



Protection of Stored Grains and their Products

Goals of Research

Detection, monitoring and control of threats to the safety of our food production and distribution system are of increasing concern to Canadians. Producers and end users continue to benefit from new Agriculture and Agri-Food Canada technologies that keep our food safe and protect our environment while enhancing economic opportunity. In recognition of these priorities, Agriculture and Agri-Food Canada has built a strong research environment to predict and mitigate pest problems during grain storage in bulk or as processed food. The Cereal Research Centre (CRC), located in Winnipeg, Manitoba, provides the expertise and infrastructure to:

- Develop guidelines for safely storing Canadian cereals, oilseeds, pulses and their finished products.
- Identify environmentally sound options to more effectively control insects and microflora in stored grains and grain products.

Challenges in Grain Storage

There are risks and challenges associated with grain storage in Canada that must be considered to ensure the grain remains in good condition:

- Canada has a zero tolerance for pest insects in stored grain for human consumption. This helps Canada maintain its reputation as a supplier of contaminant-free grain for export and domestic use.
- The chemical tools used to maintain Canadian grain and grain products free from insect infestation are becoming more difficult to use. Some stored-product insect populations have developed resistance to insecticides. Because consumers want finished products that have no insecticide residues, there are restrictions on which insecticides can be applied and to which products.
- On average, 54 million tonnes of cereal grains and oilseeds are produced in Canada each year. Annual wheat production averages 26.1 million tonnes. Carryover wheat in farm storage for more than one year averages 8.7 million tonnes. Grain can become wet at harvest, costing over \$50 million to dry. Improved technology and drying practices will reduce overdrying (below 14.5 % moisture content for wheat) costs and energy costs.

- Each stored agricultural commodity has its own specific storage requirements which govern its short- and long-term storability. For example, mould-inducing heating and spoilage were at one time prevalent in stored canola. Subsequently, our group developed safe storage guidelines for canola based on mould development and grain moisture at binning. Industry-wide usage of the guidelines resulted in an improved domestic and export product.
- Every year, moulds infect stored grains in Western Canada because of wet harvests, moisture entering granaries or convection currents in bulk grain caused by temperature differentials. A conservative estimate would indicate 1 to 2 % of grain is mould-contaminated, increasing substantially after wet harvests. Mouldy grain has mycotoxins which affect the health of livestock and marketability of grain.

Recent Advances

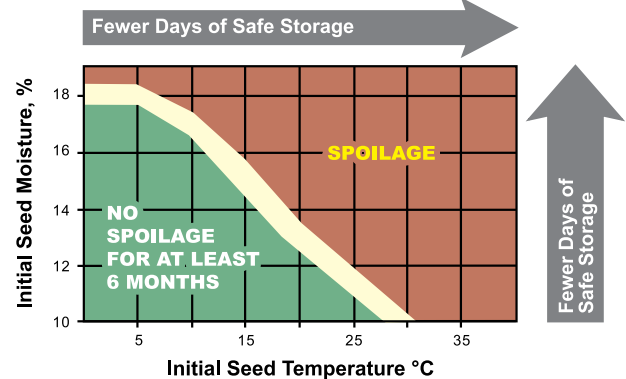
Agriculture and Agri-Food Canada has the responsibility to help producers and processors get safe, nutritious commodities into the marketplace in an economically and environmentally viable way. In response to the needs of Canadian producers and processors, significant progress has been made by the Stored Grain Protection Group on a number of fronts:

- Determined that pneumatic grain conveyors kill virtually all insects in stored grain. Only a low level of survival exists for rusty grain beetles under the seed coat at the germ. This is a practical method of physical insect control and can be used below 10 °C when fumigants are ineffective.
- Determined that dockage testers remove 95 % of all free-living insects in the aspirator pan. This assists elevator operators in rapidly detecting insect infestations.
- Collaborated in the development of improved diatomaceous earth formulations for physical control of insects in mills and stored grain. Protect-It™ is effective at lower concentrations than other formulations.
- Determined that fractions of peas are insecticidal and identified active ingredients so that future insecticides that are non-toxic to mammals can be developed.
- Promoted the use of economical aeration units which can lower moisture content and temperature of bulk grain. Use by grain producers in Western Canada is now increasing.
- Developed safe storage guidelines for canola, canola meal, sunflower, pulse crops (peas, beans, lentils), wild rice, hulled and hullless barley and oats, flax/solin and wheat. These guidelines predict storability of seeds and their products at different temperatures and moisture contents and enable producers and processors to plan sales at the time of optimal prices within the storability period.

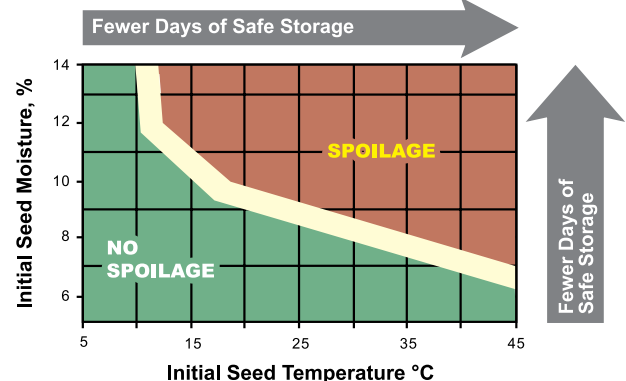


Rusty grain beetles

Safe Storage Chart for Wheat

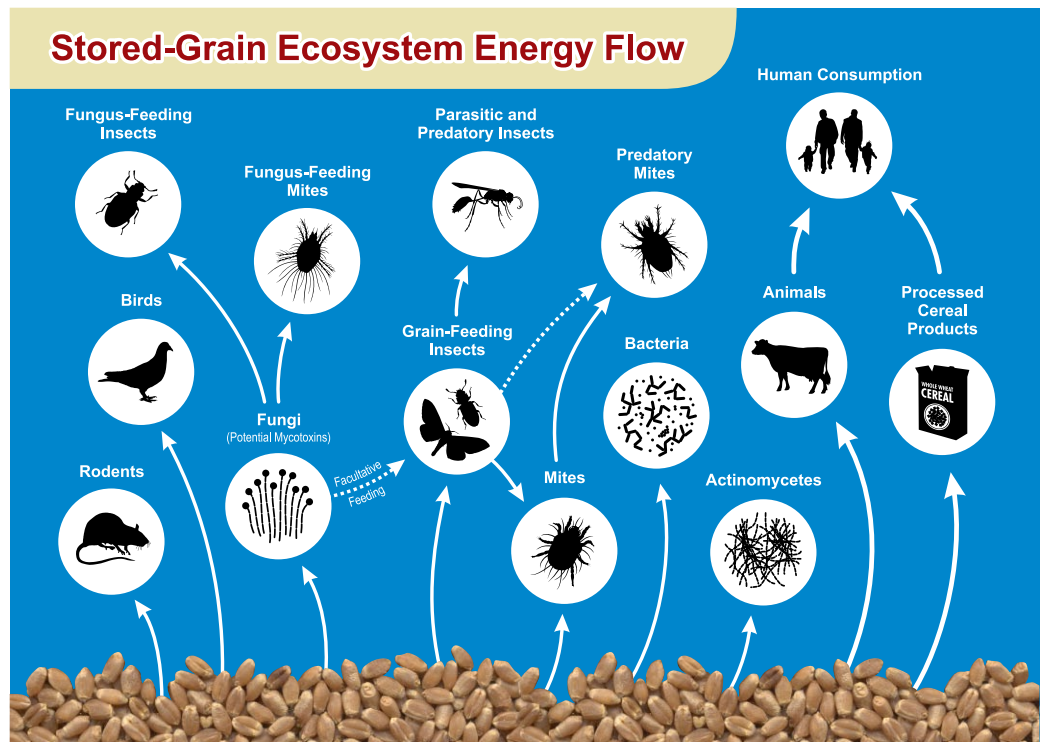


Safe Storage Chart for Canola



Aeration units - fans used to reduce grain moisture or temperature

- Determined the effectiveness of CO₂ alone or with other treatments for controlling storage insects.
- Determined the practicality of CO₂ as a fumigant for insects in stored grain in hopper bins, railcars and elevators. Hopper bins were most practical. Predicted CO₂ levels in grain through modelling.
- Developed an economical kit to retrofit welded steel hopper bins for recirculation fumigation of bulk grain with carbon dioxide from dry ice. Retrofit = \$320; dry ice = \$1.44/tonne; duration = 7 to 10 days.



- Developed a computer-based expert system for safe grain storage under Canadian conditions. (Prediction of safe storage times, pest identification, aeration, fan selection and use).
- Developed and distributed the comprehensive *Canadian Grain Storage CD-ROM* which includes pictures, videos, publications and references.

Our Facilities

Our research laboratories are located on the Fort Garry campus of the University of Manitoba in Winnipeg. We collaborate extensively with staff of the Departments of Biosystems Engineering, Animal Science and Entomology at the University. Facilities comprise a range of structures and equipment designed to conduct laboratory testing or farm-scale storage trials:

- 10 controlled environment chambers to conduct laboratory-scale testing
- Approximately 15 insect species and common storage mould strains used for field and laboratory testing
- 15 'mini bins' for running replicated trials to test grain bulks up to 300 kg
- Six 20-tonne capacity full-floor aeration bins and three additional bins, located at the CRC field station in Glenlea, Manitoba (20 kms south of Winnipeg)
- Facilities for the extraction of grain compounds for biochemical analysis.



Canadian Grain Storage CD-ROM



Our Research Team

The Stored Grain Protection Group at CRC includes

- Noel White, Ph.D. and Colin Demianyk, M.Sc. – physical and chemical control and ecology of storage insects, storage quality, handling properties and industry relations
- Paul Fields, Ph.D. and Tannis Mayert, B.Sc. (Agr.) – physiology and control of storage insects.



(Left to right) Stored Grain Protection Group: Paul Fields, Colin Demianyk, Tannis Mayert and Noel White

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