Results

The Corn Belt Region

We begin by focusing on basic results for a single region in order to clarify the concepts just discussed. We chose the Corn Belt because it produces more soybeans than any other region. In subsequent sections of the report, we examine other regions and the U.S. as a whole. We assume base production costs (irrespective of rust), a per bushel soybean price equal to the early season (May 2, 2005) futures price, and other average farm characteristics.[6] These assumptions can be combined with the data in table 1 to estimate profits for a representative farmer in the Corn Belt, which are reported in table 2.

From the possible outcomes in table 2, we evaluate the profit-maximizing management strategy and expected profits for a representative farm in the Corn Belt, depending on farmers' prior beliefs. Farmers' prior beliefs are given by the probability of being in the first column (an SBR infection) or the second column (no SBR infection). Because we cannot know farmers' prior beliefs, we evaluate their optimal (expected profit-maximizing) management strategies over a range of prior beliefs.

We find that, for that farmer, if the prior belief is a less than 19-percent chance of SBR, the optimal management strategy is to do nothing. If the prior belief is between a 19- and 63-percent chance of SBR, the optimal management strategy is to monitor fields and apply a curative fungicide if SBR occurs. If the prior belief is a greater than 63-percent chance, the optimal strategy is to apply the preventative treatment.

For each of many prior beliefs over the full range of 0-100 percent, we then evaluate the value of information associated with each of three information qualities. The information qualities are ranked on a scale from 0 to 1, with 0 indicating a forecast with no predictive power and 1 corresponding to an ideal in which the coordinated framework perfectly predicts SBR infections in advance. We consider three information qualities: low, with a value of 0.2; medium, with a value of 0.5; and high, with value of 0.8. One may think about these information qualities as the proportion of uncertainty

[6]Base production costs do not affect the value of information because they are subtracted from revenues under all SBR management strategies and SBR outcomes. The representative acreage size affects only the value of information per farm, not value per acre. The purpose of these numbers is to provide a tangible perspective for the profit values.

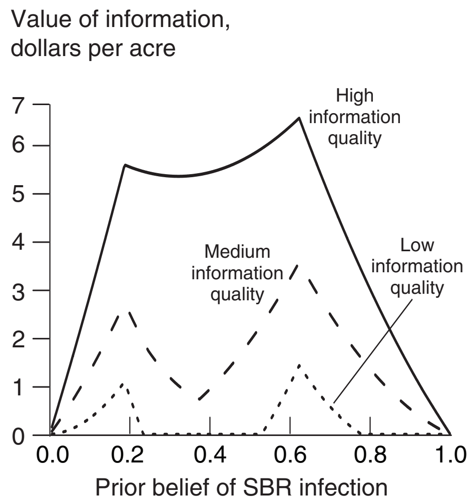
Table 2
Possible profit outcomes for a representative Corn Belt farm[1]

Management strategy	SBR infection	No SBR infection
	Dollars	
Apply preventative treatment	Payoff 1: 91,031	Payoff 2: 93,079
Monitor fields and apply curative treatment if SBR	Payoff 3: 82,532	Payoff 4: 107,118
No SBR management	Payoff 5: 60,885	Payoff 6: 112,097

[1]For this farm, production costs are $125 per acre, base yield is 44.6 bushels per acre (calculated from the regional soybean yield trend evaluated for 2004), and the farm has 742 acres of soybeans. The representative farm is defined as the farm associated with the average acre of soybean in the region. See the appendix for details.

resolved by information provided by the framework.

Figure 3
Possible information values for the Corn Belt



Per acre information values for these three information qualities are plotted in figure 3 over the whole range of possible prior beliefs. For each information quality, the value peaks at 2 points, at prior infection beliefs of 19 percent and 63 percent. These points correspond to critical prior beliefs that mark switching points between the optimal strategies and the points with greatest ambiguity for farmers. Values are highest near these switching points because information has the greatest scope for altering farmers' decisions.

Depending on farmers' prior beliefs and information quality, the value of the framework's information ranges from $0 to $6.38 per acre, or from $0 to $4,732 for the representative farm. The appendix reports a more detailed description of these values for a range of prior beliefs.

Base Case Result for All Regions

One cannot objectively quantify prior beliefs and the information provided by the coordinated framework. These values are ultimately subjective and will vary across regions and individual farmers. Although beliefs are subjective, one can reasonably expect them to be grounded roughly according to objective knowledge. For example, southern regions are thought to be more susceptible to SBR, so farmers in the South will reasonably believe that the probability of infection is high compared with that further north. To develop proxies for farmers' beliefs, we estimated the probability of infection for each region and assumed that the estimated probability represented farmers' prior beliefs of infection. Details about this estimation procedure are given in the appendix.

The estimates suggest that a reasonable average prior infection probability for the Corn Belt is 0.55. This probability corresponds to information values in the middle to higher range of those plotted in figure 3 and reported in appendix table 3, depending on the quality of information.

Scenarios similar to those presented for the Corn Belt were developed for other U.S. regions by using representative soybean production values for each region, but rather than consider a range of prior beliefs, we set assumed prior beliefs equal to our estimated probability of infection. Like the analysis of the Corn Belt region previously discussed, we consider each of three information qualities: low (0.2), medium (0.5), and high (0.8).

Regional information values per acre (app. table 2) vary due to differences in the probability of infection (column (a)) and differences in soybean yields in the absence of SBR (column (c)) across the Nation. Value per farm also varies due to regional differences in representative soybean acreage. For the lowest information quality, values range from $0 (Delta, Lake States, Northern Plains, and Southeast) to $0.64 per acre (Appalachia). For the medium information quality, values range from $0.82 (Northern Plains) to $2.48 per acre (Corn Belt). For the highest information quality, values range from $3.48 (Southeast) to $6.01 per acre (Corn Belt).

Besides the probability of infection, information quality, and base yields, the per acre value of information also depends on assumptions about farmers' risk preferences, how SBR-induced yield losses affect soybean prices, and how beliefs about the probability of infection vary within regions. In the following sections, we examine how the value of information changes as these assumptions are altered.

Risk Aversion

For the base case scenarios (app. table 2), farmers are assumed to maximize expected profits—what they would earn on average if they faced the same chances of SBR infections repeatedly over many seasons. If, however, farmers are risk averse, they also care about profit variability. For example, everything else being equal, a risk-averse farmer will be more inclined to choose the preventative treatment because the worst and best outcomes are more similar under this management decision than they are under the others. We, therefore, examine how the information values change if farmers are strongly risk averse.

We formalize the notion of risk aversion by assuming that farmers have *diminishing marginal utility of wealth*, which means that each additional dollar in wealth (or profits) is valued somewhat less than dollars already possessed. We consider the reported net worth for the representative farm in each region as a base level of wealth. We then examine how wealth and utility of wealth change for different management decisions and SBR outcomes. Additional discussion of our application of risk aversion to the problem of modeling the value of SBR information is in the appendix.

Incorporating risk aversion into the analysis increases the value of information for some regions and scenarios and reduces it for others. Overall, the difference between the risk-averse scenarios and the base case scenarios are modest relative to the influence of information quality and prior infection beliefs (app. table 3). For example, in the Corn Belt, a strongly risk-averse farmer values low-quality information at $0.37 per acre versus the base case value of $0.22. Alternatively, the same risk-averse farmer values high-quality information at $4.89 per acre, somewhat less than the base case value of $6.01.

In general, risk aversion tends to increase the lowest information values and reduce the highest values compared with base case values. The reason for this pattern is rather subtle: High-quality information has a stronger influence on management decisions, which ultimately causes profits to be more variable. Because risk-averse farmers dislike profit variability, high-quality information is valued somewhat less by risk-averse farmers compared with risk-neutral farmers. Low-quality information tends to affect decisions less, which tends to reduce profit variability, making the information more valuable to risk-averse farmers compared with risk-neutral farmers.

Commodity Price Effects

In the base case scenario, we assume that soybean prices were fixed at the early-season, May 2 futures price of $6.19. In reality, commodity prices vary markedly over time, depending on various events that affect supply and demand, including pest infections. This point is discussed more fully in the appendix. If SBR were to cause marked yield losses for a significant share of U.S. soybean acreage, one might expect soybean prices to increase as a result of the reduced supply. We, therefore, examine how the base case values change when accounting for these price effects.

We approximate the price effect of SBR yield losses by examining how historical yield shocks are associated with price changes. A region's "yield shock" refers to deviations from the regional trend in yields. Positive yield shocks tend to be associated with lower prices, and negative yield shocks tend to be associated with higher prices. These associations are stronger in regions with higher levels of soybean production (such as the Corn Belt)—because the yield shocks have a greater effect on the overall market—and less strong in regions with less soybean production. We estimated these associations by using regression analysis. Details of the analysis are available in the appendix.

For most regions, accounting for price effects has a small effect on information values relative to information quality and prior infection beliefs. The effect is somewhat greater in the Corn Belt and Northern Plains because yield shocks in these soybean-intensive regions have larger estimated price effects (app. table 4). In the Corn Belt, for example, the value of low-quality information increases from the base case amount of $0.22 per acre to $0.70 per acre and declines from $6.01 to $5.75 for high-quality information. In the Southeast, where the estimated price effects are far smaller, the values of both low-quality and high-quality information are unchanged at $0 and $3.48 per acre, respectively.

Heterogeneous Infection Beliefs

In appendix table 1, we illustrate how the framework's information value critically depends on farmers' beliefs about the probability of SBR infection (for the Corn Belt). In the base case scenarios, we assume that all farmers within a region hold similar infection beliefs and that those beliefs vary from one region to another. In appendix table 5, we consider information values when farmers within each region have widely varying beliefs about the likelihood of SBR infection. In other words, we assume that, within each region, before receiving any information from the framework, some farmers believe an SBR event would almost surely occur, some believe SBR almost surely would not occur, and others hold beliefs at all points between these extremes. On average, however, we assume that farmers within a given region have similar beliefs about the probability of infection, as presented in column (a) of the base case scenario (app. table 2).

This subtle difference in our assumption about farmers' infection beliefs can have a strong influence on the estimated information values. The difference stems from the lower value that farmers with especially high or low prior beliefs of SBR infection place on information. Thus, the more widely varying or heterogeneous farmers' beliefs are, the more we encounter farmers with extreme beliefs that generate both low and high information values (app. table 5). Compared with the base case scenario, average information values for the Corn Belt decline from $6.01 to $4.04 for high-quality information and increase from $0.22 to $0.25 for low-quality information. Similar differences are observed for other regions. In general, heterogeneous infection beliefs tend to reduce the highest information values and increase the lowest ones. The highest values decline because they are associated with the highest value prior beliefs—those near the critical probabilities that mark the switching points between strategies. With heterogeneous beliefs, these high-value prior beliefs are averaged with lower value prior beliefs, bringing down the overall average. Conversely, the lowest value prior beliefs are averaged with higher value prior beliefs, which bring those values up.