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Study: Maximizing grain yields won't meet future African needs

by Scott Schrage | University Communication



Courtesy photo | Lenny van Busse

A farm in Ghana, where corn yields sit at about a quarter of what could be grown with optimal plant and soil management. New research from the University of Nebraska-Lincoln and its collaborators has found that sub-Saharan Africa will struggle to meet its 2050 grain demands even if it maximizes the yields of corn and four other cereal crops.

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Maximizing cereal crop yields in sub-Saharan Africa would still fail to meet the region's skyrocketing grain demand by 2050, according to a new study from the University of Nebraska-Lincoln, Wageningen University and multiple African institutions.

Sub-Saharan Africa produces about 80 percent of the grain it now consumes. But that consumption could triple if its population rises an expected 250 percent by 2050. Presently, cereal crops account for about half of sub-Saharan Africa's food and farmland.

Even if sub-Saharan yields continue rising at the rate they have over the last quarter-century, the region's existing farmland would still produce only between a third and half of the grain needed in 2050, researchers reported Dec. 12 in Proceedings of the National Academy of Sciences.

"The status quo is simply not acceptable," said co-author Kenneth Cassman, professor emeritus at Nebraska and fellow of the Daugherty Water for Food Global Institute. "Complacency is the enemy. This is a clarion call for action."

To maintain even 80 percent of its self-sufficiency in 2050, sub-Saharan Africa must reach the realistic yield thresholds of corn, millet, rice, sorghum and wheat, the study found. The region currently grows about a quarter of the cereal crops it could by optimizing its plant and soil management, the authors said. Closing this gap would require what the study called a "large, abrupt acceleration" in yield trajectories similar to the Green Revolution that transformed North American, European and Asian agriculture in the mid-20th century.

"But our analysis shows that even closing the gap between potential yields using modern farming practices and current farm yields, with traditional crop varieties and little fertilizer, still leaves the area at a deficit with regard to cereals," Cassman said. "That's quite eye-opening, because my guess is that most people in the agricultural development community might have thought sub-Saharan Africa could be self-sufficient, or even produce excess cereal, if it were able to close existing yield gaps."

The authors analyzed 10 sub-Saharan countries using the Global Yield Gap Atlas, which estimates the disparity between actual and potential yields while accounting for differences in soil types and climate. After assembling location-specific data and assessments from agronomists in each of the 10 countries, the team used a novel upscaling technique to estimate yield gaps at national and sub-continental levels.

Meeting future cereal demands could depend on expanding responsible irrigation use to raise yield ceilings and stabilize cereal production, said Kindie Tesfaye, agronomist with the International Maize and Wheat Improvement Centre in Ethiopia. Recent analyses have documented regional aquifers that could become sources of sustainable irrigation, though the authors emphasized the importance of withdrawing only what can be replenished by rainfall and recharge.

Tesfaye said irrigation could ramp up yield thresholds by allowing farmers to annually grow a crop multiple times in the same field or introduce new cereals into yearly planting schedules.

Patricio Grassini, assistant professor of agronomy and horticulture at Nebraska, stressed that these efforts will require "massive and strategic investments in agricultural development on an unprecedented level." Combining the yield gap findings with socioeconomic and other data, Grassini said, could inform essential upgrades to infrastructure that might include roads and water pipelines; publicly financed research and development; and farmer access to credit, state-of-the-art equipment and pest-management resources.

A failure to upgrade could force sub-Saharan Africa to transform savannahs, rainforests or other natural ecosystems into farmland – a process, the study noted, that would produce massive amounts of greenhouse gases while shrinking the habitats of native plant and animal species.

If yield growth and cropland distribution remained constant across the 10 countries, seven would lack the land area to accommodate such expansion, said Abdullahi Bala, professor at Nigeria's Federal University of Technology, Minna. And the newly converted land would very likely prove less fertile than the region's current farmland, Cassman said.

Though the region might also resort to importing cereal crops, the authors cautioned that many of the developing countries in sub-Saharan Africa could struggle to do so. The price spikes that often accompany drought-driven market shortages could further complicate matters.

"If it is true that sub-Saharan Africa will depend more heavily on food imports," Grassini said, "the next question is: What would be the infrastructure networks needed to alleviate food shortages in the most vulnerable areas?"

The researchers said several sub-Saharan countries may produce surpluses that could be shared among neighbors. Though the projected surpluses would fall short of compensating for neighboring deficits, this represents one of several opportunities the region might seize to contend with the profound challenges ahead.

"To reach those goals is going to take very strategic, careful prioritization and adequate resources to do the job," Cassman said. "Having a strategic vision of what to invest in – to fund those things that can give greatest payoff – is critical. What this work does is allow for a much more surgical look at how to do that, which just wasn't possible before."

The Daugherty Water for Food Global Institute, the Bill and Melinda Gates Foundation, USAID and the university supported the development of the Global Yield Gap Atlas, which agronomists at Nebraska and Wageningen created in 2011. The new study was co-authored by agronomists at the International Crops Research Institute for the Semi-Arid Tropics (Kenya); International Food Policy Research Institute; Africa Rice Center (Benin); Jomo Kenyatta University of Agriculture and Technology (Kenya); International Institute of Tropical Agriculture (Ghana); AGRHYMET Regional Centre (Niger); Federal University of Technology, Minna (Nigeria); University of Zimbabwe; National Agricultural Research Laboratories (Uganda); Institute of Rural Economy (Mali); Ministry of Agriculture Food and Cooperatives (Tanzania); Environmental and Agricultural Research Institute (Burkina Faso); and the International Maize and Wheat Improvement Centre (Ethiopia).

NEWS RELEASE CONTACTS:

Kenneth Cassman, Emeritus Professor of Agronomy

402-472-1548

Website

Patricio Grassini, Assistant Professor of Agronomy and Horticulture

402-472-5554

Website

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Courtesy Marloes van Loon

A cornfield in Ghana exhibits signs of water stress and nutrient deficiency. New research from the University of Nebraska-Lincoln and its collaborators has found that sub-Saharan Africa will struggle to meet its 2050 grain demands even if it maximizes the yields of corn and four other cereal crops.



Kenneth Cassman



Patricio Grassini

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