SILOS CORDOBA

Storage and conditioning of wheat to maintain its quality

Recommendations for the storage of wheat in a metal silo.

Storage of wheat to maintain its quality

RECOMMENDATIONS FOR THE STORAGE AND CONDITIONING OF WHEAT

The proper performance of all the **processes involved in the post-harvest handling** of grains and oilseeds, which includes their **storage, transport and post-harvest conditioning**, is essential to **maintain the highest quality.** Adequate conservation measures are essential, since deterioration during storage can be very rapid due to the effects of grain respiration, which can cause the development of fungi and insects that proliferate easily in optimal humidity and temperature conditions.

Different cereals may require specific conditions. In the case of wheat, there are 3 important factors to be controlled in order to keep it in optimal conditions:

- **Innocuousness** (insecticide residues and presence of mycotoxins), a necessary condition to ensure food safety.
- **Need to segregate by quality.**
- **The effect of drying on the quality of the wheat.** It is necessary to control the drying temperatures, so that the gluten proteins are not damaged, as the process is not reversible.

POST-HARVEST HANDLING OF WHEAT AND ITS EFFECTS ON QUALITY

The main processes involved in the post-harvest handling of wheat are **cleaning, storage, aeration, drying and pest control.** If all these processes are adequately performed, the highest quality of wheat will be maintained.

SCG Silos Grupo S.L. | Glorieta de las Tres Culturas Nr. 1, 4º A . 14011 Córdoba. Spain | T +34 857 835 623 | info@siloscordoba.com | www.siloscordoba.com

Storage of wheat to maintain its quality

CLEANING

Before storage, the cereal is cleaned by a pre-cleaner, that removes dust and light particles from the wheat (grains of other cereals, stones, straw, etc.). This process leaves more room for the storage and leaves the wheat clean, improving its conservation.

STORAGE

Fungi and insects are the main cause of the loss of grain quality during post-harvest. To reduce the damage they may cause, it is very important to control the relative humidity, producing unfavorable conditions for their development.

When the relative humidity is less than 67%, the storage is safe, since the development of fungi occurs at 71% or more.
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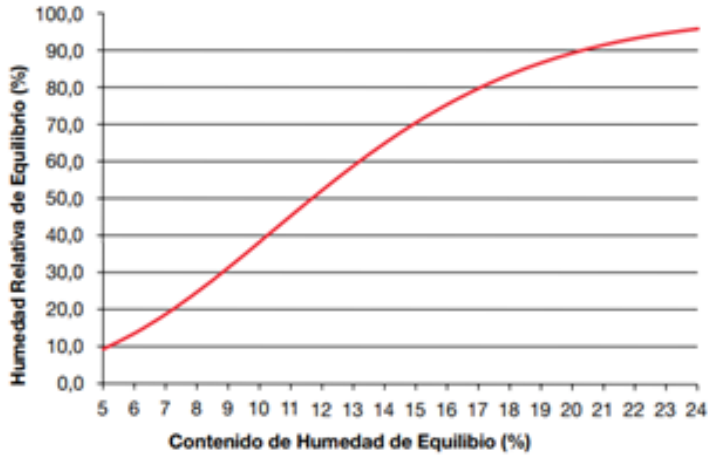
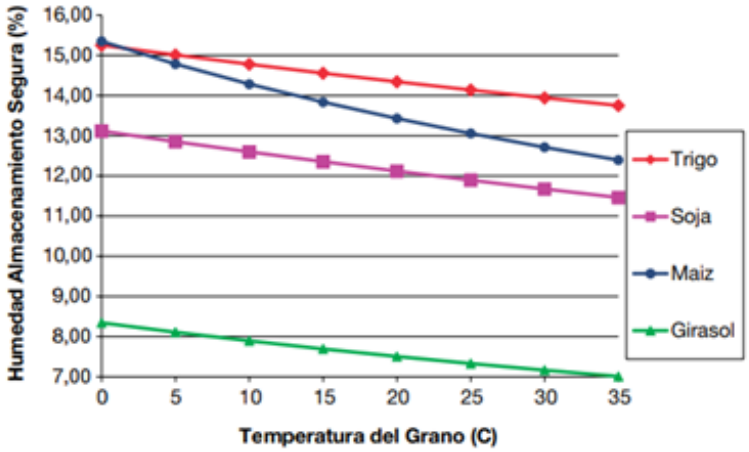
Equilibrium moisture content of wheat (20º isotherm)



Safe storage humidity of different grains



Source: ASAE, 2001

Storage of wheat to maintain its quality

The equilibrium moisture content determines the humidity to which a grain can be dried under particular conditions of relative humidity and air drying temperature.

To monitor the condition of stored grains, we use thermometry, a technology that allows us to detect temperature increases, enabling us to correct them by aeration, which avoids grain damage.

How to choose the most adequate grain storage system

Whilst the choice of grain storage methods is wide, the most popular ones are steel silos, concrete silos, storage warehouses and bag silos among others.

Features of Main Storage Systems

Features	Steel silos	Concrete silos	Warehouse	Silo bag
STORAGE	Bulk	Bulk	Bulk or bags	Bulk
RETRIEVAL	First-in, First-out	First-in, First-out	Last-in, First-out	Depending of the needs
SPACE REQUIREMENT	Vertical storage, less space	Vertical storage, less space	Horizontal storage, more space	Horizontal storage, more space
GRAIN QUALITY	Control by Temp. monitoring system , Aeration, PLC, etc.	Control by Temp. monitoring system , Aeration, PLC, etc.	Possible but not accurate	None
GRAIN LIFE	At 12% mc storage & low temperature. Long period	At 12% mc storage & low temperature. Long period	Here it will be much lesser	Un predictable
GRAIN HANDLING	Mechanized	Mechanized	Manual – Mechanized	Manual – Mechanized
DESIGN	Simple design, simple to erect	Complicate: rebar placement, concrete quality, longer com-missioning	Simple	Simple
OPERATIONAL COST	Relatively less, (initial investment)	Relatively less, (initial investment)	Higher	Higher
FOUNDATION COST	Medium – high	High	Medium	None
WASTAGE	Less than 1%	Less than 1%	Could be up to 34 %	Could be up to 34 %
INFESTATION	Practically nil	Practically nil	Open to attack by birds, rodents, termi-tes, pets, fungi, mold, fermentation, etc.	Fungi, mold, fermen-tation, insects, et.

Galvanised sheet metal silos are currently the best alternative for grain storage thanks to their versatility, easy assembly, hygienic handling and low storage cost.

Storage of wheat to maintain its quality

AERATION

Aeration helps to maintain grain quality during the storage by forcing movement of ambient air through the grain mass.

This process allows us:

- To keep the grain temperature as low as possible, thus favoring longer storage periods.
- To maintain a uniform temperature, thus avoiding areas of humidity in the grain stored in a silo.
- To dry specific areas of humidity. This requires a lengthy operating time and an adequate air flow. Drying wheat with natural air is more difficult than other grains such as soybeans or sunflower seeds.

Aeration helps to avoid the risk of insect development in dry grains, since they develop at high temperatures (between 25° and 33°). The objective is to keep the product between 17°-25°. Moreover, when the development of insects is interrupted, the activity of fungi is also reduced.

Aeration must be used frequently to maintain the temperature at the appropriate values, thus avoiding grain heat. We must be careful not to store wet wheat, since biological activity raises the temperature of the product. In order to avoid over-drying, we can install an automatic aeration control that benefits from operating at the optimal hours of the day.

When grain cannot be cooled by ambient air, either due to the season of the year or to the geographical area, it is necessary to use artificial refrigeration, which cools the product through refrigeration equipment that transforms the ambient air and introduces it into the silo at a temperature lower than the ambient temperature and also allows control of the moisture content in the air, thus avoiding over-drying or re-wetting .

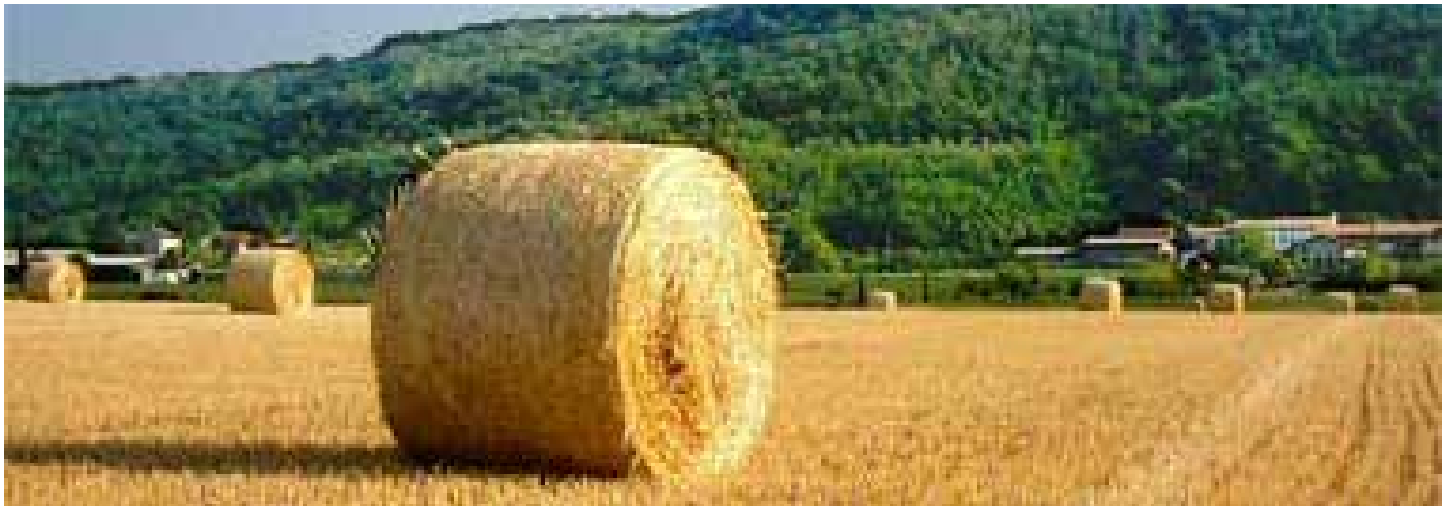
DRYING

Drying is the process that reduces the moisture content of the grain to a safe level for storage.
The final quality of the grain can be affected by:

- Excessive grain temperature inside the dryer.
- Long exposure time at high temperatures.
- High drying rate and/or high cooling rate (rapid cooling).

The quality damage will depend on the grain type and its end use. In the case of wheat, if the gluten proteins are damaged by the high drying temperatures, the process is irreversible, so it is recommended that the temperature of the grain never exceed 43° inside the dryer.

Storage of wheat to maintain its quality



PEST CONTROL

The development of microorganisms and insects has a negative influence on the quality of the stored grain and can cause serious qualitative losses such as:

- Reduction in the grain weight.
- Increase in the percentage of damaged grains.
- Decreased germination capacity of the seeds.

To prevent infestation, the main recommendations are the following:

- Thorough cleaning of the storage plant.
- Treatment of the empty facility before receiving the new harvest.
- Cooling of the grains by means of aeration or refrigeration.

Prevention must be carried out in a sustained way over time: before, during and after the arrival of the grain to the silo. Constant monitoring will allow you to make the best decision at the right time.

Storage of wheat to maintain its quality

Wheat storage plants by Silos Córdoba worldwide:

2005 | Vitaflora Slovakia

Plant conceived for the storage of wheat and rape.
The total capacity of the plant is 95.700 m³ for the storage of 72.000 T of cereal. The project includes:

- √17 silos model 20.63/15 of 5.906 m³ capacity each.

2005 | Jurex Slovakia

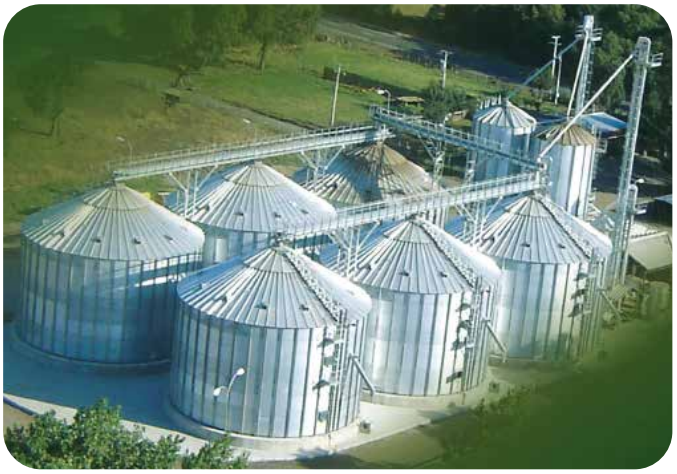
Plant conceived for the storage of wheat and rape.
The total capacity of the plant is 37.083 m³ for the storage of 27.800 T of cereal. The project includes:

- √2 silos model 9.17/8 of 661 m³ capacity each.
- √6 silos model 12.22/14 of 2.010 m³ capacity each.
- √20 hopper silos model 4.58/7 of 157 m³ capacity each.
- √6 silos model 14.51/6 of 3.427 m³ capacity each.

2006 | Agrícola Sumaya Chile

Plant conceived for the receipt, drying, precleaning and storage of wheat and maize. The total capacity of the plant is 18.500 m³ for the storage of 13.875 T of cereal. The project includes:

- √6 silos model 15.28/13 of 2.987 m³ capacity each.
- √2 hopper silos of 200 T.
- √It includes a ventilation and temperature monitoring system.



Storage of wheat to maintain its quality

2006 | Teal Perú

Execution of turn key project for the storage of wheat.
The total capacity of the plant is 13.520 m³ for the storage of 10.140 T of cereal. The project includes:

- √ 2 silos model 20.63/16 of 6.760 m³ capacity each.
- √ Flow scale.
- √ Conveying systems.
- √ Electric equipment.
- √ Ventilation and temperature monitoring systems.
- √ The project also includes the execution and turn key delivery of 5 process conic silos model 6.11/16 of 583 m³ capacity each.

2007 | Spomax Poland

Plant conceived for the storage of wheat.
The total capacity of the plant is 12.890 m³ for the storage of 10.000 T of cereal. The project includes:

- √ 10 silos model 9.17/15 with 45° cone of 1.289 m³ capacity each.
- √ Catwalks, towers and supports.

2008 | Tien Hung Vietnam

Plant conceived for the storage of wheat.
The total capacity of the plant is 8.184 m³ for the storage of 6.000 T of cereal.
The project includes:

- √ 6 silos model 9.17/16 with 45° cone of 1.364 m³ capacity each.
- √ Catwalks and supports.
- √ The conveying machinery has been delivered by Silos Cordoba.

Storage of wheat to maintain its quality

2009 | Giay Vietnam

Plant conceived for the storage of wheat.
The total capacity of the plant is 10.264 m^3 for the storage of 7.700 T of cereal. The project includes:

- √ 4 silos model 13.75/14 of 10.264 m^3 capacity each.
- √ Filling up is done at 100 T/h and unloading is done at 50 T/h.
- √ The conveying machinery has been delivered by Silos Cordoba.

2009 | Pozo Spain

Animal compound feed manufacturing plant with a production of 15 T/h for meals and 25 T/h for granulation. The project includes:

- √ It has a 120 hp mill, a 200 hp granulating press and lubrication system.
- √ The project includes also the manufacturing and assembly of 4 conic hopper silos model 9.17/12 with a total capacity of 4.252 m^3
- √ It includes a bulk load system and baling machine.
- √ Silos Córdoba has provided the full automation.

2009 | Constanza Romania

Plant conceived for the storage of wheat, barley, rape, corn, sunflower...
The total capacity of the plant is 218.960 m^3 for the storage of 164.000 T of cereal. The project includes:

- √ 17 silos model 24.45/22 of 12.880 m^3 capacity each.
- √ Filling up is done at 1.200 T/h.

Storage of wheat to maintain its quality

2009 | Alicorp Peru

Wheat processing and storage plant.
The total capacity of the plant is 37.504 m³ for the storage of 28.128 T of cereal. The project includes:

- √ 4 silos model 22.92/18 of 9.376 m³ capacity each.
- √ Grain temperature monitoring systems.
- √ Filling up is done at 300 T/h and unloading at 150 T/h.

2012 | Dan Kazakhstan

Project conceived for the storage of wheat and barley.
The total capacity of the plant is 15.837 m³ for the storage of 11.875 T of cereals. The project includes:

- √ 3 silos model 18.33/16 of 5.279 m³ capacity each.
- √ Loading and unloading is done at 120 T/h.
- √ The conveying machinery has been delivered by Silos Cordoba.
- √ It includes temperature monitoring system and ventilation.

2012 | Tiryaki Turkey

Project conceived for the storage of wheat and canola.
The total capacity of the plant is 250.168 m³ for the storage of 200.000 T of cereal. The project includes:

- √ 19 silos model 18.33/22 of 7.110 m³ capacity each.
- √ 11 silos model 14.51/22 of 4.395 m³ capacity each.
- √ 27 truck loading silos mod. 4.65/6 of 147 m³ capacity each.
- √ 6 silos model 21.39/22 of 9.752 m³ capacity each.
- √ 4 45° conic silos model 9.17/12 of 1.063 m³ capacity each.
- √ The conveying machinery has been delivered by Silos Cordoba.
- √ Loading and unloading is done at 300 T/h.

Storage of wheat to maintain its quality

2013 | Adunati Romania

Plant focused on the storage of wheat, corn, rape and sunflower.
The total capacity of the plant is 8.046 m³ for the storage of 6.000 T of cereals. The project includes:

- √ 6 silos model 12.22/9 of 1.341 m³ capacity each.
- √ Dryer for maize model SCM 2-6 with a total capacity of 5 MT per hour able to reduce moisture content from 24% to 14%. Furnace use biomass.

2015 | Berte Qvarn Sweden

Plant conceived for the storage of wheat.
The total capacity of the plant is 12.300 m³ for the storage of 9.200 T of cereals. The project includes:

- √ 3 silos model 18.33 of 4.100 m³ capacity each.
- √ The assembly of the silos has been performed by our own assembly team.

2015 | Obrinel Uruguay

Plant conceived for the storage of wheat at Montevideo Port.
The total capacity of the plant is 161.312 m³ for the storage of 121.000 T of cereal. The project includes:

- √ 12 silos model 27.50/17 of 13.083 m³ capacity each.
- √ 1 hopper silo model 10.70/16 45° of 1.893 m³ capacity each.
- √ 2 hopper silos model 5.35/6 60° of 194 m³ capacity each.
- √ 2 hopper silos model 8.40/13 45° of 944 m³ capacity each.
- √ 1 truck load silo model 4.65/6 60° of 147 m³ capacity each.
- √ Central handling tower of 9,3 X 9,3 X 45m height.
- √ Secondary central handling tower of 9 X 7 X 28m height.
- √ Weighting area 12 X 6,5 m.
- √ Loading and unloading is done at 800 T/h.
- √ It includes as well a truck dumper platform, conveyors, bucket elevators and accesories.

Storage of wheat to maintain its quality

2016 | Indeika Russia

Plant conceived for the storage of maize and wheat to provide the feed factory located at Tambov Region, Russia. The total capacity of the plant is 111.924 m³ for the storage of 80.000 T of cereals. The project includes:

- √ 6 silos model 32.08/16 of 17.237 m³ capacity each.
- √ 4 silos model 9.17/12 45° of 1063 m³ capacity each.
- √ 10 silos model 6.88/08 60° of 425 m³ capacity each.
- √ Raw material reception by train and truck.
- √ Load is done at 200 T/h.
- √ Unload is done at 120 T/h.
- √ Pre-cleaners.
- √ Dryers.
- √ Filtration systems.

2017 | Irchenko Elevator Kazakhastan

This plant is conceived for the reception, storage and expedition of wheat. The total capacity of the plant is 54.300 m³ for the storage of 40.750 T of cereals. The project includes:

- √ 8 silos model 22.92/12 of 6.500 m³ capacity each.
- √ 4 silos model 6.88/6 60° of 352 m³ capacity each.
- √ 2 silos model 6.11/9 60° of 360 m³ capacity each.
- √ 2 silos train expedition modelo 4.65/3 60° of 88 m³ capacity each.
- √ Hopper Silo.
- √ Reception, loading and unloading at 100 TPH.
- √ 2 receiving hopper for trucks and 1 receiving hopper for train.
- √ 2 pre-cleaning and cleaning lines, 2 drying lines.
- √ Elevator tower designed to have inside the cleaning system and 10 bucket elevators with plant dimensions of 9,5x16 meters and 31 meters high.
- √ 2 semiautomatic bagging system.

Storage of wheat to maintain its quality

2017 | Capa Colonia Italy

First phase of plant conceived for the reception, storage and expedition of wheat. The total capacity of the plant is 51.710 m³ for the storage of 38.800 T of cereals. The project includes:

- √6 silos model 20.63/20 of 6.811 m³ capacity each.
- √1 hopper silo model 9.17/19 45° of 1.589 m³ capacity each.
- √3 hoppe silos model 4.58/3 60° of 85 m³ capacity each.
- √Handling equipment at 200 TPH designed for ATEX21 and ATEX22.
- √Catwalks and supporting estructures.
- √Aspiration system.
- √Cleaning system made up by drum sieve and sieve cleaning.

2019 | Tonkeris Kazakhastan

Expansion of Tonkeris facility, conceived for the storage of wheat, barley, rapeseed, flax and sunflower. The total capacity of the plant is 43.882 m³ for the storage of 33.000 T of cereals. The project includes:

- √4 silos model 17.57/13 of 4.003 m3 capacity each.
- √4 silos model 22.92/13 of 6.573 m3 capacity each.
- √6 hopper silos model 5.35/9 (45°) of 263 m3 capacity each.
- √4 hopper silos model 7.64/10 (60°) of 659 m3 capacity each.
- √2 hopper silos model 1.85/2 (60°) for automatic weighing packer.
- √Loading and unloading is done at 100 T/h.
- √The conveying machinery – chain conveyors, belt conveyor, screw conveyors, bucket elevators has been delivered by Silos Córdoba.
- √Cereal sampling probe (DV company, made in Italy) supplied by Silos Córdoba.
- √Grain analyzer Foss (Denmark).
- √2 units receiving pit for truck.
- √Cleaning system consist of: rotatory drum cleaner 100 t/h, grain cleaner, aspiration and cyclone.
- √2 units vertical grain dryer machine 40 t/h.
- √2 bulk expeditions for train and also a third option for train expedi tion: 2 lines of packing grain in sacks including industrial automatic weighing packer and sewing machine.
- √Electrical panel.
- √Elevator tower 8×8, h=30 m.

Storage of wheat to maintain its quality

2019 | Jusegal Spain

Installation of hopper silos reinforced and equipped with pneumatic loading. The total capacity of the plant is 1.170 m^3 for the storage of 878 T of feed and wheat. The project includes:

- √ 9 hopper silos model 3.50/9 65° with a capacity of 103.46 m^3 each.
- √ 3 hopper silos model 3.05/9 65° with a capacity of 79.76 m^3 each.
- √ Catwalks with access to all silos.

Under construction | NKF Iran

Plant conceived for the storage of soya bean, corn and wheat.
The total capacity of the plant is 489.792 m^3 for the storage of 367.000 T of cereal. The project includes:

- √ 48 silos model 24.45/17 of 10.204 m^3 capacity each.
- √ Intake conveying capacity: 1.200 T/h (600 T/h double).
- √ Discharge capacity: 800 T/h (400 T/h double).