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Agriculture sorely needs a system for evidence synthesis

Health care has Cochrane, which regularly publishes reviews of evidence on a range of topics. Food systems needs a similar body.

How effective is 'digital agriculture'? What, for example, are the benefits of sending weather forecasts to smallholder farmers' phones? Does the digital approach improve nutrition or make agriculture more sustainable? Does it help farmers adapt to climate change, a priority for the negotiations taking place this week at the 27th United Nations Climate Change Conference of the Parties (COP27) in Sharm El-Sheikh, Egypt?

The honest answer to these questions is that we can't yet be sure. That's partly because of a lack of evidence — the needs of small-scale farmers are under-researched, as a project called Ceres2030 reported in 2020 (see go.nature.com/3o5hgl7). What's more, the rules for evidence in policy for agriculture, food systems and climate adaptation are not as systematic as they are in policy for health and medicine.

In a welcome development, that might be about to change. Three organizations are creating a network called the Juno Evidence Alliance — its name a nod to its origins in the Ceres2030 project, both being named after Roman goddesses. It is a collaboration between CABI, a non-profit intergovernmental organization that collates agricultural information, headquartered in Wallingford, UK; the University of Notre Dame in Indiana; and Havos.ai, a company specializing in machine learning for evidence synthesis, based in Washington DC and Ithaca, New York. The collaboration has obtained US$3 million in funding from the Bill & Melinda Gates Foundation for this and related projects, and the UK government says it also plans to fund the alliance.

Juno will be launched early next year. Its first project will be to assess the literature on nutrition, agriculture and climate change. Specifically, it will identify the areas in which research is and isn't meeting people's needs. After that, its creators want to develop guidance for researchers on the principles of evidence synthesis, and how to produce research that can be easily compared with other studies. Juno will also train people in evidence-synthesis skills.

Moreover, the UN Food and Agriculture Organization (FAO) last month announced plans to publish a biennial Agrifood Systems Technologies and Innovations Outlook (see go.nature.com/3hgixy7). According to Chris Barrett, an agricultural economist at Cornell University, Ithaca, and one of the project's leaders, this will explore topical questions such how widespread the use of drones is in agriculture in the global south, and how common it is for countries to fortify salt with iodine, an effective way to reduce iodine deficiency. Subject to funding, both initiatives will use machine-learning algorithms; in Juno's case, to do much of the literature mining. Mary O'Connor, who oversees evidence innovation for CABI, says that artificial intelligence could reduce the time it takes to conduct an evidence review to 6–8 months, compared with the 18 months to 2 years it usually takes.

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Efforts to publish more research, find and fill knowledge gaps, and improve evidence synthesis are clearly overdue. The committees of researchers who guide decision-makers and regulatory bodies around the world, including those in international organizations such as the FAO, are faced with an applied life-sciences literature that exceeds 10 million records in English alone. Reviews summarizing the work on many topics are few and far between.

It can be hard for decision-makers to compare the conclusions of separate studies. Different studies can use different evaluation indicators. At its most basic, there might not even be agreement on the definition of terms — for instance, the meaning of 'small-scale farmer' varies from study to study, if it is defined at all. This means that farmers, donors, non-governmental organizations and governments struggle to find reliable answers to their questions.

The task ahead

The Juno team should draw on the experiences of other fields, particularly medicine. Cochrane, a charity based in London, has been conducting and publishing healthcare evidence reviews since the 1990s. These are used by, among others, the World Health Organization (WHO) in its guidelines for doctors and patients. Only last month, the WHO announced an update to pregnancy and childbirth guidelines informed by Cochrane's work . There's also the Campbell Collaboration, a network of social scientists, which produces evidence synthesis on social-policy interventions in fields ranging from education to policing.

But evidence synthesis in food-systems science faces challenges that don't affect medicine, in which so much research is underpinned by randomized placebo-controlled trials. The Juno project will need to establish a common language to categorize basic and applied science across human health and nutrition, the microbiome, plant health, soil science, aspects of climate science and more.

Its researchers will need to seek out science from scattered repositories; capture the wealth of untapped research in non-European languages; and track down researchers (including farmers who also do research) who collect data but do not publish work in journals. They will need to find reliable ways to assess the quality of the individual studies that act as inputs to the reviews, and find methods that account for bias. Some of those who specialize in agricultural science can be oblivious to the ways that thinking on subjects such as livestock rearing, genetic modification and the farming of indigenous crops is influenced by ethical, cultural and political forces, says Sheryl Hendriks, a food-security policy expert at the University of Pretoria in South Africa.

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Evidence synthesis also needs long-term funding, international acceptance and an institutional home, as Joachim von Braun, an agricultural economist at the University of Bonn in Germany, tells *Nature*. "These initiatives need legitimacy, otherwise governments will not listen to their advice," he says. The FAO said in a statement that it will "explore synergies and potential partnerships" in this area.

There is growing recognition of the need to tackle climate, nutrition and agriculture in an integrated manner, rather than in silos. The UN Food Systems Summit of 2021 brought together organizations from across these fields, and COP27 has an unprecedented focus on agriculture. As those working in the food system tackle challenges ranging from climate change to soil erosion to population growth, the need for more, better and more-systematic evidence to underpin their efforts is only going to increase.

Use hydrogen wisely, not indiscriminately

Hydrogen is touted as a wonder fuel for everything from transport to home heating. But alternatives are often better for the climate.

As governments across the world scramble to find ways to reform energy systems to meet climate commitments, hydrogen looms large. The fuel is now seen as a pillar of most net-zero emissions scenarios. Production is expected to at least quintuple by mid-century.

On one level, the enthusiasm is understandable. If hydrogen were freely available, it would be something of a decarbonization wonder. It can make carbon-free fuels for transportation and heating, and power some energy-intensive industries that can't easily be electrified, such as the manufacture of steel or fertilizer (see Feature, page 440).

The problem is that hydrogen is not freely available. On Earth, it exists mostly in molecules bound to other elements, from which it must be extracted at huge energetic cost. Policymakers should beware potential unintended negative consequences for both people and the planet from an overwrought dash for hydrogen.

Most hydrogen is currently made by processes — such as steam reformation of natural gas (methane) — that produce large amounts of CO_2 as a by-product. Although 'green' hydrogen can be made by using electricity from renewable sources to split water molecules, this process is costly compared with more conventional production methods.

"Policymakers should beware potential unintended negative consequences for both people and the planet."

It can also be an inefficient use of renewable resources. Using green electricity to make hydrogen at times of peak demand, when that energy could be feeding the grid and displacing electricity generated from fossil fuels, could result in higher overall emissions than intended. Making hydrogen with electricity generated from unabated use of fossil fuels would be even worse.

All this means that hydrogen should be used judiciously, to address emissions that can't be eliminated in other ways. Many of the uses being touted do not tick that box. For example, some groups are advocating burning hydrogen to heat homes, as an alternative to natural gas, but this is much less efficient than using electricity directly. Most immediately, this means higher costs for consumers. But it also means that using even truly green hydrogen to heat homes displaces a smaller chunk of current CO_2 emissions than would using it for other tasks, for which there are no alternatives.

Hydrogen-powered cars and vans are another case in point. The European Union has just joined many countries in reaching a deal to ban the sale of cars and vans powered by internal-combustion engines. By 2035, all new cars in the bloc will be zero-emission, as part of the 'Fit for 55' drive to reduce carbon emissions by 55% by 2030. But industry groups and some governments would like to continue to allow vehicles that run on hydrogen-based 'e-fuels'. These fuels could one day be an effective tool for decarbonizing certain heavy-duty lorries, large ships, aeroplanes and other forms of transport for which battery technologies are not currently fit for purpose. But they are a distraction when it comes to personal vehicles, for which efficient batteries are already available.

The EU is also under pressure from industry to water down the definition of green hydrogen, and to subsidize ways of making the gas that still carry unacceptable rates of emissions, as part of Fit for 55. That smacks of past occasions when the bloc has adopted policies that looked environmentally sound on paper but came with considerable small print. Counting energy from wood derivatives as renewable, for example, has caused the destruction of woodland in Europe and elsewhere, without a positive impact on carbon emissions.

The United States has set a better example with August's passage of the Inflation Reduction Act, which subsidizes the production of true green hydrogen by up to US$3 per kilogram, and gives lower subsidies to dirtier versions. Globally, however, hydrogen production and trade would benefit from clear, uniform rules for how hydrogen should be made and under what circumstances its use is beneficial. The Hydrogen Council, an industry group based in Brussels, is pressing for international standards and certification systems for green-hydrogen production.

Such standards should be fast-tracked. But, when setting net-zero strategies, policymakers should not lose sight of the ultimate aim: to stay within a total carbon budget compatible with the Paris climate agreement. Attractive as it may look — and as real as the opportunities may be, for example in decarbonizing heavy industry — often the answer is not hydrogen.