Paper focuses on investing wisely in sustainable intensification research

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Patricio Grassini (left) and Ken Cassman Craig Chandler. Credit: University Communication

When you decide to make a large investment in something—for example, a house—you likely ask yourself a series of questions to gauge if it's a smart buy. Will the size and type of house you've chosen, in a given city or neighborhood, deliver long-term value? Will it improve your quality of life? And, of course, do the benefits justify the cost?

Asking these questions is probably an intuitive part of your personal financial decision-making, an autopilot analysis you go through before shelling out big bucks. But surprisingly, big spenders in the world of agricultural research—organizations that allocate money to scientists around the nation and world—have no equivalent framework for making funding decisions about research and development focused on sustainable intensification of agriculture, which University of Nebraska–Lincoln researchers Patricio Grassini and Ken Cassman say is widely recognized as one of the major pillars of a food-secure world.

That's why, in a paper recently published in *Nature Sustainability*, Grassini and Cassman propose a four-pronged prioritization framework for funders to use as they distribute research dollars to agricultural scientists pursuing the goal of sustainable intensification. That term refers to increasing yields of major food crops on existing farmland to avoid converting rainforests and wetlands for crop production, and doing so without negative effects on biodiversity, water and soil.

"It would be nice if we were investing in agricultural research using the same decision-making as when we spend money from our own pocket," said Grassini, associate professor of agronomy and horticulture. "We all agree on the importance of producing food on existing farmland and preserving natural ecosystems, but there is no consensus on how to get there or how to prioritize. This paper gives a blueprint for action."

The Husker duo, which has collaborated for more than a decade, was among a group of leading researchers focused on sustainable intensification who were invited to write for April's edition of Nature Sustainability. Grassini and Cassman are the first team to explicitly address the scientific community's failure to develop an effective method for prioritizing research trajectories aimed at sustainable intensification, and to set forth a strategy to fill that gap.

"This is a unique situation, because everyone agrees on the big-picture goals and understands that there is no chance to deal with climate change if we don't hold agricultural production to existing farmland," said Cassman, Robert B. Daugherty Professor Emeritus of agronomy. "What's so ironic is that there is no dialogue in the scientific community about what we should be funding in terms of research."

The lack of a strategy is problematic because of the urgency of the problem. Over the next 30 years, an additional 2 billion people will join the global dinner table. Yet today's solution to food security—which converts millions of hectares of land each year for crop production—isn't the answer, the researchers said. Land conversion is disastrous for the environment, often eliminating rainforests, grassland savannahs and wetlands that are critical for biodiversity and carbon storage.

Land-clearing triggers the release of soil carbon stocks into the atmosphere, making it the leading source of human-driven greenhouse gas emissions.

"We're converting land at the fastest rate in human history at the same time (that) we are trying to reduce greenhouse gas emissions to reduce climate change," said Cassman. "They are completely incompatible."

To slow the practice of land conversion, the researchers said funding organizations must prioritize projects most likely to result in sustainable intensification on national and global scales. Grassini and Cassman suggest funders answer four questions about proposed research efforts: First, how long is it going to take? Next, what is the probability of success? Third, how much will it cost? And fourth, what is the magnitude of potential impact if the research leads to new technologies and farming approaches that are widely adopted?

Using this framework will enable agencies like the U.S. Department of Agriculture and the U.S. Agency for International Development to better prioritize their investments in sustainable intensification, the researchers said. An example is deciding which crops and cropping systems should receive public-sector R&D investment within a funding program focused on sustainable intensification. Some argue priority should be given to diversifying cropping systems by growing a wider selection of major food crops to avoid reliance on a small number of crops. Others contend the greatest portion of funding should go toward sustainable intensification of the four crops driving the majority of land clearing: rice, wheat, corn and soybean.

Using their proposed prioritization framework, Grassini and Cassman argue it's more strategic to focus on ramped-up production of rice, wheat, corn and soybean because the other route—diversifying crop systems—would take several decades and has a low probability of success, reflected by the fact that there hasn't been a new crop introduced at scale in the past 40 years.

And no matter what happens at a local level, they said, global demand for rice, wheat, corn and soybean will remain high because those crops are easy to transport long distances, easy to dry and store, and require little energy to process and cook. They're also necessary to support the large livestock feeding operations that supply meat, dairy and fish to the world's rapidly growing middle class.

So while diversifying crops and production may yield modest environmental benefits locally, demand for the four staple crops will continue to surge, leading to land-clearing elsewhere.

"This is a good example of the need for a system of prioritization," Cassman said. "If you bet on diversifying the entire global system, you won't be able to achieve it within the time required for solutions to

meeting food demand on existing farmland."

Grassini and Cassman believe that while there is considerable public- and private-sector investment in specific technologies to support intensification of current major crops and cropping systems, their framework would show that more research is needed to merge these technologies into viable production systems and to quantify their impacts in farmers' fields, rather than in small research plots.

But for them, it's less about picking winners and losers and more about spurring their peers in the scientific community to get serious about prioritizing research with the highest odds of success. With the global population expected to approach 10 billion by 2050, there's no time to waste, they said.

"The way we prioritize has huge implications for how the world will look," Grassini said. "What has been missing is recognition of the need to move fast. We're trying to achieve food security and keep biodiversity and avoid climate change for our kids and grandkids."

More information: Kenneth G. Cassman et al. A global perspective on sustainable intensification research, *Nature Sustainability* (2020). DOI: 10.1038/s41893-020-0507-8

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