Tactical Sciences for the Protection of the U.S. Agricultural Enterprise

The Need for a Coordinated Strategy

Agriculture and agriculture-related industries contributed $835 billion to the U.S. gross domestic product and over 17 million jobs in 2014. This economic impact, and the security and safety of our food supply are under continuous threat from numerous foreign, emerging, and endemic pests, diseases, and contaminants such as toxins.

Tactical sciences are scientific assets that protect the integrity, reliability, and sustainability of the U.S. food and agriculture system against known and potential threats from plant, animal, and human health pests and diseases. While strategic science planning and investment has been a long-standing commitment of the National Institute of Food and Agriculture (NIFA) and its predecessor agencies, there is an urgent and growing need to strengthen food and agricultural tactical science capabilities and competencies, both offensive and defensive, on a scale commensurate with current and future threats to the safety, stability, diversification, and profitability of our nation's food and agricultural systems.

Vulnerability of Agricultural, Food Processing and Public/Animal Health Systems to Pests, Diseases and Toxins/Residues

Several recent examples illustrate the negative impacts of pests on agricultural yields and production costs. These examples also illustrate the effects of these threats on trade of U.S. agricultural products, rural economic growth, and sustainability of agricultural systems. The spotted wing drosophila, found in 46 states, caused $715 million of damage to berry and stone fruit crops nationwide in 2015. The brown marmorated stink bug outbreak in the mid-Atlantic region caused $37 million in damage to the apple industry and 50 percent losses in stone fruit crops in 2010. In Florida, from 2007 to 2012, citrus greening (also known as Huanglongbing) caused 23 percent yield losses, $1.7 billion in lost grower revenue, and a combined economic impact of $4.5 billion. In addition to the devastating damage in Florida, this disease poses a serious threat to the citrus industries in California, Texas, and Arizona. Weed control costs growers an average of $40 per acre in corn and $33 per acre in soybeans or approximately $6 billion per year total in these two crops alone. Even after these management expenses, yield reductions due to weeds cost U.S. corn and soybean producers approximately $4.5 billion of lost revenue annually. Collectively, these and other plant pests have contributed to escalating consumer prices, negative impacts on U.S. exports, and major disruptions in integrated pest management systems that growers have been refining for decades.

In animal production systems, the most severe US animal disease outbreak occurred in 2015 when the highly pathogenic avian influenza (HPAI) contributed to the loss of nearly 50 million chickens and turkeys. As a result, the consumer price index for eggs increased 36 percent from September 2014 to September 2015. The value of the depopulated poultry, the impact to consumers due to the increased price of eggs, and other economic effects make this multi-billion dollar outbreak the costliest animal disease episode in US history. Although poultry industries in several states were affected, Iowa (the largest egg-producing state in the United States) was hit hardest with 40 percent mortality in egg-laying hens. In Iowa alone, the HPAI outbreak resulted in loss of 8,444 jobs, demonstrating the potentially devastating impacts of emerging pests and diseases on rural communities and economies. Also, porcine epidemic diarrhea virus (PEDv), first identified in the United States in 2013 and now confirmed in 39 states, remains a serious threat to baby piglets in which losses can be as high as 80-100 percent. Combined losses through 2014 attributable to PEDv are estimated to be as high as $1.8 billion, and the disease is not yet controlled.

A number of arthropod-borne pathogens of public and animal health importance such as West Nile, Blue Tongue Virus, Zika virus, Dengue virus, encephalitis viruses, Lyme spirochaete, and anaplasma, and their native or invasive vectors are also contributing to significant morbidity, mortality, and economic impacts in America. West Nile virus, which infects both humans and horses, has contributed to 30,000 human infections and 1,200 human deaths, and has resulted in an estimated $200 million cost to our nation's economy.

Herbicide resistance requires new tactics that can be integrated into crop management strategies. Yield losses are sometimes greater than 60 percent in corn and cotton fields where herbicide resistant Palmer amaranth occurs. Similarly, mechanisms for preventing violative residues of animal drugs in meats are essential to assure food safety. For example, methods to control antibiotic residues and resistance elements in livestock would help prevent the development of foodborne "super bugs" that are resistant to conventional antibiotics and thus make it more difficult to treat animals and humans infected with resistant bacteria and other infectious microbes.

Potential adulterants in feed for food animals or food for human consumption, such as life-threatening melamine contamination uncovered in 2007 and linked to products from China, must be quickly detected and avoided at all costs. Taken together, contamination of food with pathogens, violative drug residues and toxins costs society hundreds of billions of dollars over a typical 10-year period, not counting the medical costs to treat clinically affected humans.

NIFA Investments in Tactical Sciences Supporting Surveillance, Protection and Production

NIFA has several programs that support the development of science-based tactical methods, tools and networks for surveilling, detecting, monitoring, and managing plant, animal, and public health pests, diseases and contaminations, and enhancing livestock and crop production diversification and efficiency. These applied, translational science programs not only offer effective solutions to farmers and livestock producers to deal with an array of biological, chemical and therapeutic challenges, but are also critically important to our nation's trade and economic well-being. For example, the Minor Crop Pest Management (IR-4) program contributes over $7.2 billion to our nation's GDP annually. While each of the tactical science programs addressed in this concept paper has been effective, greater integration and coordination, sharing of knowledge and technologies, interoperability, and technical expertise will offer significant synergies. These programs include:

***Detection and Diagnostics*: National Plant Diagnostic Network (NPDN) and National Animal Health Laboratory Network (NAHLN)**

- These programs are critically important for protecting our nation's homeland agrosecurity. The networks are well regarded for the surveillance and early detection of high consequence pests and diseases, timely responsiveness, deployment of management and recovery tools, technologies, and technical manpower networks.
- Interoperability of coordinated first/early detector networks and their diagnostic laboratories is progressing but remains underdeveloped. The importance of these tactical science capabilities to the success and profitability of U.S. agribusiness is grossly under-recognized. National agrosecurity depends on rapid detection, validated diagnostics with surge capacity, and expeditious quarantine

to contain infection and avert disaster in both the plant and animal production systems that are increasingly vulnerable to catastrophic incursions of transboundary and emerging infectious disease.

***Regulatory Systems Support*: Minor Crop Pest Management (IR-4), Food Animal Residue Analysis Database (FARAD), Minor Use Animal Drugs Program (MUADP)**

- These programs provide critical research to support science-based federal food and agriculture activities that insure the safety and diversity of agricultural products.
- The science-based policies and regulatory research by Land Grant Universities deliver outputs and outcomes to a larger stakeholder base (EPA, USDA-APHIS, FDA and U.S. livestock and crop producer communities at-large) and are of critical importance for both domestic and international trade of agricultural commodities and products.
- For some crop and animal species such as fruits and vegetables, small ruminant animals, pollinators and aquaculture species, IR-4 and National Research Support Project (NRSP)-7 are the only programs that support development and regulatory approval of pesticides and drugs needed to control pests and diseases, and protect animal well-being.
- Opportunities for enhancing interoperability among research laboratories are created by developing synergistic data, technology and methodology platforms.

***Development and Deployment of New Crop and Animal Production and Protection Tools and Management Strategies*: Crop Protection and Pest Management (CPPM), IR-4, MUADP, Extension Disaster Education Network (EDEN)**

- These programs support research and science-based outreach responsive to emerging local and regional threats and needs for monitoring and detection technologies and sensors, along with novel diagnostic tools, assays and therapeutic drugs.
- They provide a research platform that supports enhanced tactical research responsiveness, resulting in expedited, high impact tools to manage pests and diseases that can be jointly reported to the beneficiary communities.
- Impacts of these programs can be enhanced by facilitating common strategies for knowledge dissemination (rapid when necessary) and specialized workforce training.

Way Forward

Many urgent challenges need to be addressed as soon as possible to enhance the overall security, vitality and competitiveness of local, regional, national and international food and agricultural enterprise. These challenges include:

1) Existing and continuously-emerging foreign and endemic pests and diseases;
2) Food contaminations and inadequate pharmacologic tools to support crop, pollinator and livestock production and health, and
3) The need to bolster our capabilities and capacities to effectively reduce and respond to domestic and foreign threats to agricultural sustainability and profitability

NIFA envisions significantly strengthening and expanding the framework of translational and applied scientific approaches focused on the protection, defense and diversification of U.S. plant, animal and food production systems. The overall goal of NIFA's Tactical Sciences for Agriculture portfolio is to create a synergistic programmatic framework in which individual elements are complementary at regional and national levels to:

- Narrow existing gaps in food and agricultural defenses;
- Increase capacity to prevent, rapidly detect and respond to outbreaks and other threats to the food supply;
- Effectively support coordination and implementation of containment and recovery operations; and
- Promote one-health goals and vitality and diversity of agribusiness in the United States.

With additional resources, NIFA envisions significant strengthening of the current national framework of surveillance, detection, and rapid recovery response infrastructures, and tools, technologies and systems needed to protect against known and emerging high-consequence pests, diseases, toxins and residues that threaten the safety and security of the American agriculture and food system.

By achieving these goals, the NIFA Tactical Sciences for Agriculture portfolio will promote U.S. agricultural sustainability and minimize serious disruptions to continuity of business and trade, thereby enhancing protections for the individual producer, farm profitability, the consumer, the overall food and agriculture system, and the broader national economy.