IT tools enhance global crop management strategies

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One of the large crop fields in Uruguay where Pravia uses the simulation models. Credit: Virginia Pravia

Growing up in Uruguay—a country with four cows per every person—Virginia Pravia was immersed in the agriculture industry at an early age. During summers and holidays, Pravia watched as her family raised cattle and sheep and grew such crops as sorghum, maize, wheat, barley and soybeans.

It wasn't long before Pravia developed a similar passion for living off the land and doing so in a sustainable way. Now, as a doctoral candidate in the College of Agricultural Sciences, Pravia is using software developed at Penn State to help protect Uruguay's natural resources and ensure the country's longstanding livelihood can continue for years to come.

Working with the National Institute of Agricultural Research in Treinta y Tres, Uruguay, Pravia is using Cycles—a computational simulation model developed by researchers in Penn State's Agroecosystems Modeling Laboratory — to study soil nutrients in crop-pasture systems.

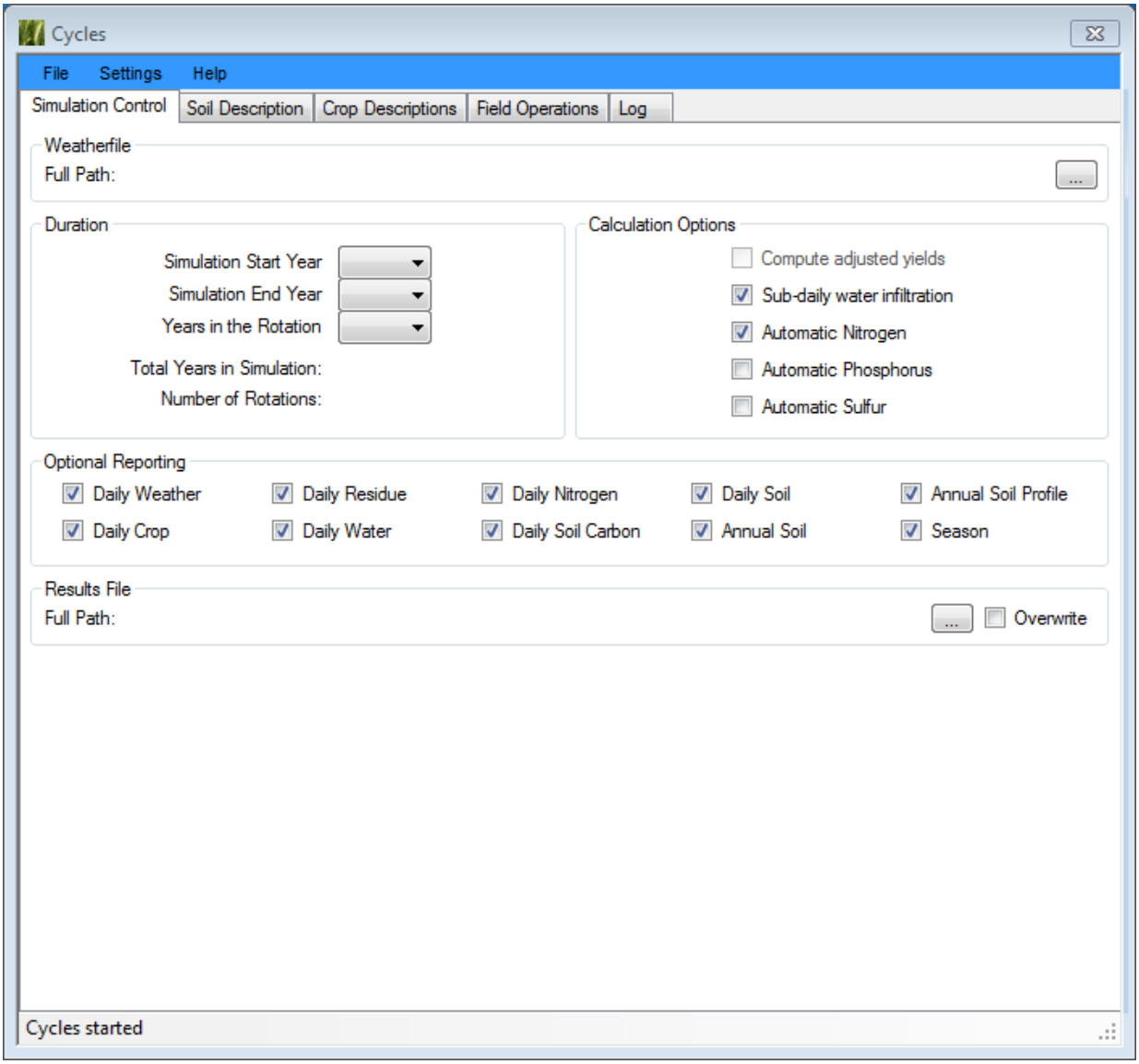
According to Armen Kemanian, an associate professor of production systems and modeling and a lead developer of the software, Cycles enables farmers and researchers to predict and study changes affecting crops over time.

"We create computer models that are used for applications at many levels—the farm level, the research level and the watershed level," Kemanian said. "These models can simulate what happens on a farm in terms of production, the nutrients that are used, how much is harvested, how much is lost to the environment and the impact of climate."

Using the Cycles software, farmers can input current data (for example, soil nutrient levels) and see potential future outcomes with just the click of a button—the software's algorithm does all the calculations.

Since even the smallest crop management decisions could hold

potentially devastating ramifications years in the future, these modeling tools could mean the difference between a booming harvest and an infertile or eroded field.



The Cycles software lets users control a variety of variables when running a simulation. Credit: Yuning Shi

As one of the leaders of the project, Pravia has found these software tools invaluable when working in the fields of Uruguay. Using Cycles to simulate levels of carbon and nitrogen, Pravia is able to work with local farmers to develop management plans and ensure successful future harvests.

"In agronomy, we have to integrate many things that are happening in the environment at the same time; for example, what's happening with the plants, the soil and the climate," Pravia said. "The modeling tools are very good at helping you visualize all the processes together."

After running the computational models in the field, Pravia securely uploads her data to Box at Penn State and the Lion-X system hosted by the Institute for CyberScience Advanced CyberInfrastructure. Using these cloud-computing tools allows Pravia to collaborate with Kemanian and his team despite being separated by more than 5,000 miles.

This focus on interdisciplinary and international collaboration is essential to the lab's mission, as a variety of industries can benefit from the Cycles software.

For example, John Wallace, a postdoctoral scholar studying plant science, says that one area of application for Cycles is the organic farming industry. Since organic farmers operate without the use of synthetic pesticides and fertilizers, smart and creative crop management decisions are essential to yielding a successful harvest.

"What we're able to do is simulate a lot of different strategies by adopting the Cycles model to organic practices," Wallace said. "There's potential for this to become a predictive tool but also a great learning tool. So while a farmer is planning his crop rotation, he can use these tools to think about how he might tweak his crop management plans."

And while Cycles hasn't gotten into the hands of Pennsylvania farmers yet, Wallace says the general response to the idea has been supportive.

A sorghum field in Uruguay is ready for harvesting. Credit: Virginia Pravia

"We have an advisory board that includes some farmers in the organic community in Pennsylvania, and this past winter we pitched the idea to them in an open-ended discussion about the potential value and how they could see themselves using the tool," Wallace said. "We've taken their input and are now moving forward with developing a beta tool for a

more user-friendly experience."

In addition to assisting farmers in crop management decisions, the Cycles software can also be used to study and predict agricultural variations due to climate change.

"Before, you could guess and say, 'The temperature will probably rise and it might be drier, so we may have less crop productivity,'" said Yuning Shi, a research associate in the Department of Ecosystem Science and Management. "But with the models, not only can we quantify those climate changes, but we can figure out how to deal with them."

As one of the co-developers of the Cycles software, Shi is working with Felipe Montes—a research associate in cropping systems modeling—to couple Cycles with the Penn State Integrated Hydrologic Modeling System (PIHM), a software that simulates hydrology and nutrient transport in agricultural watersheds. By combining these tools, researchers have a more complete understanding of the challenges that could face natural resources in the years to come.

According to Kemanian, these diverse applications of the Cycles software are part of a growing trend of integrating agriculture and information technology (IT) resources.

"Students and young researchers will lead the forward movement of these tools, Kemanian said. "Because they understand the need to seamlessly connect science and practical applications through IT."

And as for Pravia, although she isn't out tending the cattle and cultivating the land like her family, she's sure to carry on the centuries-old tradition of agricultural progress with a little help from technology.

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