APPENDIX

Crop Protection & Global Food Security

IPM Designed for the Future

Crop Protection

Fewer Pest Outbreaks

Reduced Evolution of Virulent Pests

Reduced Pesticide Use

Global Food Security

Cost Effective Protection from Insect Harm

Biologically-based Pest Management

Least Possible Risk to People, Resources, and the Environment

Integrated Pest Management

effective, safe, environmentally benign control of pest insects

- **Providing** targeted activities, durable tactics and system technologies
- **Ensuring** human and environmental safety
- **Meeting** social and regulatory concerns

Multiple Pest Resistance

- **Fundamental** objective of crop protection
- **Best Approaches** using conventional and genetic technologies

New knowledge in pest and crop ecology

- **Protecting** natural enemies, pollinators, and other beneficial organisms
- **Providing** cropping system heterogeneity and environmental resistance to pests
- **Promoting** soil and plant health

Low-Impact Interventions

- **Inundative** biological control
- **Behavior** disrupting semiochemicals
- **Selective pesticides** with targeted range of action

Entomology
Research, Extension, Education

for agriculture, food systems, and natural resources

Crop Protection and Global Food Security

With the global population expected to increase by 3 billion by 2030 and the amount of arable land available for production remaining unchanged, agriculture is facing challenges at least equivalent to those defining the Green Revolution. Besides needing to feed more people, agriculture will be challenged by increasingly scarce and costly inputs (Neff et al. 2011), pest exacerbation due to climate change, a reduction in cropland available per capita, stricter regulations, and growing numbers of resistant pest species.

With more people demanding higher quality diets a second green revolution (Serageldin and Persley 2000) is needed. In part, the success of the first green revolution was dependent on intensive pest management practices (Fresco 2009). To succeed, the second green revolution will need biologically based products to replace conventional chemical pesticides and other scarce or expensive inputs. And it will need sustainable management systems where the environment is a priority, where genetics and biotechnology are used to improve productivity, and where crop resistance to biotic and abiotic stressors is an emphasis.

To protect our crop genetics and plant protection products, we need implementation and cropping system strategies to reduce the likelihood of pest outbreaks and of evolution of pests virulent to management approaches. The United Nations Environmental Program has listed pesticide resistance as the third most serious threat to global agriculture behind soil erosion and water pollution. In the United States, crop losses due to pesticide resistance are estimated to be $1.4 billion annually (Hart and Pimentel 2002). In Nebraska alone, the occurrence of pesticide resistance in the western corn rootworm increased control costs, reduced yields, and was estimated to cost producers at least $4 million annually from 1995-1998. Today, there are populations of corn rootworms that are resistant to GMO corn in Nebraska and other Midwestern states.

Current approaches to crop protection are inadequate for meeting future food production needs. Despite a 7-fold increase in the use of crop protection products over the last 40 years, losses to all categories of crop pests have remained essentially level. Currently, insects alone consume or damage sufficient food to feed 1 billion people (Oerke et al. 2004, Oerke 2006). Climate change is likely to further increase insect pressure on crop production (Gregory et al. 2009, Newton et al. 2011). To address these challenges, an emphasis shift from reactive crop protection to a preventative genetic and ecological systems approach is essential.

Plant resistance to arthropods and other pests, whether developed through conventional breeding or genetic engineering approaches, must be a fundamental objective of future crop development and protection. Resistant crops limit the build-up of pest populations and minimize crop losses. They are generally compatible with other management techniques and are effective in conditions that can impede other pest management practices.

Another critical component to insuring food security is ecological engineering of our agroecosystems to promote diverse and robust populations of natural enemies, pollinators, and other beneficial organisms as a necessity of sustainability. Ecological engineering, especially when applied on an area-wide basis, will enhance cropping system heterogeneity and build environmental resistance to pests. Based on a thorough understanding of pest and crop ecology, designed agroecosystems will protect yield, reduce the need for pesticides, reduce selection pressure on pests, and promote sustainability.

An equally critical element is how to protect crops when conditions favor pest outbreaks or before effective plant resistance or ecological engineering technologies are available. Included are techniques such as inundative biological control, semiochemicals (pheromones, repellents, and attractants) that disrupt pest behavior, and judicious use of selective pesticides to provide local management.

A crop protection toolbox based on genetic and ecological systems complemented with specific and low-impact technologies will protect agroecosystem health and sustainability. A crop protection emphasis shift to genetic and ecological systems will reduce grower costs, protect crop quality and quantity, and better position agriculture to meet growing food security needs.

References

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Gary Brewer, November 2011

TEXAS A&M AGRILIFE RESEARCH

FY 2014 & FY 2015 Exceptional Item

Requested Amount (biennial): **$6 Million**

CONTROLLING EXOTIC AND INVASIVE INSECT-TRANSMITTED PATHOGENS

OBJECTIVE

Establish comprehensive research programs that will find new ways to disrupt the spread of insect-transmitted pathogens (disease-causing agents such as bacteria and viruses) that infect plants, humans, or animals and have a devastating economic impact in Texas.

Benefit to Texans

Texas A&M AgriLife Research will develop new ways to combat insect-transmitted pathogens to guard the overall welfare and economic sustainability of Texas. The knowledge gained through this research will position Texas as a leader in insect-vectored pathogen issues nationwide.

Description and Justification

Insect-transmitted pathogens that infect plants, humans, and/or animals are a serious threat to public health and to the Texas economy. Diseases caused by these pathogens have resulted in many deaths. They also currently cost Texas hundreds of millions of dollars in lost agricultural productivity, decreased economic opportunity, and increased health care costs for livestock, companion animals, and citizens. The introduction of exotic insects and pathogens — and of disease epidemics — has greatly increased in recent years because of expanded international trade and the need to feed an ever-increasing human population. As this trade expansion continues, more plants, insects, and animals and the microbial pathogens they harbor will find their way into Texas, overwhelming our ability to inspect for these vectors. We must improve our ability to detect and counter those threats, using our unique capabilities in the biological sciences to develop solutions, including vaccines and infection-resistant plant varieties.

In the summer of 2012, West Nile virus caused hundreds of cases of human illness and many deaths. This mosquito-vectored virus will continue to cause repeated outbreaks, but the cyclical nature of these outbreaks is not fully understood. Other vector-transmitted pathogens are increasing, such as those causing dengue fever, Lyme disease, and Chagas disease, all of which infect people, and the Chagas pathogen can also infect dogs. In relation to livestock, over one million acres in Texas were quarantined in 2010 to contain cattle fever ticks.

Insect-vectored threats include citrus greening disease (e.g. Huanglongbing), identified in Texas in 2012, which threatens citrus throughout the Lower Rio Grande Valley and has already devastated the Florida citrus industry. Two new insect-vectored citrus pathogens are migrating from Mexico, and the vector for citrus leprosis virus was recently detected in Texas. The state also has ongoing outbreaks of zebra chip disease in potatoes and Pierce's disease, which is often mentioned as the number one reason grape production in Texas is not growing in acreage. Wheat production across millions of Texas acres is subject to periodic devastation by a complex of viruses transmitted by curl mites. Oak wilt disease causes millions of dollars in losses to landowners across the state, and there is no effective control.

Texas A&M AgriLife Research scientists will develop techniques to reduce the impact of pathogens on farming and ranching operations and to assist public health agencies. Existing chemical products can temporarily reduce insect populations. However, they are only a short-term solution. Insect populations can become resistant to these compounds over time. The insect-transmitted pathogens we currently recognize represent "the tip of the iceberg" as far as these threats are concerned.

Significant research initiatives include:

- Understanding the complex molecular interactions among insect, host, and pathogen that will be exploited to disrupt acquisition, persistence, and spread of the insect vector and corresponding pathogen
- Identifying key pathogen and insect reservoirs that serve as sources of inoculation and seeking ways to eliminate or reduce these source populations
- Developing integrated and best management practices to impede and control the spread of the insect vector and corresponding pathogen
- Using rapid and flexible approaches to develop and manufacture vaccines to protect against disease agents, including potential corporate research collaborations to develop products for preclinical and clinical trials
- Improved detection methodologies which are critical to epidemiology and control of these pathogens

Texas A&M AgriLife Research

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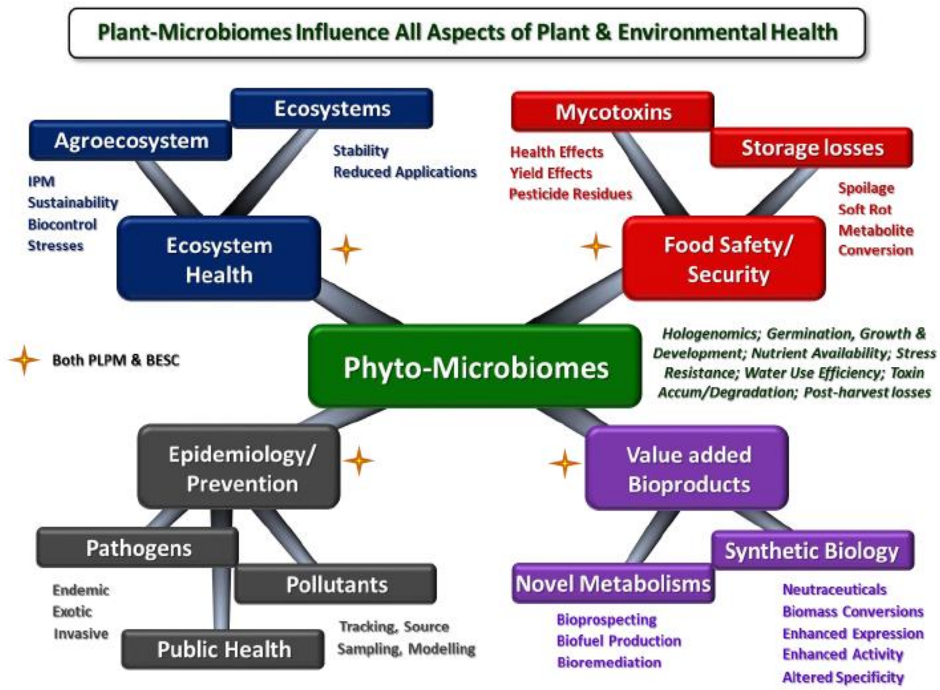
MEMBER OF THE TEXAS A&M UNIVERSITY SYSTEM

About Texas A&M AgriLife

What is AgriLife? It's a simple word for a diverse organization. With teaching, research, extension education, laboratory, and forestry facilities throughout Texas, we serve people of all ages and backgrounds. Led by Vice Chancellor Dr. Mark A. Hussey, Texas A&M AgriLife includes the Texas A&M AgriLife Extension Service, Texas A&M AgriLife Research, Texas A&M Forest Service, and the Texas A&M Veterinary Medical Diagnostic Laboratory.


Plant-Microbiomes Influence All Aspects of Plant & Environmental Health
Ecosystems
Agroecosystem
Stability
Reduced Applications
IPM
Sustainability
Biocontrol
Stresses
Ecosystem Health
Mycotoxins
Storage losses
Health Effects
Yield Effects
Pesticide Residues
Spoilage
Soft Rot
Metabolite Conversion
Food Safety/ Security
Both PLPM & BESC
Phyto-Microbiomes
Hologenomics; Germination, Growth & Development; Nutrient Availability; Stress Resistance; Water Use Efficiency; Toxin Accum/Degradation; Post-harvest losses
Epidemiology/ Prevention
Pathogens
Pollutants
Endemic
Exotic
Invasive
Public Health
Tracking, Source Sampling, Modelling
Value added Bioproducts
Synthetic Biology
Novel Metabolisms
Bioprospecting
Biofuel Production
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Biomass Conversions
Enhanced Expression
Enhanced Activity
Altered Specificity