Multi-Institutional Methyl Bromide and Alternatives Research Project

Michael Langemeier and Wat Chayaprasert

Heat Treatment Workshop

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Introduction

- Need to examine methyl bromide (MB) alternatives
  - Heat treatment (HT)
  - Sulfuryl fluoride (SF)
  - Integrated pest management (IPM) approaches
- Cost-effectiveness of MB, SF, and HT has not been adequately evaluated
  - Timing of treatment asynchronous with pest population dynamics
  - Data collected at different times of the year
  - Treatment efficacy is difficult to determine
    - Traps capture only adults
    - Immigration of adults from outside facility
  - Important to examine treatments in the same facility under similar environmental conditions and treatment practices

Introduction

- USDA/CSREES Project
  - A 3-year project funded in September 2008
    - www.oznet.ksu.edu/grsc_subi/MBT_project
  - Collaboration between K-State GSI, K-State Ag Econ, USDA-GMPRC, and Purdue University
  - Also supported by food industry service providers (Dow AgroSciences, IFC, Presto-X, Temp-Air) and stakeholders
- Project Goals
  - Analyze cost-effectiveness of MB, SF, and HT in food-processing facilities through research in pilot-scale and commercial facilities
  - Promote and implement MB transition strategies through extension and educational programs

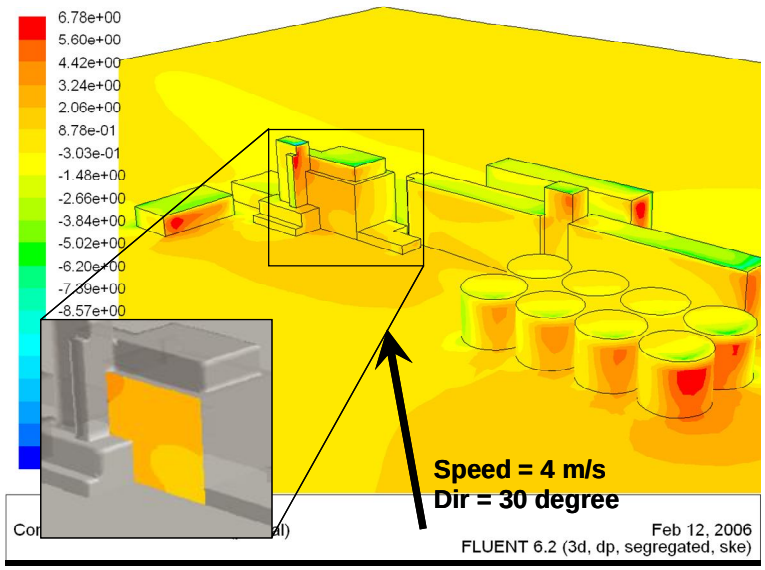
Introduction

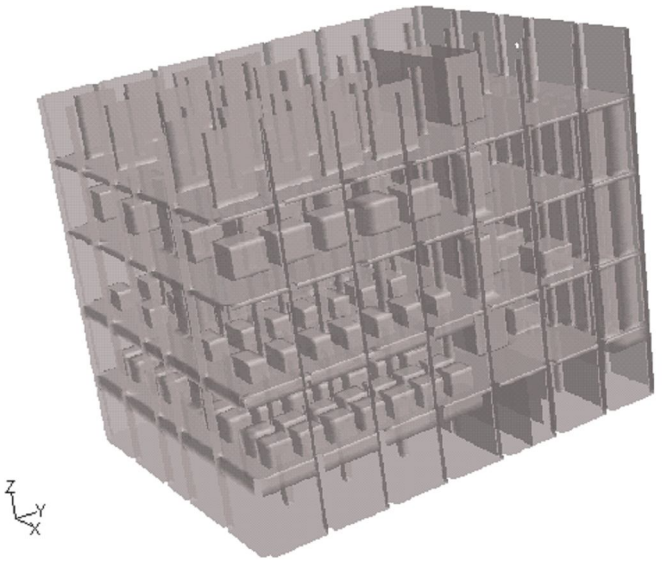
- Project Inputs
  - People
    - Investigators, research associates, and graduate students
    - Food industry stakeholders
    - Pest management service providers
  - Facilities
    - Hall Ross (pilot) mill
    - Commercial food-processing facilities
    - Workshop facilities
  - Finances
    - Support for all project activities

Past Research: CFD Simulation

- Computational Fluid Dynamics modeling
- External flow model predicts average stagnation pressures on the walls
- Average pressures are then used as boundary conditions of the internal flow model to predict gas leakage rates

Geometry of the external and internal flow models

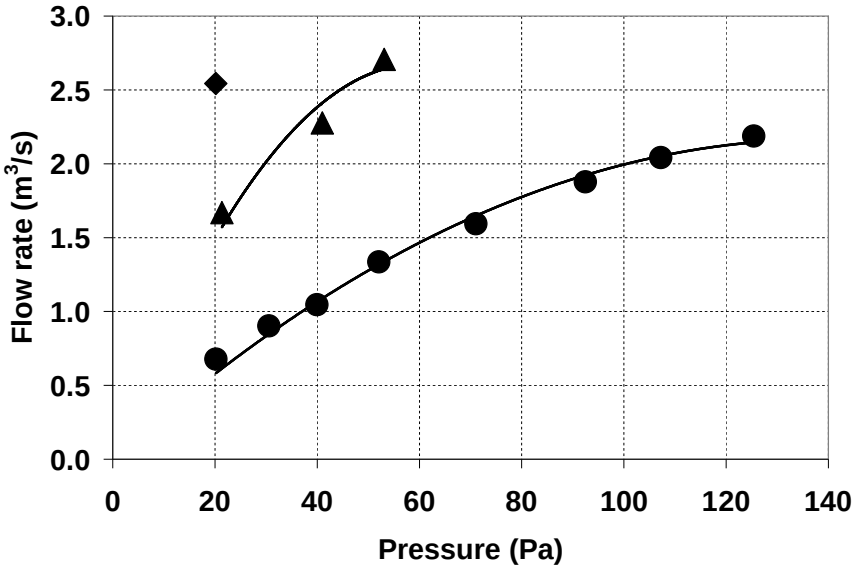




Past Research: Pressure Test

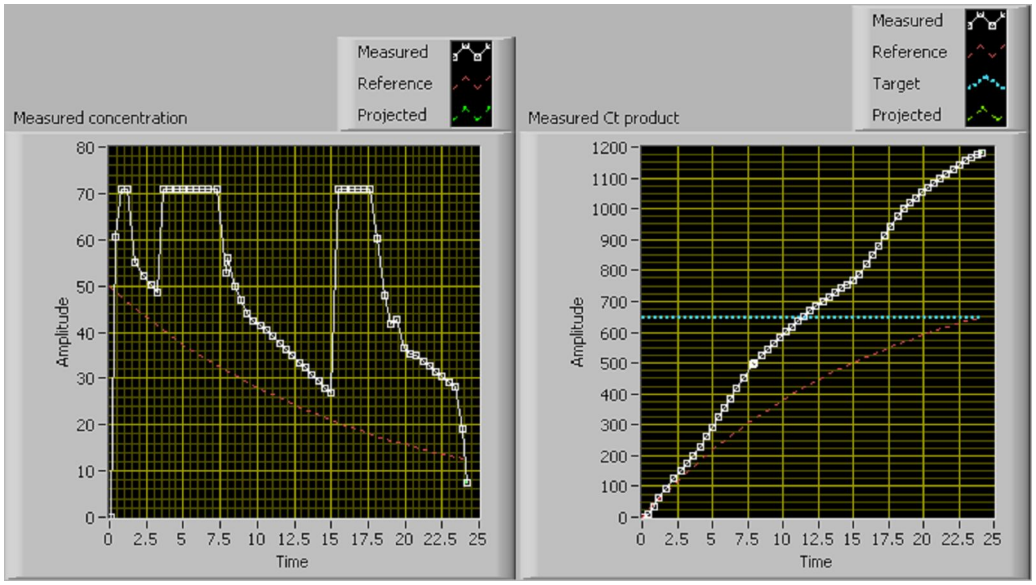
- Allows for quantification of sealing quality ahead of fumigation
  - Prediction of HLT
  - Raise predicted HLT to target HLT with extra sealing if too low
  - Calculate precise gas dosage
- Monitor fumigation to track measured HLT against target HLT
  - Correct fumigation problems in real time
- Available equipment and standard test method

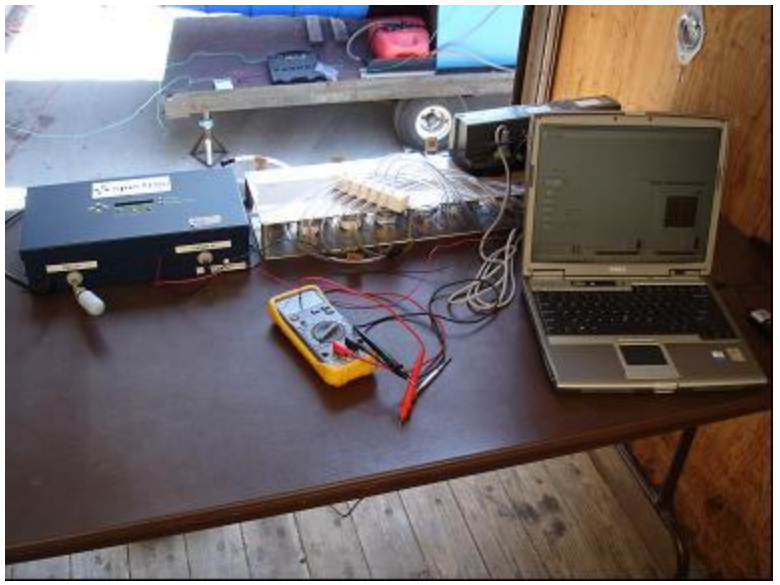
Source: www.infiltec.com



Past Research: Automatic Monitoring System

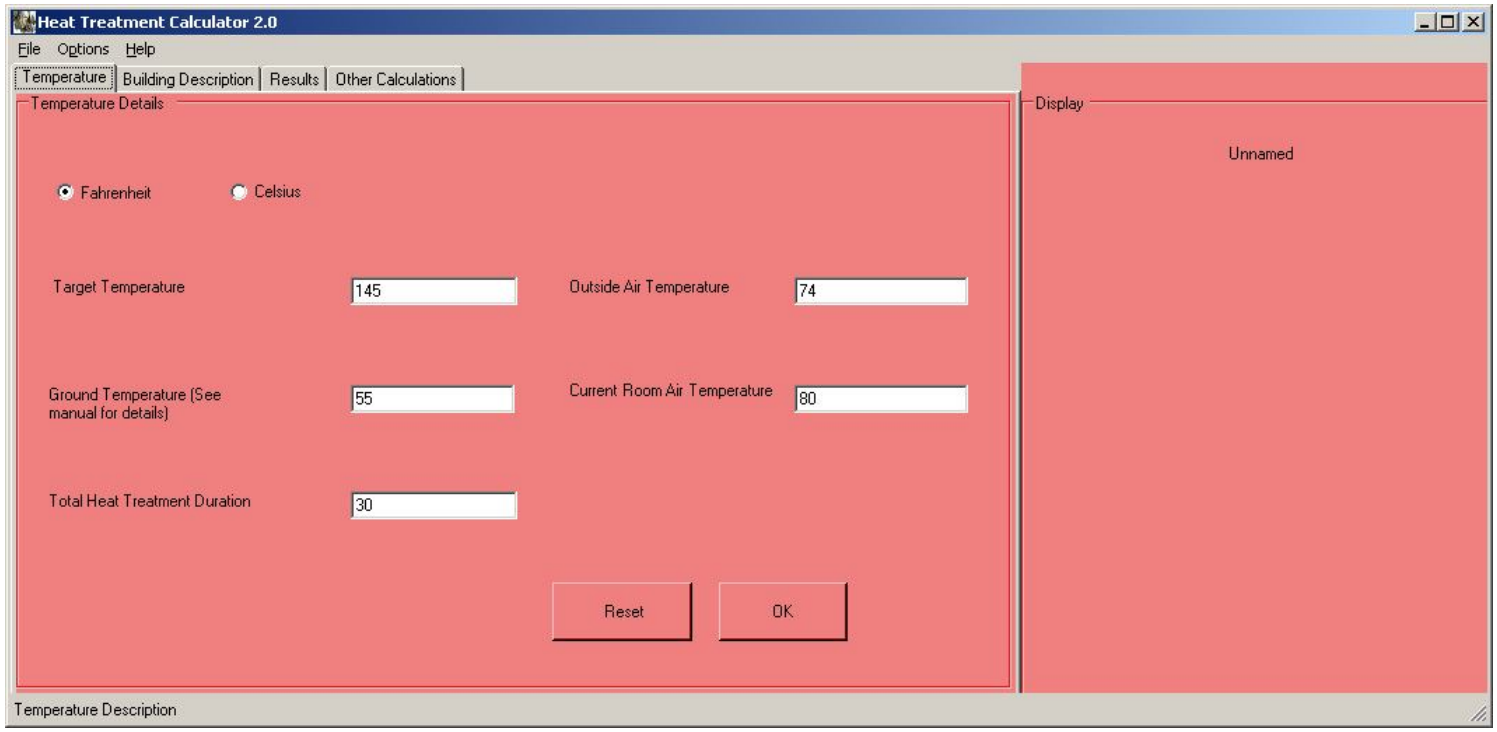
- Gas concentration acquisition
  - Simple tube-and-pump system with associated solenoids and a controller
  - Gas sensing unit
  - Up to 15 channels read in cycles
- Generic fumigation decision support program
  - HLT and accumulated Ct calculation algorithms are similar to Fumiguide
  - Concentration plus Ct product graphic displays





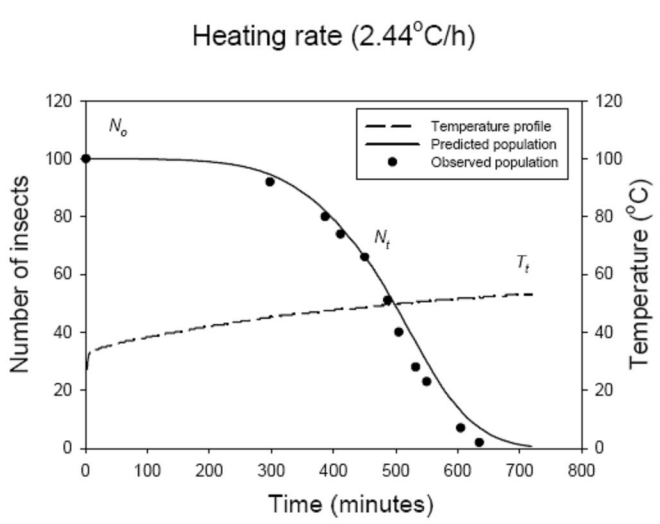
Past Research:
Heat Treatment Calculator

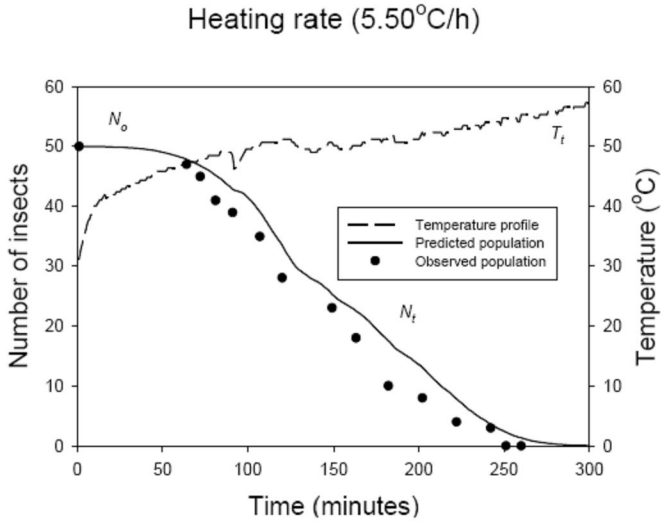
- Heat Treatment Calculator (HTC)
  - Building parameters are inputs
  - Calculates
    - Energy needed to heat a facility to the required temperature
    - Amount of fuel and associated cost



Past Research: EARTH

- Efficacy Assessment in Real-Time during Heat Treatment
  - Software interface for heat treatment users
  - Wireless sensor network
    - Transmits temperature data from various sites to the base station
    - Corrective actions taken based on temperature distribution to improve heat treatment efficiency
  - Thermal death kinetic model
    - Describes mortality of heat-tolerant stages of red flour beetle and confused flour beetle
    - Temperature data from sensor network predicts insect survival in real time





Research Activities

- Apply MB, SF, and HT in Hall Ross (pilot) mill
- Monitor gas and temperature
- Assess efficacy against red flour beetle life stages (eggs, young larvae, old larvae, pupae, and adults at two sanitation levels-dusting and 2 cm high flour))
- Determine costs
- Use precision fumigation, computational fluid dynamics, heat energy, and insect survival models
- Refine and implement models in commercial facilities; train end users to use these techniques

Extension and Education Activities

- Extension
  - Hands-on demonstrations during pilot mill treatments
- Education
  - Seminars, websites, distance education, and printed information

Experiments in Hal Ross Mill

- Bioassays placed at locations at which gas concentrations and temperatures are monitored
  - All life stages of red flour beetles
  - Same 25 locations for all treatments
- Continuous monitoring of outside weather conditions, indoor temperature, and gas concentrations
- Pressurization test before each fumigation treatment
- Document costs associated with each treatment
- Trapping
  - Inside and outside around the perimeter of the mill
  - Before and after treatment
- Implementing CFD model, pressurization test, HTC, and EARTH
  - CFD simulations
    - Predictive function of HLT based on pressurization test and weather conditions
    - Further comparisons of MB and SF fumigations
  - Comparisons between HTC predictions and actual energy consumptions
  - Evaluating and refining EARTH prior to practical use in commercial facilities

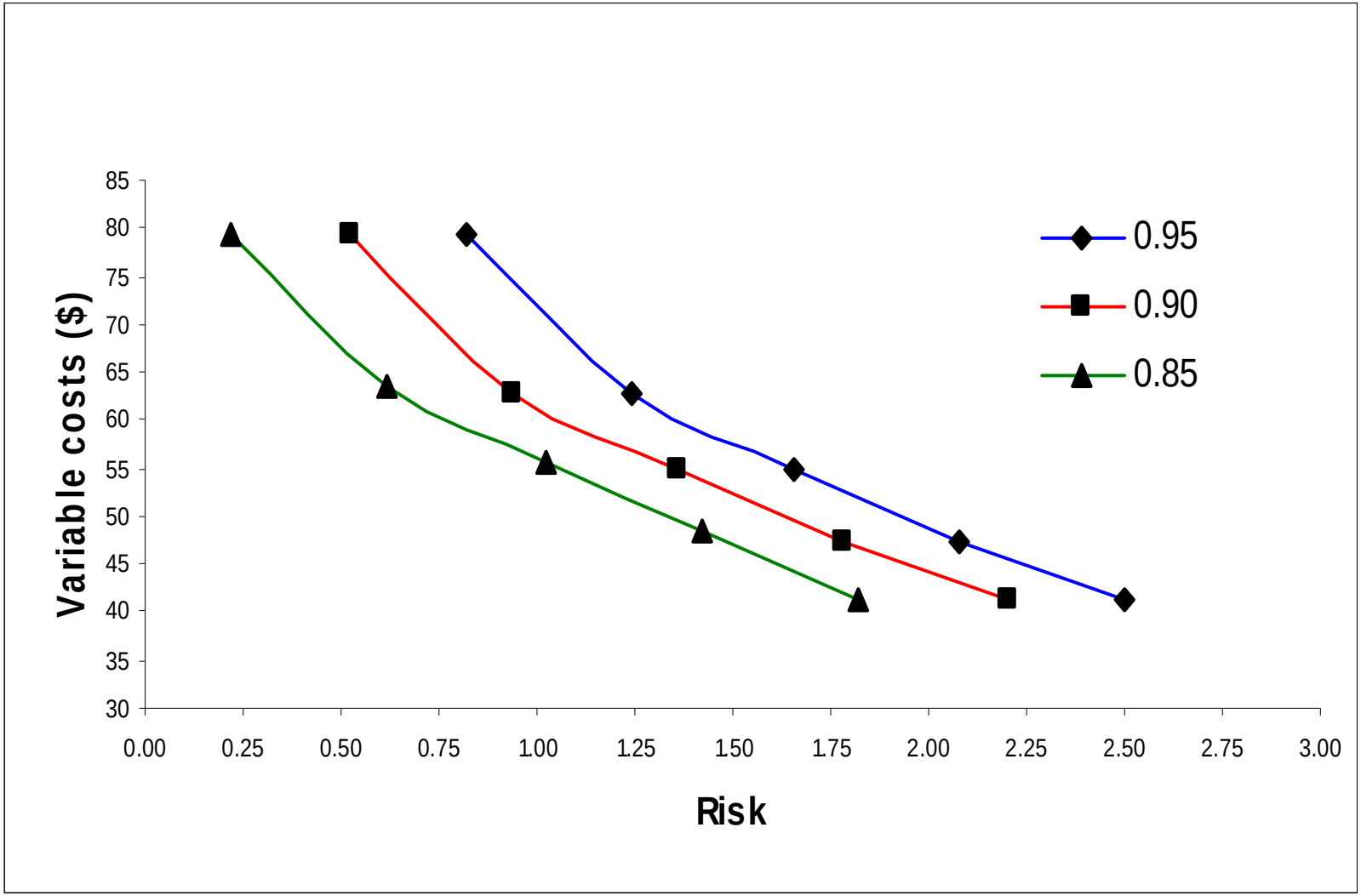
Evaluation in Commercial Facilities

- Collaborate with 15 commercial facilities; 5 facilities for each treatment
  - Open to anyone interested
- Evaluate optimization tactics based on findings from the Hal Ross mill experiments
  - Intensive data collection during normal structural treatment of the cooperating facilities
  - Applications of CFD simulation, pressurization test, HTC, and EARTH to commercial-scale treatments
- Evaluate effects of IPM practices, HT, and fumigation on red flour beetle population
  - Trapping
    - To determine degree and duration of red flour beetle populations
    - To assess spatial variation due to impact of treatments
  - Evaluation based on timing and dosage of MB or SF fumigation, timing and specific location of aerosol pesticide application, and sanitation schedules etc

Economic Analysis

- Past Research: Tilley et al. (2007)
  - An economic model of heat treatment and chemical applications was developed using minimization of costs at a target risk level associated with grain damaging insects.
  - Costs included labor, energy, and fumigants
  - Risk was measured as a deviation below a target mortality goal.

Empirical Risk Model
Tilley et al. (2007)



Economic Analysis
USDA/CSREES Project

- Cost budgets and capital budgeting will be used to compute the costs associated with MB and SF fumigations, and HT in the Hal Ross flour mill and commercial facilities
- Costs include the following: fumigants, monitoring devices, energy, discarded products, labor, opportunity cost of shutting down plant, and equipment costs.

Economic Analysis
USDA/CSREES Project

- Model developed by Tilley et al. (2007) will be used to examine the tradeoff between insect mortality and cost across control strategies.
- This model examines the tradeoff between cost and total deviations below a target insect mortality rate.
- As the model allows for more total deviations below this target, cost decreases.

Outcomes

- Short-Term
  - Increased stakeholder knowledge of MB and alternatives
  - Familiarity with models for optimizing treatment effectiveness
  - Understand fumigant and heat distribution and effectiveness in mills

Outcomes

- Medium-Term
  - Optimize cost-effectiveness of pest management practices
- Long-Term
  - Reduce MB use and emissions
  - Adopt environmentally viable IPM technologies
  - Produce wholesome and unadulterated food and feed products using MB alternatives

Thank You

Questions?