Component IV: Protection of Post-harvest Commodities and Quarantine

4b. Durable Commodities (U.S. Value 2007: $68 billion)

***Problem Statement*:** Stored grains (mainly corn, wheat, and rice) are damaged during storage and processing by the following insect pests:

- Stored Corn: Maize Weevils, Flat and Rusty Grain Beetles, Red Flour Beetles, Sawtoothed Grain Beetles, and Almond Moths, Angoumois Grain Moths, and Indianmeal Moths
- Stored Wheat: Lesser Grain Borers, Rice Weevils, Red Flour Beetles, Rusty Grain Beetles, and Sawtoothed Grain Beetles
- Stored Rice: Lesser Grain Borers, Angoumois Grain Moths, Maize and Rice Weevils, Red Flour Beetles, Rusty Grain Beetles, and Sawtoothed Grain Beetles
- Grain-based Products: Red and Confused Flour Beetles, Cigarette Beetles, Indianmeal Moths, Sawtoothed Grain Beetles, Warehouse and other Trogodermid Beetles, Flies and Incidental Night-Flying Moths
- Dried Fruits and Nuts: Research is Conducted in Parlier, California, under National Program 308, Methyl Bromide Alternatives

***Research Needs*:**

1. **Insect Pests of Stored Grain (corn, wheat, and rice)**

   Importance: Insects damage an estimated five to ten percent of the grain stored in the United States each year. They also can make grain more susceptible to development of mycotoxins. Insecticides used for their control incur additional costs and many insecticides historically used for insect control in stored grain are being lost because of resistance or regulatory changes. Information on the biology or control of psocids and other recently discovered pests of stored grains is limited. Furthermore, new pests are being introduced into the United States in grain imported from other countries, such as from organic grains from China.

   Research Gaps: Detection methods with food attractants and pheromones need to be improved or developed. In addition, interpretation of trap catches needs to be clarified in order to expedite pest management decisions. New and improved automated methods are needed for monitoring insect pests at grain depths below one meter in commercial grain elevators and for monitoring outdoor pest insect populations to predict grain elevator pests. Preventative and remedial control methods, as well as new combinations of control methods are also needed for insects in conventional and organic stored grains. This includes characterizing the biology of new target pests, as well as identifying new physiological targets and approaches for pest control through long-term research on genomics and proteomics.

Actions: ARS will:

Detection

- Develop methods for acoustic or electromagnetic detection of insects inside grain kernels.

Monitoring

- Develop and improve attractants for stored-product insects.
- Improve methods for interpretation of trap catches to aid in pest management decision making.
- Develop automated methods for monitoring insect pests at grain depths below one meter in commercial grain elevators.
- Determine whether outdoor populations of insects are an important source of infestation, and, if so, develop methods to use monitoring information from these populations to develop predictive tools.

Biology, Control, Organic

- Evaluate efficacy of registered organic insecticides as they become available.
- Improve efficacy of registered microbial agents through synergism.
- Evaluate efficacy of new microbial agents.
- Improve the ability of naturally occurring parasitoid wasps to suppress stored grain pests.
- Improve efficacy of aeration.

Control, Conventional

- Evaluate efficacy of registered insecticides as they become available.
- Optimize control technologies.
- Develop simulation models and expert systems to aid in decision making for pest management and for optimizing control technologies.
- Characterize biology of stored-product insects and their natural enemies.

Biology, Emerging Pests

- Characterize biology of emerging pests.
- Develop control technologies for emerging pests.

Control, New Physiological Targets

- Conduct genomic/proteomic studies on stored-product insects to identify potential physiological targets in the insect that can be exploited for insect control.

2. Insect Pests in Grain-processing Facilities and Stored Processed Commodities

Importance: Insect control costs and processed commodities losses have not been quantified for proprietary reasons, but probably greatly exceed the cost of losses to grain stored in the United States each year. Insects in processed commodities damage the reputations of food processors, no matter where in the marketing channel the insect infests the product. These insects also may cause allergy and other health-related problems. Many insecticides historically used for insect control in processing facilities and stored processed commodities are being lost because of insect resistance and regulatory changes. Information on the biology or control of psocids and other recently discovered pests of grain-processing facilities and stored processed commodities is limited.

Research Gaps: Detection methods before the grain is purchased for storage and processing need to be developed or improved and interpretation of the trap catches need to be clarified in order to expedite pest management decisions. New and improved automated methods are needed for monitoring insect pests that are continually being moved within facilities, as well as in and out of facilities, or are contained within difficult to sample shrink wrapped packages of processed commodities stacked on pallets. Monitoring techniques are also needed for outdoor populations that may serve as a source of pest populations and for pest refugia in flour mills that may allow pests to avoid control treatments. An understanding of the role of survivorship in refugia will help clarify the impacts of refugia on pest population dynamics and may be an important predictive tool. Preventative, remedial, and new combinations of control methods such as repellants, aerosols, and insect growth regulators must be developed and optimized for insects in conventional and organic stored grains. This includes characterizing the biology of new target pests and identifying totally new physiological targets and approaches for pest control through long-term research on genomics and proteomics. Improved insect-resistant packaging is also mandatory for protecting processed commodities from insect infestation.

Actions: ARS will:

Detection

- Develop methods for acoustic or electromagnetic detection of insects inside stored products.

Monitoring

- Develop and improve attractants for stored-product insects.
- Improve methods for implementation and interpretation of trap catches to aid in pest management decision making.
- Determine whether outdoor populations of insects are an important source of infestation, and, if so, develop methods to use monitoring information from these populations to develop predictive tools.

- Determine locations of refugia in flour mills that may allow pests to avoid control treatments, and determine how survivorship in refugia impacts pest population dynamics.

Biology, Control, Organic

- Evaluate efficacy of registered organic insecticides as they become available.

Control, Conventional

- Evaluate efficacy of registered insecticides as they become available.

Control, Optimize Technologies

- Develop simulation models and expert systems to aid in decision making for pest management and for optimizing control technologies.
- Characterize biology of stored-product insects.

Biology, Emerging Pests

- Characterize biology of emerging pests.
- Develop control technologies for emerging pests.

Control, New Physiological Targets

- Conduct genomic/proteomic studies on stored-product insects to identify potential physiological targets in the insect that can be exploited for insect control.

Anticipated Products:

- Improved pest detection methods in grain.
- New and improved traps and attractants for stored-product insect pests, and improved methods for implementation of monitoring programs and for interpreting results of trap catches.
- Optimization of use of registered conventional and organic insecticides.
- Development of computer-based pest management decision-making programs
- Increased knowledge of pest biology, ecology, behavior, genetics, and biological control agents.
- Development of knowledge of biology and control of emerging pests.
- Identification of novel physiological targets in insects for pest control through genomic and proteomic studies.

Potential Benefits (Outcomes):

- Strategies for improved Integrated Pest Management (IPM) of stored-product insect pests.
- Reductions in losses to stored grains and processed commodities caused by insect pests.
- Reductions in expenditures to manage insect pests.
- IPM tactics that are ecologically sound.
- Development of novel pest control technologies.

USDA ARS Resources:

- Biological Research Unit, Manhattan, Kansas
- Crop Bioprotection Research Unit, Peoria, Illinois
- Insect Behavior and Biocontrol Research Unit, Gainesville, Florida