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Report to the Ranking Democratic Member, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate

February 2006

AGRICULTURE PRODUCTION

USDA Needs to Build on 2005 Experience to Minimize the Effects of Asian Soybean Rust in the Future

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GAO-06-337

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Highlights

Highlights of GAO-06-337, a report to the Ranking Democratic Member, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate

AGRICULTURE PRODUCTION

USDA Needs to Build on 2005 Experience to Minimize the Effects of Asian Soybean Rust in the Future

Why GAO Did This Study

In 2005, U.S. agriculture faced potentially devastating losses from Asian Soybean Rust (ASR), a fungal disease that spreads airborne spores. Fungicides approved by the Environmental Protection Agency (EPA) can protect against ASR. In 2005, growers in 31 states planted about 72.2 million soybean acres worth about $17 billion. While favorable weather conditions limited losses due to ASR, it still threatens the soybean industry. In May 2005, GAO described the U.S. Department of Agriculture's (USDA) efforts to prepare for ASR's entry, (*Agriculture Production: USDA's Preparation for Asian Soybean Rust*, GAO-05-668R). This report examines (1) USDA's strategy to minimize ASR's effects in 2005 and the lessons learned to improve future efforts and (2) USDA, EPA, and others' efforts to develop, test, and license fungicides for ASR and to identify and breed soybeans that tolerate it.

What GAO Recommends

GAO recommends that the Secretary of Agriculture provide additional guidance on the monitoring, testing, and reporting on the incidence of ASR and develop a detailed action plan describing how USDA plans to manage the ASR program in 2006 to maintain the level of coordination, cooperation, and national priority achieved in 2005. In commenting on a draft of this report, USDA stated that the recommendations reflect its ongoing efforts with states to combat the disease.

www.gao.gov/cgi-bin/getrpt?GAO-06-337.

To view the full product, including the scope and methodology, click on the link above. For more information, contact Daniel Bertoni at (202) 512-3841 or bertonid@gao.gov.

What GAO Found

USDA developed and implemented a framework—with federal and state agencies, land grant universities, and industry—that effectively focused national attention on ASR in 2005 and helped growers make informed fungicide decisions. The framework was effective in several ways. For example, sentinel plots—about 2,500 square feet of soybeans or other host plants planted early in the growing season in the 31 soybean-producing states—provided early warning of ASR. Officials in 23 of 25 states GAO surveyed reported that this effort was effective. Researchers could also promptly identify and report on the incidence and severity of the disease on a USDA Web site, alerting officials and growers to ASR's spread. Going forward, however, differences in how researchers monitor, test, and report on the disease could lead to incomplete or inaccurate data and detract from the value of future prediction models. For example, models to forecast ASR's spread partly rely on states' observations of sentinel plots. USDA asked states to report results weekly, but updates ranged from 4 reports, in total, during the growing season in one state to 162 reports in another state. Inconsistencies also occurred in the designation and placement of plots and in the testing of samples for ASR. Further, changes to the successful management approach employed by USDA in 2005 raise questions about how the program will perform in 2006. For 2006, most operational responsibility for ASR will shift from USDA headquarters to a land grant university. GAO is concerned that USDA's lack of a detailed action plan describing how program responsibilities will be assumed and managed in 2006 could limit the effectiveness of ASR management for this year.

EPA, USDA, and others increased the number of fungicides growers can use to combat ASR while efforts continue to develop ASR-tolerant soybeans. As of December 2005, EPA had approved 20 fungicides for treating ASR on soybeans, including 12 that had emergency exemptions. According to officials in the nine states where ASR was confirmed in 2005, growers had access to fungicides. USDA, universities, and private companies are also developing ASR-tolerant soybeans and have identified 800 possible lines of resistant soybeans, out of a total of 16,000 lines. USDA estimates it may take 5 to 9 years to develop commercially available ASR-tolerant soybeans.

Soybean Plants Treated with Fungicides Next to ASR-infected Plants

Source: Rural Development Center, Tifton Campus, University of Georgia.

Contents

Abbreviations

APHIS	Animal and Plant Health Inspection Service
ASR	Asian Soybean Rust
CSREES	Cooperative State Research, Education, and Extension Service
EPA	Environmental Protection Agency
ERS	Economic Research Service
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
RMA	Risk Management Agency
SRIPMC	Southern Region Integrated Pest Management Center
USDA	U.S. Department of Agriculture

United States Government Accountability Office
Washington, D.C. 20548

February 24, 2006

The Honorable Tom Harkin
Ranking Democratic Member
Committee on Agriculture, Nutrition, and Forestry
United States Senate

Dear Senator Harkin:

In 2005, U.S. agriculture faced potentially devastating losses from Asian Soybean Rust (ASR), a fungal disease that has caused significant crop losses in other parts of the world. When ASR infects a soybean plant, spots and pustules begin to form on its leaves, which eventually turn yellow and drop prematurely, damaging the plant and decreasing the number and size of beans.[1] ASR can destroy an entire field within a few weeks. Weather conditions, such as rainfall, humidity, and temperature, affect both the severity and incidence of ASR. However, fungicides provide protection against ASR if they are applied correctly and at the proper time. In 2005, U.S. growers in 31 states planted about 72.2 million acres in soybeans that had a total estimated value of about $17 billion.

The U.S. Department of Agriculture (USDA) has been preparing for the arrival of ASR in the continental United States since its presence was first detected in Brazil in 2002. ASR was discovered for the first time in the continental United States, in Louisiana in November 2004—after most of the crop had been harvested—and had little effect on soybean production. During 2005, researchers confirmed the presence of ASR in 138 counties across nine southern states. Currently, no commercial soybeans are resistant to ASR, and fungicides are generally recognized as the most effective means for controlling the disease. USDA had predicted that U.S. economic losses from ASR could reach as high as $2 billion annually, but growers experienced few crop losses from ASR in 2005 because weather conditions and other factors were not favorable to the spread of the disease. In some cases, it appears that growers experienced higher yields than expected because the threat of ASR caused them to be more attentive to their crop. While few losses occurred in 2005, ASR still poses a significant threat to the U.S. soybean industry, depending on the severity and extent of subsequent outbreaks.

[1]ASR can infect over 90 host plant species, including legumes, such as dry beans, peas, and kudzu.

In May 2005, we reported on the status of USDA's efforts to prepare for ASR's entry into the United States.[2] This report examines (1) USDA's strategy for minimizing the effects of ASR in the 2005 crop year and the lessons learned that could be used to improve future efforts and (2) the progress USDA, the Environmental Protection Agency (EPA), and others have made in developing, testing, and licensing fungicides to treat ASR and in identifying and breeding ASR-resistant or ASR-tolerant soybeans.

In conducting our work, we met with USDA and EPA officials and reviewed agency documents on strategy, planning, and funding. We interviewed university extension faculty and laboratory diagnosticians in Georgia, Florida, Alabama, Indiana, and Iowa. We selected the first three states because they were the most significantly affected by ASR in 2005 and the latter two because they are among the largest producers of soybeans in the United States. We also surveyed officials from the 31 soybean-producing states that were included in USDA's sentinel plot program to obtain information about the events that occurred in 2005 as well as their states' preparations for dealing with ASR in 2006 (see app. II for a summary of survey results). We pretested the content and format of the survey questionnaire with several state officials. We also interviewed industry and trade representatives to discuss fungicides, fungicide application equipment, and other issues related to ASR. A more detailed description of our scope and methodology is presented in appendix I. We performed our work between May 2005 and January 2006 in accordance with generally accepted government auditing standards.

Results in Brief

In 2005, USDA developed and implemented a coordinated framework that was effective in focusing national attention on ASR and enabling growers to make informed decisions about fungicide application. The framework includes a surveillance and monitoring network; a Web-based information management system; criteria for deciding when to apply fungicides; predictive modeling; and outreach. The framework was effective in several respects. For example, the sentinel plot program—plots planted a few weeks before the beginning of the growing season to serve as an advance warning system—allowed researchers to identify and report on the incidence and severity of the disease immediately or within a few days on USDA's ASR Web site, thereby alerting officials and growers to the spread

[2] GAO, *Agriculture Production: USDA's Preparation for Asian Soybean Rust*, GAO-05-668R (Washington, D.C.: May 17, 2005).

of the disease. Researchers also advised growers about whether and what type of fungicide might be needed. State officials in most of the soybean-producing states that we surveyed characterized the 2005 sentinel plot program as effective in providing timely information on the spread of ASR. However, certain inconsistencies in implementation could hamper long-term efforts to contain ASR. For example, models developed to forecast the spread of ASR will need several years of consistently collected data to be most effective. These models rely, in part, on states' observations of the sentinel plots. Although USDA asked the states to report results at least once a week, not all states did so. For example, two states reported only four times during the entire growing season while another reported almost daily. We also noted inconsistency in the designation of sentinel plots. Some plots were stand-alone and some were part of existing commercial fields. Stand-alone plots are generally easier to access by monitors and may facilitate more regular monitoring and reporting. In addition, we noted differences in the diagnostic testing of plant samples. Some test results were based on visual inspection and others were based on advanced screening techniques, which tend to identify ASR earlier in the infection process. Going forward, such inconsistencies could eventually undermine the value of predictive modeling, whose accuracy depends upon collecting and analyzing timely, uniform, and complete data. Finally, leadership is key to the continued effectiveness of the ASR effort. The 2005 effort was directed by senior USDA officials in headquarters. In 2006, however, USDA plans to transfer most operational responsibility for ASR to a land grant university in North Carolina. Changes to the successful management approach employed by USDA in 2005 raise questions about how the program will perform in 2006. At the time of our review, USDA lacked a plan showing how all of the responsibilities carried out in 2005 would be carried out in 2006. It is important that the department have such a plan prior to the 2006 growing season to help ensure that it maintains the level of coordination, cooperation, and national priority that was achieved in 2005 to address ASR.

EPA, USDA, and others have made progress in increasing the number of fungicides that growers can use to combat ASR, while researchers continue their efforts to develop ASR-resistant or -tolerant soybeans. As of December 31, 2005, EPA had approved a total of 20 fungicide products for treating ASR on soybeans, including 12 for which emergency exemptions were granted, and officials in the nine states where ASR was confirmed reported that growers had access to fungicides. EPA also established maximum residue levels for these exempted fungicides in time for soybean growers to export their products to foreign markets. To further minimize crop losses, USDA and private companies funded fungicide efficacy trials at universities across the United States. However, the trials produced inconsistent results, in part because different protocols were followed, and the researchers concluded that future trials should use uniform protocols to ensure consistent data collection and interpretation. USDA, universities, and private companies are also working to develop ASR-resistant or -tolerant soybeans, and they identified about 800 possible resistant lines of soybeans, out of a total of about 16,000 lines of soybeans. USDA estimates it may take 5 to 9 years to develop and make commercially available ASR-resistant or -tolerant soybeans. Until then, fungicides will continue to be the primary method for controlling ASR.

To ensure continued progress in minimizing the effects of ASR and to facilitate research, we are recommending that the Secretary of Agriculture provide additional guidance to state ASR program managers on monitoring, testing, and reporting on the incidence of ASR and ensure that a detailed action plan for managing ASR in 2006 is in place prior to the 2006 growing season.

We provided a draft of this report to USDA and EPA for their review and comment. EPA provided oral technical comments, which we incorporated into the report as appropriate. In its written comments, USDA said that the report fairly describes USDA's preparations related to ASR and that both of the report's recommendations reflect its ongoing cooperative efforts with states to combat the disease. USDA also provided technical comments, which we incorporated into the report as appropriate.

Background

ASR, a disease caused by the fungus *Phakopsora pachyrhizi*, requires living host cells to survive. It can infect over 90 host species of legumes, such as kidney beans, chickpeas, and kudzu. When ASR infects soybeans, it causes the plants to lose their leaves prematurely, which reduces the size and number of the beans. In areas where the disease commonly occurs, up to 80 percent yield losses have been reported.

Environmental factors are critical to the incidence and severity of ASR. Long periods of leaf wetness, high humidity, and temperatures between 60 and 80 degrees Fahrenheit are ideal for spore germination. About 7 days after plants are infected with ASR, small brown spots surrounded by yellow rings appear on the leaf's upper surface (stage 1). Within 10 days, pustules form in the spots, primarily on the undersides of the leaves (stage 2). These pustules have raised centers that eventually break open to reveal masses of fungal spores, called urediniospores (stage 3). Pustules can produce urediniospores for about 3 weeks. When the wind blows, the spores are dispersed, spreading the infection to other fields. Once windborne, the spores can reportedly travel hundreds of miles within a single day. Figure 1 shows the progression of infection on a soybean plant.

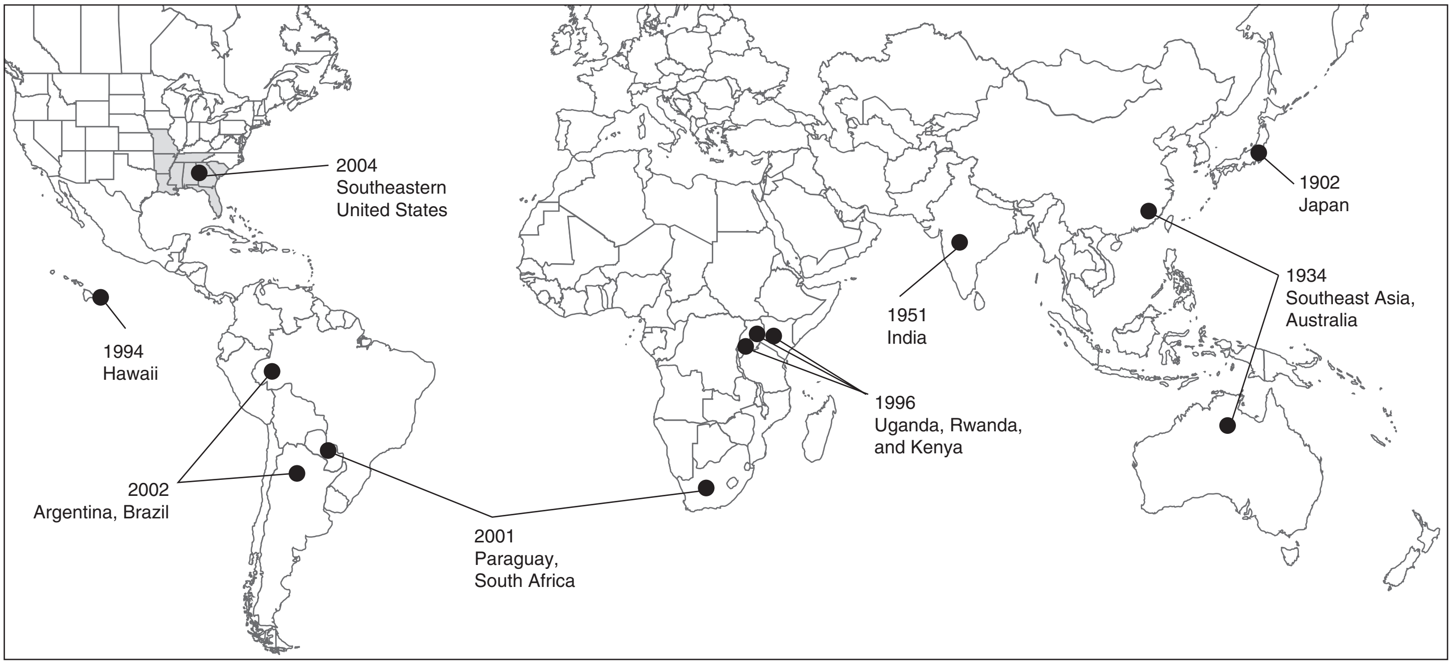
Figure 1: Progression of Infection on a Soybean Plant

Source: USDA.

Stage 1 Stage 2 Stage 3

ASR was first detected in Japan in 1902. By 1934, the disease was found in several other Asian countries as well as Australia. In 1951, the disease was first reported on soybeans in India. The disease was confirmed, and widespread infestations occurred in several African countries in 1996. In 2001, ASR was found in Paraguay and was detected in Argentina the following year. By 2002 the disease was widespread throughout Paraguay and in some limited areas of Brazil. ASR was first discovered in the continental United States in Louisiana on November 9, 2004. Researchers believe the disease was carried to the United States by tropical storms. Figure 2 shows the pattern of ASR's spread throughout the world.

Figure 2: Spread of ASR across the World



Sources: GAO, and Map Art.

USDA has been following the path of the disease and planning for its introduction into the United States for several years. In May 2002, three USDA agencies—the Animal and Plant Health Inspection Service (APHIS), the Cooperative State Research, Education, and Extension Service (CSREES), and the Agricultural Research Service—together with the National Plant Board, industry, and several land grant universities formed the ad hoc Soybean Rust Committee. In addition, USDA established the National Plant Diagnostic Network to enable diagnosticians, state regulatory personnel, and first detectors to communicate images and methods of detection for ASR as well as other diseases in a timely manner.

USDA determined that once ASR arrived in the United States it could not be eradicated because of its rapid transmission rate and an abundance of host species. Thus, it decided fungicides would be the primary means of managing ASR in the United States and Canada until researchers can develop acceptable soybean cultivars that are resistant to the disease. Although the disease has resulted in significant losses in yield and production in other countries, soybean growers have learned to successfully manage the disease by applying appropriate fungicides.

However, the use of such fungicides increases the production costs associated with soybeans, which had typically required relatively little or no management in the United States. For example, during the 2003 to 2004 growing season, Brazilian growers spent close to $1 billion on fungicides to prevent and reduce the spread of the disease. In the United States, the costs of applying fungicides for ASR are estimated to range from $10 to $35 per acre for each application. The total cost of applying fungicides will depend on the number of acres treated.

All pesticides, including fungicides, must be registered and labeled in accordance with EPA regulations in order for them to be sold or used in the United States. If emergency conditions exist, however, EPA can grant an emergency exemption to state and federal agencies that allows the unregistered use of the pesticide under section 18 of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).[3] EPA regulations require state and federal agencies to submit an application for emergency exemptions and set limits on the duration of those exemptions. Under the Federal Food, Drug, and Cosmetic Act, as amended by the Food Quality Protection Act, EPA sets tolerances for pesticides—the maximum residue levels of pesticides permitted on foods. Unlike its process for registering fungicides, EPA may grant an emergency exemption for the use of a fungicide before it sets a tolerance for that fungicide.

Fungicides for ASR are classified as preventative or curative. Preventative fungicides, such as strobilurins, prevent fungi from successfully infecting and/or penetrating the host tissue of the plant, while curative fungicides, such as triazoles, inhibit or stop the development of infections that have already begun. In addition, some fungicides contain both preventative and curative chemicals.

To properly manage ASR, growers must apply the right class of fungicides at the appropriate time and with proper equipment. Applying fungicides too early can increase production costs, and the fungicide could wear off by the time an infection actually occurs. However, if growers wait too long to apply the fungicide, the disease could progress to an untreatable stage, and some crop could be lost. In order for fungicides to be optimally effective, they must be applied to the whole plant and be placed as deeply into the canopy as possible because the disease usually begins in the lower canopy before traveling into the middle and upper canopies as the crop matures.

[3]Pub. L. No. 92-516, § 18 (1972) (codified at 7 U.S.C. § 136 p.).

Fungicides can be applied by ground sprayers or from the air. Aerial application is a viable alternative when rainfall makes the fields too muddy or when large amounts of soybean acreage need to be sprayed within a short time.

In April 2004, USDA's Economic Research Service (ERS) conducted a study to project the potential economic losses associated with various degrees of ASR infestation in the United States. ERS concluded that the extent of economic impacts from ASR will depend on the timing, location, spread, and severity of the disease as well as the response of growers, livestock producers, and consumers of agricultural commodities. For the first year of ASR's establishment in the United States, ERS estimated that the expected value of net economic losses could range from $640 million to $1.3 billion, depending on the geographic extent and severity of the disease's initial entry.

When ASR was discovered in Louisiana in November 2004, it was too late in the crop year to damage 2004 soybean production. Since ASR must have a living host to survive the winter, USDA believed the disease could only successfully survive over the winter in the southernmost areas of the United States and would have to be reintroduced each year into more northern soybean-producing areas. Therefore, its arrival provided an early warning to USDA, growers, and industry, allowing them time to prepare strategies for minimizing the impact of the disease before the 2005 crop year.

2005 ASR Efforts Showed Benefits of a National Coordination Strategy and Highlight the Importance of Consistent Data and Strong Leadership

USDA's development and implementation of a coordinated framework was instrumental in providing an effective response to ASR on soybeans in 2005. The framework includes (1) a surveillance and monitoring network, (2) a Web-based information system, (3) decision criteria for fungicide application, (4) predictive modeling, and (5) outreach for training, education, and information dissemination. The goal of the framework was to provide stakeholders with effective decision support for managing soybean rust during the 2005 growing season, and USDA was generally successful in doing so. However, inconsistencies in how researchers monitor, test, and report on the disease could lead to incomplete or inaccurate data and detract from the value of future prediction models. Furthermore, the success of the 2005 framework was due in part to the leadership of senior USDA officials, who were able to mount a national campaign. The transfer of operational responsibilities to a land grant university, under the direction of USDA, raises concerns about the department's ability to maintain the level of coordination, cooperation, and national priority that was achieved in 2005 to address ASR.[4]

The Surveillance and Monitoring Network Was Generally Implemented Effectively, but Inconsistencies Could Impair Future Predictive Efforts

The early detection of ASR through the sentinel plot network—one of the key components of the surveillance and monitoring program—was effective, according to officials in 23 of the 25 states we surveyed.[5] Sentinel plots—typically about 2,500 square feet of soybeans, other host plants, or a combination of the two—are planted a few weeks before the beginning of the growing season and serve as an advance warning of approaching ASR. In total, states monitored more than 1,000 sentinel plots in 2005. USDA and the North Central Soybean Research Program, in affiliation with the United Soybean Board, funded the sentinel plot network established under the framework. USDA provided about $800,000 for a total of 300 plots in the 31 soybean-producing states and an additional 20 plots in 4 other states that produce dry beans, such as navy beans and chick peas.[6] (USDA plans to fund a similar number of sentinel plots in 2006.) The North Central Soybean Research Program and United Soybean Board provided approximately $390,000 for a total of 400 plots in 20 states (20 plots per state).[7] In addition, some states established and monitored other plots during the growing season. Officials of the 31 states we surveyed provided data on the number of sentinel plots sponsored by USDA and others during 2005 (see fig. 3).[8]

[4]In addition to steps taken as part of USDA's coordinated framework, unavoidable crop losses due to ASR are covered under the federal crop insurance program administered by USDA's Risk Management Agency (RMA). As of December 31, 2005, no one had filed a claim for crop loss from ASR.

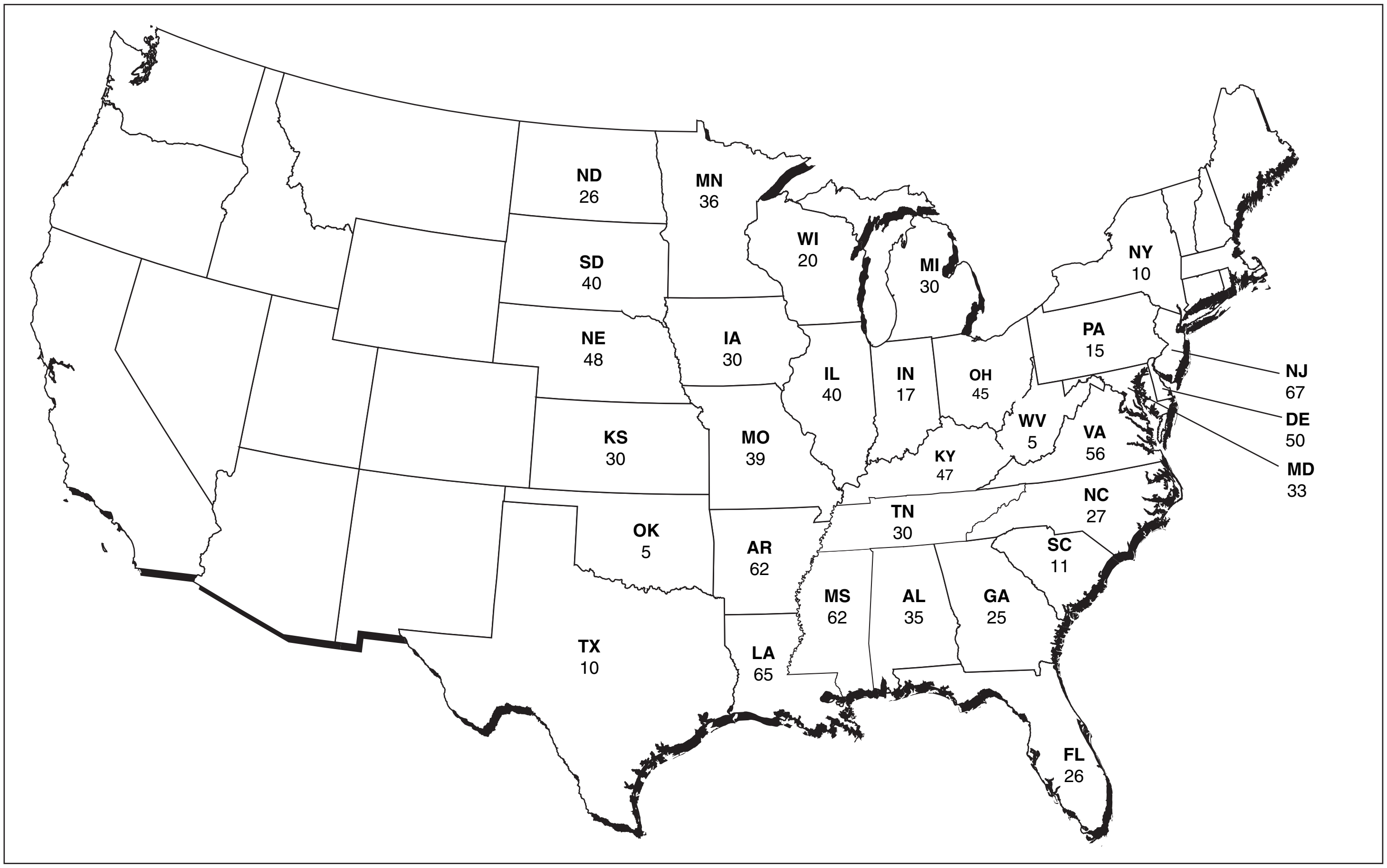
[5]Six states did not express a view on the effectiveness of the sentinel plot program.

[6]Five of these plots were located in Puerto Rico.

[7]According to USDA officials, USDA provided more money per plot because it funded the "infrastructure" for the sentinel plot network, which included transportation expenses and equipment, in addition to salaries for personnel to monitor the plots and, in some cases, the rental of farmland to maintain them.

[8]Other plots included those funded by the North Central Soybean Research Program, the United Soybean Board, state governments, or other grants; plots not monitored by state officials, such as those sponsored by private industry, are not included in this total.

Figure 3: Number of Sentinel Plots in Each State, 2005



Source: GAO survey of soybean-producing states.

State personnel monitored these plots throughout the growing season to determine the presence and severity of ASR. Within each state, a designated official entered the monitoring data from the plots into USDA's ASR Web site, an online, real-time data system. Once the data were entered, growers and others could access the information to determine in which counties ASR-infected plants were found. In addition, state specialists used the Web site to provide guidance to growers about whether and what type of fungicides should be applied.

Once ASR was detected and confirmed in a state, the framework specified that mobile monitoring teams—one assigned to each of five regions—

would be dispatched to the affected areas to help determine the severity and spread of the disease. During the 2005 growing season, the disease was confined to the southeastern region, and therefore only the team assigned to that region was deployed.

Researchers use the information from states on sentinel plot monitoring, including diagnostic testing results, to develop prediction models that estimate where and how severe ASR will be in certain areas of a state or county. These models depend in large part on timely and consistent data from the state observations and diagnostic testing results. Researchers will rely on this information, in part, to validate the predictive models over the next few years, while extension personnel and growers rely on this information to make informed and timely decisions on the need to apply fungicides.

USDA asked the states to monitor their sentinel plots at least once a week and report the results on a weekly basis by posting them to a restricted USDA Web site.[9] Monitoring results from the sentinel plots supported by USDA and the North Central Soybean Research Program were to include, for example, the location, host, and severity of the disease.[10] However, state officials did not consistently report weekly updated information to the Web site during the 2005 growing season. Updates from the states ranged from a total of 4 each for two states to 162 for another. USDA also provided states considerable flexibility in how they designated sentinel plots. In some cases, fields were planted as stand-alone surveillance fields while in other cases, sentinel plots were part of commercial fields. Such differences might affect the extent to which crops are accessible for crop monitors. While there is no evidence that this variation in plots affected data reporting in 2005, a lack of consistency in designating sentinel plots could ultimately affect the quality of data that are essential to alerting USDA to the initial presence and spread of ASR in future years.

Diagnostic testing was important to confirming suspected cases of ASR because several plant diseases resemble it and because U.S. growers have little experience in identifying ASR. States are to send the first suspected sample of ASR on soybeans and each new host to USDA's APHIS laboratory

[9]The information from this restricted Web site is used to provide information for the public Web site.

[10]North Central Soybean Research Program and USDA Protocol for Soybean Rust Sentinel Plots, updated April 7, 2005, and August 23, 2005.

in Beltsville, Maryland, for confirmation testing. However, subsequent samples submitted within each state may be tested at either a state or National Plant Diagnostic Network laboratory. According to our survey of officials in the 31 soybean-producing states, state diagnostic laboratories received about 12,100 samples for ASR research and screening. Of these samples, about 9,500 were submitted for routine research or monitoring and about 2,600 were submitted specifically because of suspected ASR. Of the total number of samples tested, only 877, or about 7 percent, tested positive for ASR. For samples suspected of having ASR, states primarily relied on morphological examinations—i.e., examining the spores from lesions on leaf samples, visually or under a microscope—to screen the samples suspected of ASR. However, in selected cases, the states conducted advanced screening using the polymerase chain reaction (PCR) test or an enzyme-linked immunosorbent assay (ELISA) test to detect the presence of ASR.[11] Table 1 summarizes the results of states' tests performed on samples suspected of having ASR in 2005.

Table 1: Type of Testing Performed on Samples Suspected of ASR in 2005

Type of testing	Number of samples screened or tested
Morphological examination only	2,202
Morphological exam and PCR	195
Morphological exam and ELISA	137
Morphological exam, ELISA, and PCR	71
Total	**2,605**

Source: GAO's survey of soybean-producing states.

The National Plant Diagnostic Network issued standard operating procedures for how to submit samples to a diagnostic laboratory and procedures for initially screening the samples and conducting advanced screening. However, the procedures did not specify how often or under

[11]In the PCR test, Deoxyribonucleic acid (DNA) is extracted from spores or infected leaf samples, subjected to PCR, and then ground and purified before being analyzed for the presence of key diagnostic sequences of DNA that distinguish ASR from related species. The ELISA test, which is conducted similarly, requires about 2 hours and is the first commercial rapid kit available to detect soybean rust in plant tissue. Although ELISA is capable of detecting soybean rust at a very early stage, unlike the PCR test, USDA officials were uncertain whether it can distinguish between ASR and other types of rust.

what circumstances, the laboratory should conduct advanced screening to confirm an initial diagnosis of ASR. Advanced screening might be warranted because a morphological examination of a sample in the early stages of the disease may fail to detect ASR. Also, in some cases, diagnosticians may have limited experience in detecting the disease morphologically. Conversely, officials in some states where ASR appeared to be no real threat in 2005 may have believed that advanced screening was not necessary. Officials in 13 of the states that we surveyed reported that a morphological examination was the only type of testing they performed on samples of suspected ASR. Officials in 13 states also indicated that they performed a morphological examination as well as at least one other type of advanced screening test, and officials in 3 states reported that they only performed advanced screening on suspected cases of ASR.[12] The various methods used to diagnose ASR, and hence to report the results to the Web site, could determine the difference between detecting the disease early, when it is most easily treated, or delaying detection until it is well established.

As of October 31, 2005, state laboratories had spent an estimated total of $465,800 on screening and testing samples for ASR; about $14,600 of this cost was offset by the fees the state laboratories charged for sample testing. Most of the state officials we surveyed reported that their states had sufficient funding and staffing to perform diagnostic screening and testing for ASR during 2005. For 2006, officials from 30 of the states that we surveyed indicated that they plan to have the same number or more laboratory staff. However, officials from nine of the states indicated that they still lacked sufficient equipment to perform recommended diagnostic testing. In addition to testing field samples, USDA sampled rainwater to help in the early detection of ASR.[13] With these samples, scientists can detect spore concentrations before ASR is apparent on the plant. Positive samples were found in most of the regions tested, including the Midwest and the Northeast, where ASR was not apparent on the plant. USDA is

[12]Officials in the remaining two states that we surveyed indicated that they received no samples suspected of ASR during 2005.

[13]This technique is still experimental.

using this information for research and plans to publish its findings in a professional journal.[14]

USDA's Web-Based Information System Was Viewed Favorably, but Users Suggested Improvements

As a means to share information among all interested parties, in March 2005, USDA activated the public ASR information Web site, which provided disease observations, management recommendations, and scouting information, among other things.[15] The site allows growers and other interested parties to go to a single location for real-time, county-level information on the spread of the disease in soybean-producing states. The Web site displays two maps of the United States. One map shows the counties in which researchers scouted for ASR and did not find it (in green) and counties in which ASR was confirmed (in red). Another map allows the public to click on a state and obtain information on ASR management, such as disease management, scouting results, growth stages, and forecast outlook. In addition, the Web site provides a chronology of positive ASR detection by date confirmed, county, and state; information on the spread of ASR nationwide; and links to related Web sites.

USDA has also established a restricted Web site that has several access levels for various users, such as state specialists, observers, researchers, and selected industry representatives. Among other things, this site presents information on observed and predicted disease severity and spore deposition. The Web site is restricted to prevent unauthorized users from entering erroneous data and to allow state specialists to share and assess data before distributing information to the public. The information in this restricted Web site then becomes the basis for the information on the public Web site.

Officials in the soybean-producing states that we surveyed characterized USDA's Web sites (public and restricted) as useful to their states. However, several officials provided suggestions for improvement. These suggestions

[14]In addition to the monitoring plan laid out in the framework, industry distributed various types of "spore traps" to collect spore samples in the air. Researchers hoped that these traps would allow them to detect the presence of ASR spores before the disease had spread to soybean fields. However, because the traps did not collect enough spores for testing and because ASR and other rust spores are similar in appearance, USDA issued a position statement in August 2005, stating that many challenges and questions need to be resolved before spore data can be used most effectively.

[15]http://www.sbrusa.net/.

included making the Web sites easier to use, giving multiple officials within each state access to update the Web sites, considering the needs of the colorblind, providing better instructions to users, recognizing the efforts of extension service personnel on the Web site, considering the needs of users without high-speed Internet connections, and publicizing the Web sites to a greater extent.

Decision Criteria for Fungicide Application Useful to Advisers and Soybean Growers in Responding to ASR

To educate and assist growers and extension personnel in making decisions regarding the use of fungicides to combat ASR, state land grant university extension specialists and USDA developed a fungicide guide. The April 2005 ASR fungicide manual—*Using Foliar Fungicides to Manage Soybean Rust*—was developed under a USDA grant by state extension and scientists at 22 U.S. universities, USDA, and the Ontario Ministry of Agriculture and Food. It was widely available to state officials, growers, and other stakeholders. The manual provides basic fungicide information, such as the chemistry involved and the brand names of different products, as well as information on factors involved in making fungicide spray decisions, including whether to use a preventative or curative fungicide, and how and when to apply the fungicide. Over 150,000 copies of the manual were distributed during 2005. In addition, extension officials in the states we visited commented that the manual was very useful to growers in deciding when and how to apply fungicides during the 2005 crop season. Using information from USDA's Web site and the ASR fungicide manual, extension service offices in five states where ASR was confirmed suggested that some growers apply fungicides for ASR at least once during the 2005 growing season.[16]

Predictive Modeling Is a Work in Progress and Will Depend on Good Data in the Future

During the 2005 growing season, state specialists could obtain ASR forecast information from various models, synthesize the information, and use it to prepare state forecast outlooks for dissemination on USDA's public Web site. These models included one supported by USDA that predicted the aerial spread of ASR spores from active source regions in the United States to other soybean-growing areas; the results of this model were

[16]Although ASR was confirmed in another four states, it was detected late in the growing season, making a recommendation unnecessary.

published on USDA's restricted Web site.[17] Other ASR prediction models available during 2005 included one from the North American Disease Forecast Center at North Carolina State University and another developed by researchers at Iowa State University. These models depend in large part on timely and consistent data from the states' observations and diagnostic testing results.

According to researchers who used the models, ASR prediction models tended to overstate the spread of ASR in 2005. However, this was the first full year that ASR was in the United States and it generally takes several years to calibrate and validate models like these. One researcher has proposed that USDA use an "ensemble approach" to predict the spread of ASR in 2006—that is, using forecast information from several ASR models in predicting the spread of ASR. Regardless of which models are used, inconsistencies in defining or designating sentinel plots, in diagnosing ASR, and hence in reporting the results to the Web site could affect the development of predictive models and ultimately could determine the difference between detecting ASR early, when it is most easily treated, or delaying detection until ASR is well established.

Outreach for Training, Education, and Information Dissemination Was Effective in 2005 and Is Planned to Continue in 2006

In preparation for the 2005 growing season, USDA and the 31 soybean-producing states we surveyed sponsored about 1,500 presentations, programs, and workshops on ASR. Officials in these states reported that they planned to offer over 400 presentations, programs, and workshops on ASR between November 1, 2005, and April 30, 2006. According to the state officials we surveyed, the three most important topics to include in these workshops are identification of ASR and "look-alike" diseases, availability and use of fungicides, and observations and results from 2005.

During the 2005 growing season, several other outreach efforts were also conducted to help growers. For example:

- Some states supported telephone hotlines that presented the latest information on ASR, enabling growers using cellular phones to get information when they were out in the fields.

[17] USDA's model was developed by Pennsylvania State University, North Carolina State University, and ZedX, Inc., an information technology company.

- The University of Kentucky created two ASR electronic mailing lists—one that facilitated discussion and information sharing about ASR among 137 industry, state, federal, and university officials and another that facilitated communication among 108 individuals regarding the soybean rust sentinel plot and surveillance network.
- The American Phytopathological Society organized a symposium in November 2005—attended by over 350 participants—to discuss ASR and lessons learned during the past growing season.
- Several states also displayed ASR information on their state Web sites.

Lack of an Action Plan Describing How Leadership Responsibilities Will Be Assumed and Managed in 2006 Raises Concerns About a Sustained National Effort for ASR

The national effort for ASR during the 2005 growing season was directed by senior APHIS headquarters officials, who coordinated the federal, state, and industry effort to develop the framework. Before and during the growing season, they conducted regular meetings with state specialists. According to a representative of the American Soybean Association, soybean growers were pleased with the central, coordinated effort led by APHIS to fight against ASR. In addition, 30 of the officials in the states we surveyed reported that communication was effective between their state and USDA in addressing ASR during 2005.

APHIS has been involved in preparing for ASR because of its responsibility to protect the nation from the introduction of foreign plant pests. However, now that ASR is in the United States, CSREES is responsible for managing efforts to minimize its effects.[18] In November 2005, USDA formally announced the transition of operational responsibility for managing ASR in 2006, from APHIS to the Southern Region Integrated Pest Management Center (SRIPMC) at North Carolina State University, under the direction and coordination of CSREES.[19] The current ASR national system will be expanded to provide growers with information about additional legume pests and diseases in 2006. SRIPMC and USDA recently signed a cooperative agreement that will provide about $2.4 million to fund ASR

[18]CSREES' mission is to advance knowledge for agriculture, the environment, human health and well-being, and communities by supporting research, education, and extension programs in the Land-Grant University System and other partner organizations.

[19]CSREES transferred responsibility to SRIPMC because it had available staff and office space and was located in the South where ASR was present during 2005.

monitoring, diagnostics, and communication efforts in 2006.[20] Total funding includes $1 million for sentinel plots and $800,000 for diagnostic testing. In 2005, USDA provided nearly $1.2 million for these activities.

During 2006, selected APHIS personnel will assist with the transition to CSREES. One key APHIS official will serve as the national coleader of the USDA Web site and train SRIPMC personnel, and a contractor will continue to serve as data manager to help ensure that the Web site continues to provide current, useful information. In addition, the contractor will continue to provide meteorology and modeling expertise. However, as of January 25, 2006, USDA lacked a detailed plan describing how it plans to ensure that all elements of the 2005 framework will be effectively implemented in 2006. In commenting on a draft of this report, USDA reported that it was developing, but had not completed, such a plan.

Changes to the successful management approach employed by USDA in 2005 raise questions about how the program will perform in 2006. We are concerned that without a detailed action plan in place prior to the 2006 growing season, describing how CSREES will assume and manage important responsibilities, USDA may not be able to ensure that the level of coordination, cooperation, and national priority that was achieved in 2005 to address ASR will continue in 2006.

EPA, USDA, and Others Have Made More Fungicides Available While Continuing to Develop Longer-Term Solutions

As of December 31, 2005, EPA had approved a total of 20 fungicide products for treating ASR on soybeans, including 12 for which emergency exemptions were granted. Officials in the nine states where ASR was confirmed reported no problems in obtaining access to fungicide application equipment. While officials in three of these states reported that not all fungicide products were available to their growers, they did not indicate that growers experienced fungicide shortages overall. To determine which fungicides are the most effective under given conditions, USDA and private companies also supported research efforts at universities across the United States. For the longer term, USDA, universities, and private companies are conducting research to develop

[20] USDA's RMA will fund this effort in 2006 as part of an initiative to develop a broader system. According to RMA, this effort is aimed at providing a mechanism to educate farmers about risk-management strategies and providing timely information about good farming practices specific to current crop pest and disease status—ASR and others.

ASR-resistant or -tolerant soybeans but expect that these will not be available commercially for 5 to 9 years.

EPA and USDA Worked Cooperatively to Make Multiple Fungicides Available in 2005

Efforts to ensure that fungicides would be approved for treating ASR on soybeans have been under way for some time. (See app. IV for a complete list of approved fungicides.) Before March 2004, 4 fungicides had been registered for preventing ASR on soybeans. However, between March 2004 and June 2005, EPA approved another 16 fungicides—all in time for application during the 2005 growing season. These fungicides included the following:

- 4 registered fungicides that are preventative; and
- 12 fungicides for which emergency exemptions were granted.[21] Nine of these products are curative,[22] and 3 have both preventative and curative properties.

As of November 2005, five additional fungicides for ASR were pending approval for emergency exemption, and two others were pending full registration.

EPA was able to act expeditiously, in part because, in July 2002, USDA and EPA began discussing preparations for emergency exemptions and working with private industry and state departments of agriculture to prepare for ASR. They identified fungicides with known efficacy against ASR and fungicides that needed additional testing to gain EPA approval. During 2003, USDA's Office of Pest Management Policy hosted several teleconferences and meetings with researchers, EPA, and state officials to discuss the development of emergency exemptions for soybeans and other legumes. In November 2003, EPA suggested a procedure for states to follow for requesting emergency exemptions. That is, although each state typically submits a unique request to EPA for an emergency exemption, EPA allowed Minnesota and South Dakota to prepare a joint request for treating ASR on soybeans and allowed other states to copy this request. USDA also began

[21]Thirty-three states, including the 31 soybean-producing states participating in USDA's sentinel plot program, have received emergency exemptions to use some or all of these fungicides.

[22]These fungicides are classified as triazoles, which have some preventative properties.

contacting states to offer help preparing requests for emergency exemptions.

As a result of these preparations, when ASR was first confirmed in the continental United States in November 2004, 26 states, representing 99 percent of the U.S. soybean acreage, had requested emergency exemptions for fungicides to treat ASR, and 25 of these states had received at least one emergency exemption. Furthermore, although emergency exemptions are usually granted for a single year, EPA approved the exemptions for ASR fungicides through November 2007, as quarantine emergency exemptions. These exemptions may be authorized for up to 3 years in an emergency condition to control the introduction or spread of any pest new to or not known to be widely prevalent or distributed within and throughout the United States. Consequently, in 2007, states will have to renew their emergency status, with the support of the manufacturer; work to have these fungicides registered; or use already registered fungicides.[23] In addition to these efforts, in April 2004, USDA met with the American Soyfoods Association of North America to plan efficacy research on chemicals permitted to treat organically grown soybeans and to discuss organic certification of fields treated with conventional chemicals. Furthermore, by August 2005, EPA had established maximum residue levels for the exempted fungicides in time for soybean growers to export their products to foreign markets.

At the November 2005 ASR symposium, EPA announced that it remains receptive to receiving future registration and exemption requests for additional fungicides to treat ASR.[24] According to state officials with whom we spoke, the variety of fungicides available as a result of the exemption process helped reduce the risk that ASR would become resistant to

[23]Several of the pesticides for which emergency exemptions have been granted are under consideration at EPA for registration for use on soybeans. The science and regulatory evaluations on certain of the currently authorized section 18 products and other fungicides proposed by their manufacturer for control of ASR may be completed prior to the expiration date for the emergency exemptions.

[24]In early 2004, USDA met with state and federal officials to begin making plans for exemptions to use fungicides to treat other leguminous crops, such as peas and lima beans, but they did not begin working to develop them with EPA until December 2004. Although EPA also allowed Florida and Tennessee to prepare a joint request for emergency exemptions to use fungicides to treat ASR on other leguminous crops, as of December 31, 2005, no states had been approved for these exemptions.

fungicides and ensured that a supply of fungicides would be available to growers.

In terms of the availability of application equipment and fungicides in 2005, the officials we surveyed in the nine states where ASR was confirmed reported no problems with access to equipment. Although officials in three of these states indicated that their growers did not have access to all fungicide products, none of the states reported that growers encountered any shortages of fungicides to treat their crop. State, EPA, and USDA officials cautioned that actual fungicide inventory and availability depends largely on market forces outside their control. These officials also stated that it is not possible to determine the sufficiency of fungicides and equipment for 2006 because of uncertainties about (1) the timing and potential spread of ASR into northern states, which do not generally apply fungicides on soybeans and therefore may not have supplies and equipment available and (2) the potential need in southern states for growers to use fungicides and equipment for other major crops, such as peanuts, thereby creating a shortage for use on soybeans.

USDA and Other Sponsors Have Supported Research Efforts to Determine the Most Effective Types of Fungicides and Application Methods

USDA began evaluating fungicide efficacy for ASR in 2001,[25] and it supported its own field work in this area from 2003 through 2005 in Africa and South America with funding from private companies and the United Soybean Board.[26] In addition, beginning in 2002, the agency began contacting approximately 20 companies and trade organizations to participate in efficacy trials for the registration of ASR fungicides at several U.S. universities and international locations. Efficacy trials examine the impact fungicides have on factors such as crop yield and disease severity by testing the

- effectiveness of fungicides under various spray conditions, such as volume, pressure, and application frequency;
- effectiveness of fungicides under different crop conditions, such as maturity, row spacing, and plant varieties; and

[25]USDA conducts its research efforts primarily through its Agricultural Research Service.

[26]The United Soybean Board is a marketing and research organization supported by soybean growers through a levy on their sales.

- impact of various application techniques and equipment on such things as coverage and penetration of the crop canopy.

Figure 4 shows the application of fungicides at a trial in 2005.

Figure 4: Spraying at a Fungicide Trial in Colquitt County, Georgia

Source: GAO.

Conducting trials at different locations allows researchers to study the effectiveness of fungicides and application methods in different climates and on different strains of ASR. EPA can use efficacy data from these trials to evaluate fungicides for emergency exemptions. USDA started posting fungicide efficacy data, including some data from private companies,[27] to a USDA research Web site in 2003.[28] According to agency officials, these trials showed that (1) fungicides reduced crop losses, (2) some fungicides were more effective than others, and (3) different fungicides with different active ingredients were necessary to combat ASR because what works best in one region may not be as effective in another. In terms of equipment, the trials showed that better coverage of the plant using higher spray volume is more important for effective spraying than the type of nozzles used. USDA has not taken a position concerning the application of fungicides on soybeans not threatened by ASR, although some private companies have promoted such an approach.[29]

Most recently, in 2005, researchers at southern universities conducted efficacy trials on several fungicides approved by EPA and some fungicides only approved for use in Brazil. Many of these trials were conducted in areas infected with ASR. These trials produced mixed results, but researchers concluded that timing the first spray may be the most critical factor when applying fungicides to treat ASR. Fungicide trials were also conducted in 2005 in 13 northern states where ASR has not yet been confirmed. The researchers conducting these trials focused on questions such as whether fungicides improved soybean yields in the absence of ASR. These trials produced inconsistent data, in part because different protocols—for example, plot management and fungicide application techniques—were followed; and the researchers concluded that uniform protocols should be established for future trials to ensure consistent data collection and interpretation.

Rust-Resistant Soybeans Will Not Be Available to Growers for Several Years

Breeding commercial soybeans with resistance to or tolerance of ASR is generally regarded as the best long-term solution for managing the disease; and USDA, several universities, and private companies are currently working to develop such soybeans. Breeding new varieties of soybeans and making them commercially available takes time—up to 9 years—according to USDA officials. The Agricultural Research Service has approximately

[27]Private companies often only study their own products, or they do not release comparative data to the public.

[28]http://www.ipmcenters.org/NewsAlerts/soybeanrust/efficacy.cfm.

[29]EPA may consider marketing or promotion of an exempted pesticide for uses other than those approved in the emergency exemption to be illegal. 40 C.F.R. § 168.22.

16,000 soybean lines in its soybean germplasm collection.[30] As of June 2005, researchers had finished an initial screening of these lines. Approximately 800 lines were identified as having some form of resistance or tolerance to ASR and are currently being evaluated using more advanced screening tests. Subsets of these 800 lines are also being evaluated in field trials in collaboration with researchers in Africa, Asia, and South America. An intermediate screening of these 800 lines was completed and the results published in a scientific journal in January 2006.[31] Some of these lines are only resistant to a few of the known strains of ASR. USDA researchers hope to eventually find lines that are resistant to all known strains.[32] The United Soybean Board and the Iowa Soybean Association and Promotion Board have provided financial support for this work.

In addition to the sheer volume of germplasm that researchers need to examine, other factors have also contributed to the time taken to identify soybean varieties that are resistant or tolerant to ASR. Before USDA removed ASR from the select agents and toxins list under the Agricultural Bioterrorism Protection Act of 2002 in March 2005,[33] USDA's research in the United States was limited to a few containment facilities. Researchers could not conduct yield loss studies because the available containment facilities did not have enough room to allow soybean plants to reach maturity. The limited space in containment facilities has also slowed USDA's ability to germinate and study foreign strains of ASR (see fig. 5). ASR's arrival in the United States should facilitate USDA's efforts to study the disease because researchers in affected states can now work with ASR and soybean plants under field conditions.

[30]Germplasm is the hereditary material in plant cells.

[31]Miles, M.R.; Frederick, R.D.; and Hartman, G.L., 2006. Evaluation of soybean germplasm for resistance to Phakopsora pachyrhizi. Online. Plant Health Progress doi: 10.1094/PHP-2006-0104-01-RS.

[32]USDA is currently still trying to identify all of the strains of ASR.

[33]70 *Fed. Reg.* 13242 (March 2005).

Figure 5: An Agricultural Research Containment Facility

Source: GAO.

The Agricultural Research Service expects to have soybean germplasm with some level of resistance to ASR within 5 years. It intends to work with industry through cooperative research and development agreements and other mechanisms to provide access to this germplasm so that private companies can develop commercial soybeans with resistance or tolerance to ASR. Commercialization may take an additional 2 to 4 years. According to agency researchers, it is difficult to develop germplasm that is completely resistant to all strains of ASR; and therefore, the most effective approach for developing resistance will be to develop tolerant soybeans to provide growers more time each season to prepare for and manage ASR.

The Agricultural Research Service is also conducting research to examine the genetic variability among the various strains of ASR. The expected outcomes of this project are to identify genes required for the infection process and disease cycle, as well as the discovery of potential targets for new fungicides. Both the Agricultural Research Service and the United

Soybean Board have supported this research, and the agency has also worked with the Department of Energy's Joint Genome Institute.

In April 2005, the Agricultural Research Service issued a *National Strategic Plan for the Coordination and Integration of Soybean Rust Research*. It began to develop this strategic plan at a meeting held in December 2004, 3 weeks after the disease was confirmed in the continental United States. USDA, together with the United Soybean Board and the North Central Soybean Research Program, held a national workshop with more than 90 soybean experts to set priorities, identify strategic goals for ASR research, and develop a national research plan. This plan is linked to the agency's overall strategic plan and coordinated with other USDA agencies. The research plan also promises project review and program assessment by independent peers via annual research progress reports.

Of the research plan's six strategic goals, three aim directly at developing ASR resistance or tolerance:

- develop new, high-yielding germplasm with resistance to soybean rust;
- determine the genetic basis for ASR's virulence and determine the genetic basis for soybeans' resistance to ASR; and
- improve understanding of ASR's biology and epidemiology.[34]

The Agricultural Research Service has since developed a draft of an action plan intended to measure the progress of the research plan initiative.

Conclusion

Effective, timely communication and coordination at the federal, state, and local levels, coupled with favorable weather conditions, were keys to limiting the impact of ASR on U.S. soybean production in 2005. Indeed, in many areas of the country, soybean production exceeded expectations, in part because producers were more attentive to their crop. While the experience in 2005 was favorable, it is unlikely that the fungus will be eliminated. Accordingly, it will still be important for all agricultural stakeholders to remain vigilant and to consistently monitor, test, and report on ASR and to develop models for predicting the spread of the disease.

[34]Epidemiology includes the incidence, distribution, and control of a disease.

Going forward, however, differences in how researchers monitor, test, and report on the disease could detract from the value of future prediction models.

The 2005 ASR experience also highlights the importance of preparing for, coordinating, and monitoring a new agricultural disease. The lessons learned from managing ASR could be valuable in minimizing the effects of other agricultural pests that threaten crops and can cause significant economic losses. In this regard, a clear plan of action and strong leadership in coordinating the actions of all stakeholders was important in 2005 and will continue to be critical to the success of efforts to monitor, report, and manage the spread of ASR in 2006.

Recommendations for Executive Action

We are making two recommendations to the Secretary of Agriculture to ensure continued strong leadership and improved efforts to predict and limit the spread of ASR.

- To ensure reliable, quality reporting on the spread of the disease, USDA should provide additional guidance to state ASR program managers and monitors on the timing and frequency of reporting on the incidence of ASR, the designation of sentinel plots, and when to use advanced diagnostic testing.

- To ensure that ASR continues to receive national priority and the same level of effective coordination and cooperation evidenced in 2005, USDA should develop a detailed action plan, prior to the beginning of the growing season, describing how it will manage ASR in 2006.

Agency Comments and Our Evaluation

We provided a draft of this report to USDA and EPA for their review and comment. In oral comments, EPA told us that the factual information in our draft report is correct and provided technical comments, which we incorporated as appropriate. In written comments, USDA said that the report fairly describes USDA's preparations related to ASR. In addition, it stated that both of the report's recommendations reflect its ongoing cooperative efforts with states to combat the disease (see app. VI). USDA also provided a number of technical comments, which we incorporated as appropriate.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution until 30 days from the report date. At that time, we will send copies of this report to the appropriate committees; the Secretary of Agriculture; the Administrator of EPA; and other interested parties. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you have any questions about this report, please contact me at (202) 512-3841 or bertonid@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. GAO staff who made major contributions to this report are listed in appendix VII.

Sincerely yours,

Daniel Bertoni
Acting Director, Natural Resources
and Environment

Objectives, Scope, and Methodology

To determine the U.S. Department of Agriculture's (USDA) strategy for minimizing the effects of Asian Soybean Rust (ASR) now that the disease has arrived in the continental United States and the lessons learned that could be used to improve future efforts, we interviewed officials from USDA's Animal and Plant Health Inspection Service (APHIS), the Cooperative State Research, Education, and Extension Service (CSREES), the Agricultural Research Service, the Farm Service Agency (FSA), and the Risk Management Agency (RMA) to identify efforts that have been implemented since November 2004. We also surveyed state officials in the 31 soybean-producing states that were included in USDA's sentinel plot program to obtain information on their efforts to minimize the effects of ASR through education, training, surveillance, and testing and to obtain information about the lessons learned during the 2005 crop year. The survey included questions about the states' university extension programs; sentinel plots, monitoring, and scouting; diagnostic screening and testing; fungicide use; and perceptions of USDA's efforts. Prior to implementing our survey, we pretested the questionnaire with several state officials (university extension faculty) in Florida and Alabama. During these pretests, we interviewed the respondents to ensure that (1) the questions were clear and unambiguous, (2) the terms we used were precise, and (3) the survey did not place an undue burden on the staff completing it. The questionnaire was also reviewed by a GAO survey expert. We made changes to the questionnaire based on these pretests. We received responses from all 31 states surveyed. The state information presented in this report is based on information obtained from this survey and interviews with state officials. Appendix II contains the state questionnaire and aggregated responses. We conducted site visits to Alabama, Georgia, and Florida, where we inspected ASR-infected soybeans while touring sentinel plots, a fungicide efficacy trial, diagnostic facilities, and a commercial soybean field with state extension officials. We interviewed university extension faculty and laboratory diagnosticians in these states, as well as in Indiana and Iowa, to gain more in-depth information about their efforts to mitigate the effects of ASR and test for the disease. We also toured USDA diagnostic facilities in Beltsville, Maryland. In addition, we interviewed industry and trade representatives to discuss the adequacy of available fungicides and application equipment. Finally, we attended the November 2005 National Soybean Rust Symposium in Nashville, Tennessee to determine stakeholders' assessment of USDA's efforts.

To determine the progress that USDA, the Environmental Protection Agency (EPA), and others have made in developing, testing, and licensing fungicides to treat ASR and in identifying and breeding ASR-resistant or

-tolerant soybeans, we interviewed officials from EPA and state departments of agriculture to obtain information about their efforts to license fungicides to treat ASR. In addition, we asked about the adequacy of fungicide supplies and equipment when surveying the 31 soybean-producing states that were included in USDA's sentinel plot program. We interviewed Agricultural Research Service personnel as well as researchers from academia and industry and reviewed related reports and studies regarding efforts to research fungicide efficacy and identify and breed ASR-resistant or -tolerant soybeans. We also toured USDA research facilities at Ft. Detrick, Maryland.

We conducted our work between May 2005 and January 2006 in accordance with generally accepted government auditing standards.

Results of GAO's Survey of Soybean-Producing States

GAO
Accountability * Integrity * Reliability
U.S. Government Accountability Office
Washington, DC

Asian Soybean Rust: Soybean-Producing States' Review of 2005 Events and Preparations for 2006

Please coordinate with others at your state's land grant university or in your state's Department of Agriculture to complete this questionnaire.

Questions? **Contact:**

Deborah Ortega (404) 679-1848 ortegad@gao.gov
or
Jim Dishmon (202) 512-9814 dishmonj@gao.gov

Please fax your completed questionnaire to: 202-512-2502 (alternate #: 202-512-2514) by November 14.

For your convenience, the last page of this questionnaire is a fax cover sheet.

Part 1: Extension Programs

Someone knowledgeable about your state's university extension program should answer Questions 1 - 2.

N=31

1. **Do you plan to offer any Asian Soybean Rust (ASR) presentations, programs, or workshops for growers between November 1, 2005, and April 30, 2006?** (*For number, enter 0 if none. If you do not know the exact number, please provide an estimate.)*

Yes **30** → How many? → Number **459** Is this an estimate? Yes **27** No **3**

No **1** → Go to Q3

Uncertain **0** → Go to Q3

N = 30 (Not all respondents answered all parts.)

2a. Which of the following topics will likely be included in upcoming (that is, between November 1, 2005, and April 30, 2006) extension presentations, programs, or workshops on ASR? (*Please check 'Will likely be included' [Column 1] or 'Will likely not be included' [Column 2] for each topic.*)

Topic	*Column 1* Will Likely be Included	*Column 2* Will Likely Not be Included	*Column 3* Three Most Critical to Include
a. Identification of ASR and "look-alike" diseases	29	0	15
b. Types and purposes of fungicides	28	1	10
c. When to apply fungicides	29	0	24
d. Ground and aerial application of fungicides	23	6	3
e. Current ASR tracking and forecasting information	29	1	14
f. Insurance coverage or disaster funding for losses due to ASR	15	13	2
g. Observations and results from 2005, "Lessons Learned"	30	0	19

2b. Which three of the above topics do you consider the most critical to include? (*In Column 3, please check the three topics you consider the most critical to include.*)

Part 2: Sentinel Plots, Monitoring, and Scouting

Someone knowledgeable about your state's sentinel plots and monitoring and scouting programs should answer Questions 3 – 14.

N=31

3. How many USDA-sponsored sentinel plots were in your state in 2005? (Note: If you had plots that were not USDA plots, record them in Question 4.)

Total Number: 331

	Total Number
3a. How many of these plots used only soybeans as the host? (*Enter 0 if none.*)	308
3b. How many of these plots used only other (nonsoybean) plants as hosts? (*Enter 0 if*	10
3c. How many of these plots used both soybeans and other (nonsoybean) plants as hosts? (*Enter 0 if none.*)	13

Rows 3a, 3b, and 3c should add up to the total number above.

N=31

4. How many other sentinel plots (e.g., funded or sponsored by state government, the North Central Soybean Research Program, the United Soybean Board, or by other grants.) were in your state in 2005? (*Enter 0 if none.*)

Total Number: 711

	Total Number
4a. How many of these plots used only soybeans as the host? (*Enter 0 if none.*)	566
4b. How many of these plots used only other (nonsoybean) plants as hosts? (*Enter 0 if none.*)	79
4c. How many of these plots used both soybeans and other (nonsoybean) plants as hosts? (*Enter 0 if none.*)	66

Rows 4a, 4b, and 4c should add up to the total number above.

N=31

5. How often were individual USDA-sponsored sentinel plots typically monitored after the plants reached reproductive stages before ASR was detected and after ASR was detected in your state or a bordering state? (*Please check one in each column. If ASR was not detected in your state or a bordering state, leave the right column blank.*)

	ASR Not Yet Detected or Never Detected	After ASR Detected
a. Daily	0	0
b. Several times a week	1	0
c. Weekly	29	5
d. Bi-weekly	1	2
e. Monthly	0	0

N=27

6. How often were individual other-sponsored[a] sentinel plots typically monitored after the plants reached reproductive stages before ASR was detected and after ASR was detected in your state or a bordering state? (*Please check one in each column. If ASR was not detected in your state or a bordering state, leave the right column blank.*)

	ASR Not Yet Detected or Never Detected	After ASR Detected
a. Daily	0	0
b. Several times a week	1	0
c. Weekly	25	3
d. Bi-weekly	1	0
e. Monthly	0	0

[a]Other-sponsored plots are funded or sponsored by state government, the North Central Soybean Research Program, the United Soybean Board, or by other grants.

N=31

7. How many individuals in your state worked, on a regular basis, as monitors for 2005 sentinel plots funded or sponsored by USDA or other sources? (*Please indicate number of monitors in each category. If none, enter 0.*)

Monitors for Plots Sponsored by USDA or Other Sources	Number of Individuals	Approximate Total Number of Hrs./Wk. Spent Monitoring (Sum)	Check Below if You Don't Know # of Hours
a. Field-based extension or research personnel	29	354	
b. Campus-based extension or research personnel	26	56	
c. Private, independent crop consultants	17	46	
d. State Department of Agriculture personnel	21	18	
e. Agribusiness employees or consultants	19	69	
f. USDA/APHIS personnel	21	11	
g. Owner/operator	18	5	
h. Other(s) (*Please specify below.*)	16	29	

Three states listed other responses, including master gardeners, students, retired extension specialists, and temporary employees.

N=31

8. Is the number of sentinel plot monitors planned for your state in 2006 the same, more, or less than in 2005? (*Please check one.*)

Same as 2005 **18** More than 2005 **5** Less than 2005 **8**

N=31

9. In your opinion, how effective was the sentinel plot monitoring program as an early warning system in your state? (*Please check one.*)

a. Very effective	18
b. Somewhat effective	5
c. Neither effective nor ineffective	1
d. Somewhat ineffective	1
e. Very ineffective	0
f. Not applicable	6

N=30

10. In your opinion, which of the following was the most important benefit of your state's sentinel plot program? (*Please check one.*)

a. Provided an early warning network	21
b. Supported research to quantify spore production	0
c. Provided data for epidemiological studies	3
d. Provided information to guide decisions about fungicide application	6
e. Other (*Please describe below.*)	0

N=31

11. Did any of the following factors limit your state's effectiveness in monitoring sentinel plots? (*Please check 'Limited Effectiveness' or 'Did Not Limit Effectiveness' for each factor.*)

Factors	Limited Effectiveness	Did Not Limit Effectiveness
a. Insufficient funds to cover salaries of monitors	11	20
b. Insufficient funds for travel and travel-related expenses	11	20
c. Insufficient number of qualified personnel available	14	17
d. Lack of mobile diagnostic equipment or inadequate equipment	8	23
e. Inadequate training	4	27
f. Other (*Please specify below.*)	2	4

Two states listed timeliness of receiving funds and another listed the need to hire a plant pathologist to test samples.

N=31

12. Assuming adequate funding, how many sentinel plots are planned in your state for 2006? (*Enter 0 if none.*)

Total Number: **795**[a]

12a. How many of these plots will be USDA-sponsored sentinel plots? (*Enter 0 if none.*) **323**

12b. How many of these plots will be sponsored through other sources[b]**?** (*Please enter 0 if none. If not 0, specify source of funding below.*) **402**

Rows 12a and 12b should add up to the total number above.

[a] Two states representing a total of 70 plots did not separate their plots between 12a and 12b so these amounts do not equal the total amount for question 12.
[b] Other-sponsored plots include plots funded or sponsored by state government, the North Central Soybean Research Program, the United Soybean Board, or by other grants.

N = 31

13. Do you plan to make any major changes in how you will manage your sentinel plots for next year? (*Please check one. If 'Yes,' please explain below.*)

Yes **18** → What changes do you plan to make? (*Please explain below.*)

Various changes are planned, such as planting different maturity groups, hiring additional monitors, changing the monitoring frequency, and examining more samples in the laboratory.

No **13**

N = 31

14. About how often did your state typically update the USDA Soybean Rust Web sites with monitoring data? (*Please check one in each column.*)

	Public Web site	Research (Password Protected) Web site
a. More than once a day	0	0
b. Daily	0	0
c. Several times a week	7	8
d. Weekly	17	20
e. Biweekly	7	2
f. Monthly	0	1

Part 3: Diagnostic Screening

Someone knowledgeable about your state's diagnostic screening for ASR should answer Questions 15 – 23.

N=31

15. From January 1, 2005, through October 31, 2005, how many samples were received by your state's diagnostic lab(s) for ASR research and screening purposes? (*Enter 0 if none.*)

	Total Number
15. Total samples received	12119
15a. How many of these samples were submitted for routine research or monitoring purposes? (*Enter 0 if none.*)	9098
15b. How many of these samples were submitted because of suspected ASR? (*Enter 0 if none.*)	2605
15c. How many samples were submitted for other reasons? (*Please enter 0 if none, or specify reason for submitting below.*)	416

Rows 15a, 15b, and 15c should add up to the total number above.

____
____
____

15d. How many of these samples (total number, above) were positive for ASR? (*Enter 0 if none.*)	877

15e. Of those samples submitted because of suspected ASR (15b, above), how many were screened and/or tested using each of the following procedures? (*Enter 0 if none.*)

	Number Screened and/or Tested
15e-1. Morphological examination only	2202
15e-2. Morphological exam + PCR	195
15e-3. Morphological exam + ELISA	137
15e-4. Morphological exam + PCR + ELISA	71

Rows 15e-1, 15e-2, 15e-3 and 15e-4 should add up to the number of samples in 15b, above.

N=31

16a. Of those samples identified in Question 15b (above), where were the samples collected and what was the host crop? (*Please enter number of samples for each type of host for each location. If none, enter 0.*)

Location Where Screening Samples Were Collected

Host	**Sentinel Plot**	**University Research Field**	**Commercial Field**	**Other**
Soybeans	**1407**	**245**	**729**	**0**
Kudzu	**159**	**0**	**0**	**88**
Other	**4**	**20**	**0**	**36**

16b. If you indicated that samples were screened from 'Other' hosts or at 'Other' locations, please specify host and/or location below.

Ten states listed other hosts, such as cowpeas, clover, snap beans, and lima beans, which were screened in roadside mobile plots and field borders where soybeans are commercially grown.

N=31 (Not all respondents answered all parts.)

17a. How much did your state's diagnostic lab(s) spend on screening and testing samples for ASR from January 1, 2005, through October 31, 2005? In your answer include equipment, supplies (e.g., slides), and salaries. (*Enter 0 if none. If you do not know the exact amount, please provide an estimate.*)

	Dollars	Check if an estimate
17a.	**$465,793**	**27**

17b. Was any of the cost of screening and testing offset by fees charged for testing samples? (*Please check one.*)

			Dollars
Yes	**8**	→ How much was offset?	**$14,583**
No	**22**		

N=31

18. Did your state have sufficient funding to perform diagnostic screening and testing for ASR in 2005? (*Please check one.*)

Yes **25** No **6**

N=31

19. How many laboratory staff, including state laboratory staff, performed diagnostic screening and testing for ASR, on a regular basis, during the 2005 season? (*Please enter number. Enter 0 if none.*)

Number of Staff: **76.5**

N=31

20. Was the number of laboratory staff sufficient to perform diagnostic testing for ASR in 2005? (*Please check one.*)

Yes **28** No **1** Uncertain **2**

N=31

21. Will the number of laboratory staff planned for 2006 be the same as for 2005? (*Please check one.*)

Same as 2005 **24** More than **6** Less than 2005 **1**

N=31

22. Did your state have sufficient laboratory equipment to perform screening and diagnostic testing for ASR in 2005? (*Please check one.*)

Yes **22**

No **9** → What additional equipment was needed? (*Please specify below.*)

Six states listed PCR equipment and other sample testing equipment and supplies, two listed microscopes, and another listed ELISA.

N=30

23. Does your state plan to add laboratory equipment for screening or diagnostic testing for ASR in 2006? (*Please check one.*)

Yes **15** → What additional equipment do you plan to obtain? (*Please specify below.*)

Fifteen states responded, and most listed PCR equipment. Other equipment listed includes microscopes, ELISA plate readers, and test kits for screening purposes.

No **15**

Part 4: Fungicides

Someone knowledgeable about fungicide application in your state should answer Questions 24 - 28.

N=31

24. From January 1, 2005, through October 31, 2005 was ASR confirmed in your state? (*Please check one.*)

Yes [7] No [24]

N=31

25. Did your state's extension service suggest or recommend applying fungicides for ASR? (*Please check one.*)

Yes [5] No [26] → *Go to Question 27.*

N=5

26. Were the suggestion(s) or recommendation(s) for applying fungicides posted on USDA's Soybean Rust Web sites? (*Please check one.*)

Yes [5] No [0]

N=31

27. Were there any problems involving equipment availability for ASR fungicide spraying in your state? (*Please check one.*)

Yes [0] → If Yes, please explain problems with equipment availability. (*Please use the space below.*)

No [26]

Uncertain [5]

N=31

28. Were there any problems involving the <u>availability</u> <u>of</u> <u>fungicides</u> for ASR in your state? (*Please check one.*)

Yes **5** → If Yes, please explain problems with fungicide availability. (*Please use the space below.*)

Three states where ASR was detected in 2005 noted that not all fungicides were available to growers in their states. Another state where ASR was not detected made a similar comment, while another state said that the use of fungicides in the south led to a shortage of fungicides for the wheat crop in the north.

No **22**

Uncertain **4**

Part 5: USDA's 2005 ASR Program

Someone knowledgeable about USDA's efforts to minimize the impact of ASR in 2005 should answer Questions 29 – 33.

N=31

29. In your opinion, how effective were USDA's efforts to minimize the impact of ASR? (*Please check one.*)

a. Very effective	**19**
b. Somewhat effective	**9**
c. Neither effective nor ineffective	**1**
d. Somewhat ineffective	**0**
e. Very ineffective	**0**
f. Uncertain	**2**

N=13

30. If you have any suggestions for improving USDA's ASR program, please briefly explain in the space below.

We received 13 comments regarding suggestions for improving USDA's ASR program. For example, some states commented that increased funding is needed or needs to be provided earlier. Another state noted more suspected ASR samples need to be examined by microscope because of look-alike diseases. One state said that USDA needs to determine and specify what sentinel plot monitoring data is essential for modeling purposes, and those monitoring the plots should adhere to a strict methodology in collecting the data. Another state suggested that the program should be reduced in scope until the economic impact is greater.

N=31

31. In your opinion, how effective was communication between USDA and your state in addressing ASR during 2005? (*Please check one.*)

a. Very effective	22
b. Somewhat effective	8
c. Neither effective nor ineffective	1
d. Somewhat ineffective	0
e. Very ineffective	0
f. Uncertain	0

N=30

32. In your opinion, to what extent were USDA's Soybean Rust Web sites useful to your state? (*Please check one in each column.*)

	Public Web site	Research (Password Protected) Web site
a. Very great extent	10	14
b. Great extent	11	11
c. Moderate extent	7	4
d. Some extent	2	1
e. Little or no extent	0	0

N=12

33. If you have specific suggestions for improving USDA's Soybean Rust Web sites, please note them in the space below.

Twelve states provided comments. Several states suggested technical improvements to USDA's Web site for improved ease of use, and one state suggested that improvements were needed for growers using a dial-up connection to download maps. One state suggested that the USDA Web site should consider using colors other than red and green to aid males who are color blind. One state commented that USDA's public Web site needs more publicity, and another state suggested that land grant universities and extension educators be given more credit on the Web site.

Thank you for taking the time to answer this questionnaire. No questionnaire of this type can cover every relevant topic. If you wish to expand your answer(s) or comment on any other topic related to ASR, please feel free to attach additional pages or to E-mail us.

Our report will be available early next spring. We will notify you when it is issued and provide you with a free copy.

Information About Individuals Completing Questionnaire

Name: ______________________________
Title: ______________________________
Department: ______________________________
Organization: ______________________________
Mailing Address: ______________________________
City, State, Zip: ______________________________
Phone: ______________ Email: ______________

Name: ______________________________
Title: ______________________________
Department: ______________________________
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Title: ______________________________
Department: ______________________________
Organization: ______________________________
Mailing Address: ______________________________
City, State, Zip: ______________________________
Phone: ______________ Email: ______________

2005 Sentinel Plots and Soybean Acreage

State	Soybean acres planted	USDA sentinel plots	Other sentinel plots[a]
Alabama	150,000	10	25
Arkansas	3,030,000	25	37
Delaware	185,000	6	44
Florida	11,000	15	11
Georgia	180,000	10	15
Illinois	9,500,000	10	30
Indiana	5,400,000	9	8
Iowa	10,100,000	10	20
Kansas	2,900,000	10	20
Kentucky	1,260,000	10	37
Louisiana	880,000	15	50
Maryland	480,000	5	28
Michigan	2,000,000	10	20
Minnesota	6,900,000	10	26
Mississippi	1,600,000	24	38
Missouri	5,000,000	16	23
Nebraska	4,700,000	10	38
New Jersey	95,000	5	62
New York	190,000	10	0
North Carolina	1,500,000	10	17
North Dakota	3,000,000	10	16
Ohio	4,500,000	10	35
Oklahoma	320,000	5	0
Pennsylvania	440,000	5	10
South Carolina	430,000	11	0
South Dakota	3,900,000	10	30
Tennessee	1,130,000	25	5
Texas	260,000	5	5
Virginia	530,000	5	51
West Virginia	19,000	5	0
Wisconsin	1,610,000	10	10
Total	**72,200,000**	**331**	**711**

Source: GAO survey of soybean-producing states, USDA acreage data.

[a]Other sentinel plots were funded or sponsored by state government, the North Central Soybean Research Program, or other grants.

Approved Fungicides for Treating Soybeans for ASR

Table 2: Fungicides Approved by EPA for Treating ASR on Soybeans, as of December 31, 2005

Fungicide (Trade name)	Active ingredients	Class of chemicals	Major properties	Type of label	Date first Approved[a]	Date tolerance level approved	Date expires
Quadris	Azoxystrobin	Strobilurin	Preventative	Section 3	4/10/03		
Pristine	Boscalid & Pyraclostrobin	Carboxamide & Strobilurin	Preventative	Section 3	3/16/05		
Bravo Weather Stik	Chlorothalonil	Chloronitrile	Preventative	Section 3	11/8/02		
Echo 720	Chlorothalonil	Chloronitrile	Preventative	Section 3	6/17/03		
Echo 90DF	Chlorothalonil	Chloronitrile	Preventative	Section 3	6/17/03		
EQUUS 720 SST	Chlorothalonil	Chloronitrile	Preventative	Section 3	7/15/04		
EQUUS DF	Chlorothalonil	Chloronitrile	Preventative	Section 3	7/15/04		
Headline	Pyraclostrobin	Strobilurin	Preventative	Section 3	11/30/04		
Tilt	Propiconazole	Triazole	Curative	Section 18	4/23/04	7/27/05	11/10/07
Propimax	Propiconazole	Triazole	Curative	Section 18	4/23/04	7/27/05	11/10/07
Bumper	Propiconazole	Triazole	Curative	Section 18	4/23/04	7/27/05	11/10/07
Folicur 3.6F	Tebuconazole	Triazole	Curative	Section 18	7/20/04	8/4/05	11/10/07
Orius 3.6F	Tebuconazole	Triazole	Curative	Section 18	4/21/05	8/4/05	11/10/07
Uppercut	Tebuconazole	Triazole	Curative	Section 18	6/30/05	8/4/05	11/10/07
Laredo EC	Myclobutanil	Triazole	Curative	Section 18	3/25/04	8/24/05	11/10/07
Laredo EW	Myclobutanil	Triazole	Curative	Section 18	3/25/04	8/24/05	11/10/07
Stratego	Propiconazole & Trifloxystrobin	Triazole & Strobilurin	Curative and preventative	Section 18	12/13/04	6/24/05 7/27/05	11/10/07
Domark 230 ME	Tetraconazole	Triazole	Curative	Section 18	3/2/05	6/1/05	11/10/07
Quilt	Propiconazole & Azoxystrobin	Triazole & Strobilurin	Curative and preventative	Section 18	3/28/05	7/27/05	11/10/07
Headline SBR	Tebuconazole & Pyraclostrobin	Triazole & Strobilurin	Curative and preventative	Section 18	3/28/05	8/4/05	11/10/07

Source: EPA.

[a]For some Section 3 products, this is the date fungicide manufacturers notified EPA that Asian soybean rust was added to the label as a treatable pest.

Table 3: Section 18 Fungicides Approved for ASR and States Where Approved, as of December 31, 2005

<table>
<tr><th>Fungicide</th><th>States with approved Section 18 requests</th></tr>
<tr><td>Tilt</td><td rowspan="3">AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
<tr><td>Propimax</td></tr>
<tr><td>Bumper</td></tr>
<tr><td>Folicur 3.6F</td><td>AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
<tr><td>Orius 3.6F</td><td>AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV</td></tr>
<tr><td>Uppercut</td><td>AR, DE, IA, IL, IN, KY, MD, MN, MO, MS, NC, NE, OH, SC, TN, VA</td></tr>
<tr><td>Laredo EC</td><td rowspan="2">AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ , NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
<tr><td>Laredo EW</td></tr>
<tr><td>Stratego</td><td>AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TX, VA, TN, VT, WV, WI</td></tr>
<tr><td>Domark 230 ME</td><td>AL, AR, DE, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
<tr><td>Quilt</td><td>AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
<tr><td>Headline SBR</td><td>AL, AR, CO, DE, FL, GA, IA, IL, IN, KS, KY, LA, MD, MI, MN, MO, MS, NC, ND, NE, NJ, NY, OH, OK, PA, SC, SD, TN, TX, VA, VT, WV, WI</td></tr>
</table>

Source: EPA.

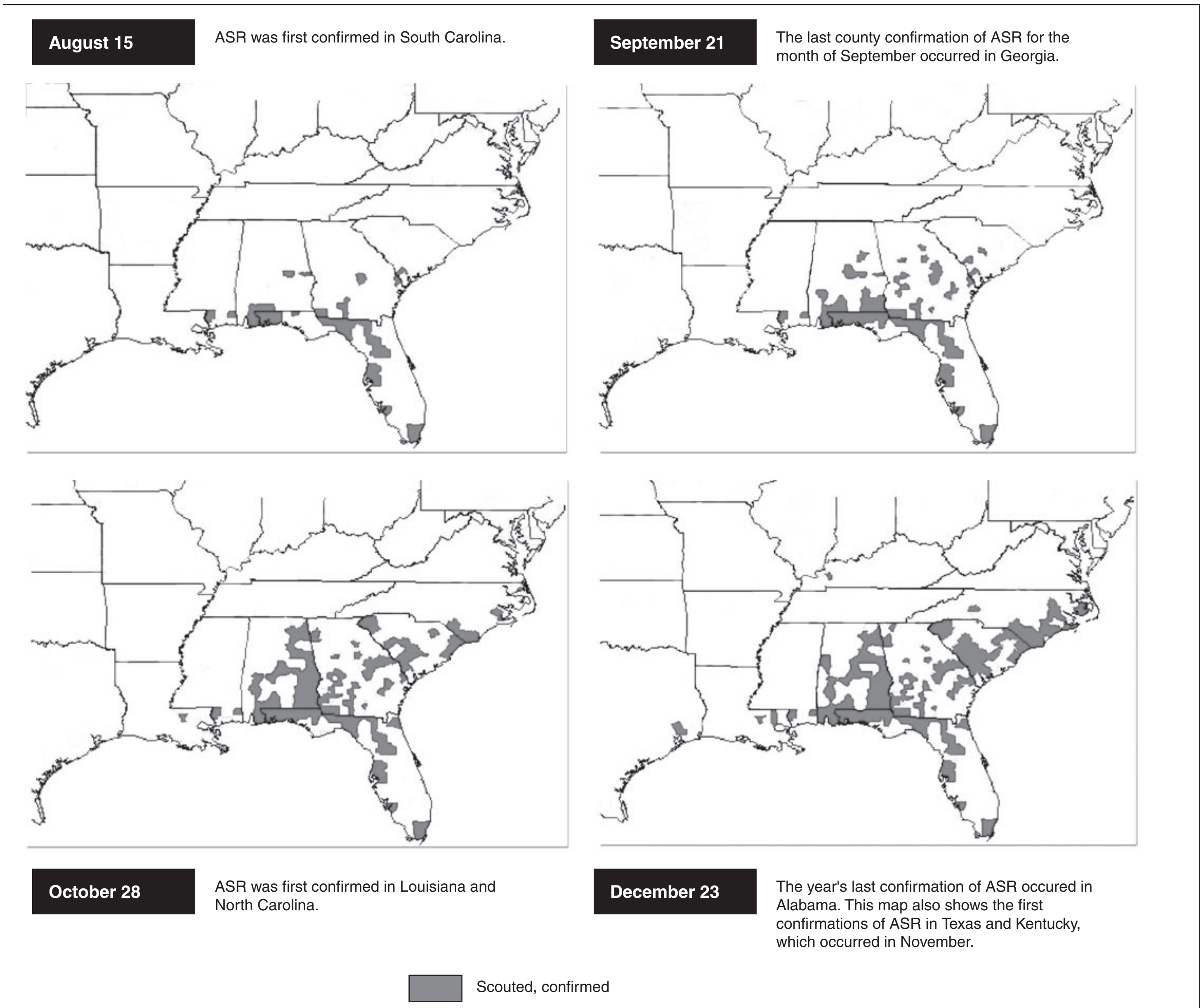
Progression of ASR during the 2005 Growing Season

February 24 The year's first confirmation of ASR occurred in Florida.

April 27 ASR was first confirmed in Georgia.

June 30 ASR was first confirmed in Alabama.

July 18 ASR was first confirmed in Mississippi.



Source: GAO based on USDA information.

Comments from the U.S. Department of Agriculture

USDA

United States Department of Agriculture

Office of the Secretary
Washington, D.C. 20250

FEB 15 2006

Mr. Dan Bertoni
Acting Director
Natural Resources and Environment
United States Government Accountability Office
Washington, D.C. 20548

Dear Mr. Bertoni:

The U.S. Department of Agriculture (USDA) has reviewed the Government Accountability Office's (GAO) draft report, "Agriculture Production: USDA Needs to Build on 2005 Experience to Minimize the Effects of Asian Soybean Rust in the Future" (GAO-06-337). We appreciate the opportunity to review this document and are developing ways to address its recommendations.

We have found that the report fairly describes USDA's preparations related to ASR and that both of the report's recommendations reflect our ongoing cooperative efforts with various States to combat this disease. We will continue to provide additional guidance to our State cooperators to facilitate the collection of the best possible monitoring information during 2006. We also agree that our continued actions will be best served through the detailed transition plan that is currently under development with our State cooperators to further ensure strong leadership in predicting and limiting the spread of ASR. To these ends, we provide the following comments and observations based on our review of the draft document provided to USDA.

In its report, GAO appropriately recognizes that multiple USDA agencies and offices have been working to prepare for the onset of ASR. These agencies include the Agricultural Marketing Service; the Agricultural Research Service; the Animal and Plant Health Inspection Service; the Cooperative State Research, Education, and Extension Service; the Foreign Agricultural Service; the Farm Service Agency; the Economic Research Service; the Natural Resources Conservation Service; the Office of Communications; the Office of Homeland Security; the Office of Pest Management Policy; and the Risk Management Agency.

Research to identify the virulence of *P. pachyrhizi* as well as potential crop resistance has been conducted by the Agricultural Research Service since the 1980's. Since 2002, the other agencies listed above have also been actively working to initially exclude the disease organism, to prepare for its eventual arrival by training field personnel around the country to recognize the disease, and to plan for a national response once ASR was discovered in the continental United States.

Mr. Dan Bertoni
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A central theme of the GAO report is a focus on the lack of uniformity in the responses provided by each of the approximately 30 States cooperating in the ASR response. During 2005, specific guidance was provided in the mechanism for collecting and reporting observations from the sentinel plot system. Once the initial detection was confirmed by USDA, States did exercise latitude in their implementation of diagnostic techniques and in their frequency of providing management information for entry into the system.

GAO correctly reports that States varied in their level of response (e.g. frequency of reporting), but those States in which the disease was found provided information on a timely basis to inform the State specialists and the USDA data collection/modeling system. As the principal information collected from sentinel plots is the presence or absence of ASR at any given point during the season, there is always a tradeoff between the frequency of making observations and the cost of conducting an individual trial.

It is the position of USDA that most States did provide information in a timely and accurate fashion. For example, States reported their observations based on the (a) growth stage and (b) potential susceptibility of host plants based on their proximity to known areas of ASR infection. Six States (i.e. Colorado, Iowa, Missouri, Ohio, Washington, and Wisconsin) reported fewer than seven times during the season. States that reported several times weekly were much closer to or actually comprised the infected areas (e.g. Alabama, Florida, Georgia, Mississippi, and South Carolina). Lessons learned from the diversity of these individual responses will be considered carefully during the implementation of the 2006 sentinel plot program.

Training on the visual detection of ASR was provided to more than 15,000 individuals prior to the 2005 growing season. To a trained diagnostician, visual identification of ASR in the field can be quite straightforward if the pathogen is sporulating, but USDA also implemented standardized procedures to confirm first-find diagnoses in 2005—including microscopic examination and testing using the validated real-time polymerase chain reaction test.

Additional molecular and biochemical identification techniques were available, and State diagnosticians had latitude to determine the techniques they believed were appropriate to use in processing samples from sentinel plots and producers' fields during 2005. Guidelines for diagnostic labs regarding screening procedures are being refined based on USDA's experience in 2005 and as new technologies become available that may allow earlier detection of infection (e.g. before sporulation). We would like to note, however, that the use of different diagnostic techniques by various States is not a shortcoming; rather, it reflects flexibility in providing a local response subject to availability of resources and skilled personnel as well as the volume of samples that a diagnostic facility may anticipate. USDA is working with the National Plant Diagnostic Network in modifying standard operating procedures based on experience gained during the 2005 season.

With regard to the modeling employed by USDA to predict the movement of ASR, these models integrate weather data, disease incidence reports, crop growth stage, and plant disease

Mr. Dan Bertoni
Page 3

development information in order to derive estimates of where the disease may emerge. Much experience gained from other plant disease modeling has been incorporated into the techniques utilized by USDA to anticipate movement of ASR. The availability and use of other models, supported or developed in part by funding from USDA, is viewed as an asset in providing predictive information to the ASR specialists.

With guidance from its Risk Management Agency, USDA has placed increased emphasis on good farming practices for combating ASR and has posted management information on the USDA website. In combating ASR, soybean growers are required to carry out good farming practices in order to receive crop insurance indemnities that may result from soybean rust. The guidance provided through the website by State and local Cooperative Extension System personnel was based on local ASR observations through the monitoring effort. This interaction between State and Federal authorities and local soybean growers reduced fungicide inputs, increased the effectiveness of preventative and curative fungicide applications, and provided growers with documentation necessary to prove their use of good farming practices.

Since May 2005, efforts have been underway at USDA to provide the framework for the ASR response in 2006. The State and Federal cooperative framework established in response to ASR will continue, with the notable change that funding for the State sentinel plot program will be provided through the Southern Regional Integrated Pest Management Center at North Carolina State University rather than directly from USDA's Animal and Plant Health Inspection Service. A written plan outlining the elements of this program has been developed and is being finalized in conjunction with the States that are cooperating in the 2006 ASR response. As the establishment and management of the plots previously has been conducted primarily through the land-grant universities in most of the affected States, USDA's Cooperative State Research, Education, and Extension Service will oversee the ASR response in 2006. This change is not intended to alter the USDA commitment to a national ASR response; rather, it more accurately reflects the coordinated management and funding mechanisms to be employed in 2006.

Again, I appreciate the opportunity to comment on the draft report. The document is informative and thorough, and I hope that our observations prove useful in helping others to better understand USDA's role in combating ASR.

Sincerely,

Mike Johanns
Secretary

GAO Contacts and Staff Acknowledgments

GAO Contacts

Daniel Bertoni (202) 512-3841 or bertonid@gao.gov

Staff Acknowledgments

In addition to the contact named above, Ronald E. Maxon, Jr., Assistant Director; James L. Dishmon, Jr.; Chad M. Gorman; Lynn M. Musser; Deborah S. Ortega; Paul J. Pansini; Carol Herrnstadt Shulman; and Amy E. Webbink made key contributions to this report.

Related GAO Products

Agriculture Production: USDA's Preparation for Asian Soybean Rust. GAO-05-668R. Washington, D.C.: May 17, 2005.

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