National Program 305 - Crop Production

Assessment Report

Executive Summary

Panel members: Richard Adee, Ken Giles, Dewayne Ingram (chair), William Lamont, Marc Teffeau, James Walgenbach, Chris Walsh and Thomas Webster

The review panel appreciates the opportunity to serve ARS by offering this assessment report for NP 305 – Crop Production. We each gained by learning more about this broad program. We are also impressed by the breadth, quality and impact of this program. It is clear that the ARS scientists involved in this program are conducting critically important research, much of which would not be done by others or at least not in a timely manner. ARS resources are being utilized effectively to provide leadership in critical areas with land-grant university partners and industry. The impact of some of the work will be long-term but some work has addressed critical, time-sensitive issues that are making immediate impact. There appears to be an appropriate balance in these categories in the program as a whole, although some Subcomponents are focused primarily on short-term needs while others are concentrated on long-term goals. The output of high quality publications in appropriate journals and discoveries protected through patents were noted. The NP 305 Accomplishment Report followed very closely the NP 305 Action Plan with a few deviations. Some deviation to a five-year plan would be expected with most of those in this case being related primarily to loss of scientists in the Crop Production area due to transfer, retirement, resignation or station closure.

Below are the panel's assessments of the impact and a brief overview statement for each Problem Statement in the five Subcomponents.

Component 1: Crop Production

SUBCOMPONENT 1A: ANNUAL CROPPING SYSTEMS	
Problem Statement 1A.1	High Impact
Problem Statement 1A.2	High Impact
Problem Statement 1A.3	High Impact
Problem Statement 1A.4	High Impact

Problem Statement 1A.1: Develop Integrated Strategies for Soil, Water, and Nutrient Management for Optimal Yield and Economic Returns in Annual Cropping Systems.

Soil, water and nutrient management issues are among the most critical elements of sustainable crop production for profitability and natural resource base protection or enhancement. Projects in this problem area address these system components and their interaction. Research resulting from these projects is of high quality and current impact and impact potential are high. This area of research remains a high priority as ARS scientists lead and collaborate with scientists at other institutions and agencies. Anticipated Product #3 was not addressed in the Accomplishment Report.

Problem Statement 1A.2: Develop Automation and Mechanization Systems and Strategies to Optimize Pest Management, Improve Crop Yield and Quality, Reduce Worker Exposure, and Protect the Environment While Maintaining a Profitable Production System.

Pesticide delivery research is yielding great results that are making immediate impact. The scale of this project, from aerial application to use of air-blasted grit for weed control, is impressive. The research on aerial spray technology for increased efficiency and effectiveness and minimal non-target impact is unique and world class. Clientele input in the problem statement was obvious and collaboration between ARS stations and with university scientists is a strength.

Problem Statement 1A.3: Decision Support Systems to Optimize Pest Management.

A smart phone application was an excellent extension of laboratory research that developed the spreadsheet-based models for integrating data to facilitate decisions. Real-time data from weather conditions and digital imaging from un-manned aircraft and ground-based sprayers are being integrated for machine and operator decisions. Collaboration with other governmental agencies to ensure the development of science-based regulations will continue to be important.

Problem Statement 1A.4: Develop Crop Production Systems that are Productive, Profitable, and Environmentally Acceptable.

Research to develop improved and new production systems for currently important crops and to develop production systems for new crops with economic potential remains a priority. These projects have resulted or will result in modified production systems to expand markets and capture niche markets. New crops for bio-based fuels are important for the economic viability of this sector.

SUBCOMPONENT 1B: PERENNIAL CROPS	
Problem Statement 1B.1	High Impact
Problem Statement 1B.2	Medium - High Impact
Problem Statement 1B.3	High Impact

Problem Statement 1B.1: Develop Integrated Strategies for the Management of Pests and Environmental Factors that Impact Yield, Quality, and Profitability of Perennial Crops.

ARS scientists have effectively addressed important components of sustainable perennial crop production in a systems approach. Knowledge of biological processes, micro-environment monitoring and control and pest management strategies have led to improved protocols and products. Understanding water relations in grapes using High Resolution Computed Tomography is but an example of important discoveries in this area that have resulted in noteworthy production protocol modifications. A rapid, strategic response to Brown Marmorated Stinkbug (BMSB), a devastating exotic pest, was a natural extension of a multi-disciplinary approach to production systems research that has had immediate, national impact.

Problem Statement 1B.2: Develop Mechanization and Automation Practices that Increase Production Efficiency.

Adaptation of technologies for spray applications to time-sensitive problems was the hallmark of this problem area. There has been rapid payoff to this work, for example in psyllid

control related to citrus greening. Future efforts in this area could be improved by forward-thinking, new technologies to advance the base knowledge. Important mechanical system development research is resulting in economically and environmental sound alternative protocols for production of trailing blackberry, sugar cane, peaches, grapes and pecans.

Problem Statement 1B.3: Develop Perennial Crop Production Systems that are Productive, Profitable, and Environmentally Acceptable.

Application of novel production systems for off-season blackberry and peach (tree architecture in lieu of size-controlling rootstocks) will improve yields for more profitable production for high-value markets. Work with tropical fruits relative to their potential for harboring West Indian fruit fly has opened the continental US market for these crops. Research with cacao will result in more sustainable production through soil improvement strategies.

	SUBCOMPONENT 1C: GREENHOUSE,HIGH TUNNEL, AND NURSERY PRODUCTION SYSTEMS	
	Problem Statement 1C.1	High Impact
	Problem Statement 1C.2	Medium - High Impact
	Problem Statement 1C.3	High Impact
	Problem Statement 1C.4	Medium - High Impact

Problem Statement 1C.1: Develop Integrated Strategies for the Management of Pests and Environmental Factors that Impact Yield, Quality, and Profitability of Greenhouse, High Tunnel, and Nursery Production Systems.

This problem area was obviously defined with stakeholder input and work to address the identified opportunities has been executed through collaboration with university scientists and industry. Water quality (particularly N and P) and nutrition (including silicon and boron) are among the topics of this research, developing data for use in expected environmental regulation development. This work has focused on nursery and greenhouse production but did not appear to address high tunnel systems. Additional attention to greenhouse vegetable production is warranted.

Problem Statement 1C.2: Develop Sensors and Automation Technologies for Greenhouses, High Tunnel, and Nursery Production Systems.

Research in this problem area reflects the diversity of opportunities and crops related to sensors and automation technologies. Pesticide application technologies, in particular the half-rate spray application technologies, root rot detection through foliar temperature sensing, and insect trapping systems developed through this research are already resulting in economic and environmental protection advancements for landscape and floral crops. There is a strong continuum for some projects from bench to end user. The research answered some of the fundamental questions with appropriate development and final application and adoption of the technology to the producer. The problem area appears to be a collection of projects as compared to a coordinated effort, missing the opportunity for synergy among projects.

Problem Statement 1C.3: Develop Decision Support Systems Optimized for Greenhouse, Nursery, and High Tunnel Production Systems.

Virtual Grower has become an important tool for greenhouse production managers and even greenhouse manufacturers. The decision tool has allowed increased profitability and decreased environmental impact. Improvements during the past 5 years have been significant through the inclusion of new knowledge into the model. Expansion to include decision aids for high tunnels would be valuable as this low-input, protected culture system is expanding rapidly.

Problem Statement 1C.4: Develop Improved Crop Production Systems for High Quality Greenhouse, High Tunnel, and Nursery Crops.

Discovery and development of alternative substrate components for pine bark and peat is a high priority for container production of nursery and floral crops. A technique for measuring available moisture in organic substrates will be an extremely helpful tool in developing and evaluating alternative substrates, such as processed whole tree. The database of images of nutrient deficiencies on a wide range of plants will assist growers in diagnosing nutritional problems. Timing of N in rhododendron, production systems for hydrangea and post-harvest strategies have added to the knowledge required to increase the quality and decrease production costs of these plants. No accomplishments were reported for Anticipated Products #3 and #5.

Component 2: Bees and Pollination

SUBCOMPONENT 2A: HONEY BEES [*APIS*]	
Problem Statement 2A.1	High Impact
Problem Statement 2A.2	High Impact
Problem Statement 2A.3	High Impact

Problem Statement 2A.1: Improving Honey Bee Health.

Research with varroa mites and their interactions with important diseases is critically important and is increasing the knowledge base and resulting in increased control measures. Research on non-chemical controls of small hive beetle and honey bee colony nutrition is making immediate impact. More effective traps for small hive beetle will give bee keepers alternatives to chemical controls. Long-term effects are likely to be found by improved knowledge of varroa mite host-seeking behavior. Long-term impact would be expected from the research on the molecular assay to detect diseases, bee genetics and use of RNAi for control of selected viruses. Research on the long-term impact of selected pesticides on bee health is adding important knowledge and will continue to be important. No accomplishments were reported for Anticipated Products #11, #12 or #13.

Problem Statement 2A.2: Pollination of Crops.

Research on improved feeding strategies for spring build-up and winter survival will improve hive health and result in strong populations for early-season crop pollination. Strong, healthy hives at this time of year will significantly increase profitability. All of this Subcomponent could be included in 2A.1 related to honey bee health.

Problem Statement 2A.3: Developing and Using New Research Tools: Genomics, Genetics, Physiology, Germplasm Preservation, and Cell Culture.

Powerful tools have been developed to understand and modify honey bee genetics. These tools are critical for developing bee populations resistant to diseases (*N. ceranae*, chalkbrood, American foulbrood). Cell culture of bees is difficult but ARS scientists are making significant headway in developing this as a research tool for understanding diseases under controlled environments. No accomplishments were reported for Anticipated Products #6, #7 and #8.

SUBCOMPONENT 2B: NON-*APIS* BEES	
Problem Statement 2B.1	Medium - High Impact
Problem Statement 2B.2	High Impact

Problem Statement 2B.1: Management for Crop Pollination.

Much of the research in this area has been narrowly focused on western bee populations and crops. Chemical cues in nest establishment (patent pending) and pollination of cane berries, almonds and greenhouse crops are among impact-potential discoveries. Immunity-related genes identified in alfalfa leafcutting bees will play an important role in helping address diseases in wild bees. This group of scientists has much to contribute to work in other parts of the U.S. A clearer statement of need and importance in this problem area would been helpful to the panel.

Problem Statement 2B.2: Bee Biodiversity and Contribution to Land Conservation.

High quality research with non-Apis bees has resulted in many manuscripts published in high-impact journals. ARS is serving an important role in bee taxonomy, an expertise that predominately resides in this Agency. Subsequent contributions to web-based identification programs are important tools for scientists and non-scientist users. Bumble bee population declines can be linked to diseases and lack of genetic diversity. The importance of native bee species and their specificity in pollination of native plants has been described by this group and extended to stakeholders. This work will help policy makers improve Conservation Reserve Program acreage requirements to include significant vegetation diversity to support native bee and honey bee populations.