A Report from the Economic Research Service

The Value of Plant Disease Early-Warning Systems

A Case Study of USDA's Soybean Rust Coordinated Framework

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Abstract

Early-warning systems for plant diseases are valuable when the systems provide timely forecasts that farmers can use to inform their pest management decisions. To evaluate the value of the systems, this study examines, as a case study, USDA's coordinated framework for soybean rust surveillance, reporting, prediction, and management, which was developed before the 2005 growing season. The framework's linchpin is a website that provides real-time, county-level information on the spread of the disease. The study assesses the value of the information tool to farmers and factors that influence that value. The information's value depends most heavily on farmers' perceptions of the forecast's accuracy. The study finds that the framework's information is valuable to farmers even in a year with a low rust infection like that of 2005. We estimate that the information provided by the framework increased U.S. soybean producers' profits by a total of $11-$299 million in 2005, or between 16 cents and $4.12 per acre, depending on the quality of information and other factors. The reported cost of the framework was between $2.6 million and almost $5 million in 2005.

Keywords: Soybean rust, farmers' perceptions, forecast accuracy, updating beliefs, value of information, real-time disease location, plant disease management, pest management, risk management

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Contents

Summary

Early-warning systems for plant diseases are valuable when the systems provide timely forecasts that farmers can use to mitigate potentially damaging events through preventative management. For example, soybean rust (SBR), a soybean fungus, which entered the United States in late 2004, posed a new, uncertain, and potentially large threat at the beginning of the 2005 U.S. soybean season. Farmers anticipated markedly reduced soybean yields on fields infected with SBR, but with sufficient notice, they could treat the fields in advance with preventative fungicides, a costly, but prudent, measure.

What Is the Issue?

In 2005, USDA developed an early-warning system that provides real-time, county-level forecasts of soybean rust. This system provides farmers, crop consultants, and others with interests in the U.S. soybean crop timely forecasts of SBR infections that could sharply reduce soybean yields. Forecasts and recommended management activities are provided via a publicly accessible website, the first time a web-based system has been used for this purpose. The information on the website is developed through a large coordinated framework that involves many government and nongovernment organizations that regularly collect samples from fields, test them, and incorporate them into forecasting models. But how valuable is the information provided by the framework? This question has become particularly salient in light of modest outbreaks of SBR in 2005. This study uses the SBR system as a case study to determine the effectiveness of such early-warning systems.

What Did the Study Find?

The value of the framework's information depends on many factors, particularly farmers' perceived risk at the beginning of the season of SBR infection and the accuracy of the system's forecast. These factors cannot be precisely quantified, but our analysis shows that, although the value of information from the system varies somewhat geographically, overall the system's value exceeded its costs in 2005. Even if forecasts are imprecise, resolving only 20 percent of SBR infection uncertainty for all fields planted with soybeans, the system's value is an estimated $11 million in farmer profits in the first year. If forecasts resolve 80 percent of infection uncertainty, the estimated value is $299 million. Our analysis suggests that the value of the information in 2005 likely exceeds reported costs of developing the information of between $2.6 million and almost $5 million.

The study also analyzes two more subtle features that affect estimated information values: anticipated price shocks in the event of large rust outbreaks and soybean farmers' aversion to risk. We found that both of these factors reduce the largest estimated values and increase the smallest ones, but the magnitude of the effects are modest relative to the perceived forecast quality. The potential benefits of the framework suggest that similar programs for other crop pests can be cost effective if, as in the case of soybean rust, preventative action can strongly mitigate damages in the event of an outbreak.

How Was the Study Conducted?

The study applies conceptual methods from decision science to evaluate how much expected profits increase if farmers are able to fine-tune their rust management decisions in response to SBR forecasts. These methods are combined with USDA data on historical soybean yields, data from USDA's Agricultural Resource Management Survey, estimated soybean rust damages from Brazil and Paraguay, and spore dispersion estimates based on an aerobiology analysis and historical experience with wheat stem rust. Information values were calculated over a broad range of assumptions because some of the parameters were not estimable and some parameter estimates were uncertain.

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