

WHAT WORKS TO END HUNGER?

Finding and synthesizing global evidence

Ceres2030
Sustainable Solutions to End Hunger





Over the past sixty years, scientific research coupled with significant public investment led to dramatic increases in agricultural yields, particularly in Asia and the Americas.

The incidence of hunger is now at one in nine people on the planet, according to the Food and Agriculture Organization of the United Nations (FAO)¹, which marks a notable decline despite an equally dramatic increase in the earth's human population. Yet one in nine people is still one in nine too many, while the increasing demands of farming is putting acute stress on environments that are often already fragile. Modern agricultural practices are responsible for a significant share of the global total of greenhouse gases and have reduced biological diversity while depleting precious sources of clean freshwater. Concurrently, a recent report² from the Intergovernmental Panel on Climate Change (IPCC) reiterates and reinforces past warnings of climate change's adverse impacts on food security, along with what it could mean for land quality and related issues.

Sustainable Development Goal 2 (SDG 2) presents hunger as a multi-dimensional problem. How can we meet today's caloric needs to end acute hunger and the malnourishment while at the same time protecting the environment? How do we ensure the food supply is both abundant and sustainable for the existing global population, ensuring that people and the planet do not merely survive, but also thrive?

Food systems are complex, and as problems change and evolve, so will our understanding of their root causes and effective solutions. As donors mobilize to meet the targets set by SDG 2, one of the most pervasive challenges they will face involves information: they need to know how much it will cost to fix these problems, what interventions have been researched and which are most effective in addressing them, and how those interventions will affect the rest of the economy.

1 <http://www.fao.org/state-of-food-security-nutrition/en/>

2 https://www.ipcc.ch/site/assets/uploads/2019/08/Edited-SPM_Approved_Microsite_FINAL.pdf





Photo by Trevor Butterworth

GENERATING EVIDENCE TO HELP DONOR-DECISION MAKING

Ceres2030 brings together an international team of 77 researchers from 23 countries in eight teams. The teams comprise interdisciplinary groups of development and environmental economists, geographers, physical and social scientists, all working together to review tens of thousands of papers in their search for evidence-based solutions.

These eight teams are each tasked with an article that will respond to an intervention question, which was developed with the help of an evidence advisory board. Each article focuses on a particular dimension of the agricultural-productivity-environmental interface within food systems. The selected interventions explore different parts of the value chain, from small-scale producers on the land, to how food moves into markets, to how investments in agriculture can contribute to a supportive and enabling macro-environment for food systems to thrive.

All eight questions examine critical dimensions of food security. For example, how effective are interventions to support farmers who live in drought or water-scarce conditions? What is the critical role of nutrition in livestock, which are a vital resource for one billion people? What does it really take to store and sell crops to growing urban populations? Which policies and

incentives work to encourage farmers to adopt sustainable farming practices? What mix of approaches do organizations use to seek out knowledge? How can training programs offer better employment opportunities for young people in the agricultural sector? What are various engagement strategies that farmers' organizations use to reach farmers?

We used standards-based synthesis methods for our analysis. These methods—the best known of which are systematic reviews—are designed to inform policy decisions and take seriously the reproducibility of their results and the transparency of evaluation decisions. Each author team produced and published an *a priori* protocol that explains the criteria for articles to be included or excluded from the review. The eight evidence syntheses will provide us with a summary of the current state of knowledge by exploring how various interventions in the agricultural farm and off-farm sectors have succeeded or failed in the outcomes inherent in the SDG2 objectives.

By its very nature, evidence synthesis reflects what we know from past experience in the published literature – but all of this needs to be interpreted in light of today's conditions and explored from multiple perspectives. The evidence synthesis results will be accompanied by articles that discuss different facets of achieving SDG 2, including synergies and trade-offs among competing policy objectives and the innovative methods behind evidence syntheses. These materials, subject to peer review, will be published as a high-impact collection in Nature Research Journals in 2020.

The resulting syntheses enhance our understanding and improve the conditions under which policy-makers operate. The findings from the eight evidence syntheses will be integrated into a cost model that is estimating the public investment needed from official development assistance (ODA) to support the realization of SDG 2. The Ceres2030 process is itself an experiment that brings together diverse knowledge systems to generate credible, transparent and relevant evidence for policy-makers.

HOW DID WE SELECT THESE EIGHT QUESTIONS?

The selection process for these eight questions involved various phases, which built on one another and used advanced technologies and expert inputs. First, Cornell University created a semantic machine-learning model to explore text-based materials. The model has reviewed more than 500,000 grey and academic materials in agriculture to improve our knowledge about what exists in the published literature. We analyzed scientific text to explore which populations have been studied, and which interventions. We extracted simple details like plant, animal and geographies, along with more complex details such as study design type. Pulling this data together into an analytical framework offers a “big data” perspective into agricultural literature. Being able to

CONTEXT

ON THE FARM

2 ZERO HUNGER

- How do we find what works? Ceres2030 models and key findings
- A donors' blueprint to achieve the Sustainable Development Goals
- How can we use evidence in the context of multiple and interacting SDGs?
- Can machine learning and methods bridge the gap between science and policy?



Adopting climate resilient crops



Solutions for short and long-term water scarcity



Sustainable and healthy approaches to feed livestock





Photo by Trevor Butterworth

extract these details also helped our author teams increase the speed with which they could explore thousands of documents.

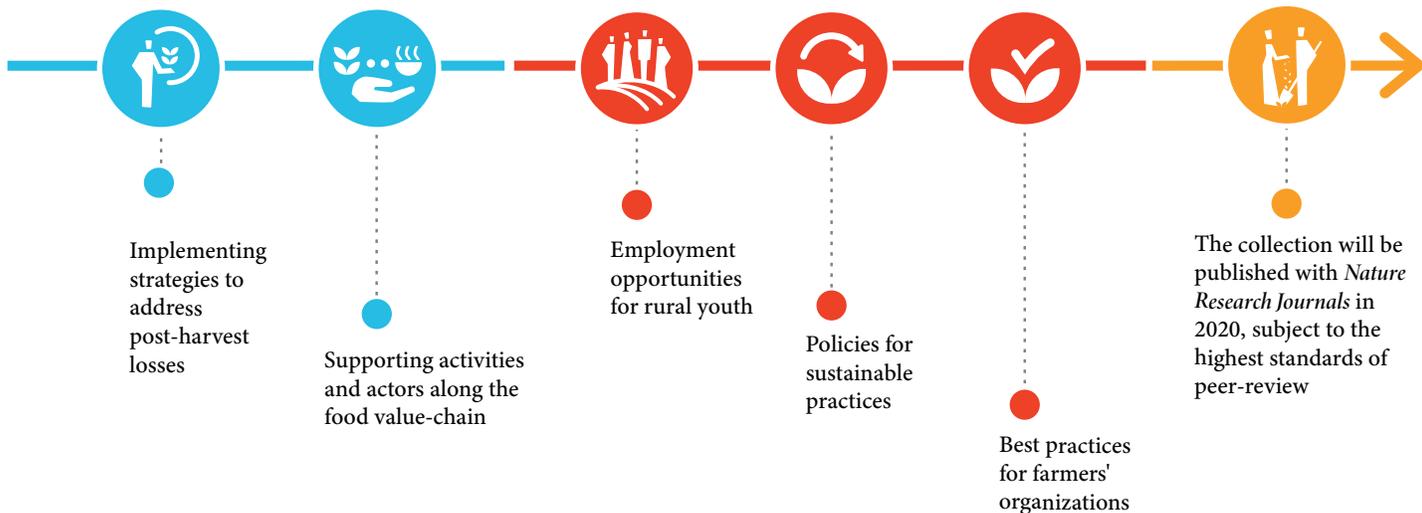
This approach helped us select relevant topics for the eight articles. We were able to generate machine-driven maps of evidence gaps—an example can be seen on page 15— that could involve potentially relevant interventions, and these maps helped us look at how much literature was likely to be available for distinct topics. We worked with our global advisory board of experts to explore the data with us, and they helped us pick the most important interventions—those that should go on for detailed academic review to better understand how they work, and in what contexts.

One of the challenges of reviewing evidence in agriculture is that almost everything works in some context. Unlike biomedicine, where evidence for “what works” can often be examined in carefully controlled clinical isolation, evidence in agriculture is influenced by many diverse economic, geographical, and social factors.

Our research questions had to be broad enough to account for these factors, yet precise enough to reveal the kind of robust evidence for ‘what works’ so that people can use to make investment and policy decisions.

FOOD ON THE MOVE

ENABLING GROWTH



What leads farmers in climate-vulnerable countries to adopt climate-resilient crops?



Photo caption: John Wambugu via USAID



ON THE FARM

Read the protocol: <https://osf.io/am3kb/>

Climate change exposes our food systems to increasing and potentially devastating risk. Less predictable and more extreme weather—from droughts to floods—increases farmers’ costs. Exposure to loss threatens domestic production in many developing countries to the point of imperiling their food security, and increasing the risk of disruption to international markets.

As the unpredictability and extremity of damaging weather increases through climate change, there is an urgent need to find climate resilient crops and crop varieties. Agricultural research and development have invested significant resources in creating alternatives for farmers to consider in stressed situations. But which crops, and which traits of crops, are best adapted to changing conditions? How successful have new varieties been in the face of extreme weather events? And most importantly, to what extent have the crops been adopted by small scale producers?

New adaption practices are a critical line of defense in the midst of climate change uncertainty, and we better understand adaptation when we first understand the reasons that farmers adopt new crops. We look across geography, financial incentives, socioeconomic details, market access, gender and more in order to get to the heart of ‘why’ farmers adopt new crops. This evidence synthesis will review more than 30 years of research and 5,000 papers as we characterize “climate-resilient” crops and reasons for adoption.



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What interventions improve farm income and productivity while tackling water scarcity?



Photo caption: Jervis Sundays, Kenya Red Cross Society, via USAID.



ON THE FARM

Read the protocol: <https://osf.io/efk7b/>

Water use has been growing globally at more than twice the rate of population increase in the last century, and an increasing number of regions are reaching the limit at which water services can be sustainably delivered, especially in arid regions (UN Water 2019). The sentence should be “At the same time, farmers also face potential water scarcity. Droughts have been responsible for some of the most serious famines in the world, wreaking havoc on crop growth, livestock health, fisheries and aquaculture production (FAO 2018). How do we farm without depleting our water but farm in a way that increases productivity so that we meet the Sustainable Development Goal of “zero hunger” by 2030?

Farmers face an urgent need to adopt sustainable agricultural practices that match the need for increased productivity to meet demand with the need to preserve water use. These initiatives range from downscaling irrigation technologies to improved crop storage. This synthesis will examine more than 18,000 papers to explore and reveal the spectrum of interventions that have tested the effectiveness of on-farm interventions for improving smallholders’ yield and incomes in water scarce regions. This evidence synthesis will offer a thorough review of the most promising incentives for farmers and describe some of the ways to encourage adoption of new practices addressing water scarcity.



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How can we improve livestock nutrition to benefit small-scale farmers in Africa and Asia?



Photo caption: International Livestock Research Institute (ILRI)



ON THE FARM

Read the protocol: <https://osf.io/6ywh7/>

Over a billion people depend on livestock for their livelihoods. Their animals are not just a source for food, or assets to be sold, they also serve many vital roles on farms, from providing the energy for plowing to producing high-value compost. Whole food systems, most of them nomadic, are centered on livestock, and these systems make an invaluable contribution to global food security and nutrition. A productive farm depends on having productive animals—and productive animals depend on good feed.

Food security experts have increasingly focused their attention on how to improve the quality, the quantity, and the year-round availability of fresh livestock feed. Interventions include the introduction of more nutritional grasses and legumes and better methods to preserve fresh feed throughout the year.

This evidence synthesis looks at whether farmers have embraced these interventions; and where there is evidence that they have, what have the results been? Has better feed led to higher productivity? This evidence synthesis is looking at more than 20,000 papers in order to identify the most promising feed options for improved productivity animal nutrition and how this contributes to improvements in their livelihoods.



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Do value chain small and medium enterprises address market failure of small farmers in developing regions?



Photo caption: Fintrac Inc. for USAID



FOOD ON THE MOVE

Read the protocol: <https://osf.io/qm8vg/>

When we talk about specific foods in a food system, we are often talking about “value chains.” A value chain describes the process that takes a crop from the field to the supermarket shelf. It begins with the inputs that lie behind a farmer planting their crops and then extends through warehouses, transportation, processors, food manufacturers, wholesalers, exporters, supermarkets, street food vendors, and fast food restaurants. They all influence the way small-scale producers farm and market their produce.

And all these elements of the value chain have, in turn, been influenced by urbanization, population growth, and rising incomes in developing countries, which have transformed what people eat over the past twenty years. Diets are now more diverse with people eating more meat and processed food. These trends both drive and reflect changes in the way food is created, stored, shipped, processed, and sold, and change the risks borne by small scale producers and farmers.

This evidence synthesis looks at service providers who support small-scale producers. Who are they, and what services are the most beneficial to farmers? This evidence synthesis will expand our knowledge about the interactions between farmers and value chain service providers.



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What interventions can reduce crop losses at, and after, harvesting and how can they be implemented?

Photo caption: Michael Foley



FOOD ON THE MOVE

Read the protocol: <https://osf.io/6zc92/>

Postharvest loss is not just about losing valuable crops during and after their harvesting, but wasting the precious and finite resources—land, labor, water, fertilizer, and energy—that went into their growth. It happens in a myriad of different ways, from poor handling to spillage during transport, or spoilage due to poor storage. And these food losses are often happening in the midst of local hunger and poverty.

For farmers, reduced losses mean greater productivity and increased food security, with higher quality produce resulting in more bargaining power with buyers. For governments, fewer losses would mean improved environmental and economic performance. For consumers, fewer losses would mean more and cheaper food. Tackling postharvest loss is a critical element in achieving zero hunger.

And yet despite widespread agreement among decision-makers about the importance of solving this problem, there has been little coordinated research and evaluation on how, exactly, to do this—especially around the training and finance needed to get technological solutions into widespread use.

The goal of this evidence synthesis is to identify the range of field-tested interventions available to tackle postharvest losses across the food system, and then assess whether these interventions are effective and to what degree.



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Can more young people in Africa, Asia, and Latin America enter the agricultural workforce through better skills training?



Photo caption: USAID



ENABLING ENVIRONMENT

Read the protocol: <https://osf.io/xv56k/>

Working poverty and unemployment figures for youth in developing world countries are sobering, estimated to be as high as 70% in Sub-Saharan Africa (ILO 2019). Yet youth are more educated than ever before, both in terms of years in school and levels of literacy (Roser and Ortiz-Ospina, 2019). Such demographics shape the future, so how should youth be supported to ensure that they could put educational attainment to good use while earning enough to transform the structure of their economies?

Young people in different regions of the world are not necessarily opposed to the idea of farming, though often face constraints in doing so. This synthesis will consider the importance of skills training on youth in the agricultural sector in developing countries. We emphasize agricultural value chains, agribusiness and contract farming interventions. We explore the extent to which training programs have been considered the heterogeneity of educational attainment and livelihood aspirations of both girls and boys. We examine whether such factors have been considered as part of youth training programs. This review will provide insights on how to prioritize investments to achieve SDG2 through livelihoods in agricultural-related activities.



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What policy incentives will lead farmers to adopt environmentally sustainable practices?



Photo caption: World Bank Photo Collection



ENABLING ENVIRONMENT

Read the protocol: <https://osf.io/hqnp3/>

Forward-looking policies to encourage sustainable agricultural practices by land users can facilitate the protection of the ecosystem, increase productivity, enable sustainable production, reduce poverty and advance food security. Yet the OCED reported in 2019 that many agricultural policies obstruct efforts to make agriculture more productive, sustainable and resilient. But differentiated interventions are the backbone of sustainable food systems, incentivizing farmers to adopt sustainable agricultural practices that enhance farm productivity while ensuring environmental sustainability.

When policies and incentives are calibrated to local contexts, they can help ensure that we are on path to making the right changes for the future. This synthesis will look at more than 17,000 papers to examine market, regulatory and cross-compliance incentives that are offered to farmers by the government, NGOs, international organizations, development banks and other market actors to encourage the adoption of sustainable land management practices. The implementation of sustainable practices may require significant effort from farmers and the support of governments and public-private partnerships at national and local levels. We examine the extent to which environmental and development goals can be achieved using the same policy tools, and where trade-offs may exist between socio-economic and environmental objectives. The outputs from this review will be able to guide decision-makers in considering a range of possible policy solutions to encourage practices for a more sustainable future.



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How can farmers organizations be better supported to achieve outcomes-based programming?



Photo caption: Fintrac Inc via USAID



ENABLING ENVIRONMENT

Read the protocol: <https://osf.io/cxrwb/>

Farmers organizations have a long history in agriculture. For producers, they provide support on issues as varied as collective action and bargaining for better prices to providing training and extension services. For external partners, such as donors and NGOs who have programs they hope will reach farmers, they are an intermediary for these groups to reach farmers. Farmers organizations can empower smallholder farmers and allow them to address issues of scale.

But, what are the various strategies that farmers organizations use to reach farmers? What are the impacts of the farmers' organization strategies on smallholder producers and on the environment? Support for farmer organizations is one of the strategies considered to be the most effective in overcoming the challenges facing smallholder farmers—challenges that act as barriers to urban market access among other opportunities. We are reviewing more than 7,000 papers from the past 20 years to assess the various strategies that farmers organizations have used to support farmers. This review will provide an in-depth understanding of how farmers organizations can be better supported in order to achieve outcomes-based programming.



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With the clock ticking on the Sustainable Development Goals, machine learning can transform how we find the right evidence to inform policy

And the whole picture is a lot of information. Agricultural research has doubled in the past ten years from two to more than four million articles—a trend mirrored across the sciences where, every seven seconds, a new scientific study is published (Science, 2013). There are thousands of academic journals, and hundreds of organizations publishing their own important research.

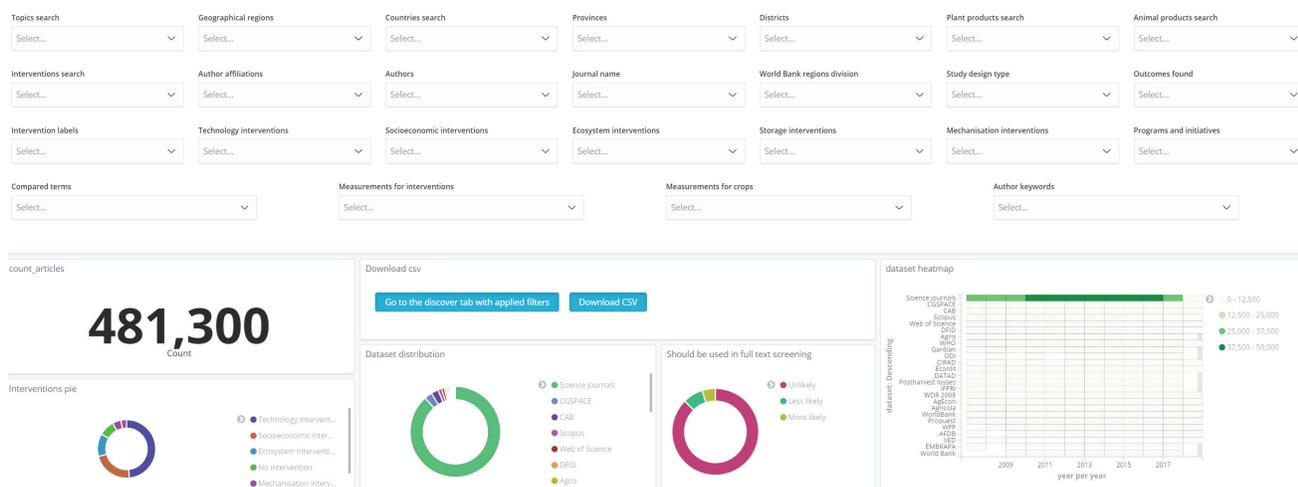
To look at what research says on a particular issue, it may take us a year just to figure out where all the relevant research is. There is no current system—not even Google—that can connect all this information in a way that gets us quickly and precisely to what we need to examine and with the confidence that we have been comprehensive in our search.

Increasingly, policy makers want evidence on “what works,” meaning research findings about programs that have been tried on the ground. But even if we could find all of the research from organizations and journals that describes ‘what works,’ we still need to make sense of it all—and to do so efficiently.

We relied on advances in text-based machine learning models to build a new semantic model. This model is capable of bringing together and analyzing any text-based information—peer-review journals, agency reports—in order to create ‘big data’ analytics for agriculture and related disciplines.

We encounter vast amounts of research and information everyday. When it comes to evidence-based decision-making, we need new ways to see and make sense of the whole picture.

FINDING ‘WHAT WORKS’ THROUGH OUR EVIDENCE DASHBOARD



The Sustainable Development Goals are all united by a common challenge: they need evidence—evidence that can inform policies that will address, mitigate, and solve complex problems. While scientists and policy makers often find themselves trying to solve the same problems, they look at information in distinct ways. We’ve designed a transformative approach that can bridge this divide and synthesize research from a policy perspective.



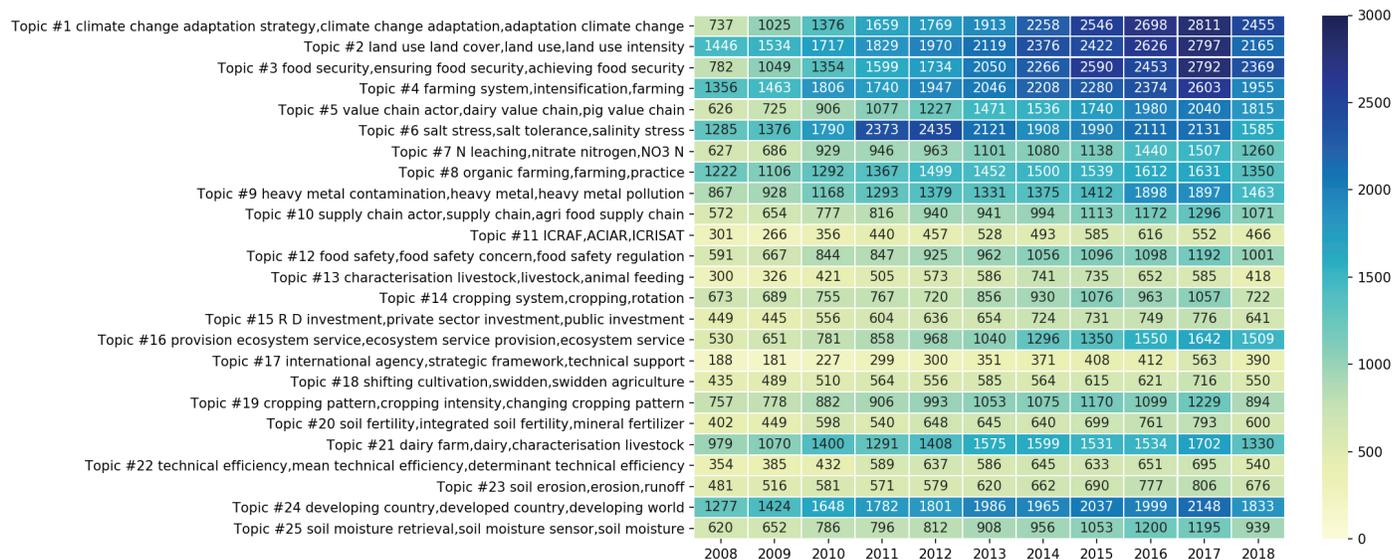
“ For me, this has been quite exciting. Two things I am excited about are the extent to which this process will prove superior to traditional approaches to reviews and second, the extent to which we will find other people studying these topics, which are not as evident as one would think in the general literature. Sometimes, when we have a few very important and powerful voices that we know, we tend to go to these voices for what they have said. Already we have seen some very interesting work that is not from the people that we would typically see—and it is work which has actually been done well. ”

— Saweda Liverpool Tasje, Evidence Synthesis Lead Author, Associate Professor at Michigan State University, and Principal Investigator with the Feed the Future Nigeria Agricultural Policy Project.



Photo by Trevor Butterworth

THE KEYWORD PROBLEM—HOW TO GET THE RESEARCH TO TELL US WHAT IT'S REALLY ABOUT



This is a research density map of climate adaptation research in agriculture. Along the Y-axis are topic-strings, and these can be thought of as keywords. These are specific research areas. They are the descriptive data about the articles derived by analyzing the dataset using a machine-learning model, independent of a controlled taxonomy or metadata. This frees researchers from the time-consuming task of manually coding the dataset with descriptive terms. Along the X-axis is a timeline of 2008-2018 and, within each cell, number of articles published per year. The coloring from light yellow to dark blue is volume of research per topic

Ceres2030 is a partnership of Cornell University, the International Food Policy and Research Institute (IFPRI), and the International Institute for Sustainable Development (IISD) with support from the Federal Ministry for Economic Cooperation of Germany (BMZ) and the Bill & Melinda Gates Foundation.

The mission of Ceres2030 is to support the efforts of international donor community toward the United Nations' Sustainable Development Goal (SDG) 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture. In order to meet the goal of "Zero Hunger" worldwide by 2030 we must quickly identify the most effective opportunities for public investment. Ceres2030 utilizes economic modelling, semantic machine-learning models, and evidence-based synthesis to identify how foreign aid donors can most effectively focus their resources in the international effort to end hunger.

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Ceres2030
Sustainable Solutions to End Hunger

