El Niño 2023/2024 Anticipated Climate and Agricultural Yield Impacts

Updated August 24, 2023

Highlights

- The El Niño-Southern Oscillation (ENSO) is currently in the El Niño phase and is likely to continue through the Northern Hemisphere spring of 2024.
- The ongoing El Niño will likely be a strong event that will reach peak strength from November to January.
- El Niño events tend to increase the likelihood of above and below-average precipitation in different parts of the globe, with related impacts on crop yields and agricultural production.
- At the global scale, past El Niño events are related to rice yields decreasing by around 0 to 2% from expected levels, and wheat yields experiencing a slight decline, with highly variable outcomes possible.
- Strong regional effects on maize and sorghum yields are likely. However, at the global scale, the adverse effects on yields could be partially mitigated as the areas where El Niño improves yields may offset the areas where it reduces yields.
- Soybean yields tend to improve in both the United States and Argentina and decline in India during El Niño events.

Overview

Following three consecutive years of La Niña, the El Niño-Southern Oscillation (ENSO) is currently in the El Niño phase. The ongoing El Niño is forecast to be a strong event, reaching its maximum intensity in late 2023 and persisting through early 2024, according to the official August NOAA ENSO Forecast.

El Niño events are estimated to affect crop yields on at least 25 percent of global croplands. Characteristics of an El Niño, like its intensity, are related to the severity of the global climate impacts. The current forecast for a strong El Niño is expected to have significant impacts on regional precipitation patterns and agricultural yield outcomes at the regional and possibly global level.

While crop yield impacts vary from one El Niño event to another, average global-mean soybean yields generally improve during an El Niño event while global mean rice yields, and to a lesser extent wheat yields, slightly decrease (Figure 1).

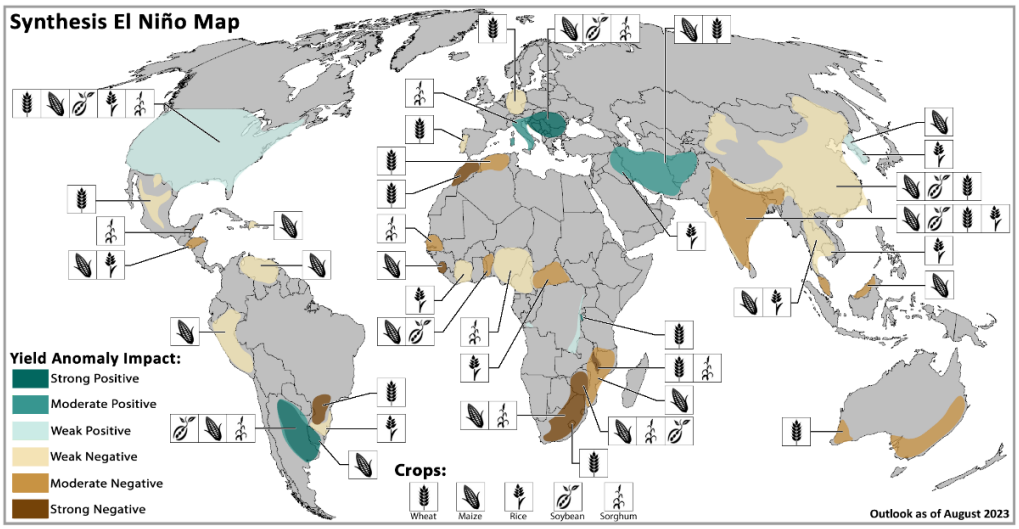

Figure 1: Historical crop yield conditions during El Niño events for wheat, maize, rice, soybeans, and sorghum using FAO country level yield data and ERSSTv5 from 1961-2020. In countries with more than one crop affected, the color reflects the strongest effect.

El Niño Regional Climatic Impacts

El Niño is related to increases in the likelihood of above and below-average precipitation in many parts of the globe (Figure 2). El Niño events tend to enhance rainfall relative to average in Central Asia, southern North America, south-eastern South America, southern Europe, eastern and southern East Africa, and southern and eastern China. Drier-than-average conditions tend to occur in Central America, the Caribbean, northern South America, parts of western and northern East Africa, Southern Africa, India, northern China, the Maritime Continent, and Australia.

The ongoing El Niño has already affected seasonal precipitation in different parts of the globe, impacting ongoing cropping seasons notably in Central America, East Africa, India, and Southeast Asia. This El Niño also raises concerns for upcoming cropping seasons in some areas, including parts of Southern Africa, Southeast Asia, Central America, northern South America, Australia, and elsewhere.

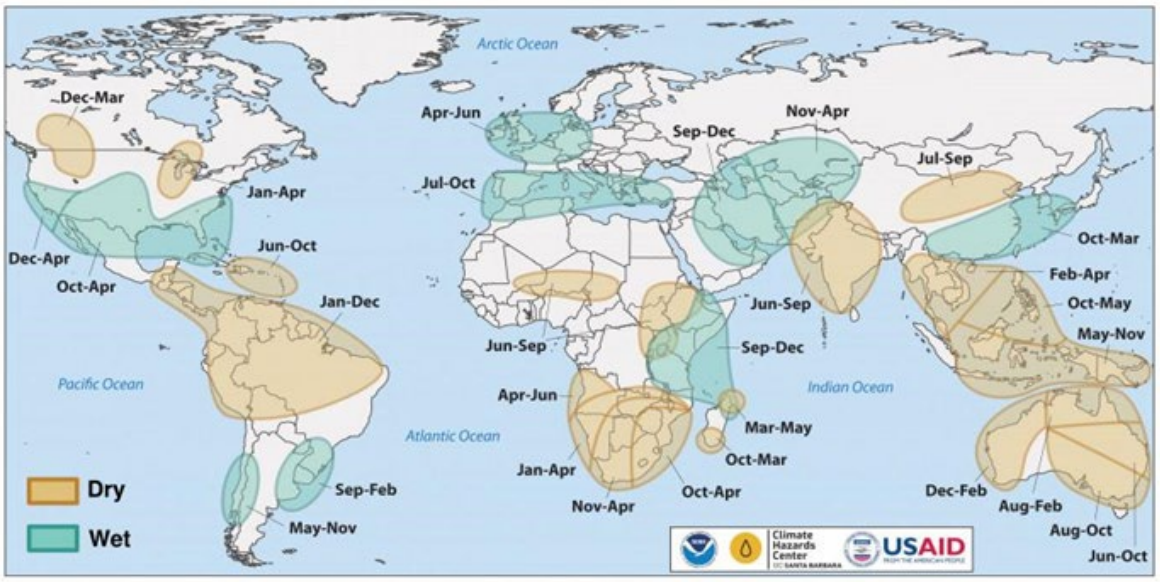

Figure 2: Areas of dry and wet conditions during El Niño phase of ENSO. Source: NOAA, CHC, FEWSNET

Current Cropping Season Impacts

In **Central America**, drier and hotter-than average conditions prevailed during the past several months, impacting *Primera* season crops. During the ongoing El Niño event, adverse weather conditions may continue. *Primera* season rainfall was below-average across the region through early August (Figure 3-left), and high temperatures accelerated the loss of soil moisture between rain events. In northern and southern Guatemala and western El Salvador, rainfall deficits were severe, and rainfall totals through early August were close to the lowest on record (1981-2023), based on preliminary CHIRPS data for August. Recent extreme rainfall events also resulted in flash floods and landslides in localized crop production areas, primarily impacting subsistence farmers. Poor *Primera* season yield outcomes are expected for much of the region (See Crop Monitor for Early Warning August 2023). For the months ahead, guidance comes from historical outcomes during El Niño years with strength comparable to the current year's event (Figure 3-right) and model forecasts. Historically, Central America's Pacific side has most often received below-average precipitation during August to December, raising concerns for the upcoming *Segunda/Postrera* cropping season. Dry soils due to irregular rainfall distribution and high temperatures are currently affecting sowing activities for the *Segunda* season, and model forecasts indicate an El Niño drying influence from September 2023 in central Guatemala, El Salvador, Honduras, and in areas to the south, as well as above-normal temperatures. While regional outcomes will be influenced by multiple factors, including tropical storms that are unpredictable at long lead times, the likelihood of adverse weather combined with poor *Primera* rainfall performance creates a tenuous situation, particularly for subsistence farmers with limited resources for replanting and fertilizer application.

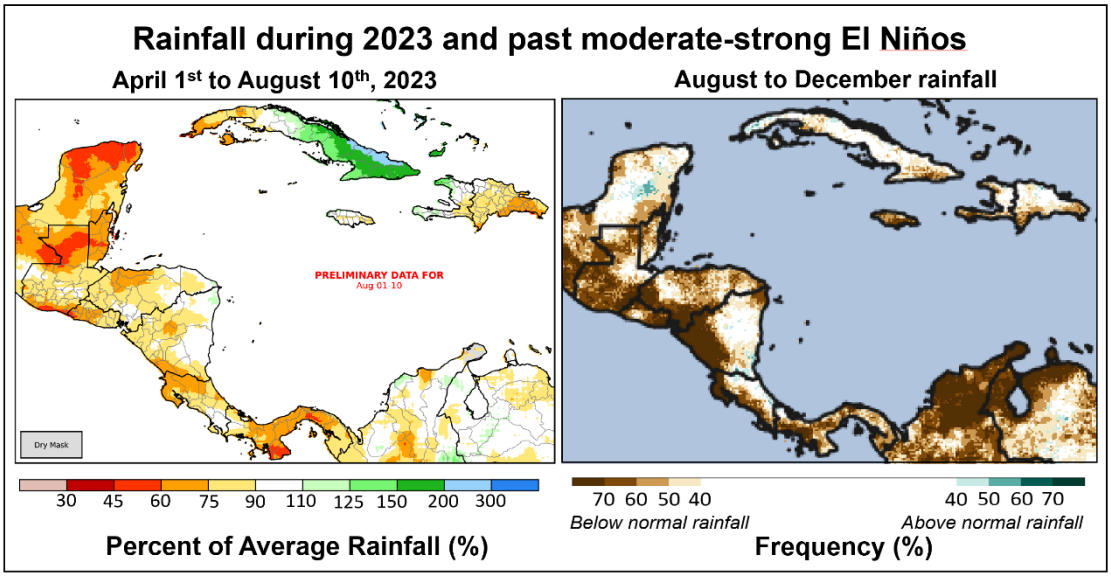

Figure 3: Central America 2023 rainfall and outcomes during moderate to strong El Niño years. Left: UCSB CHC Early Estimates for percent of average rainfall, based on 1981-2023 CHIRPS data, including preliminary data for August 1st to August 10th. Right: Frequency of below-normal and above-normal August to December rainfall, also based on CHIRPS.

In **East Africa**, June to September rainfall tends to be suppressed in western and northern areas during El Niño years. During the 2023 season through early August, areas in Ethiopia, South Sudan, Uganda, Rwanda, Kenya, and southern Somalia received below-average rainfall (Figure 4-left). Poor yield outcomes are expected for Long Rains cereals in parts of the region (See Crop Monitor for Early Warning August 2023). Rainfall conditions may worsen in some western and northern areas, based on pessimistic model forecasts for August and September. In contrast, near-average seasonal totals are anticipated in Sudan and most of western Ethiopia. Compared to the 2015 El Niño drought, rainfall conditions are much better across the region, but highly above-average temperatures are a cause for concern, particularly in regards to crop stress during dry spells, extreme high temperatures in northern areas, and accelerated drying of pastoral resources in the eastern Horn.

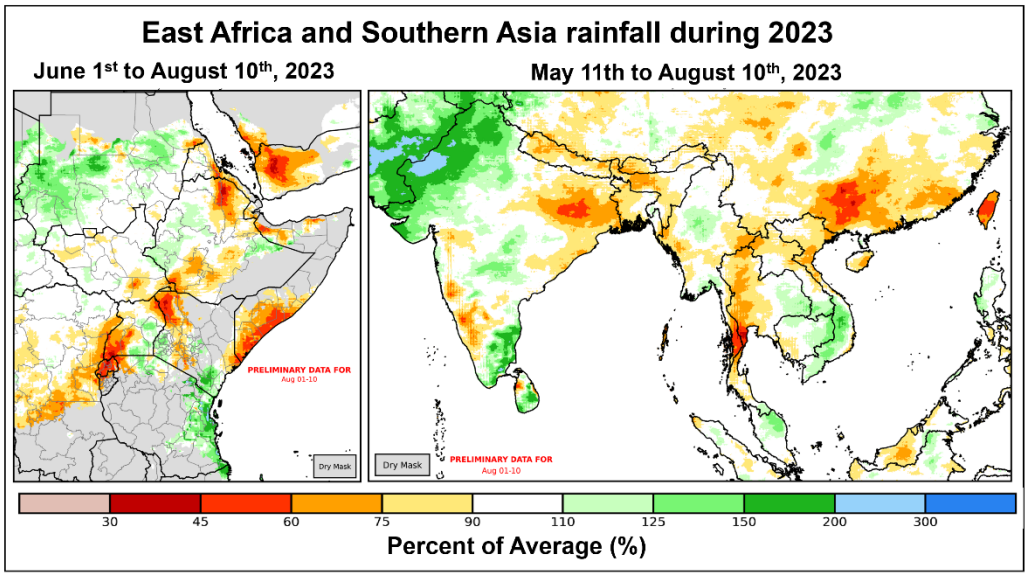

Figure 4: Seasonal rainfall performance update for mid-2023, for East Africa and Southern Asia, regions with El Niño linkages to rainfall or observed crop yields. UCSB CHC Early Estimates for percent of average rainfall, based on 1981-2023 CHIRPS data, including preliminary data for August 1st to August 10th.

In **India**, June to September rainfall is often suppressed during moderate and strong El Niño years in western, central, and southern areas. During the first part of the 2023 season, rainfall was below-average in eastern India and in the western Ghats Mountain region, while the northwest continuously

received abnormally heavy rainfall (Figure 4-right). A late rainfall onset delayed rice and maize cropping activities in southern and eastern India (See Crop Monitor for AMIS August 2023). Forecasts and past El Niño outcomes give reason to be on watch for possible negative impacts. Below-average August rainfall is forecast across much of the country, with large rainfall deficits possible in central and western areas, based on observations and the GEFS forecast. Eastern rice growing areas with seasonal rainfall deficits are forecast to receive heavy rains in late August, which could improve the situation. Longer-range NMME and ECMWF forecasts indicate that southern, central, and western areas may experience drier and hotter-than-normal conditions into September and October.

In **Southeast Asia**, negative impacts of El Niño on seasonal rainfall are typically strongest and most consistent in Indonesia, Malaysia, and the Philippines. For August to December 2023, model forecasts support this outlook. Mainland areas tend to have more mixed outcomes during El Niño throughout summer months, followed by drier-than-normal conditions after September. In northern Thailand, where rice yields are often lower during El Niño years, late onset of rains and dry and hotter than average conditions have been present through early August (Figure 4-right) and there is concern for the ongoing wet-season rice crop in most areas (See Crop Monitor for Early Warning August 2023 and Crop Monitor for AMIS August 2023). Substantial improvement in rainfall conditions in northern Thailand seems unlikely, based on below-average rainfall forecast during August by the GEFS; for rainfall from September, model disagreement limits a confident outlook. Highly above-normal temperatures are expected to continue across the region.

Anticipated Cropping Season Impacts in Africa

In **Southern Africa**, negative impacts of El Niño are typically strongest and most consistent in southeastern areas of the region, including in Zimbabwe, southern Zambia, southern and central Mozambique, and northeastern South Africa. During past moderate to strong El Niño years, these areas have often received below-normal rainfall during the key months of the growing season, as well as above-average daytime temperatures (Figure 5). While rainfall is the more limiting factor for maize production, high temperatures can worsen the impacts of dry spells and negatively affect maize development. Long-range NMME models are pointing to below-normal December 2023 to February 2024 rainfall in Zimbabwe, South Africa, and other areas in the region, as well as above-normal temperatures.

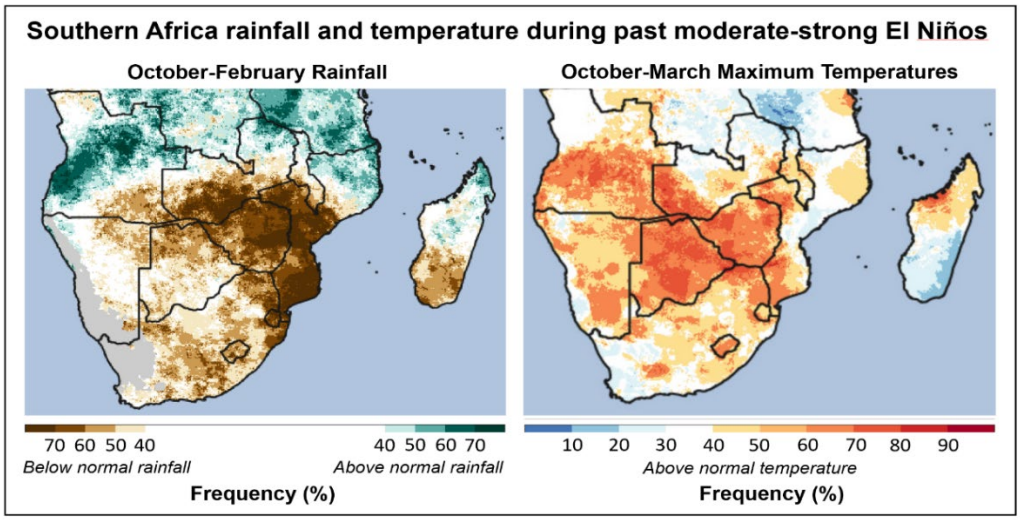

Figure 5: Historical seasonal rainfall and temperature during moderate to strong El Niño years. Left: Frequency of below-normal and above-normal October to February rainfall, based on CHIRPS data. Right: Frequency of above-normal maximum temperatures during October to March, based on CHIRTSmax data.

In **East Africa**, September to December rainfall in eastern and southern areas tends to be higher than average during El Niño years. Forecasts support this outlook for late 2023. Generally positive agricultural outcomes are therefore anticipated in bimodal rainfall season areas of eastern Kenya,

southeastern Ethiopia, Somalia, and northern United Republic of Tanzania for Short Rains crops. However, in these areas, converging influences from the Indian and Pacific Ocean may also lead to flooding in riverine cropping areas and settlements, as well as associated negative impacts such as crop and livestock losses, health emergencies, and disruptions to infrastructure and food distribution networks. Concerns for these risks are due to the forecast strong positive Indian Ocean Dipole and El Niño conditions, which can reinforce wind patterns and rainfall processes that produce heavy and consistent rainfall during this season. If these conditions develop, an extremely wet season like 1997 is possible, underscoring the need for monitoring extensive above-average rainfall that could lead to a hazardous situation and loss of lives.

Global El Niño Yield Impacts

The impact of El Niño on seasonal precipitation has both positive and negative impacts on agricultural production and yields in different regions of the world. A historical yield analysis was carried out by FEWSNET partners at NASA/NOAA/UCSB CHC/NASA Harvest using UN FAO country level yield data to understand the impacts of ENSO on past yield outcomes for key global crops, including wheat, maize, rice, soybean, and sorghum (Figure 6). The historical analysis covers the period 1961-2020, using FAO crop yields in years without data quality flags passing a quality control algorithm developed to identify unreliable data. Historical El Niño-like conditions were identified based on sea surface temperatures in the Niño 3.4 region during the October to December season, using the ERSSTv5 dataset. For boreal summer-grown crops harvested in the fall (September to November), yield anomalies indicate conditions for harvests occurring during a developing El Niño event. For boreal winter-grown crops harvested in late spring/early summer (May to July), yield anomalies reflect harvests occurring during the decaying calendar year of El Niño. Southern hemisphere wheat planted in austral winter and harvested in austral late spring/early summer (October to January) indicates yield values for harvests coinciding with peak intensity of El Niño events. The below graphic and text outline the results of this analysis for key global commodity crops:

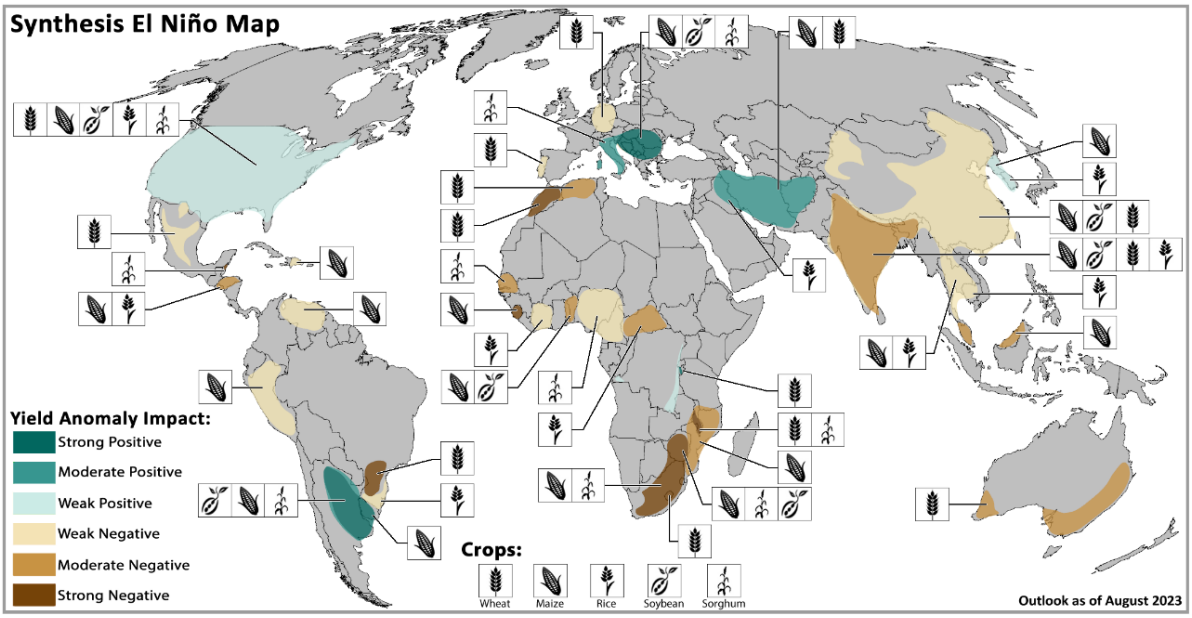

Figure 6: Historical crop yield conditions during El Niño events for wheat, maize, rice, soybeans, and sorghum using FAO country level yield data and ERSSTv5 from 1961-2020. In countries with more than one crop affected, the color reflects the strongest effect.

Maize: Past El Niño events have led to deficit maize production in India, China, southeastern Africa, and parts of Central America and northern South America (Figure 6). The effects tend to be strongest in southeastern Africa where average deficits are around 10 to 15% relative to expected yields in Zimbabwe and South Africa, with some events resulting in deficits of over 50%.

Wheat: Historically, the impact of El Niño events on wheat yields has been modest at the country scale. Average yield declines relative to expected yields are around 5% or less in India, China, Australia, southeastern South America, and parts of Europe and North Africa (Figure 6), although Morocco tends to experience yield deficits of up to 15%.

Rice: Past El Niño events have reduced rice yields in major production regions of South and Southeast Asia. The strongest impacts of El Niño events have been in India and Thailand, which were the world's two leading rice exporters in 2022/2023. Average yield declines in India and Thailand during El Niño events have been 2 to 4% with declines of 5 to 10% possible.

Soybeans: El Niño events tend to improve soybean yields in both the United States and Argentina, while reducing yields in India. Yields tend to be around 3% and 8% above expected levels in the United States and Argentina, respectively, while they are around 9% below expected levels in India on average.

Conclusions

The recent shift to El Niño follows three consecutive years of La Niña that impacted many parts of the globe and resulted in above and below-average yields across different regions. These impacts were felt particularly in East Africa where some areas experienced up to five consecutive poor rainfall seasons, resulting in crop failure and heightened food insecurity.

The ongoing El Niño and its associated impacts on seasonal rainfall and temperatures is likely to result in negative yield impacts in different regions and also has the potential to influence global crop yields. While the severity of the impacts is unknown, heightened monitoring for agricultural production is advised, and efforts to mitigate the effects should be undertaken to reduce the impacts on the most vulnerable regions.

List of Abbreviations:
CHIRPS: Climate Hazards Center InfraRed Precipitation with Station data
ECMWF: European Centre for Medium-Range Weather Forecasts
ENSO: El Niño-Southern Oscillation
ERSSTv5: NOAA Extended Reconstructed Sea Surface Temperature V5
FEWSNET: Famine Early Warning Systems Network
GEFS: Global Ensemble Forecast System
NASA: National Aeronautics and Space Administration
NMME: North American Multi-Model Ensemble
NOAA: National Oceanic and Atmospheric Administration
UCSB CHC: University of California Santa Barbara Climate Hazards Center
UN FAO: United Nations Food and Agricultural Organization

Prepared in Collaboration with:

Prepared by members of the GEOGLAM Community of Practice Coordinated by the University of Maryland with funding from NASA Harvest The Crop Monitor is a part of GEOGLAM, a GEO global initiative.

https://cropmonitor.org/

@GEOCropMonitor

Disclaimer

Disclaimer: The Crop Monitor special report is produced by GEOGLAM with inputs from the following partners (in alphabetical order): CHC UCSB, FEWS NET, NOAA, NASA GSFC, and UMD. The findings and conclusions in this joint multiagency report are consensual statements from the GEOGLAM experts, and do not necessarily reflect those of the individual agencies represented by these experts. GEOGLAM accepts no responsibility for any application, use or interpretation of the information contained in this report and disclaims all liability for direct, indirect or consequential damages resulting from the use of this report.