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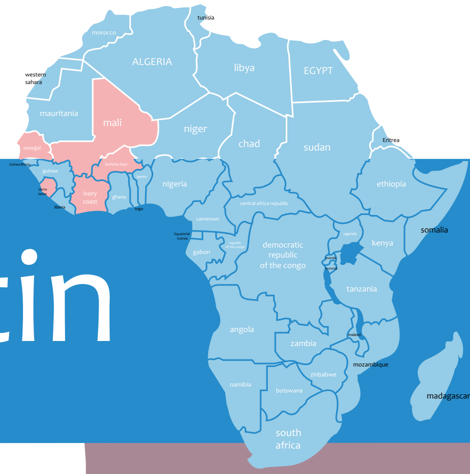

Covid-19 Bulletin

2020 Pearl Millet Production Forecasts for Selected West African Countries: Côte d'Ivoire, Mali, Burkina Faso, Sierra Leone, The Gambia, and Senegal.

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The COVID-19 pandemic continues to impact economies around the world. While most countries have lifted restrictions on mobility, protective measures such as mandatory use of masks, COVID-19 screenings for travelers, and bans on large public gatherings remain.

Most governments have revised their country's estimated economic growth rate downwards due to the shocks that the pandemic introduced. As a response, governments subsequently provided stimulus packages to support both private and public sectors.

Policies implemented by countries to mitigate the spread of the COVID-19 pandemic have added to disruptions of national economies. The impact of these policies has put a heavy strain on different sectors of the economy and communities' livelihoods. One of the biggest fears is that the pandemic and the public health measures taken to mitigate its impacts also affect agricultural production and could trigger a potential food crisis in many parts of the world, especially in Africa. While on the health side, official data shows that Africa is currently less affected by the COVID-19 pandemic compared to the rest of the world, there have been several impacts on African economies, which are largely dominated by the informal sector and, as such, greatly dependent on the mobility of its populace.

In the Agricultural sector, some undesired consequences on food production include input scarcity, the shortage of agricultural workers, limited access to export markets, and disruptions to the food supply,

FINDING A SOLUTION TO THE PROBLEM OF FOOD CROP PRODUCTION DATA

From effects on access to seeds and fertilizers, limited movement of goods, declining demand, to labor shortage, the disruptive impact of Covid-19 on food production systems is real. The challenge here is not only the likely extent and complexity of the disruptions but also the difficulty to identify and track them in real time. Unlike the propagation of the disease itself which can be tracked through testing and tracing, it is impossible, even in normal times, to have accurate information on cropping activities. The introduction of confinement and other measures to control the pandemic make the situation even more difficult. There is no way of knowing whether farmers have access to inputs, in time or in adequate quantities, whether they have been too sick to tend to their farmers or could work only partially. One would eventually find out at the end of the growing season from the impact of harvested quantities. One is then left to play catch up to deal with a crisis situation.

The complete lack of information about growing conditions can be overcome by using today's digital technologies. Remotely sensed data allow to track in real time changes in vegetation cover, weather data and other parameters related to cropping activities. Recent developments in machine learning and computer modeling make it possible to track and predict crop production using these data. The benefits go far beyond the ability to overcome the obstacles to data gathering during crises. The many weaknesses hampering the access to good quality agricultural statistics also can be overcome using the same digital technologies, from measuring arable land, planted areas, crop yields to the spatial distribution of harvested quantities. Our scientists are using these technologies to assess changes in food production systems during the pandemic and thereby provide valuable information to tackle the impact of the pandemic among local communities.

Ousmane Badiane, Executive Chairperson including from imports. For countries with mono-seasonal food crops, late delivery, and use of imported seeds and fertilizers can disrupt their agricultural production activities. Good planning by governments and other decision-makers is crucial to anticipate and mitigate the potentially detrimental effects on the agricultural sector to prevent a food crisis. The ability to evaluate early how much food is expected to be produced provides a better assessment of food security and allows for a more precise and disaggregated understanding of threats to livelihoods.

The complexity of the pandemic ramifications and the difficulty of observing changes on the ground in a context of already weak data systems often lead to rather passive approaches to dealing with production disruptions. One discovers the damage at the end of the growing season when it becomes clear where production has fallen short and where not. Little time is left to act and protect livelihoods. Although the COVID pandemic may serve as a trigger, there has been a need for a while for Africa's agricultural sector strategy to shift onto harnessing data-driven approaches for better data-gathering techniques and planning. The recent developments in machine learning and the disaggregated access to remotely sensed data opened a new momentum in tackling complex uncertainties.

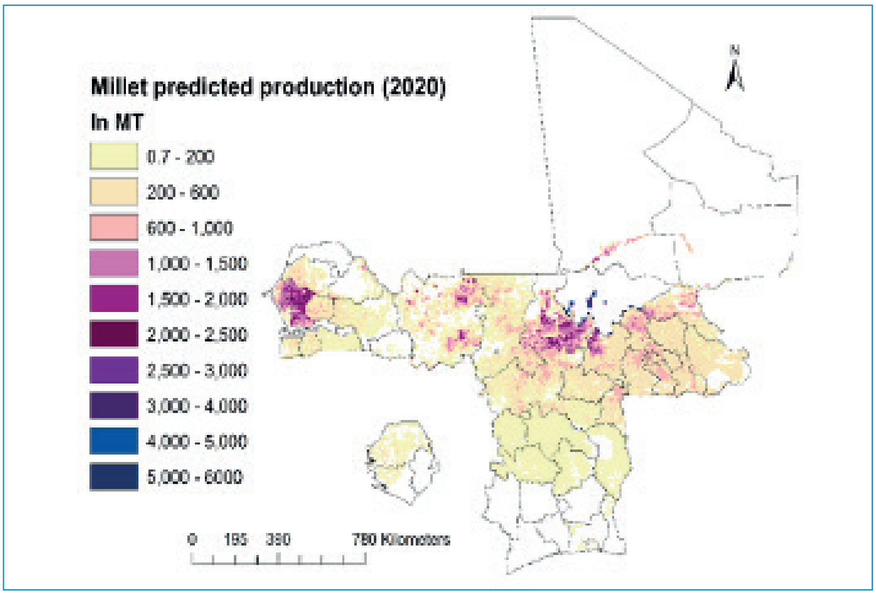
On the one hand, supervised machine learning techniques, in contrast to rule-based approaches, tend to solve problems through "learning" from a large number of examples of historical explanatory variables along with their equally large number of corresponding outcomes, and this is one without initial learning hypotheses. Such characteristics confer learning machines and abilities to discover data patterns invisible to humans and use these patterns to predict future states. On the other hand, remote sensing, through satellite images, makes it possible to detect features on earth such as agricultural land and vegetation, from the smallest area to a global scale, and with a relatively high frequency of observation. One of the most valuable features of satellite-based, remotely sensed data is their spatial resolution, which allows for the availability of highly disaggregated data over time and across space.

The team of data scientists at AKADEMIYA2063 assembled remote sensing products and applied machine learning techniques (Ly & Dia, 2020) to estimate millet production for the current agricultural season in Mali, Burkina Faso, Côte d'Ivoire, Sierra Leone, The Gambia, and Senegal. The findings show that it is possible to produce accurate production and yield forecasts, for individual crops and large geographic areas, in a relatively short time and use that as input in designing and executing agricultural and food policies and programs. Furthermore, improved forecasting capacity in the light of possible widespread disruption of production systems from increasingly frequent weather shocks represents a critical component of future readiness to effectively respond to events such as the COVID-19 pandemic and mitigate their effect on local food systems. In its current application, the model examines the spatial distribution of millet production and yields at a pixel level across a number of countries in West Africa. The findings discussed below illustrate how it can be applied to deal with a larger number of crops and countries to raise our capacity to observe and monitor cropping seasons' progress and detect early signs of troubles.

Overview of production and yield estimations in selected countries

In West Africa, pearl millet (Pennisetum glaucum L.) is an important cereal crop for local communities and has recognized suitability in semi-arid zones. It is a staple food crop and therefore plays a significant role in smallholders and other consumers' food security status. In the following sections, we present the results for millet production in 2020 from our forecasting model and contrast it with 2017 production levels to assess the direction of changes. Figure 1 shows the map of the predicted 2020 millet production across the six study countries. It shows that the highest levels of expected production are western Senegal, northern Gambia, western and central Mali, and western and northern Burkina Faso. In contrast, the lowest predicted production levels are observed in northern Côte d'Ivoire and western and northern Sierra Leone.

__Figure 1.__ The 2020 predicted millet production for Côte d'Ivoire, Mali, Sierra Leone, The Gambia, and Senegal. Pixels are of size 10 by 10 km. Data and map source: Authors;



According to the United Nations Food and Agriculture Organization (FAO), the six countries' aggregated millet production was around 3.5 million metric tons in 2017. The most significant contributors were mainly Mali (50%), Burkina Faso (28%), and Senegal (16.5%). While the Gambia, Côte d'Ivoire, and Sierra Leone counted for 2.6, 1.8, and 1.2 percent, respectively. Our model suggests a total millet production close to 3.6 million metric tons for the same countries in 2020, which corresponds to an slight increase of 0.1% compared to 2017.However, the distribution of total production across individual countries has changed for some countries. Indeed, based on the model predictions, Mali, Burkina Faso, and Senegal account for 47, 34, and 17 percent of total production, respectively. The corresponding shares for The Gambia, Côte d'Ivoire, and Sierra Leone are 0.1, 1.8, and 0.8 percent, respectively.

*Figure 2. Estimated millet yield for the 2020 agricultural season. For each pixel, the production value is divided by the corresponding harvested areas retrieved from the MapSPAM database. Map and data **source:** Authors;*

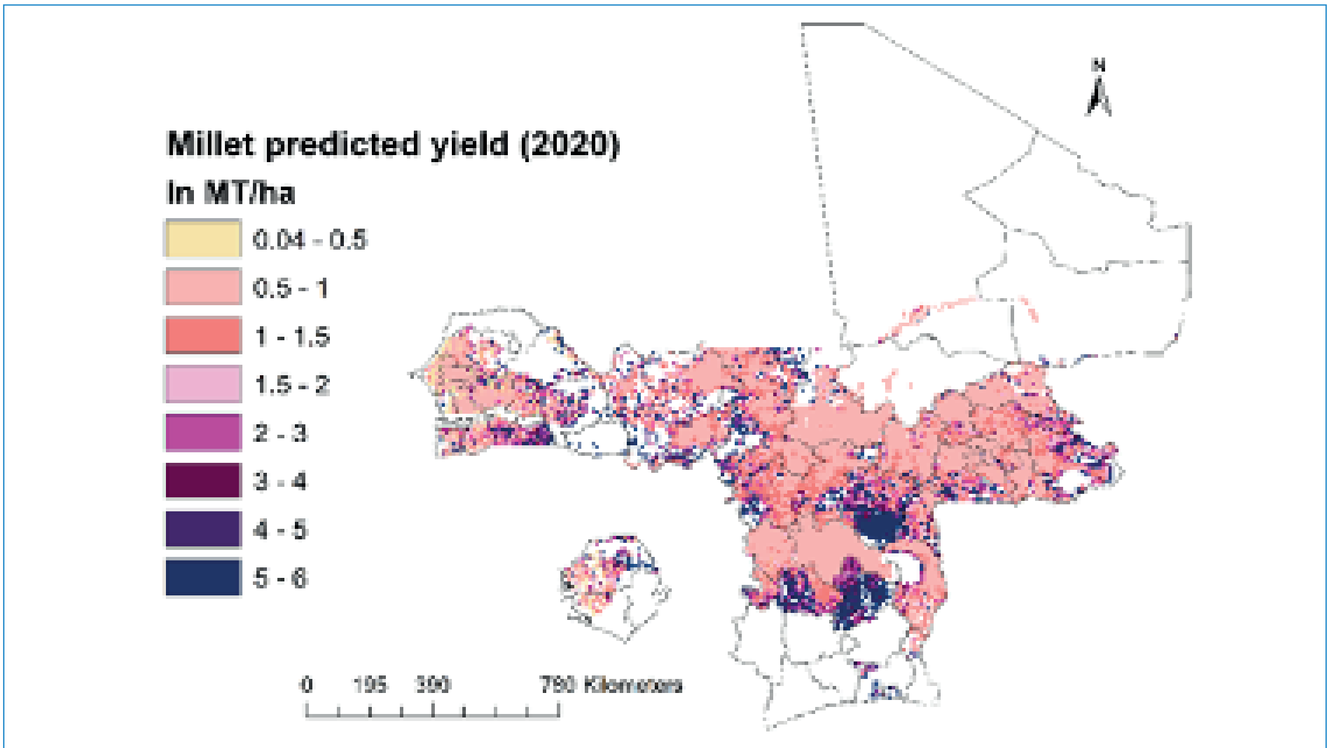
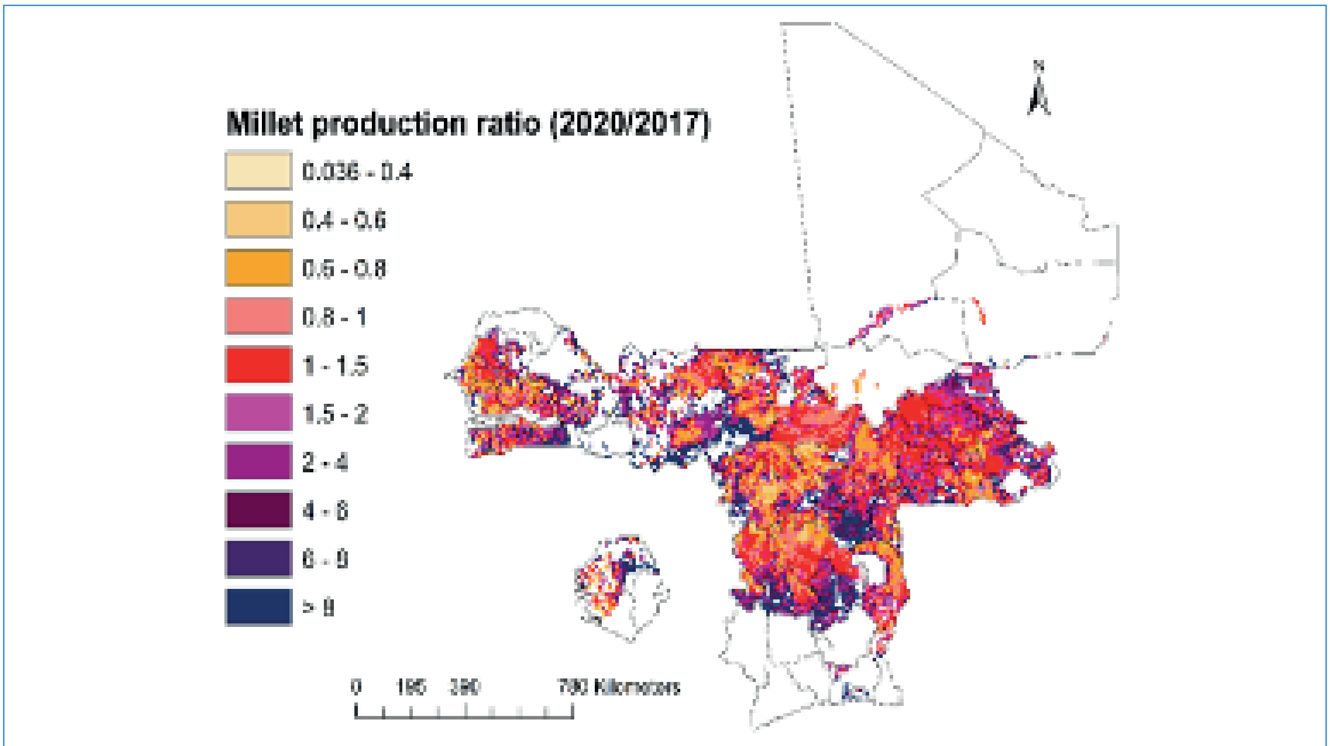


*Figure 3. Comparison between 2020 (predicted) as a fraction of the 2017 millet production. The values under unity mean that 2020 production is less than the 2017 production. Pixels are of size 10 by 10 km. Map and data **sources:** Authors;*



When it comes to projected yields (Figure 2) - estimated as the ratios between predicted 2020 production levels and MapSPAM harvested areas, it appears that there is a different geographical distribution compared to that of production. Countries' location in different agro-ecological zones could partly explain the above observation. Indeed, Senegal, Mali, and Burkina Faso make up the majority of the arid and semi-arid zones, while northern Côte d'Ivoire is in the sub-humid area and Sierra Leone in the humid zone. In most of areas, predicted millet yields in 2020 range between 0.5 to 1 MT/ha. However, for most countries, there is a little spatial variation of yield levels apart from Burkina Faso and Côte d'Ivoire. Yields are particularly high, in relative terms, in some parts of Northern Côte d'Ivoire and Southern Burkina Faso. For other countries, high yield areas are not significant and represent small, sparse spots.

Millet production changes in 2020 across the study countries

Figure 3 shows the ratios between predicted millet production levels for the 2020 season and actual levels in 2017. On average, the map suggests better millet production for the 2020 season compared to 2017 for Senegal[1] and Burkina Faso. Compared to 2017 production levels, projected millet production in 2020 in Burkina Faso and Senegal shows a progression of 22.7% and 2.6% respectively, while other countries show a decline. However, the disaggregation at pixel level reveals disparities within each country, with zones of higher production alongside zones with projected lower production levels in 2020.

The above findings illustrate the promise of combining machine learning algorithms and remote sensing to augment available data and produce valuable insights into agricultural production systems' behavior. While data gathering remains a major challenge in normal times and significantly more so during crises such as the current pandemic, the recourse to remotely sensed data and information is changing how the issue of data scarcity can be tackled in Africa. More importantly, applications such as machine learning make it possible to extract a large amount of useful information and knowledge otherwise hidden in the data. AKADEMIYA2063 is harnessing this opportunity to leverage data-driven approaches to solve the agricultural sector's most pressing issues. Through these COVID-19's publication series, AKADEMIYA2063's team of data scientists is taking a holistic approach—with available datasets—to treat and provide policy-relevant data for policymaking processes. The team does this by predicting food crop productions, assessing changes in growing conditions, and analyzing shifts in yields. This bulletin is the first to focus on several countries in the same region.

Note

The shown boundaries and names, and the designations used on maps do not imply official endorsement or acceptance by AKADEMIYA2063.

Background documents

Ly, R., & Dia, K. (2020). Application of Remote Sensing and Machine Learning for Crop Production Forecasting During Crises. AKADEMIYA2063. Kigali: AKADEMIYA2063.

1 The increase in Senegalese production here is due to the consideration of rainy season in August and September.

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