United States Department of Agriculture
Agricultural Research Service

National Program 305 • Crop Production

FY 2019 Annual Report

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 controlled environment crop production (e.g., greenhouse and other protected systems) 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 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 2019, 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@usda.gov), Joe Munyaneza (joseph.munyaneza@usda.gov), Tim Rinehart (tim.rinehart@usda.gov), Jack Okamuro (jack.okamuro@usda.gov), and Roy Scott (roy.scott@usda.gov)

Component 1 – Integrated Sustainable Crop Production Systems

Improved mechanical blueberry harvesters. Blueberry growers want to replace hand pickers with machines to harvest blueberries, but current blueberry harvesting machines use hard fruit catching plates that cause a significant amount of impact damage to the blueberries that fall on them. ARS researchers in Kearneysville, West Virginia, developed and patented durable catch plates that allow mechanical harvesting of blueberries without bruise damage. In 2018, new catch plates for commercial blueberry harvesters were manufactured using the USDA patent and tested in California, Florida, Oregon, and Washington. U.S. commercial blueberry growers are now mechanically harvesting high-quality blueberries using the ARS-patented design.

Oilseed cover crops reduce unwanted soil nitrogen loss. Contamination of water from the leaching and runoff of labile soil nitrogen and phosphorus from corn-soybean cropping systems in the Upper Midwest is a major concern. This loss occurs mostly during fall and spring when the soil is left bare between summer crops. Winter annual cover crops can use leftover nitrogen and phosphorus from the previous crop and keep these nutrients from contaminating water. ARS researchers from Morris, Minnesota, in collaboration with University of Minnesota

scientists, demonstrated that winter camelina and pennycress grown as cover crops are as effective as winter rye at using excess nitrogen and preventing its escape from agricultural system into waterways. Compared with typical no-till and conventional till systems lacking a cover crop, use of camelina and pennycress winter oilseeds resulted in soil and water nitrogen reductions of 84 percent and 91 percent, respectively. Camelina and pennycress also can be harvested as oilseed cash crops, which is an added value to the system. This information is being used in developing new sustainable cropping systems and will benefit growers interested in cover cropping; it will also be of interest to agricultural scientists, extension educators, and consultants.

Improved crop water use sensor for grapes. Water conservation during crop production is an important environmental consideration for vineyard producers. Where water supplies are limited, such as California, efficient water use is critical for profitability. To reduce irrigation, growers need precise information on how much water their grapevines need. In collaboration with University of California-Davis researchers and industry cooperators, ARS scientists in Davis, California, developed an inexpensive, stand-alone sensor that provides growers with low-cost, site-specific estimates of crop water use for scheduling irrigation. The new system is based on "surface renewal" methods that estimate plant evapotranspiration using measured and modeled energy balance components to quantify vineyard water use. The new surface renewal method does not rely on calibration against other methods to obtain accurate measurements of plant water use.

Profitability of abrasive weeding in organic crops. In organic grain and vegetable crops, weeds that emerge within rows greatly impact yield and are difficult to control. An alternative to hand-weeding is to use air-propelled grit to control small weed seedlings. ARS researchers in Morris, Minnesota, in collaboration with South Dakota State University researchers, developed and evaluated the profitability of a new abrasive weeding system to control weeds in organic corn, tomato, and peppers. They discovered that abrasive weeding was not profitable in organic corn production compared to mechanical tilling between rows. However, abrasive weeding was profitable in organic tomato and pepper production, increasing net income by $4,960 to $13,460 per acre. These discoveries are being used by organic farmers, weed scientists, extension educators, and others to develop innovative methods of weed control in organic crops.

Improved diagnostic sampling protocol for detection of citrus huanglongbing (HLB) pathogen infections in citrus trees. Detection of citrus HLB pathogen 'Candidatus Liberibacter asiaticus' (CLas) infection triggers regulatory action and affects management decisions by citrus growers, so early detection is a critical component of HLB management. Many diagnostic methods and protocols have been developed, including official protocols used by the Animal and Plant Health Inspection Service (APHIS). However, detection of CLas in citrus trees is challenging in the absence of HLB symptoms because samples collected from CLas-infected trees often test negative for infection when tree is actually infected. This is known as a false negative. Research conducted by ARS scientists in Fort Pierce, Florida, determined a hierarchical sampling strategy that, at the tree level, reduces the probability of false negative diagnoses of CLas. The

hierarchical sampling scheme is based on where CLas is most likely to be found in a tree. Results demonstrated that this new sampling method can detect CLas infections within 24 hours after infection occurs. The results also have been shared with APHIS to improve official protocols for CLas infection detection and monitoring in citrus groves.

Yard waste is a suitable compost material for organic blueberry production. Organic blueberry growers often use compost to supply nutrients and improve soil health, but the pH and salts in many composts are too high and result in poor plant growth or death. ARS scientists in Corvallis, Oregon, and Oregon State University collaborators evaluated the suitability of a variety of composts for blueberry. Plant growth was best when compost pH was <7.0 and improved consistently when the composts were acidified with elemental sulfur. The most favorable composts contained 80 percent grass seed hulls and 20 percent peppermint hay, horse manure with pelletized wood bedding, Douglas fir bark, fine sawdust, digested and dewatered municipal wastewater treatment biosolids, chipped deciduous tree leaves from municipal street sweeping, and ground urban yard debris (grass, leaves, woody debris). The availability of most of these composts may be limited in many regions, but yard debris composts are widely available from commercial vendors and can be used by blueberry growers to build soil organic matter without supplying excessive salts.

Detection of a new grapevine leafroll-associated virus in Idaho. The wine grape industry is a $6 billion business in the United States, and some grapevine viruses can be detrimental to grapevine health, crop load ratio, fruit characteristics, and wine quality. Grapevine leafroll-associated virus-3 (GLRaV-3) is one of the most important grapevine viral diseases affecting grapevines worldwide. ARS scientists in Parma, Idaho, and Corvallis, Oregon, with University of Idaho collaborators, conducted research on grapevine viruses in collaboration with commercial Idaho grape growers to identify a novel genetic variant of GLRaV-3. The variant was sequenced and named GLRaV-3-ID45. Scientists then developed new, reliable diagnostic tools for detecting the variant in vineyards, which will aid in protecting growers from GLRaV-3 losses by the timely deployment of proper and effective management strategies against the virus.

New strategies for managing root rot in Pacific Northwest nurseries. *Phytophthora plurivora* is an important root rot pathogen in Oregon nurseries and among the most damaging *Phytophthora* pathogens on ornamental and landscape plants. Growers typically use fungicides to control root rot disease but have concerns about this plant pathogen developing fungicide resistance. Therefore, ARS researchers in Corvallis, Oregon, characterized the genetic variation of *P. plurivora* from Oregon nurseries to better understand pathogen diversity for fungicide use strategies. Recent sampling and population structure analyses of fungal samples obtained from Pacific Northwest nurseries indicated the presence of one dominant clonal lineage in all nurseries, as well as isolates of cryptic diversity mostly found in one nursery. Within the predominant clonal lineage, a broad range of sensitivity was found in the two most common fungicides available to growers. There was also a correlation between sensitivity to the two fungicides; isolates that had a low sensitivity to one fungicide also had a low sensitivity to the second fungicide. The broad range of fungicide sensitivity within the population and low genetic diversity has important implications for managing this key pathogen by Pacific

Northwest nursery producers when selecting which fungicides to use and how often to use them.

Component 2 – Bees and Pollination

Small hive beetle genome sequenced: Unique ability to detoxify pesticides revealed. Small hive beetle is an important worldwide parasite of social bee colonies that eats through honey bee hive comb, honey, pollen, and brood. ARS scientists in Beltsville, Maryland, sequenced the beetle genome and characterized it, finding unique detoxification genes. In addition, sequencing described the proteins used by these beetles to identify each other and honey bee colonies by smell, a critical target for attempts to trap the beetles. The study provides new insights into the genomic basis for local adaption and invasiveness in the beetle and a blueprint for control strategies that target this pest without harming their honey bee hosts.

Access to U.S. Conservation Reserve Program (CRP) lands greatly improves honey bee colony health. It is critically important to maintain environmental landscapes with adequate sources of nutrition to ensure the sustainability of commercial beekeeping. ARS researchers in Tucson, Arizona, demonstrated that compared with intensively managed agricultural lands, honey bee colonies in CRP lands showed markedly improved performance; the bees also had higher levels of vitellogenin, a nutritionally regulated protein with central storage and regulatory functions that also promotes oxidative stress resistance and improved immunity. Honey production was up, and revenue for almond pollination services also increased from honey bee colonies that were raised on CRP lands. The study confirms the overwhelming utility of U.S. conservation lands for commercial beekeepers and agricultural pollination services.