Crop Production
FY 2001 National Program Annual Report

Introduction

The goal of the Crop Production National Program is to develop technologies for sustainable crop production that are applicable to small, medium, and large-sized farms in a variety of production systems. Program outcomes ensure and promote the use of sustainable agricultural production systems, as well as organic farming systems. Research includes, but is not limited to models and decision aids, integrated pest management of multiple pests in a holistic approach, sustainable cropping systems, economic evaluation, automation and mechanization to improve labor productivity, application technology for agrochemicals and bioproducts, sensor and sensing technology, controlled environmental production systems, and worker safety and ergonomics. The program also focuses on all aspects of bees as efficient pollinators and honey producers, as well as their protection and management.

In FY 2001, a comprehensive Action Plan for the Crop Protection National Program was completed and published on the ARS National Program website. To help in formulating the Action Plan, two workshops were held to solicit customer input pertaining to needs for ARS research in the crop production area. The first was held on November 19-20, 1999, in Beltsville, Maryland, to solicit customer input on research issues for the Bees and Pollination Component of the Crop Production National Program. Customers and stakeholders from national, regional, and state beekeeping organizations, State departments of agriculture, pesticide companies, university scientists and extension personnel, individual beekeepers including producers and users of other than *Apis* (honey bee) pollinators, and others involved in agribusiness met to provide input to ARS concerning their needs and concerns. The second workshop was held on October 30-November 2, 2000, in San Diego, California, to obtain customer input on all aspects of crop production, over and beyond bees and pollination.

Writing teams for each National Program Action Plan components, which were composed of ARS scientists and members of the ARS National Program Staff, were subsequently formed. The first function of each team was to identify problem area topics for inclusion in the Action Plan. Writing teams and individual writers used input from the workshops, their own knowledge of the subject matter, and input from other ARS scientists and cooperators to identify research goals and activities to develop the Action Plan for the Crop Production National Program.

Selected Accomplishments by Component

Component I: Integrated Production Systems

For better strawberries, grow them over red mulch. Strawberries grown on red plastic mulch are sweeter and more flavorful than conventionally grown berries. ARS scientists at the Coastal Plain Soil, Water and Plant Conservation Research Unit, Florence, South Carolina, and at the Fruit Laboratory in Beltsville, Maryland, grew strawberries on raised beds covered with red plastic mulch. By using a specially formulated red plastic, the scientists were able to keep the water-conservation benefits attributed to black plastic mulch, yet alter the amounts of far-red and red light reaching developing berries. That light, reflected from the red mulch on the soil surface, acted through the plants' natural growth-regulating system to influence the size and flavor of developing berries. Plastic mulches--most often black--are frequently used in raised-bed culture to conserve water, control weeds with less herbicide, keep fruit clean and produce ripe berries earlier in the season.

Vegetative mulch reduces pesticide and soil losses in runoff. As a mulch in vegetable production, the cover crop hairy vetch greatly reduces pesticide runoff and soil erosion, making it an excellent alternative to plastic mulch often used by vegetable growers. Vegetable growers now often use plastic (polyethylene) mulch to maintain soil moisture and control weeds. When it rains, however, the plastic increases surface runoff because 50-75 percent of the field is covered with plastic that will not allow rain to penetrate into the soil. The runoff contains eroded soil and agricultural chemicals that may have potential harmful effects on organisms in nearby streams and rivers. In a 3-year collaborative study, ARS scientists at the Soil and Water Management Research Unit in St. Paul, Minnesota, working with ARS scientists at the Environmental Quality Laboratory and the Sustainable Agricultural Systems Laboratory in Beltsville, Maryland, have developed a more sustainable vegetable production system that uses hairy vetch, a vegetative mulch. The scientists have demonstrated that hairy vetch is economical and can effectively control weeds. The study compared runoff and soil erosion from field plots using vegetative and plastic mulch. Fields with plastic mulch lost two to four times more water and up to 10 times more sediment than the plots using hairy vetch mulch.

Component II: Agroengineering, Agrochemical, and Related Technology

Pressure changes in spraying systems damage biological pesticides. Application systems are needed to improve performance of biological pest control agents. ARS engineers and scientists at the Application Technology Research Unit in Wooster, Ohio, when studying effects of nozzles, pumps, screens, and bypass agitation on live biopesticides, found that sudden fluid pressure changes at low flow rates could damage entomopathogenic nematodes. These findings could lead to the development of spraying systems for more effective application of biopesticides.

ARS research yields improved understanding of orchard sprayers. Data on forces and motions imposed on trees by large air-assist sprayers, which could improve pesticide application efficiency, is limited and variable. ARS engineers at the Application Technology Research Unit in Wooster, Ohio, used a unique transducer to more precisely measure forces and bending effects applied to a dwarf apple tree by a multiple, cross-flow fan orchard air sprayer and found statistically significant differences associated with sprayer operating conditions. This better understanding of air-assist sprayer technology could lead to improved spray coverage and reduced spray drift loss.

Effectiveness of combining remotely sensed images with pest-scouting data to develop variable insecticide prescription to better control the tarnished plant bug. Cotton producers spend $75 million annually to control the tarnished plant bug. A new system using multispectral imagery to draw a correlation between plant vigor and pest density has been developed by ARS scientists at the Crop Science Research Laboratory in Mississippi State, Mississippi. It relies on a digital camera, sensitive to different wavelengths of light. Mounted in an aircraft that flies over cotton fields at various altitudes, the camera records images that can be processed to display variations in plant vigor. The scientists have found that plant bugs are more common in areas with more vigorous plants. The combination system is not only better at locating a variety of pests, but also gives growers a more cost effective method of controlling the pests by improving the placement and timing of pesticide applications. Rather than spray an entire field at one rate, this system allows growers to vary their coverage. Unsprayed areas can act as safe havens for a variety of beneficial insects, which can then repopulate the field after spraying. This all translates into less chemical usage.

New peanut planting system to boost yields. Higher yields could be in store for peanut farmers, thanks to a new planter and planting pattern engineered by ARS scientists at the National Peanut Research Laboratory, Dawson, Georgia. For 72-inch-wide raised beds, runner-type peanut cultivars are normally seeded at a rate of six seeds per foot in pairs of either single or twin (double) rows. ARS scientists recommend staggering the seeds in an offset or diamond-shaped pattern that accommodates up to 12 rows on each bed. Data from fall 2001 harvests suggest the method promotes higher yields than either single- or twin-row patterns by reducing the plants' competition for sunlight, water and nutrients. Spacing the plants in a uniform, staggered manner also promotes thicker, faster-spreading canopies that help keep the soil bed cool, moist, and better protected from erosion. In field plots, beds planted with diamond rows had 34 percent fewer weeds than beds with twin rows.

Ginned cotton poses no threat when shipped to boll weevil-free areas. Boll weevils have been eradicated from part of the United States, and keeping the boll weevils from coming back is an important goal. When cotton infested with boll weevils is ginned, baled, and shipped into an eradicated zone, are the boll weevils all dead? ARS scientists at the Cotton Production and Processing Research Unit in Lubbock, Texas, in cooperation with Texas A & M, undertook to answer this important question in 2000 and 2001. The answer is now clear: ginning kills all boll weevils, making the cotton safe for shipment without further treatment. Based on this finding, the cotton industry has asked countries that import U.S. cotton to waive fumigation requirements for boll weevils. In 2001, Peru became the first country to do so for the100,000 bales of U.S. cotton that it imports per year. The cost savings at $7 per bale amount to $700,000 per year. Many other countries are expected to take the same action in the near future.

Component III: Bees and Pollination

Researchers better understand how parasitic mites like Varroa interact with their bee hosts. Varroa mites feed on the blood of adult and developing young bees. Parasitized bees may have deformed wings and abdomens and a shorter life span than their unparasitized hivemates. Because LT-SEM freezes and captures the Varroa mites on bees at the moment they are parasitizing them, a team of ARS scientists at the Bee Research Laboratory in Beltsville, Maryland, has discovered some intriguing behavioral and morphological patterns. A state-of-the-art scanning electron microscope mounting technique that uses low temperature (LT-SEM) has shown that Varroa mites may be camouflaging themselves by aligning their setae (tiny hairs) with the hairs on the bee's body. By doing this, they may escape detection when the bee grooms itself or is groomed by another. If this hypothesis is correct, it may be possible to breed bees that more easily detect mites and aid their removal from their bodies. LT-SEM technology provides an exciting new tool that will be used to reveal the exact types and behavior of mites. It is already providing valuable new information that could be used to control mites as agricultural pests or to enhance their efficacy as biological control agents.

Antibiotics for American foulbrood control. The bacterium that causes American foulbrood disease is currently controlled by the terramycin antibiotic, the only antibiotic registered for control of this disease. The bacterium, however, is showing resistance to terramycin in areas of the United States, and American foulbrood is again threatening a bee industry already weakened by low honey prices and the attack of invasive mites, as well as the small hive beetle. ARS scientists at the Bee Research Laboratory in Beltsville, Maryland, and at the Beneficial Insects Research Unit, Weslaco, Texas, demonstrated that the antibiotics lincomycin and tylosin are non-toxic to immature and adult honey bees and effective in controlling American foulbrood disease. Once registered, these antibiotics will provide an effective alternative antibiotic to control American foulbrood by beekeepers.

Honey bees from Russia are mite resistant and have winter hardiness. The most important pests of honey bees in the United States are the Varroa mite and the tracheal mite; bees are also lost due to severe winters. ARS scientists at the Honey Bee Breeding, Genetics, and Physiology Research Unit in Baton Rouge, Louisiana, have now imported and demonstrated that the Russian honey bees are resistant to both mites, are winter hardy, and are effective pollinators. A method also was developed to insert useful genes from the Russian bees into U.S. strains of the honey bee in order to preserve genetic diversity in the U.S. honey bee population.

New tool for battling Varroa mite offered to beekeepers. The Varroa mite, *Varroa jacobsoni*, is regarded as the single worst pest of honey bees in the United States. Beekeepers can now get help from their computers when the varroa mite shows up in their hives. New software called "VarroaPop"--short for "varroa populations"--gives U.S.

beekeepers a science-based estimate of how fast the mite population in a beehive, or colony, might grow. The software was developed by ARS scientists at the Honey Bee Research Unit in Tucson, Arizona, in collaboration with the University of Arizona at Tucson. Beekeepers can use the computer-generated estimates in deciding whether to spend money to treat hives with miticides. VarroaPop also helps them decide whether weak, underpopulated hives are doomed--and best discarded--or whether a better option would be to combine the struggling hives with larger, stronger colonies that might be able to withstand mite attack. Available for downloading from the Internet, VarroaPop is the first publicly available software program that beekeepers can use to predict the mite's impact and to manage their hives accordingly. Scientists are updating VarroaPop to incorporate suggestions from some of the more than 300 beekeepers and others who have already downloaded and tested the software. VarroaPop is available at: http://gears.tucson.ars.ag.gov.