CGIAR
RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security
CCAFS

Big Data for climate-smart agriculture

Data-driven climate adaptation could revive rice yields in Colombia and beyond.

From forecasting presidential elections to predicting disease outbreaks, analysts are finding ways to turn Big Data — the immense stocks of information collected in computers worldwide — into an invaluable resource for planning and decision-making. Now, scientists at the International Center for Tropical Agriculture (CIAT) have applied Big Data tools to pinpoint strategies that work for small-scale farmers in a changing climate.

"With the availability of modern information technology, we have an opportunity in agriculture to make more informed decisions based on the data," says project leader Daniel Jimenez. His team has been studying rice in Colombia, where CIAT leads a major research partnership between the Colombian government and the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Colombia enjoys tropical sunshine, diverse landscapes and multiple crops per year, so agriculture should be driving its economic development. The whole region of Latin America was dubbed "the next global breadbasket" in a recent report from the Inter-American Development Bank and the Global Harvest Initiative. Yet Colombia's rice sector is in trouble. Between 2007 and 2012, the yield from irrigated rice mysteriously dropped from 6 to 5 tons per hectare, erasing the increase achieved over the previous decade.

The cause of the shrinking yields is unknown, but climate change is a leading suspect. Subtle shifts in rainfall as well as more extreme weather are forcing rice growers to toss aside old assumptions about when, where and what to plant.

CIAT's initiative in Colombia has several research groups studying the impacts and looking for ways to better cope with climate change. The Big Data team believed they could uncover answers in existing data sets — historical measurements of climate, yields and farming practices, gathered and filed away by Colombia's National Federation of Rice Growers (FEDEARROZ).

Fast facts

- Researchers have applied Big Data analytics to agricultural and weather records in Colombia, revealing how climate variation impacts rice yields.
- These analyses identify the most productive rice varieties and planting times for specific sites and seasonal forecasts. The recommendations could potentially boost yields by 1 to 3 tons per hectare.
- The tools work wherever data is available, and are now being scaled out through Colombia, Argentina, Nicaragua, Peru and Uruguay.

Crunching the numbers

First, they needed the data. CIAT brought their idea to FEDEARROZ, which keeps country-wide records. It was a delicate proposition, as open data sharing is still in its infancy in many places and primary data holders often have legitimate concerns about how the information they share will be used.

Once FEDEARROZ understood and trusted CIAT's intentions, the federation agreed to provide an annual rice survey, harvest monitoring records and results from agronomic experiments. The CIAT analysts used advanced algorithms borrowed from fields like biology, robotics and neuroscience to comb through these data and tease out patterns that lined up with weather records.

Turning rice research upside down

The Big Data on Colombian rice comes from commercial fields in ambient weather, a stark departure from other research. Traditionally, agronomists seeking the optimal varieties and techniques for a given environment would conduct small field experiments with tightly controlled climate and soil conditions. CIAT embraced the opposite: large, uncontrolled, real-world data sets. With good analytics, this produces nuanced, reliable recommendations much more quickly. It also gives rice breeders the feedback they need to develop climate-adapted lines.

The results are highly site-specific. In the town of Saldaña, for example, the analysis showed that rice yields were limited mainly by solar radiation during the grain-ripening stage. Meanwhile, in the town of Espinal, limiting factors differed by rice variety. Looking at the variety most commonly cultivated in Espinal, the team found that it suffered from sensitivity to warm nights. This suggests that farmers in Saldaña can boost yields by lining up their sowing dates with sunnier seasons, whereas those in Espinal may need to choose a variety more suited to the local climate.

For even more predictive power, the scientists tried pairing the historical records with state-of-the-art seasonal forecasts generated by a separate CIAT team in Colombia. They searched for weather patterns in previous years that resembled the forecast, and checked which varieties did best in those years. In this way, researchers can learn from the past to anticipate what is coming. Farmers can be advised months in advance about tried-and-true rice varieties and planting dates, even in the midst of erratic climate patterns. Applying this information could potentially raise yields by 1 to 3 tons per hectare, Jimenez says.

To find out more about Big Data please visit: http://ccafs.cgiar.org/bigdata

Ready for scale-up

The project won the UN Global Pulse's Big Data Climate Challenge last year, with contest organizers calling it "uniquely innovative." Now the team is ready to scale up the techniques from their pilot. Branching out to other countries and crops will help ensure that these methods are adaptable and useful in different contexts.

With support from CCAFS and the World Bank, CIAT researchers will partner with the Fund for Irrigated Rice in Latin America (FLAR) to introduce the approach to rice growers associations in other countries, starting with Nicaragua, Peru, Argentina and Uruguay in 2015 and 2016. FLAR plans to include the big data tools in its agronomy program, which will deliver them to a wide range of actors and institutions — farmers, breeders and agricultural support organizations. The projects in Latin America will serve as case studies, potentially laying the groundwork to bring this approach to even more farmers elsewhere.

The team will also be working to improve the new tools. Further research will incorporate data on soils, pests, diseases, costs and other factors to increase explanatory power. The researchers will test new ways of capturing and analysing data that could further strengthen the approach.

At the same time, they want to reach out to potential users and promote what they call a "revolution in data-driven agronomy". Jimenez and his co-workers envision scientists routinely using advanced analyses of commercial data in their research, breeders gathering feedback on the real-world performance of their strains, and agricultural support organizations helping farmers make informed decisions and become more resilient to the vagaries of the weather.

"Climate change obligates us to manage our food systems in a more dynamic way, and big data offers the most effective way to achieve this," says Jimenez's colleague Andy Jarvis, director of CIAT's Policy Analysis Research Area and CCAFS Flagship 1 Leader. "Like the hoe and spade, these new tools are becoming crucial implements for global food production."

Photo: FAO Research

About CCAFS

The CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) is a strategic partnership of CGIAR and Future Earth, led by the International Center for Tropical Agriculture (CIAT). CCAFS brings together the world's best researchers in agricultural science, development research, climate science and earth system science, to identify and address the most important interactions, synergies and tradeoffs between climate change, agriculture and food security. www.ccafs.cgiar.org

CCAFS is supported by CGIAR Fund Donors, Danish International Development Agency (DANIDA), Australian Government Overseas Aid Program (AusAid), Irish Aid, Environment Canada, Ministry of Foreign Affairs for the Netherlands, Swiss Agency for Development and Cooperation (SDC), Instituto de Investigação Científica Tropical (IICT), UK Aid, Government of Russia, The European Union, New Zealand Ministry of Foreign Affairs and Trade, with technical support from the International Fund for Agricultural Development (IFAD).

Led by CIAT International Center for Tropical Agriculture Since 1967 / Science to cultivate change

Strategic partner futureearth

Implementing partner MINAGRICULTURA TODOS POR UN NUEVO PAÍS PAZ EQUIDAD EDUCACIÓN

2015

CCAFS Coordinating Unit,
University of Copenhagen, Faculty of Science,
Department of Plant and Environmental Sciences,
Rolighedsvej 21, DK-1958, Frederiksberg C, Denmark
Phone: +45 35331046, Email: ccafs@cgiar.org
www.ccafs.cgiar.org