When a research study reports findings that increase the productivity and profits of agricultural practices, farmers and practitioners typically ask, “How can I get the same result?” For a similar site, a farmer may apply the same treatment and see the same results, but locations with a different site history, different soils, or different weather patterns are unlikely to have the same outcome as the researchers. These differences among sites are typically of interest to researchers, and understanding the mechanisms that control outcomes improves recommendations and best practices.

Dr. Nicolas Tremblay, a researcher with Agriculture and Agri-Food Canada, and colleagues observed differences in outcomes when applying the same treatments at sites across North America. A meta-analysis “gave us confidence in the key parameters” responsible for the different experimental outcomes, specifically that soil texture and precipitation regulate nitrogen uptake by corn. Knowing that soil and weather data are easily obtained for most sites, Tremblay, a member of ASA, CSSA, and SSSA, and his colleagues developed a tool that uses soil and precipitation data as inputs to provide a custom recommended level of nitrogen fertilizer to corn growers.

The tool is called SCAN, which stands for Soil, Crops, and Atmosphere for Nitrogen management, and it can make field-specific nitrogen recommendation.
rates to farmers. Currently, SCAN has been tested in field trials in eastern Canada since 2013. While the framework for this product was the direct result of the North American meta-analysis, Tremblay points out that “the SCAN algorithm was developed around the database of Ontario and Québec nitrogen trials.”

The field trials have compared SCAN recommendations to farmers’ typical practices—side by side on the landscape. The initial data set used to develop the tool was from 55 trials, and as of 2016, there is data from almost 300. The field trial results have led to some fine tuning of the model, or as Tremblay calls it, “a never-ending flow of adjustment.” He says that although versions of SCAN have changed year to year, the new data continue to support the original findings that soil texture and precipitation are the most important variables to consider.

Cost Savings for Farmers

Carl Bélec is a colleague of Tremblay’s from the Knowledge and Technology Transfer Division. He conducted field trials in Québec, and from 2013 to 2015, which were considered very wet years, SCAN recommended reducing nitrogen rates at sidedressing for half of the fields, by an average of 25%. This reduction in fertilizer resulted in cost savings without affecting yield. Preliminary results from 2016, when the conditions at the time of sidedressing were very dry, indicate that SCAN recommendations have been much lower than the nitrogen rates applied by farmers. Yield data are not available yet.

These differences in nitrogen application rate also impact profits. Using the SCAN recommendations has resulted in an average profit increase of $28/ha (U.S. dollars). The profit increase is greatest when SCAN recommends a lower rate of N application ($36/ha), but increased profits are also observed when SCAN recommends a higher rate of N application ($16/ha).

Launching the Tool in 2017

The economic gains will likely convince farmers to use this tool, but there are also ecological benefits to targeting nitrogen application. When SCAN recommends a fertilization rate lower than what a farmer would typically use, they will save money, and Tremblay says, “nitrogen losses to the environment are hence also reduced, leading to lower risks of aquifer contamination and greenhouse gas release.” The plan is to make SCAN as accessible as possible to Canadian farmers as an online tool. The product will launch commercially in 2017 for Québec where approximately 90% of Canadian corn is grown.

Julie Surprenant, a Geomatics Analyst with Effigis Geosolutions (the company responsible for the web development and maintenance of SCAN), says the online interface is simple. Users define a management unit, typically a field, by drawing a polygon on a map. For each unit, users are required to enter the previous crop, soil organic matter, and soil texture. When users request a fertilization rate, they input the expected price of corn and cost of nitrogen, and SCAN automati-
ASA, CSSA, and SSSA member Nicolas Tremblay and his colleagues developed SCAN, a tool that uses soil and precipitation data as inputs to provide a custom recommended level of nitrogen fertilizer to corn growers.

Dig Deeper
Read the 2012 meta-analysis article in Agronomy Journal by Tremblay et al. that examined the influence of soil and weather parameters on N response of corn across 51 studies: http://bit.ly/2aWtOrM. Learn more about the value of meta-analyses by reading this article from last year in CSA News magazine: http://bit.ly/2bgHisD.

Expanding Model Use with Fuzzy Inference Decision Making
The economic and ecological benefits of this tool could go far beyond Canada. Tremblay sees the potential for the SCAN model to be adapted to other parts of the world. “It’s a matter of adjusting for specific needs, the specific soils and weather patterns,” he says. One of the reasons the model would be easy to adjust is the use of fuzzy inference decision making.

Fuzzy inference, which is based on fuzzy logic, is a logic-based approach. In classical modeling, calculations are based on discrete, or “hard” values, like 0 and 1. Fuzzy logic can evaluate all of the values in between 0 and 1 and can handle categorical values that overlap. This flexibility makes fuzzy logic useful for complex problems that are imprecise and have nonlinear relationships.

Take, for example, the timing of traffic lights. If lights are set to change every four minutes, a hard value, drivers will often wait at a stop signal even if there is no cross traffic. But, using sensors and fuzzy logic rules, signals can be changed more or less frequently by simultaneously evaluating the number of cars passing through a green signal and the number of cars waiting at a red signal. The timing of signals becomes defined by the situation, much as the SCAN nitrogen recommendations will change from year to year as a function of precipitation patterns.

The SCAN tool is an example of how researchers can use their results to build a product for practitioners. Tremblay points out that SCAN is built on collaboration. Starting with the multi-site experiment and meta-analysis, to the on-farm trials, and the work with web designers to build the final product, Tremblay emphasizes that researchers can’t work alone to produce something like SCAN. Large collaborations and data sharing are necessary to move the science forward.

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