
**Stored cereal grains and pulses —
Guidance on the detection of infestation
by live invertebrates by trapping**

*Céréales en grains et légumineuses stockées — Lignes directrices pour
la détection de l'infestation par des invertébrés vivants par piégeage*

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16002 was prepared by Technical Committee ISO/TC 34, *Food products*, Subcommittee SC 4, *Cereals and pulses*.

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Introduction

Within the food sector, cereal grains are the commodities which are traded in the greatest quantities. They often form nations' strategic food reserves. They can be stored for varying periods and under differing conditions, and are always susceptible to invertebrate infestation. The risk of infestation varies with the storage methods used, with time, and with the ambient temperature and humidity in the storage area. Even short storage periods in the tropics can result in the development of significantly damaging infestations.

If cereal grains become infested, the consequences can be damage, loss of quality, loss of value, and deterioration of nutritional value, and can lead to illness in animals and humans.

Infested cereal grains can act as a reservoir for the subsequent infestation of sound cereal grains. Infestation can lead to rejection of deliveries, contractual problems, loss of international trade and reputation, and problems with phytosanitary certification under the International Plant Health Convention.

Effective detection of infestation enables informed decisions to be made about if and how cereal grains require remedial treatment. Such treatments, examples of which are given in Annex D, may have implications for the subsequent use of such cereal grains in products destined for animal and human consumption.

Many methods may be used for the detection of live invertebrate infestation in stored grains, but it is considered that the most satisfactory systems for their detection in stored cereal grains and pulses are based on trapping, as described in this International Standard. Some of the other methods are listed in Annex A. These various methods have their own advantages and disadvantages. Methods based on the removal and subsequent assessment of samples are inherently less suitable for insect detection due to the sampling method.

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Trapping for invertebrates in the storage of cereal grains and pulses can be used to detect the existence of pests, to collect specimens for accurate identification, to assess their numbers if action thresholds have been set, and to monitor invertebrate populations after the application of control measures to test their effectiveness.

The standard method (ISO 13690) for the sampling of cereal grains and pulses specifically does not apply to sampling for the detection of infestation. There are standard methods for the detection of hidden infestation [see ISO 6639 (all parts)] but no other International Standard exists for the detection of live invertebrates moving freely within cereal grains and pulses stored in bulk or in bags.

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WARNING — The placement of traps within bulk grain stores will involve access to the grain surface. It is important that operator safety is considered. Access into closed storage silos may be hazardous and due assessment must be made of the risks involved, including entry and exit procedures and the possibility of the presence of noxious gases.

For these reasons, this standard is most applicable to grain which is stored in bulk in open bins and silos, and in flat or floor stores and in sack stores.

1 Scope

This International Standard describes methods for the detection by trapping of live invertebrates in cereal grains and pulses stored in bags or in bulk.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1

grains

cereal grains and/or pulses

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2.2

beetles

species (members) of order *Coleoptera*

NOTE Many weevils within the coleopteran family Curculionidae are highly significant pests of stored cereals, being “hidden infestations” for much of their life cycles. Several other coleopteran families include important grain damaging species.

2.3

infestation

live insect and mite species which, during some stage(s) of their life cycle, are capable of causing damage to the grain

NOTE These are also known as “pest species”.

2.4

invertebrates

multicellular animals without spinal column, with special reference to insect and mite species within the phylum *Arthropoda*

2.5

moths

species of the order *Lepidoptera* (*Heterocera*), which are less brightly coloured than butterflies and fly mainly at night

NOTE Butterflies (*Rhopalocera*) and moths (*Heterocera*) belong to the same order *Lepidoptera*, but butterflies are not encountered in grain storage.

2.6
natural pheromone

chemical scent produced by an animal to affect the behaviour of other animals of the same or very closely related species

2.7
synthetic pheromone

replica pheromone molecule synthesized to duplicate the effect of the natural pheromone

NOTE Synthetic pheromones are frequently used as sex scents to confuse or decoy males of a species, for example in moth traps in agriculture and food storage.

2.8
trap

device designed and intended to retain target species or groups, which have entered its structure, or to entice and encourage them to remain within the device

3 Principle

Insects and mites are detected by physical entrapment, or retention by means of food or other attractants, or both. Physical entrapment devices retain all, or the majority, of invertebrates which enter them since they are designed to preclude escape. Food or other attractants may also be used in devices which attract invertebrates but which do not subsequently prevent their escape. Their effectiveness then relies on the attractiveness of the lure, encouraging a large proportion of the local target invertebrate population to remain in the device.

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Since trapping relies upon insect and mite activity, trapping results in cold or very hot conditions may be markedly different from results obtained in the "normal" range between 15 °C and 40 °C.

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4 General

4.1 The presence of insects and mites in grain storage depends on a range of factors.

The standard of hygiene (sanitation), the type of pest management in operation (temperature and humidity control, percussive methods, for example) and the potential uses to which the grain will be put, can all have a bearing on the significance of insects and mites detected through trapping. See also ISO 6322-2.

4.2 Physical traps depend for their effectiveness on the natural movement of insects, and their entry into trap structures from which they cannot or choose not to escape.

4.3 A baiting device depends on the principle that insects are attracted to a food or other attractant, and once in the vicinity of the bait, they are likely to remain.

4.4 Traps for flying insects depend on the principle that adult insects will fly towards an attractant housed within a trap and are then retained by the device.

4.5 It should be noted that the attractants used in some systems are synthetic pheromones which are mostly effective only for one genus of species and usually for only one sex of that species, often the males. Food-based attractants are generally attractive to many species.

4.6 Unbaited trap systems depend entirely on invertebrates encountering the device by chance and then being retained by the design of the trap. This type is sometimes called "blunder traps".

4.7 The range of insect and mite grain pests which could be expected in grain storage include the following:

- a) grain beetles and weevils whose adults cannot fly;
- b) grain beetles and weevils whose adults can fly;

- c) moth species whose adults can fly;
- d) grain mites which cannot fly and which are only just visible to the naked eye.

The choice of the best trap type is dependent upon the expected range or spectrum of pests and the physical (climatic and local store) conditions under which it is expected to operate.

5 Trap types

Many different types of trap are available. Those listed in Annexes B and C are representative of trap types available in many countries, and are included as a guide to their construction and design. It is known that the use of the various types of trap can give rise to differing results of relative estimates of the infesting pest population within the same storage. Locally made traps, following the principles covered in this International Standard, will provide valuable information on infestation, but their level of efficacy may not be known and thus their results will not be directly comparable with other traps.

Annex B gives examples of trap types, and this and the illustrations in Annex C are included to help in the selection of suitable trapping methods in a variety of food storage situations.

6 Method of trapping

6.1 Trapping in bulk grain

6.1.1 Trapping crawling insects and mites in bulk grain

The variable conditions to be considered are

- type of storage system,
- access to the grain surface,
- exposure to weather,
- tonnage in each bulk mass, and
- length of expected storage period.

The most suitable type of trap should be selected. Probe-type traps (Figure C.1) are inserted in pairs, one trap into the upper 10 cm to 30 cm of grain, and the second trap at a depth of up to 200 cm of grain. Covered combination pitfall/probe-type traps (Figure C.3) should be used in pairs, the upper trap just level with the grain surface and the lower trap at a depth of about 20 cm to 30 cm in the grain. Open pitfall-type traps (Figure C.2) are positioned level with the grain surface. Dust on internal surfaces of the open pitfall trap may help mites, moth larvae and some beetles (notably the rice and maize weevil, *Sitophilus oryzae* and *Zea mays*) which are able to climb some shiny plastic surfaces to escape. For this reason, the inner surface of the rim is often treated with a dried water solution of PTFE (polytetrafluoroethene), which can be cleaned off and replaced at intervals according to the rate of deterioration.

The baited mesh bag trap (a bag made from 2 mm plastic mesh containing mixed food attractant) (Figure C.9) can be used directly on the grain surface, although this is inadvisable if there is significant rodent activity in the store. Its efficacy declines with the age of the food constituents. In some countries, carob or locust bean is chosen as the component most attractive to invertebrates; its aromatic odours gradually decrease on exposure. Other component foods include whole or cracked wheat or maize, flaked maize, oats, groundnuts, and brown rice. The choice of formulation will depend on local supplies, and also on the nature of the grains being stored and known or suspected preferences of target pest species. Invertebrates will remain inside the perforated bag and food by choice rather than by preventing their escape. In most bulk storage situations, the baited mesh bag is more suitable for detecting invertebrates in the structure of the stores, or in sack stores.

All trap types used in bulk grain should be secured by string or other material to marker canes or to the store structure, to ensure their easy location and subsequent recovery. A plan or drawing of the grain surface where the traps are in use can be kept to aid recording of results.

Storage mites, which are up to 0,5 mm length, are difficult to see with the unaided eye, and are frequently dispersed amongst foods and spillage, making visual inspection even more difficult. For the detection of mites within the bulk store structure, attractant lure-type traps are currently the most effective.

A baited plastic refuge-type trap relies on the attractiveness of the high moisture content food-based lure inside a chamber of localized high humidity to encourage mites to enter and remain inside the trap. There is no method to prevent mites from dispersing from the trap, which they will do as the food lure dries out. Therefore mite counts in the trap are only a guide to mite activity, and the frequency of monitoring may need to be increased to optimize count numbers whilst the lure remains at its highest humidity and most attractive.

The baited mesh bag trap can be used for the detection of mites in almost any situation in a store. Its efficacy will be less than the baited refuge trap, because of the lower internal moisture content of the food constituents and the resulting lower humidity. Mites remain inside the perforated bag and food by choice rather than by being unable to escape.

Mite traps can be placed wherever is convenient, at floor level, at approximately 2 m or 3 m intervals, or closer together in targeted trapping. Servicing the baited-refuge mite traps is generally by removal of the entire trap for laboratory assessment, and replacement by another trap. In some designs the replacement is a recycled plastic container with a new lure installed. Replacement intervals depend on the lure remaining fresh and moist, and are generally about 7 days to 10 days. This vary depending on local climatic conditions and, although most baits contain mould inhibitors, the onset of fungal development within the trap may be the practical replacement time.

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6.1.2 Trapping flying insects in bulk grain

The trap types suitable for flying insects (Figures C.4, C.5 and C.8) can be used directly on the grain surface, or suspended between 100 cm and 300 cm above the grain. When deciding trap placement in the grain store, consideration must be given to the patterns for trap placement and for retrieving the traps at each recording interval.

All types, except the exposed adhesive strip trap, are satisfactory in dusty grain storage situations. However, it should be noted that excessive dust deposits may impair their retention efficacy. Where trapping is dependent on pheromone lures, it is important that the lures be replaced according to the manufacturer's instructions, to maintain consistent attraction. In hot tropical climates, pheromone lure renewal may need to be more frequent than standard recommendations to take account of a more rapid rate of evaporation. Unused lures should also be stored at cool temperatures until required.

6.2 Trapping in sack stores

6.2.1 General

For effective detection, trapping techniques should be selected according to the type of invertebrate expected. See 4.7 for more detail. No trap types are mutually exclusive and a combination of types can be used in the same store.

6.2.2 Trapping crawling insects in sack stores

The distribution of traps in a sack store depends on the stacking arrangements and the need for regular inspection of the traps. Some trap types need more frequent maintenance where some of the components should be replaced at recommended intervals. Examples include pheromone dispensers, adhesive base sheets and strips, and oil-impregnated paper disks, all of which have a variable but limited effective life.

As a general guide, traps should be placed in the darker and slightly less accessible areas of the store where invertebrate activity is likely to be greatest, and close to or amongst the bags and pallets. Spacing need not be constant but generally traps can be placed at about 3 m to 6 m linear spacing around the bases of stacks and wall/floor junctions. Vertical distribution will depend on the type of trap and the stacking arrangements. Where possible, traps should also be placed between sacks or, if pallets are used, then flat within the pallets for ease of retrieval.

The folded cardboard box trap with adhesive internal base sheet (Figure C.8) and the plastic tray trap with lid and replaceable adhesive base sheet (Figure C.7) are both dependent on the adhesive being suitably sticky to retain invertebrates which enter the traps. These trap types are seldom baited. However, where food-based sachets or tablets are available to bait the traps, these lures should be replaced at the intervals recommended by the manufacturer.

The flat-based pitfall trap with domed perforated cover may be baited with food-lure tablets or sachets, or with pheromone capsules. This trap type depends on the smooth and shiny internal surfaces preventing invertebrates from escaping, and is therefore less affected by dusty atmospheres in stores. However, mites, moth larvae and some beetles (notably the rice weevil, *Sitophilus oryzae*) are able to crawl up the shiny plastic surfaces and escape.

The corrugated or sheet card cover with integral plastic pitfall type (Figure C.6) is usually baited with a small absorbent paper disk treated with a few drops of an attractive vegetable oil (for example maize oil, sunflower oil, rape oil). Depending on which design of trap is used, airborne dust may be a problem by covering the oil-impregnated disk.

The baited mesh bag trap (Figure C.9) can be used in almost any situation in a sack store. Its efficacy declines with the age of the food constituents. Invertebrates remain inside the mesh bag and food by choice rather than by being unable to escape. Typical food components include kibbled carob pods (locust bean), groundnuts and wheat. Flaked maize has replaced nuts for use in sensitive parts of some food processors where nut contamination may be an important consideration. Oats are also a very attractive food for many beetle species. Brown rice has been successfully used on its own in milled rice stores.

6.2.3 Trapping flying insects in sack stores

Traps used for detecting flying insects are usually positioned in open air spaces, on the top and sides of bag stacks, or on the walls of the store. Their positioning should take account of any servicing required and the need for regular inspection. In general, flying insect traps are baited with pheromone-impregnated capsules and/or food-based lures, and these "targeted" traps are less dependent on accidental encounters by insects.

The bucket- or funnel-type pheromone-baited moth trap (Figure C.4) is most frequently suspended from convenient overhead ceiling or racking positions, or placed directly on the top of stacks. Access for checking moth catches is important, and there should be a method of retaining adult moths once inside the bucket/receiver. This can be achieved by the installation of small dichlorvos-impregnated strips inside the receiver (where these are permitted by national and local regulations), or by placing an adhesive strip either inside the flat base or around the inside walls of the receiver. The trap should also be accessible for regular renewal of the pheromone capsule according to the manufacturer's or supplier's recommendations.

The cardboard or corrugated plastic tent-type trap (Figure C.5) is suspended in a similar manner to the bucket-type trap. It also has a pheromone-impregnated capsule, which requires routine replacement. However its method of trapping depends on an adhesive basal surface beneath the tent structure. Due to the large openings at each end, this type of trap can be affected by airborne dust and the adhesive surface can become ineffective quickly in dusty conditions. A variation of this design uses adhesive surfaces under the top cover, and on the facing base. This type often has slightly restricted end openings, reducing the ingress of airborne dust particles.

Traps which capture flying insects, and are based on an exposed adhesive strip baited with an impregnated pheromone capsule, require replacement of the capsule at routine intervals, according to the manufacturer's or supplier's recommendations. The trap's exposed adhesive surfaces will be adversely affected by airborne dust more quickly than traps with internal adhesive surfaces. Many traps of this type are intended to be completely replaced at pheromone renewal time; their construction is simple and relatively cheap. Positioning