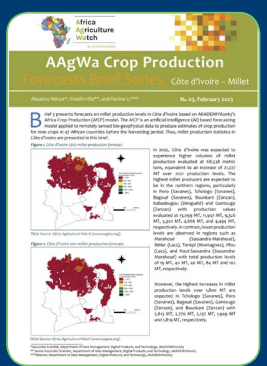
The Ukraine-Russia crisis has disrupted the global wheat trade as exports from Russia and Ukraine are restricted, and other major wheat exporters have limited or banned wheat exports altogether. The data scientists at AKADEMIYA2063 used the Africa Crop Production (AfCP) model developed in-house to predict wheat production in Kenya, Mozambique, South Africa, among others. The model uses satellite remote sensing data as explanatory variables and machine learning techniques as a predictive modeling framework to provide production level information before the harvesting period at the pixel-level. The remote sensing data enables the unique characterization of features on the earth surface on several wavelengths, eliminating the need for a physical human presence on the ground.

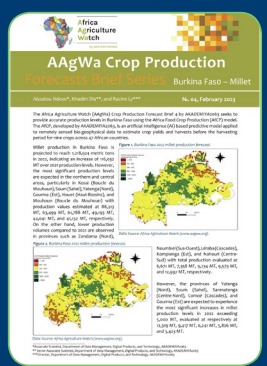
The AAgWa Crop Production Forecasts Brief Series

The AAgWa Crop Production Forecasts Briefs by AKADEMIYA2063 aim to provide more accurate and timely statistics about harvest and yield levels for nine key crops across nearly 50 African countries. The briefs are developed based on the AfCP model to produce estimates of expected crop yields and harvests at the beginning of every growing season.



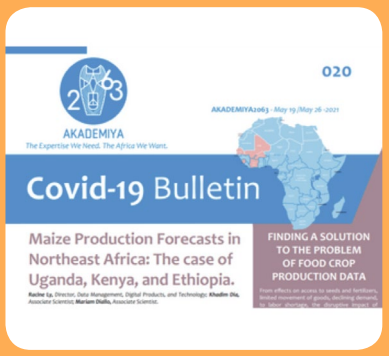


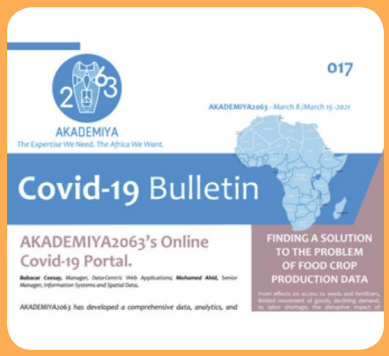


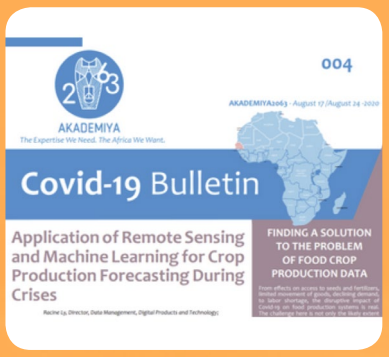


COVID-19 – Production Systems Disruption

COVID-19 has had wide ranging impacts on production systems, resulting from a host of disruptions not just to health, but also transport, market and broader food systems. The difficulty of in-person data collection posed a real challenge to assessing the situation and providing an accurate picture of the crisis' ramifications. Under this workstream, AAgWa scientists used innovative remote sensing, big data, and computer learning methodologies to evaluate the impact on production systems at the local community level. The research focused on tracking the growing season for key local staples and applying cutting-edge tools to issue real time predictions of future food production at community level in a number of countries.







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