INTERNATIONAL STANDARD

ISO 6322-2

Second edition
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Storage of cereals and pulses —

Part 2: Practical recommendations

Stockage des céréales et des légumineuses —

Partie 2: Recommandations pratiques

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 part of ISO 6322 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6322-2 was prepared by Technical Committee ISO/TC 34, A*gricultural food products*, Subcommittee SC 4, *Cereals and pulses*.

This second edition cancels and replaces the first edition (ISO 6322-2:1981), which has been technically revised.

ISO 6322 consists of the following parts, under the general title *Storage of cereals and pulses*:

— *Part 1: General recommendations for the keeping of cereals*

— *Part 2: Practical recommendations*

— *Part 3: Control of attack by pests*

Introduction

The most important factors affecting the storage of grain are:

a) initial grain temperature and moisture content;

b) condition of the ambient air (with daily and seasonal variations in relative humidity and temperature);

c) attack by pests (birds, rodents, insects and mites);

d) attack by microorganisms (mainly moulds);

e) condition of the storage building and the means and methods of handling.

In general, the condition of grain changes slowly while in storage; the extent of any change depends on ambient conditions at harvest. Changes in moisture content and temperature are limited to the periphery of a bulk or to the outer bags of a stack, unless the storage period is prolonged or the grain is ventilated. Heavy infestations of insects, however, may cause a rise in temperature in the grain mass, possibly due to the development of fungi. The temperature gradients produced may cause sufficient migration of moisture to cause damage; i.e. sprouting and damage by enzymatic and chemical actions.

It is therefore important that sound, dry, clean grain, free from infestation, is stored in sound, clean storage containers free from infestation and that subsequent deterioration is prevented by keeping the grain as cool and as dry as possible.

Grain may be stored either in the open, or in a specially constructed store or other container. The choice of the method of storage is often dictated by different criteria: the state of the grain at harvest; transport, labour and materials costs; duration of storage; and other technical and economic factors.

A distinction should be made between grain stored in sacks and grain stored in bulk. Furthermore, for bulk grain there is a difference between grain stored in heaps in buildings (flat bottom storage) where it has a larger surface area exposed in relation to its volume, and grain stored in silos (vertical storage), where it has a smaller area exposed in relation to its volume.

Storage of cereals and pulses —

Part 2:
Practical recommendations

1 Scope

This part of ISO 6322 gives guidance on the choice of a method of storage of cereals and pulses, and on the practical recommendations for good storage, according to the method chosen. Other aspects of the storage of cereals and pulses are dealt with in ISO 6322-1 and ISO 6322-3.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 6322. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 6322 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6322-1, *Storage of cereals and pulses — Part 1: General recommendations for the keeping of cereals.*

ISO 6322-3, *Storage of cereals and pulses — Part 3: Control of attack by pests.*

3 Handling

Any storage system requires a means for moving the commodity into and out of the store. These should be selected to minimize damage to or deterioration of the grain and the storage containers. As far as is practical, these means should limit dust emissions in the building or its immediate environment.

4 Storage in the open

4.1 General

Storage in the open is the cheapest but the least satisfactory method. There is high risk of attack by birds, rodents, insects and mites (see ISO 6322-3), development of fungi, damage by bad weather, theft and other mishaps. Generally, such storage should be for short periods only. Open storage may be used for bumper harvests when other stores are full. It should be in a dry, cool place.

4.2 Uncovered storage

Uncovered storage is less undesirable in dry countries, where a short, sharp shower will only affect the surface (to a depth of up to 5 cm) and subsequent sunshine will dry out the grain again. Such exposure, however, may result in damage by bleaching. Storage under snow or in cold climates is also practicable because the low temperature

restricts insect and mould development. Even so, a few toxin-producing fungi can grow at near freezing temperatures on grain wetted by the snow and therefore great care is needed if this method of storage is used.

Storage in the open should, if possible, be on a "hard standing" surface or another prepared smooth surface, preferably raised 0,5 m above ground level, and featuring an insulating system giving protection against running water and moisture rising from the ground, and allowing a complete removal of the grain.

With bulk grain, artificial ventilation of the heaps is sometimes desirable but not always possible.

4.3 Covered storage

Sometimes, a temporary roof, for example of corrugated iron on a wooden frame, may be erected over a stack of bagged grain or a heap of bulk grain; "walls" of hessian curtains or tarpaulins may be used to give additional protection against the weather.

Alternatively heaps of grain (bulk or bagged) may be covered with waterproof tarpaulins provided that suitable precautions are taken against sun and consequent sweating. It is good practice to fold back these tarpaulins on dry days to allow any condensed moisture to evaporate. The cover should be tightened by heavy objects (tyre, sandbag, breeze-block, etc.) placed at the foot of heaps.The cover should overlap at least 50 cm taking account of the direction of the dominant wind.

Unthreshed maize is commonly stored in open-sided cribs, for example with wire-mesh sides, to allow drying to take place where atmospheric conditions are favourable. Maize on the cob can be stored relatively easily and safely, as it has not suffered mechanical damage due to threshing. It is essential to cover the open-sided cribs, to avoid rain getting into the cereals and to restrict mould growth. Special attention should be given to protecting maize from birds and rodents (see ISO 6322-3).

5 Storage in specially constructed buildings other than silos (flat stores)

5.1 General

The objectives of putting grain in buildings are protection from the weather, prevention of the entry of pests, and security. Ideally, such storage should permit some control of temperature and humidity, to keep the grain as cool, as dry and at as uniform a temperature as possible. The structure should be properly built to provide good storage conditions, easy access and safe working conditions, and should not provide harbourage for pests.

5.2 Construction of the building

5.2.1 Site and foundations

The orientation should be such that radiant heat gain from the sun is minimal; i.e. with the long axis north-south in the temperate zone, and with the long axis east-west in the tropics. The foundations should be of adequate strength to take the weight of the building and of the grain filling, and should be termite proofed where necessary. The surroundings should be kept clear of vegetation, rubbish, flooding or water logging, etc. There should be direct access for appropriate forms of transport.

5.2.2 Floor

The floor should be sound, smooth, hard and waterproof. "Tamped" earth is not recommended. A wooden floor has cracks and crevices which can harbour rubbish, insects and mites. A smooth and hard surface usually means concrete of good quality treated with a hardener to prevent dust. A walled construction joined to the ground by a curved, smooth profile without projections eases cleaning. The water barrier should be carried through to the damp-proof course in the walls; usually it is "sandwiched" in the concrete.

The foundation of the stock should be constructed above ground level or, where it is downstream, above the highest water level in order to avoid flooding.

5.2.3 Walls

The walls should be sound and smooth, and, if permitted by local regulations, light in colour (usually white) on the outside to reduce the absorption of heat. In tropical countries, some insulation may be desirable. The construction should avoid having "dead spaces", and the interior plastering should be free from cracks.

Walls of buildings may be constructed of different materials in accordance with local availability and practice: timber (not recommended), clay bricks or blocks, bricks or masonry. They should be covered on the interior with a coating. They can also be in galvanized iron, aluminium, poured-on-site concrete or reinforced concrete. Hollow concrete blocks are not generally recommended (unless filled in) as they can harbour rodents and insects.

It is important that the construction be strong enough to withstand the pressure exerted on the walls by the grain.

5.2.4 Roof

The roof should be sound, waterproof and, if permitted by local regulations, light in colour (usually white) on the outside. Girders and supporting pillars should be avoided as far as possible. Supporting pillars do not present problems on the side of stores, however in the middle they cause obstructions to the loading/unloading, cause grain stacking and decrease the store capacity. Grain shall not be stacked around pillars because of fumigation problems. If the roof is flat, it should have a slight slope so that rainwater runs off. In the tropics a pitched roof with wide eaves helps insulation. The roof should be a good thermal insulator, not affected by condensation, and give protection against attack by pests and moulds. It should be designed so as not to provide harbourage for insects and mites. These measures require attention to the sealing between walls and roof, and protection of all possible openings with a finely meshed grill. An internal ceiling is not advised, as it may provide harbourage for predators. Roofing materials include tiles, slates, bituminized felt and galvanized iron or aluminium sheet.

All drain pipes from roof gutters should be external. It is bad practice to have pipes running down the insides of buildings, as they act as a harbourage for insects and mites and as runways for rodents, and, if defective, can allow rainwater to damage the grain. All external water and drain pipes should be fitted with sheet metal rat guards to prevent rats gaining access to the store eaves. Pipes should also have mesh baffles fitted inside their lower open ends.

5.2.5 Doors and windows

Ventilation should be controllable. In a nearly full building, the grain itself largely controls the conditions in the store. Permanent natural ventilation is not desirable, as it may let in moist air. However, a certain degree of ventilation shall be possible at certain times of day to obtain the required coolness. This coolness can be helped by shading by slatted windows, provision of wide eaves, etc.

Ventilation apertures are vital for the circulation of air. They should be small but suitable for the size of the building and positioned in the upper part of the walls. These apertures should be fitted with an anti-bird grille on the outside and with a mesh on the inside.

A suitable meshed ventilation duct should be placed in each gable so that warm air accumulating under the roof can escape.

Roof lights and windows should be kept to a minimum or avoided. They should be left open as little as possible. Windows should be protected by mesh grilles to keep birds out when the windows are open.

Store doors should close tightly and should, if possible, be made of metal. If they are made of timber, the lower part of both the door and the frame should be covered by a steel strip protecting them against attack by rodents. In certain areas, it is useful to protect them with a canopy against rain.

The number of doors will depend on the required frequency of access to the stored product. The size of the doors depends on loading/unloading operations (e.g. if trucks need to enter the store). The design of loading doors should take into account the difficulties in maintaining them rodent-proof in service.