Valuing the Information Provided by the Coordinated Framework

USDA's coordinated framework provides a range of services that farmers may use, directly or indirectly, to manage SBR risks. Elements of the program include surveillance and monitoring of potential infections, predictive modeling, developing fungicide management strategies, and communication and outreach. The framework involves collaboration of many government and nongovernment agencies and universities, with the culmination of their efforts reported on the publicly accessible website.[2]

Our analysis of the information provided by the framework need not presume that all farmers access the website. The framework provided fungicide companies, crop consultants, extension specialists, and perhaps other intermediaries with an accessible repository of information that could have been channeled to farmers. A picture of the website is given in figure 1. More detail about the framework is described in the box, "The Coordinated Framework and www.sbrusa.net."

The value of information is closely tied to whether the framework provides farmers with useful information to fine-tune their SBR management decisions. Without the information, farmers may be more likely to monitor their fields and apply costly fungicides when it is inappropriate to do so (when SBR risk is low) or not monitor and apply costly fungicides when they are likely to be most effective (when SBR risk is high).

During the growing season, after the soybean crop is planted, the main SBR management decisions a farmer must make are whether or not to apply a preventative fungicide, to monitor fields and apply a curative fungicide if SBR occurs, or to do nothing (fig. 2 and app. fig. 1).[3] The optimal strategy depends on farmers' perceived risk of SBR. Thus, the better information farmers have about the threat, the more likely they will choose the optimal management strategy and the greater their expected profits will be. We calculate the value of information as the increase in expected profits, as viewed from the beginning of the growing season, stemming from improved SBR forecasts that arrive between first plant emergence and flowering.

Although the information is public and freely available, one might also view its value as the most farmers would have been willing to pay for the information service at the beginning of the season. It is important to consider the expected value of information before the season, not after, because that is when decisions about investments in information technologies are necessarily made.

Strategies for Managing Soybean Rust

Developing estimates of this value requires estimates of the costs and benefits of each of the three management strategies: (1) applying a preventative fungicide, (2) monitoring fields and then applying a curative fungicide in the event SBR occurs, or (3) doing nothing and bearing SBR losses should they occur.[4] The website provides information that might be used to forecast an impending SBR threat, and farmers may use the information in choosing a management strategy. Here we describe the costs and benefits of each strategy.

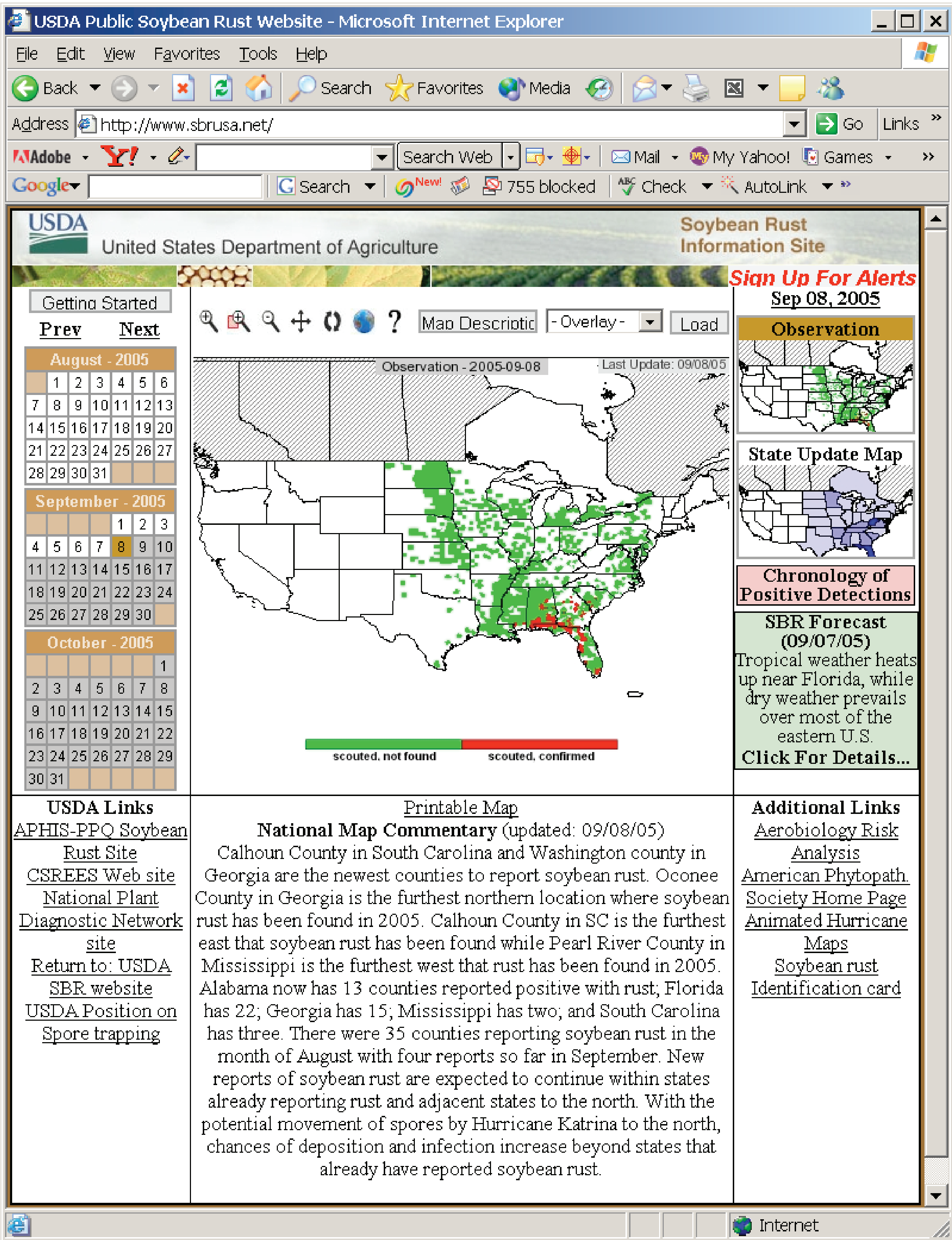
[2]These agencies include Animal and Plant Health Inspection Service (APHIS), USDA; Cooperative State Research, Education and Extension Service (CSREES), USDA; Agricultural Research Service (ARS), USDA; National Plant Board (NPB); American Soybean Association (ASA); United Soybean Board (USB); American Seed Trade Association (ASTA); and North Central Soybean Research Program (NCSRP) (see "Abbreviations" at the end of the report for all acronym definitions). The framework also drew on the collaboration of the Cooperative State Extension Services based mainly at land-grant universities.

[3]To simplify our analysis, we focus on farmer management decisions that occur after planting. In reality, farmers may react to the possibility of soybean rust infection by switching to other crops or taking some of their acreage out of production. Calculating the pre-planting value of information would lead to different results than what we present in this report. The framework may also allow farmers to improve the timing of the application of preventative sprays that improve their efficacy. Poorly timed sprays could lead to the need for second applications. We do not attempt to quantify the value of improved timing, which would likely increase the presented estimates of the value of information. See Dorrance, Draper, and Hershman for current fungicide use guidelines.

[4]We have chosen two strategies for the analysis that might be combined under some field conditions. One spraying regimen for the monitor-and-cure strategy that has been used is to apply both curative and preventative fungicides at the same time.

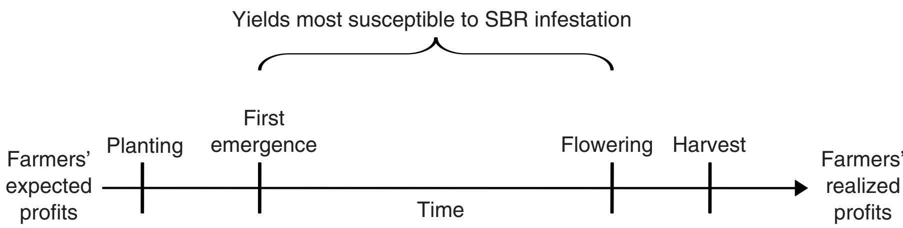
Figure 1

The SBR website on September 8, 2005, www.sbrusa.net



The first strategy is to apply a preventative fungicide, which must be done before infection to be effective. Using estimates developed in previous ERS research and discussed in the appendix, at $25.63 per acre, the estimated cost of preventative fungicide is high, but if applied before an impending SBR threat, estimated yield losses due to SBR are estimated to be 1 percent.

Figure 2
Timeline for SBR management decisions



The Coordinated Framework and www.sbrusa.net

Two SBR websites are maintained under the framework: One is public, and one is not. The nonpublic website is designed to integrate information from the large network of disease-management professionals who gather data and analyze it. The nonpublic website has different screens for the different user groups. The layouts of these screens include a calendar of archived products, a map display, Geographic Information System (GIS) tools for navigating the maps, map reference overlays, support materials to identify SBR in the field, an entry tool for commentary, an edit tool for links, a researcher observation map (which displays suspected as well as confirmed infections), and a list of model simulation maps. The simulation maps, which are selectively displayed for each user group, include daily spore transport, daily wet deposition of spores over land, accumulated wet deposition of spores over land, and other forecast model variables.

The public website (http://www.sbrusa.net), a snapshot of which is displayed in figure 1, is linked to USDA's homepage (http://www.usda.gov/) and is the central reference tool for farmers, researchers, and others who want to know about the advent and management of the SBR fungus. The national map shows where SBR was either found and confirmed by standard laboratory operating procedures (red) or not found (green) in a given county. A calendared archive allows viewers of the map to track the movement of SBR across the United States and Canada. The website provides a user with GIS tools for zooming from the national to the subcounty scale and offers interstate highways, soybean-growing areas, county boundaries, and major cities as reference overlay options. A State Update map provides periodic commentary by State specialists, including a history of observations, current growth stages, management, forecast outlook, scouting recommendations, and scouting techniques. A Chronology of Positive Detections provides the public with a pop-up text box listing positive finds by date, State, and county. The SBR Forecast is a pop-up text box that informs the public about daily forecasts of transport and deposition of SBR spores made from prevailing and forecasted weather conditions and soybean rust model predictions.

Visitors can also view pictures and descriptions to identify soybean rust, read up on the disease, and find links to other SBR sources. These sources include the National Plant Diagnostic Network (NPDN), the Plant Management Network, the American Phytopathological Society, Extension Disaster Education Network, regional Integrated Pest Management centers, and the USDA National Agricultural Library. The site's fungicide section includes best practices guidance and product approval updates from the Environmental Protection Agency. The crop insurance link offers an agent locator, along with policy information and news from USDA's Risk Management Agency.

The first component of the detection program is a sentinel plot system. Funded by USDA and the United Soybean Board (USB), these plots are located in over 30 States and are examined regularly for signs of soybean rust. In addition to providing real-time warnings of new disease discoveries via the SBR map, testing allows for quantification of the timing of spore production and the collection of data for epidemiological research. Sentinel plots are usually planted to early-maturing soybean varieties and are located in areas with heavy soybean production and in possible overwintering havens (i.e., areas south of the 28° F line, which is the latitude limit of SBR overwintering). The plots can be made up of alternative hosts of the disease, including pigeon pea, yam, beans, kudzu, and leguminous winter cover crops, in addition to soybeans. The plots are inspected for disease at least every 3 days in high-risk areas and at least once a week elsewhere.

Once the crop is infected with SBR, a different, curative fungicide may be applied at a lower cost of $13.81 per acre. The curative option is somewhat precarious, however, as it must be applied within the first few days after soybean plants are infected. Curative fungicides also tend to be less effective, resulting in an estimated yield loss of 7 percent. This option, therefore, requires regular monitoring of fields between emergence and full podset, at an estimated cost of $6.71 per acre, so that farmers can apply the curative fungicide in a timely manner. If farmers choose this strategy, they must pay monitoring costs regardless of whether or not an SBR infection actually occurs.

The third option is simply to do nothing. This option clearly has the lowest cost but results in estimated yield losses of 25 percent in the event the field is infected with SBR.[5]

[5]Yield loss estimates are based on analysis of yield data from Brazil and Paraguay, where farmers have some experience with actual rust infections. More details about our estimates of fungicide costs, monitoring costs, and yield losses are in the appendix.

In order to extend the capacity of the monitoring program beyond the scope of sentinel plots, the coordinated framework dispatches mobile teams to observe disease incidence in assigned regions. Cooperative Extension Services urge county extension agents, growers, and private crop consultants to scout for SBR and to bring samples to the closest land-grant university diagnostic laboratory. Samples from these sources, as well as sentinel testers and mobile teams, are submitted to NPDN, a network that links plant disease and pest diagnostic clinics from around the country.

After initial screenings for SBR are performed by State laboratories or the NPDN, positive findings are sent to USDA's Animal and Plant Health Inspection Service (APHIS) for confirmation. APHIS's Plant Protection and Quarantine (PPQ)-National Identification Service morphologically examines samples for physical damage from SBR, and the PPQ-Center for Plant Health Science and Technology performs real-time polymerase chain reaction procedures. Diagnostic authorities enter all results in one of several SBR databases, either the Plant Diagnostic System (PDIS), the Southern Plant Diagnostic Network (SPDN), the National Pest Information System (NAPIS), or APHIS records. NAPIS, located at Purdue University, serves as the archive for data from regional networks. Information from APHIS, PDIS, and SPDN is transferred to NAPIS and, from there, is uploaded to the SBR map.

Besides results gleaned from its own diagnostic activities, the coordinated framework incorporates pertinent information from a variety of other sources. Industry surveys provide rust location information for areas outside the reach of sentinel plots, international networking allows for the monitoring of offshore SBR source areas, and rain is sampled for spore presence.

All the data are used to develop SBR early-warning systems and to calibrate spore deposition models. APHIS joined with North Carolina State University (NCSU) and ZedX, Inc., to develop the NCSU/APHIS Plant Pest Forecast System. Concurrently, Penn State University and ZedX, Inc., developed the Integrated Aerobiological Modeling System (IAMS) in collaboration with APHIS. IAMS combines biological and meteorological science to predict movement patterns for windborne species, such as soybean rust. IAMS was modified to address the specifics of SBR, and the resulting model is known as the Soybean Rust Aerobiology Prediction System. The forecasts describe risk levels for sensitive plants in potential rust-harboring regions throughout the United States. Predictive forecasting, although in its first year of testing, may provide useful data well before SBR is observed in the field. For example, it could be used to time fungicide applications, thereby delaying first applications and eliminating second applications. As an additional benefit, these models inform decisions as to which sentinel plots merit increased frequency of monitoring.

Agencies affiliated with the coordinated framework have engaged in communication and outreach activities to disseminate surveillance and modeling results to growers beyond making information available on the website. These activities include workshops, symposia, telephone hotlines, and e-mail alert lists. Land-grant university extension personnel have also made special efforts to communicate with soybean producers on such topics as fungicide selection and timing, decision criteria and risk management, and correct interpretation of the SBR map.

Table 1 presents the outcomes from the three management strategies cross-tabulated with the two possible SBR events: an SBR infection (the first column) and no SBR infection (the second column). Costs and benefits vary somewhat across regions, depending mainly on regional differences in typical yields in the absence of SBR. For example, because yields in the Corn Belt are about 65 percent greater than those in the Southeast, so are the potential losses from an SBR infection.

An important caveat is that the estimated returns in table 1 exclude possible yield-enhancing effects from fungicide application even when SBR does not occur. After the fall 2005 harvest, fields sprayed with fungicides but not infected with SBR nevertheless had higher yields than fields not sprayed, suggesting that the fungicides mitigated losses from pests other than SBR and thus enhanced yields despite SBR's absence. Table 1 does not account for this possible auxiliary benefit to spraying, mainly because it would seem unlikely that the benefit would have been anticipated in advance but also because the magnitude of this yield-enhancing effect remains uncertain. If one wished to incorporate this effect into the analysis, one could do so by adjusting the payoffs associated with the preventative treatment.

The Uncertainty of SBR Infection

We assume farmers would like to fine-tune their decisions to the SBR event, but which event will arise is uncertain. If SBR does occur, scenario 1, applying preventative treatment, has the highest profit (table 1). If SBR does not occur, scenario 6, no SBR management (or doing nothing), has the highest profit. In other words, given the values in table 1, applying the preventative fungicide if an SBR infection is sure to occur is most profitable and doing nothing is most profitable if SBR is sure not to occur.

Because the SBR event is uncertain, farmers may find at harvesting that their strategy was not optimal. On the one hand, farmers who believe an infection is very likely and, thus, apply the preventative fungicide could needlessly apply the costly fungicide if SBR does not occur. On the other

Table 1
Possible farm outcomes from the possibility of SBR infection

Management strategy	SBR infection	No SBR infection
Apply preventative treatment	Payoff 1: 1% yield loss, cost of $25.63/acre	Payoff 2: Cost of $25.63/acre
Monitor fields and apply curative treatment if SBR	Payoff 3: 7% yield loss, cost of $2.52/acre	Payoff 4: Cost of $6.71/acre
No SBR management	Payoff 5: 25% yield loss	Payoff 6: Base return (as if no SBR threat)

Source: M. Livingston, R. Johansson, S. Daberkow, M. Roberts, M. Ash, and V. Breneman, *Economic and Policy Implications of Wind-Borne Entry of Asian Soybean Rust into the United States*, Outlook Report No. OCS-04D-02, Economic Research Service, U.S. Department of Agriculture, April 2004, Available at http://www.ers.usda.gov/Publications/ocs/apr04/ocs04d02/.

hand, farmers who believe an infection is unlikely may choose to do nothing and will find that the decision is not optimal if their fields are infected. If farmers choose the monitoring-curative option, they will always find that their decision is suboptimal at harvesting, but the loss is less than if they choose the worst of the other two strategies. The optimal decision thus depends not just on the costs and benefits of each strategy under certainty, but also on the probability that an SBR infection will occur.

The Role of Information

Information does not affect the possible outcomes, only farmers' beliefs about whether SBR will occur and the management actions taken in response to those beliefs. An accurate forecast of an impending SBR threat will cause farmers to increase their perceived probability that rust will occur and may cause them to choose the preventative strategy. Alternatively, an accurate forecast that SBR poses little or no threat may cause them to do nothing. For the forecast to have economic value, it needs to be timely enough and reliable enough to influence farmers' management strategies. If the information influences farmers' decisions in this way, it reduces the chance of after-the-fact errors, described earlier. In other words, the better the SBR forecast, the more likely that farmers will end up in scenarios 1 or 6 and the less likely that they will end up in one of the other scenarios and regret their decision later. The reduced error rate translates into higher expected profits at the beginning of the season, creating value to the producer.

Two key features needed to value information in this way are farmers' beliefs about the probability of SBR occurring in the first place (their prior beliefs) and the perceived quality of the SBR forecast, which may cause farmers to change their beliefs. Prior beliefs matter because if farmers are already confident that an infection will or will not occur, new information is unlikely to affect their management strategy, and therefore creates little value. Conversely, information will have the greatest value to farmers with prior beliefs near the critical probabilities of SBR that mark changes in the optimal management strategies. For these farmers, the website information may cause them to change their management strategy and reduce their after-the-fact errors.

In this report, information quality refers to the accuracy of the framework's SBR forecast. The greater the quality, the more weight farmers will give to the forecast relative to their prior beliefs and the more likely they will be to alter their management strategies in light of information received. Because it is difficult to quantify the framework's quality of information in its first season, we consider a range of information qualities. The appendix provides a more precise explanation of the broader framework, including how the range of information qualities was derived.