

Agricultural Research Service • National Program 305 • Crop Production  
FY 2017 Annual Report

# USDA



The Crop Production National Program (NP 305) supports research to develop knowledge, strategies, systems, and technologies that contribute to greater cropping efficiency, productivity, quality, marketability, and protection of annual, perennial, greenhouse, and nursery crops, while increasing environmental quality and worker safety.

The Nation's rural economic vitality depends on the ability of growers to profitably produce and market agricultural products including food, fiber, flowers, industrial products, feed, and fuels, while enhancing the natural resource base of crop production. Future financial success depends on increasing productivity, accessing new markets for specialized products, developing technologies to provide new opportunities for U.S. farmers, and utilizing tools and information to mitigate risks and enable rapid adjustments to changing market conditions. The farm sector has great and varied needs driven by a wide variety of resource, climatic, economic, and social factors that require an equally diverse array of solutions.

Contemporary cropping enterprises are complex and depend on highly integrated management components that address crop production and protection, resource management, mechanization, and automation. U.S. annual, perennial, and greenhouse (protected systems) crop production are based on the successful integration of these components. The development of successful new production systems requires a focus on new and traditional crops; the availability and implementation of improved models and decision aids; cropping systems that are profitable and productive; production methods fostering conservation of natural resources; efficient and effective integrated control strategies for multiple pests; improved methods, principles, and systems for irrigation; improved mechanization; and reduced inputs – all while sustaining or increasing yield and quality.

Production systems must better address the needs of small, intermediate, and large farming enterprises including those using field-, greenhouse-, orchard-, and vineyard-based production platforms with conventional, organic, or controlled environment strategies. Additionally, adaptation and development of technologies are required to ensure a sustainable and profitable environment for production agriculture. New technologies must address the need for lower cost, higher efficiency inputs that foster conservation of energy and natural resources, while maintaining profitability and promoting environmental sustainability.

In addition, declining bee populations and honey production require special attention. Over the past several years, a myriad of pests and potentially adverse cultural and pest management practices have been threatening many of the bee species required for pollination of multitudinous crops. Colony Collapse Disorder had increased honey bee (*Apis*) over-wintering mortality to over 30 percent; and while CCD incidence has declined, bee mortality still remains unsustainably high. Also, as new crops or niches are introduced, there is an increasing need for non-honey bee pollinators for specific crops or protected environments.

National Program 305 coordinates and collaborates extensively with other ARS National Programs, universities, and industries in adapting and incorporating technologies, approaches, and strategies that enable the advancement of the Nation's agricultural industry and enhanced international competitiveness.

This National Program is divided into two main research components:

- **Component 1: Integrated Sustainable Crop Production Systems**
- **Component 2: Bees and Pollination**

Below are National Program 305 accomplishments from fiscal year 2017, grouped by research component. This report is not intended to be a progress report describing all ongoing research, but rather an overview that highlights accomplishments, some of which are based on multiple years of research (not all research projects will reach an “accomplishment” endpoint each year).

ARS welcomes your input regarding our ongoing research programs. If you have any questions, please do not hesitate to contact the National Program 305 team, Kevin Hackett ([Kevin.Hackett@ars.usda.gov](mailto:Kevin.Hackett@ars.usda.gov)), Rosalind James ([Rosalind.James@ars.usda.gov](mailto:Rosalind.James@ars.usda.gov)) and Joe Munyaneza ([Joseph.Munyaneza@ars.usda.gov](mailto:Joseph.Munyaneza@ars.usda.gov)).

## Component 1 – Integrated Sustainable Crop Production Systems

**Optimum production systems for two new alternative oilseed crops.** ARS research was critical in domestication and establishment of *Camelina* and pennycress (*Thlaspi* spp.) as new oilseed crops, though sound agricultural management practices are critical to the success of farmers growing them. Although ARS has published information on effective crop production systems that include these crops, optimum seeding methods for best stand establishments have not been determined. Therefore, ARS researchers in Morris, Minnesota, developed better methods for timing and planting both crops that can lead to improved plant establishment, and potentially higher seed and oil yields. Much of the research information developed on *Camelina*, including using winter varieties in dual cropping systems, was summarized in an ARS-produced growers guide, and published in two different review articles in collaboration with universities. In addition to providing new alternative crops for growers, this work offers producers a way to teach themselves how to grow *Camelina* and pennycress for maximum economic benefit.

**Validation of intelligent sprayer for managing pests in nurseries.** Conducting on-farm evaluations of pest control and determining its economic feasibility is a necessary procedure to assure successful adoption of new spray technologies by commercial horticulture enterprises. ARS researchers in Wooster, Ohio, developed and tested in three commercial nurseries in Ohio and Oregon a new intelligent sprayer that targets insect pests. Variable rates from the intelligent sprayer were achieved automatically based on the plant presence, canopy structure, and foliage density. Efficacy of the sprayer for pest control treatments was compared with two types of conventional air-assisted sprayers. **Insect control with the intelligent sprayer was as effective as that of** conventional sprayers. However, the intelligent sprayer used 30 to 78 percent less spray volume (and thus fewer chemicals) to control pest insects, thereby offering an economically and environmentally responsible spray system to controlling pests.

**Water-saving strategies developed for highbush blueberries.** Many blueberry growers are facing serious water limitations due to warmer and drier weather conditions, greater scrutiny of water used for agricultural purposes, and greater demand by other sectors. To stay profitable under these conditions, blueberry growers need to use less water to grow blueberries. ARS scientists in Corvallis, Oregon, evaluated the potential of using water-saving management strategies, including deficit irrigation, early and late-season irrigation cut-offs, and crop thinning, to maintain yield and fruit quality with less water in northern highbush blueberry. Fruit production was unaffected by deficit irrigation and, by the second year, was actually greater with crop thinning than with no thinning in the early cutoff treatment. Late cutoffs, on the other hand, reduced yield, but increased several fruit quality characteristics, including

firmness, storability, and sugar content of the berries. Compared with using full irrigation, deficit irrigation saved nearly 270,000 gallons per acre of water per year, whereas early and late-season irrigation cutoffs saved approximately 140,000 and 250,000 gallons per acre of water per year, respectively.

**Small fruit production in containers with soil-less substrates.** There are many geographical and environmental conditions that prevent the traditional production of crops in soil. Soils of vacated urban areas may contain industrial pollutants, and soils of some regions in the U.S. have unsuitable mineralogical properties for crop production. ARS researchers in Wooster, Ohio, collaborated with Ohio State University scientists to develop cultural practices for growing small fruit crops, including blueberries, raspberries, and blackberries, in large containers filled with a soil-less pine bark substrate. Fertilizer and irrigation requirements were refined to optimize growth of these crops in the substrate. Based on these findings, rural and urban farmers can produce harvestable fruit crops in areas where regional soil properties had once prevented their adoption.

**Increasing soil health in California vineyards.** Cover crops in vineyards help to prevent soil erosion and increase soil structure for the benefit of grape vines. However, the long term impact of no till management strategies is hard to predict without long term studies. Therefore, ARS researchers in Davis, California, compared two treatments over 20 years that measured soil health in the vineyard floor. In one treatment the cover crop was tilled once annually and in the other treatment the permanent cover crop was maintained without tillage. No tillage at all led to greater increases in microbial biomass and biological activity, total soil carbon content and specific pools representing stable organic carbon that contribute to soil carbon storage for mitigation of greenhouse gas emissions. Soil aggregate stability was greater in the no-till, permanent cover crop treatment, indicating these soils possess greater resistance to degradation from erosion caused by runoff and precipitation. These findings show that even a single tillage pass per year can diminish soil structure and organic matter. Thus, adopting no-till practices in California vineyards will preserve soil health, improve soil nutrient availability, and reduce fossil fuel use incurred due to use of tractors for tillage.

**Fertilizer potassium can increase cane and sugar yields in Louisiana sugarcane.** For many sugarcane producers in Louisiana, nitrogen is the only fertilizer that is routinely applied to their crop in the spring because of the high cost of potassium and phosphorus fertilizers. ARS scientists in Houma, Louisiana, have previously demonstrated that phosphorus is not needed for sugarcane in Louisiana, but possible beneficial effects of potassium fertilizer have not recently been studied. A series of experiments was conducted on light (silt loams) and heavy soils (silty clay loams and clays) on plant-cane and stubble fields of two of the major Louisiana sugarcane cultivars to study the effects of potassium fertilizer on sugarcane yields. Results from these studies demonstrate that increases in both cane and sugar yields can be achieved with potassium fertilizer application in both plant-cane and ratoon fields in both light and heavy soils. Louisiana sugarcane producers that have eliminated potassium from their soil fertility programs may experience decreases in their cane and sugar yields as potassium levels fall to limiting levels.

**Spotted Wing Drosophila controlled with an artificial sweetener.** Spotted wing drosophila (SWD) is a major global insect pest of berry crops. Currently, there are no effective natural enemies or insecticides to control this fly, especially under organic berry production. ARS researchers in Poplarville, Mississippi, discovered that food grade meso-erythritol, an artificial sweetener in Truvia®, is a potent organic insecticide that kills 75 – 99 percent of adult and larval SWD under field and lab conditions. ARS researchers have been approached by the Manager of the Biopesticide and Organic Support Program Interregional Research (IR)-4 Project at Rutgers University, Director of Business Strategy with Biologic Insecticide Inc., and berry producers in Georgia, Texas, Michigan, Wisconsin, and Ohio to aid in testing and development of this product.

**Use of unmanned aerial vehicle for remote sensing of crop fields.** Unmanned aerial vehicle (UAV) remote sensing significantly helps to improve crop field monitoring for precision agriculture with low cost, flexibility and high-resolution data. ARS researchers in Stoneville, Mississippi, have developed digital color, multispectral, and thermal imaging systems to be mounted on small UAVs. The applications of these systems have included assessment of soybean injury from dicamba spray, soybean and cotton plant height estimation, and cotton yield estimation. These UAV systems could cover any field on the research farm quickly and provide the images with a spatial resolution of a few centimeters. In addition, the researchers used UAVs to detect naturally grown glyphosate-resistant (GR) and glyphosate-susceptible (GS) weeds in soybean fields with digital color and multispectral cameras at very low altitude of 10 meters. The main goal of this research is transfer of the previous greenhouse and field research results to regular crop fields to be able to detect naturally grown GR and GS weeds for site-specific weed management maps. This project is a collaboration with the Geosystems Research Institute, Mississippi State University, and funded by Mississippi Soybean Promotion Board.

**Should we consume food or dietary supplements to obtain dietary anthocyanins?** Nutraceutical manufacturers offer a vast array of small fruit-based supplement products because of their potential health benefits. However, it is difficult to know if the products are beneficial because the health benefits accrue over long term use. Therefore, an ARS scientist in Parma, Idaho, tested dietary supplements and found that over 20 percent of the Rosaceae (strawberry, cherry, blackberry, red raspberry, and black raspberry) dietary supplements evaluated contained no detectable anthocyanins, or had unlabeled anthocyanins, despite packaging labels promising specific sources of anthocyanins. Anthocyanin concentrations between the dietary supplements and food products were not significantly different in mg per serving. Individual anthocyanin profiles can be used to evaluate quality of Rosaceae food products and dietary supplements. Systems to improve Rosaceae dietary supplements' quality are needed, from source material to final products.

**Early identification of cotton fields using mosaicked aerial multispectral imagery.** Early identification of cotton fields is important for advancing boll weevil eradication progress and reducing the risk of re-infestation. Remote sensing has long been used for crop identification, but limited work has been reported on early identification of cotton fields. ARS scientists in College Station, Texas, evaluated aerial imagery for identifying cotton fields before cotton plants start to bloom. Aerial color and near-infrared images taken over an 8 km by 12 km cropping area were mosaicked and then classified into different crops and cover types using image classification techniques. Results showed that classification maps were able to correctly identify over 90 percent of the cotton areas. The methodologies presented in this study will be useful for boll weevil eradication program managers to quickly and efficiently identify cotton fields at relatively early growth stages using mosaicked aerial imagery.

## Component 2 – Bees and Pollination

**Honey bee spermatozoa cryopreserved.** The lack of reliable sperm cryopreservation is a key roadblock to the development of a comprehensive and integrated honey bee breeding program. To address this problem, ARS researchers in Fargo, North Dakota, in collaboration with ARS scientists in Baton Rouge, Louisiana, and the ARS National Bee Gene Bank Program in Fort Collins, Colorado, have developed a better method to cryopreserve honey bee spermatozoa, including development of the Fargo Honey Bee Extender Medium. This medium not only improves sperm quality after cryopreservation, but allows for semen shipment at room temperature before and after storage, potentially improving the accessibility of cryopreserved samples for bee breeding programs worldwide.

**Insecticide sensitivity in honey bees is affected by genetic background and age of bees.** Increased attention on the potential harm of agricultural insecticides to honey bees has led to increased scrutiny on methods of how insecticides are tested on bees. ARS researchers in Baton Rouge, Louisiana, found that responses to common insecticides are affected by the genetic background and the age of the commercial stocks of bees being tested. The results can be used to help in risk assessments of different genetic types. The researchers established baseline information for future assessments and suggest that standardizing testing protocols would be beneficial.

**Development of a new genetic-engineering technology to control honey bee Nosema disease.** The fungal parasite Nosema is often implicated in honey bee colony declines. Fumagillin is the only antibiotic approved for control of Nosema disease. However, because antibiotic resistance is rising, new therapeutic options are needed. ARS scientists in Beltsville, Maryland, found that silencing a honey bee immune suppressor using a new genetic-engineering technology called RNAi (gene silencing) could inhibit the reproduction of Nosema and improve the overall health of honey bees. This is the first success in designing an effective therapeutic to control honey bee diseases by use of a host immune suppressor. The information obtained from this study will help improve bee disease management practices.

**Aged diet consumption alters the structure of the worker gut microbiome.** Bees fed aged nutrition sources differed markedly from those fed fresh nutrition sources, suffering impaired development and increased mortality, and developing a significantly different microbiome (mix of microbes), differences that extended throughout the entire alimentary tract. ARS scientists in Tucson, Arizona, determined that consuming an aged nutrient source resulted in a significant reduction of the core ileum bacterium *Snodgrassella alvi* and a corresponding increase in the abundance and diversity of opportunistic gut pathogens. In the context of host health, the researchers found that the abundance of *S. alvi* in the ileum correlated with host survival and development. The inverse was true for three different bacterial species, reinforcing their role as opportunistic pathogens or markers of disease. Collectively, findings suggest that the early establishment of *S. alvi* is associated with healthy nurse bee development, suppressing opportunistic bacteria in the ileum. This knowledge is used by customers and stakeholders in decisions about which supplemental diet to provide to bees.