

# Pest Control Is an Ongoing Effort

Integrated pest management and heat treatment offer economical protection.

It's no coincidence that three of the 10 plagues of Egypt involved insects of one type or another. Ever since humankind learned to grow and harvest grains, a pitched battle has been waged with

the insect world for a share of raw and milled grains.

A century ago, hydrogen cyanide was the fumigant of choice to control insect infestations in grain storage facilities and mills. Methyl bromide replaced it, but its days are numbered as a legal fumigant, and alternatives such as sulfuryl fluoride face an uncertain future.

Indianmeal moths, red flour beetles, and other pests still will need to be controlled at flour mills, pasta plants and other food operations.

Fortunately, scientists at Kansas State University (KSU), Manhattan, and USDA's Agricultural Research

Service Center for Grain and Animal Health Research in Manhattan, are pursuing various options. Much of the work is occurring at Kansas State University, in part because of the prominence of the university's long history in postharvest protection and grain-science faculty. In addition, KSU also is home to the Hal Ross Flour Mill, a 9,628-cubic-meter mill facility that provides a controlled environment, where the efficacy of methyl bromide, sulfuryl

fluoride, heat treatment, and other remediations commercially used in food-processing facilities can be evaluated in controlling eggs, larvae, pupae, and adult life stages of economically important insect species.

## Pest Management



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## Integrated Pest Management

The whole point in using the integrated pest management (IPM) approach is to manage pests below damaging levels, instead of trying to get rid of pests entirely.

The term IPM was part of a fundamental change that occurred during the 1960s and 1970s in California, when researchers and pest management practitioners agreed to the terms "integrated pest management" rather than "pest control." The former

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approach referred to management based on human intervention.

Those scientists determined that managing pest levels instead of trying to eliminate them completely was the more feasible and economical approach.

In using the IPM approach, the idea is to set a threshold level that is manageable. As long as insect populations are below that level, scientists concluded, humans and insects can coexist peacefully.

IPM is an ecologically-sound approach for managing pests, because the concept is to use multiple tactics that are cost-effective, with favorable social and environmental consequences.

IPM has been used successfully in field crops, because scientists have developed thresholds for instituting pest management intervention, when pest density reaches the threshold where some type of action is required to prevent economic losses.

Sampling plans and programs have been developed and implemented for various crops and pests. However, establishing threshold levels that would trigger some type of action plan has not been developed with regard to insects in stored grain and food-processing facilities.

### Standards for Infested Grain

In grain, facilities rely on the U.S. Department of Agriculture (USDA)-Grain Inspection, Packers, and Stockyards Administration (GIPSA) federal grain inspection standards for “infested grain” or grain graded as “sample grade” to be the established thresholds—and these thresholds are higher than thresholds required to take action to make pest management cost-effective.

These standards are enforced at the point-of-sale at grain elevators receiving the grain.

However, what we need are thresholds established by researchers, so that grain can be managed effectively well below the federal standards. In fact, the federal standards dictate very few samples to be taken, resulting in the inability to detect an insect problem in grain delivered to the elevators.

At the same time, farmers can sell infested grain that far exceeds the prescribed thresholds. If a grain elevator rejects a farmer’s grain, the farmer simply takes it to the next elevator, where the operator might dock him five cents a bushel to fumigate the load.

The regulations for wheat, for ex-

ample, require that sampling be done at the elevator to determine if the grain (wheat) has more than two live insects per kilogram.

The nominal probability of finding two live insects in a kilogram of wheat delivered at the elevator by a truck (loaded with 800 bushels or 20 metric tons of wheat), and assuming a uniform distribution of one insect per kilogram, would be one in 27. This means that only one out of 27 trucks would be classified as infested.

In food-processing facilities, standards are dictated by buyers (processors) of grain or by federal agencies like the Food and Drug Administration (FDA) for milled products unfit for human consumption.

For example, wheat flour is unfit for human consumption or further processing if it has 75 insect fragments per 50 grams of flour. These standards are called “defect action levels,” and are considered to offer no health-specific consequences.

Additionally, food companies have pest management programs done internally or, most probably, contracted to an outside service provider. In many cases, very little research-based information is ►

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used to determine why sanitation is done on a regular basis, or why certain applications are made to manage pests.

In the food industry, whole facility treatments with heat, methyl bromide, or sulfuryl fluoride are made on major holidays and not based on pest dynamics.

KSU research shows that such an approach is not cost-effective, because treatments are made when no treatment is needed, and such treatments go against the very principle of IPM, which is making need-based treatment when pests exceed a set threshold. Clearly, no thresholds currently exist for pests in the food industry.

Here is an area where more support and research are needed from a private sector and federal partnership. There has been support from these two constituents in the last decade, but we are still in our infancy, and much work is needed.

#### The Role of Heat Treatment

KSU conducted the first side-by-side comparisons of methyl bromide, sulfuryl fluoride, and heat treatment for managing eggs, young larvae, old larvae, pupae, and adults of red flour beetles—major mill insect pests throughout the

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Flour is a poor conductor of heat, and red flour beetle adults will tunnel into the flour for protection, which increases survival rates.

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world—in the Hal Ross mill in May and August 2009 and May 2010.

In that research, three times more sulfuryl fluoride than methyl bromide was used. Temperatures during heat treatment were held between 50 to 60 degrees C (122 to 140 degrees F). All treatments were limited to 24 hours. All three treatments achieved 90% to 100% kill of red flour beetles in bioassay boxes. Egg mortality was less than 100% with all three, though the differences between them were statistically insignificant.

The only significant difference was in bioassay filled with flour 2-cm-deep (three-fourths of an inch). Heat treatment mortality was 90-96% for certain red flour beetle life stages (eggs, old larvae, and adults), significantly less

than with the chemicals.

This underscores the importance of sanitation for enhancing effectiveness. Flour is a poor conductor of heat, and red flour beetle adults will tunnel into the flour for protection, which increases survival rates.

Air movement is important for heat distribution, so large fans were placed on each floor. Six air exchanges occurred every hour.

KSU has very good data now on all three treatments. One of the things learned is that sulfuryl fluoride really needs to be combined with heat. If temperatures are below 27 degrees C (80 degrees F), the eggs will not be killed. More gas needs to be introduced or the treatment time has to be extended beyond the 24-hour period. Heating the facility to 30 degrees C or higher (85 degrees F or higher) would be more preferable to the other options.

#### Comparing Costs of Heat Treatment

One of my students developed a side-by-side comparison of costs for the three treatment alternatives (i.e., heat, methyl bromide, and sulfuryl fluoride).

Heat treatment costs include pro-

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pane, equipment rental, transportation per diem for four technicians and a one-time \$11,000 cost for fabric ducting to move heat from forced-air gas heaters positioned outside the mill.

Because the ducting was not pro-rated, there was some distortion of the first heat treatment's cost, but overall, the cost of heat treatment was cost-competitive with methyl bromide and sulfuryl fluoride.

The average cost per cubic meter in the mill was \$3.14 for heat, compared to \$3.77 for sulfuryl fluoride. Methyl bromide at \$1.76 was the least costly, but prices are going up as supplies dwindle, and it is not a long-term option, in any case.

The labor costs may not change with size of the facility, but the costs presented here may vary slightly with larger facilities.

A rule of thumb is that changes take 7 to 10 BTUs per cubic foot per hour to 0.07 to 0.10 kW per cubic meter per hour to conduct a heat treatment.

KSU has developed a calculator that companies can license to more accurately estimate the heat demand and cost.

In addition, KSU also developed another software program called EARTH (Efficacy Assessment in Real Time for Heat Treatment) to predict how heat-resistant life stages of the red flour beetle (young larvae) and confused flour beetle (old larvae) are dying, as temperatures are slowly increased over time in heated facilities.

This software has been validated and is ready for licensing to interested heat treatment service providers or food-processing facilities. However, it requires the use of wireless sensors. KSU worked with several food companies that rely on heat for insect control and have documented how heat treatments can be optimized.

KSU research has shown that companies need to use heat for 24 hours, but a great job can be done effectively with a heat treatment lasting less than 15 hours.

Based on KSU data and science, one major food company, which used heat treatment on a monthly basis, cut back its heat treatment time from 34 to 24 hours, with annual savings of \$25,000.

KSU also worked with another company and validated that its heat treatment time of 16 to 17 hours was adequate, as long as it followed good sanitation and pest exclusion procedures.

#### Heat Treatment Calculator

KSU developed a calculator around 2007, which will be copyrighted and

made available via a license to commercial interests.

The calculator provides the heat transfer coefficient for an application based on building specs, such as exposed surfaces, construction materials, heat loss and infiltration, outside temperatures, number and size of windows and doors, and a variety of other attributes.

Essentially, it lets you create a variety of scenarios and determine how much heat energy would be required for the applications, as well as the cost of treat-

ment depending on the fuel you select, all while sitting at the computer.

It's a tool to prevent overheating the space and to help answer the question: "What would be the cost, if I stop generating more heat after 10 hours, when the insects are dead?"

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