SILOS CORDOBA

Storing grain to reduce post-harvest losses and protect its quality

Facts

√ Current world population is expected to reach 10.5 billion by 2050 (UN March, 2013).

√ This increase translates into 33% more human mouths to feed

√ Food availability and accessibility can be increased by increasing production, improving distribution, and reducing the losses.

√ Crop production contributes significant proportion of typical incomes in certain regions of the world (70 percent in Sub-Saharan Africa)

√ In some Sub-Saharan Africa countries, the post harvesting losses because of the bad storage can reach sometime 37-40 %.

√ The PHL “post-harvest grain losses” can be qualitative and quantitative.

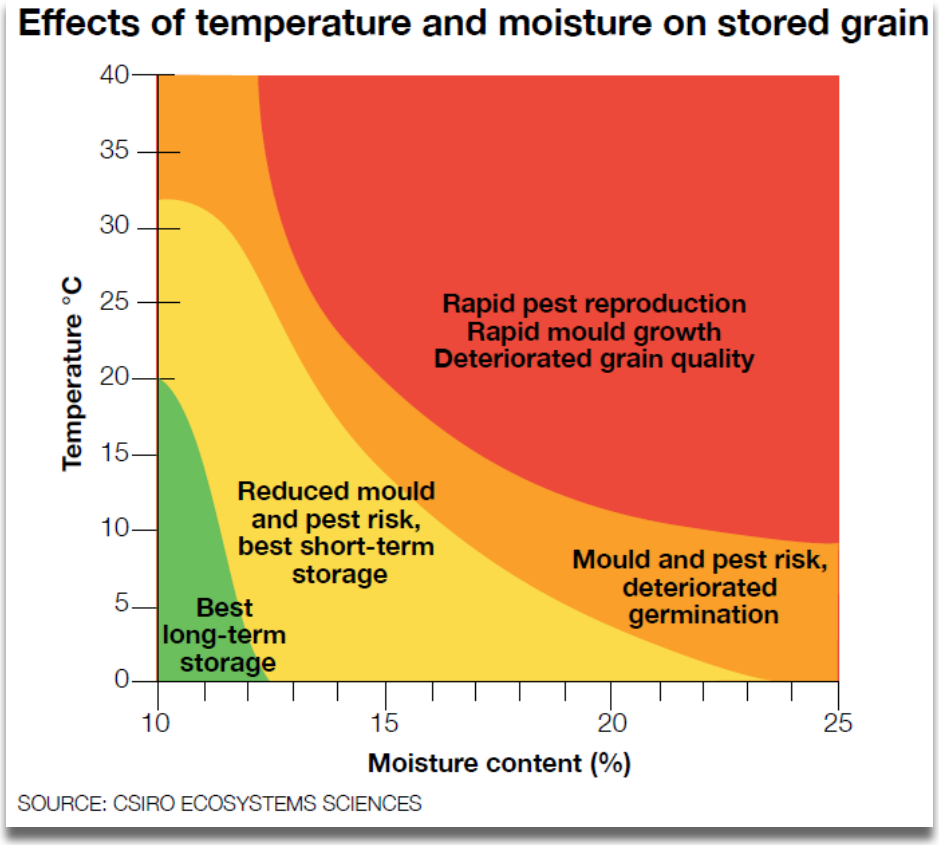
SILOS CORDOBA

Initial Factors of Harvesting

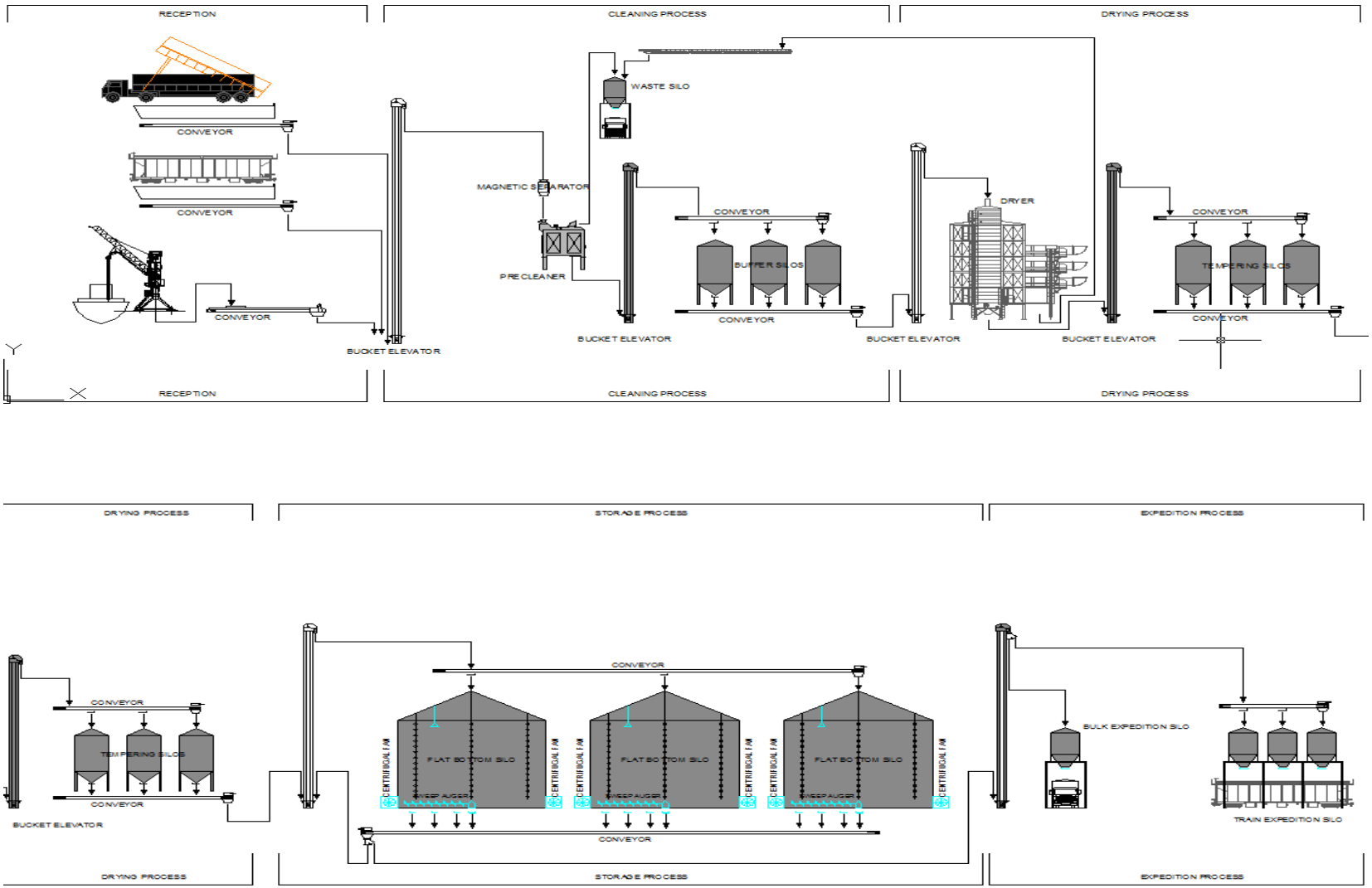
The three major factors affecting the grain storage are:

- √ Moisture content.
- √ Temperature.
- √ Storage period.

Storage technologies don't do anything by themselves. Proper management has to be done by the owner.



Basic Flow Diagram



Reception

Before unloading:

√ Take samples for measuring the temperature and moisture content.

√ Grain laboratory will easily analyze the grain conditions.

During unloading:

It is recommendable an aspiration system. In some countries is even mandatory.

Some aspects regarding this system should be consider:

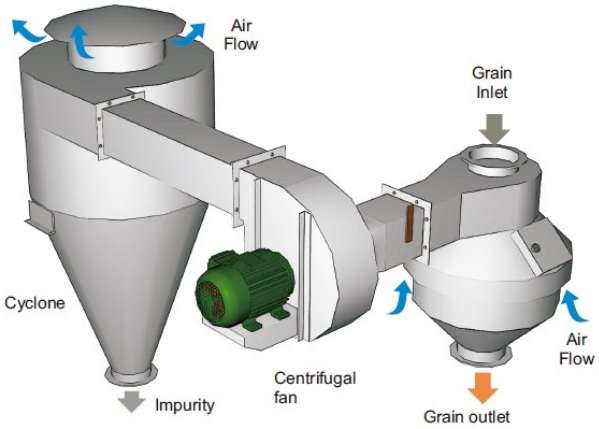
- √ Pit intake dimension
- √ Installed inside a building / cover
- √ Receiving capacity
- √ Aspiration volume

Cleaning Process

Cleaning is the process that removes from the bulk the foreign particles.

Magnet separator

Grain precleaner



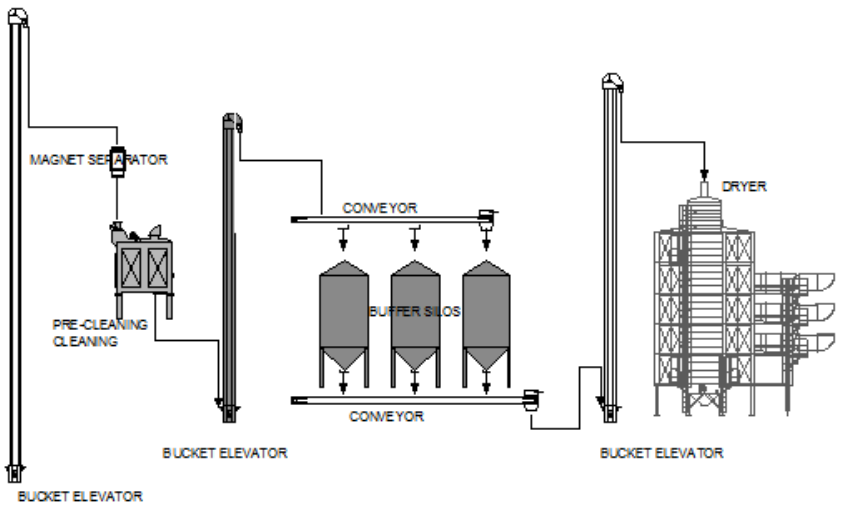
Drum Sieve

Grain cleaner

Cleaning Process – Buffer silos

After Cleaning process, buffer silos should be installed. Why? Because Drying process tend to be the bottleneck in every single storage plant.

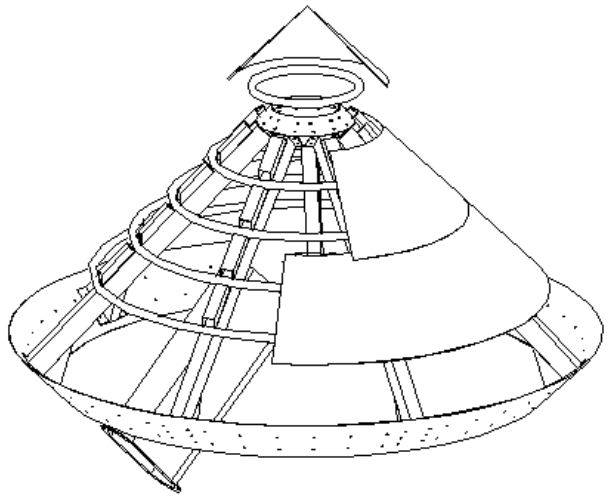
High investment



Ventilation system: should be calculated depending of the grain we are going to store.

Exhaust fans: to prevent condensation.

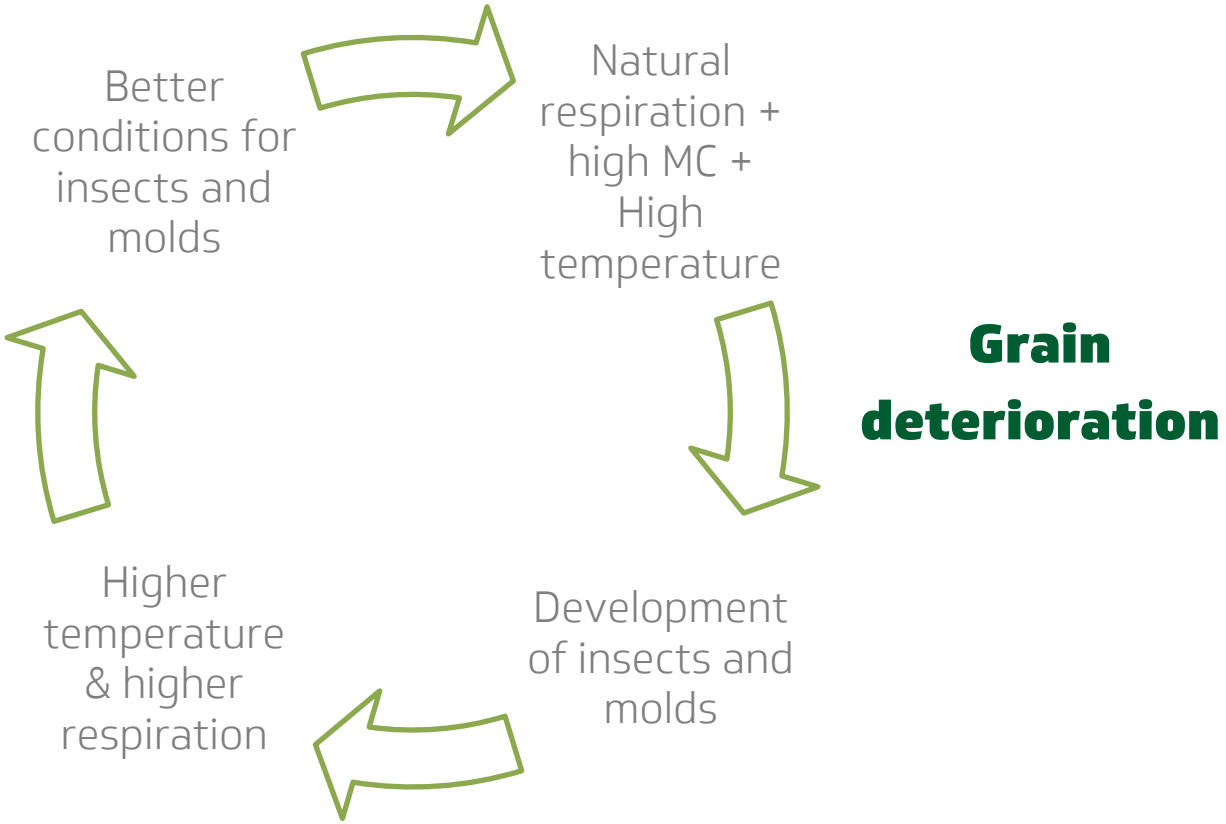
Over-head cone: This system allow a FIFO flow system , guaranteeing that all grain will remain inside the silo the same period.



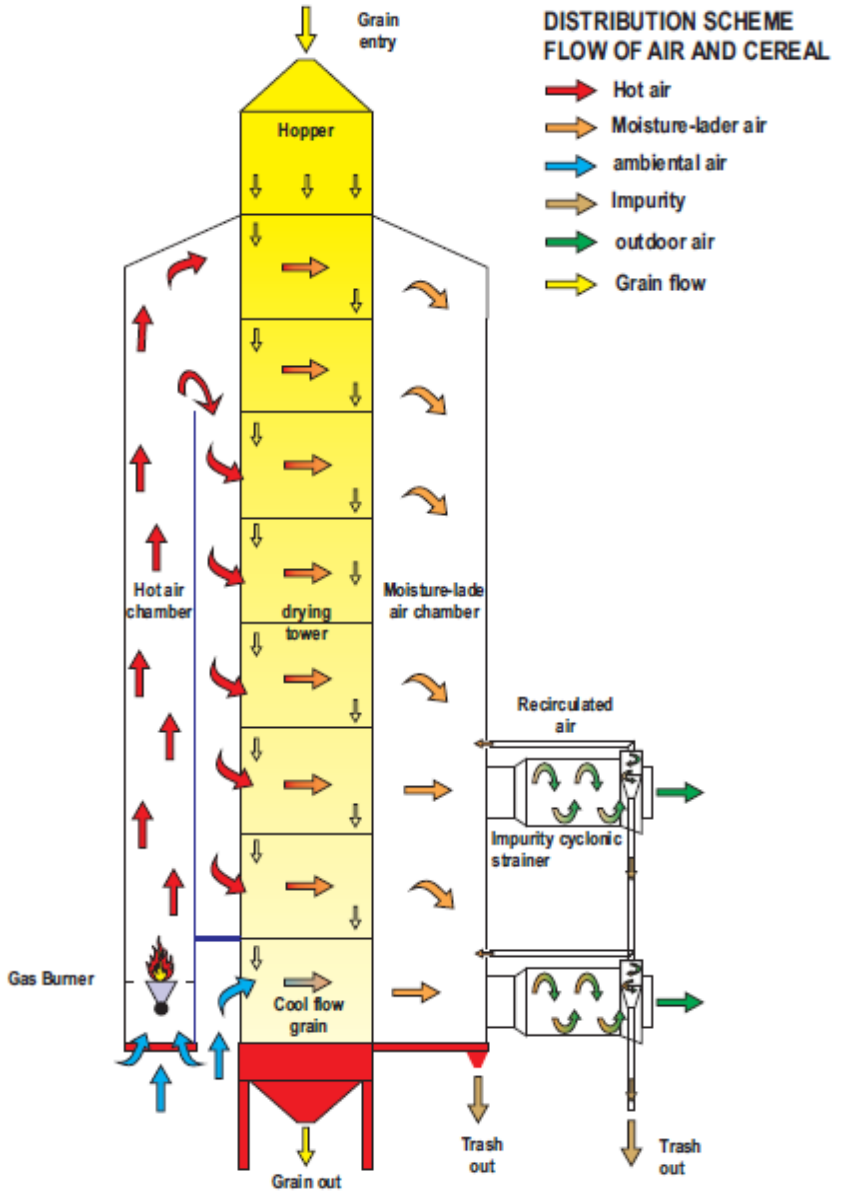
Drying Process

Drying is the process that reduces grain moisture content to level where it is safe for storage.

Initial factor: at harvest time the grain used to contains high MC.



Drying Process



Drying Process

Moisture content required for safe storage for different storage periods

Storage time	MC level	Potential problems
2 – 3 weeks	14 – 18 %	Molds, respiration loss, discoloration, loss of germination, loss of freshness, odor development, etc.
8 – 12 months	13 % or lower	Insect damage
More than 1 year	9% or lower	Loss of viability

Drying process: using the ambient air with a low relative humidity or heating air. This will evaporate the moisture from the grain.

Drying rate and temperature:

- √ Seed, should never exceed 43 °C
- √ Grain processed: should never exceed 60 – 65 °C

Drying Process

Recommendations:

√ Dryer election will depend on your technical requirement.

√ Get the knowledge from the dryer manufacturer: training.

√ Clean before dry. Impurities in grain bulk reduce the air flow and make it non homogeneous flow creating priority paths.

√ Do not mix wet and dry grain.

√ Take samples: control the moisture content and temperature in the drying process.

√ Experience in previous drying will lead you to increase the drying efficiency.

√ Dry a maximum of 5% of the moisture content at a time and then leave the grain to rest for a minimum of 8 – 12 hours.

Drying Process – Tempering silos

Tempering silos are used to cold down the grain and make the bulk grain uniform in terms of temperature and MC.

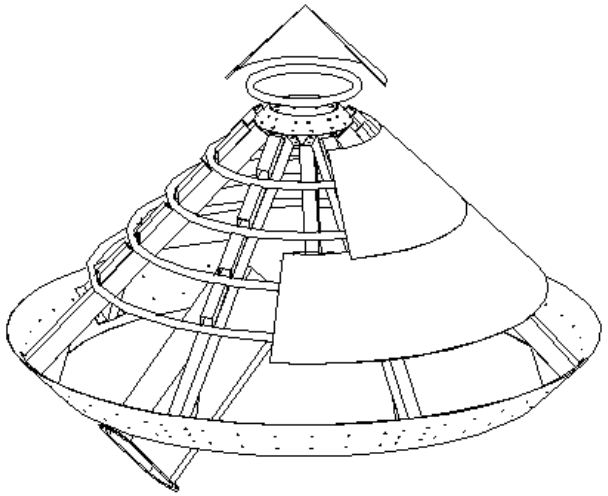
Depending of the storage capacity, we can cold down the grain either using a tempering silo or in the final storage system.

How to do ventilation at this point?

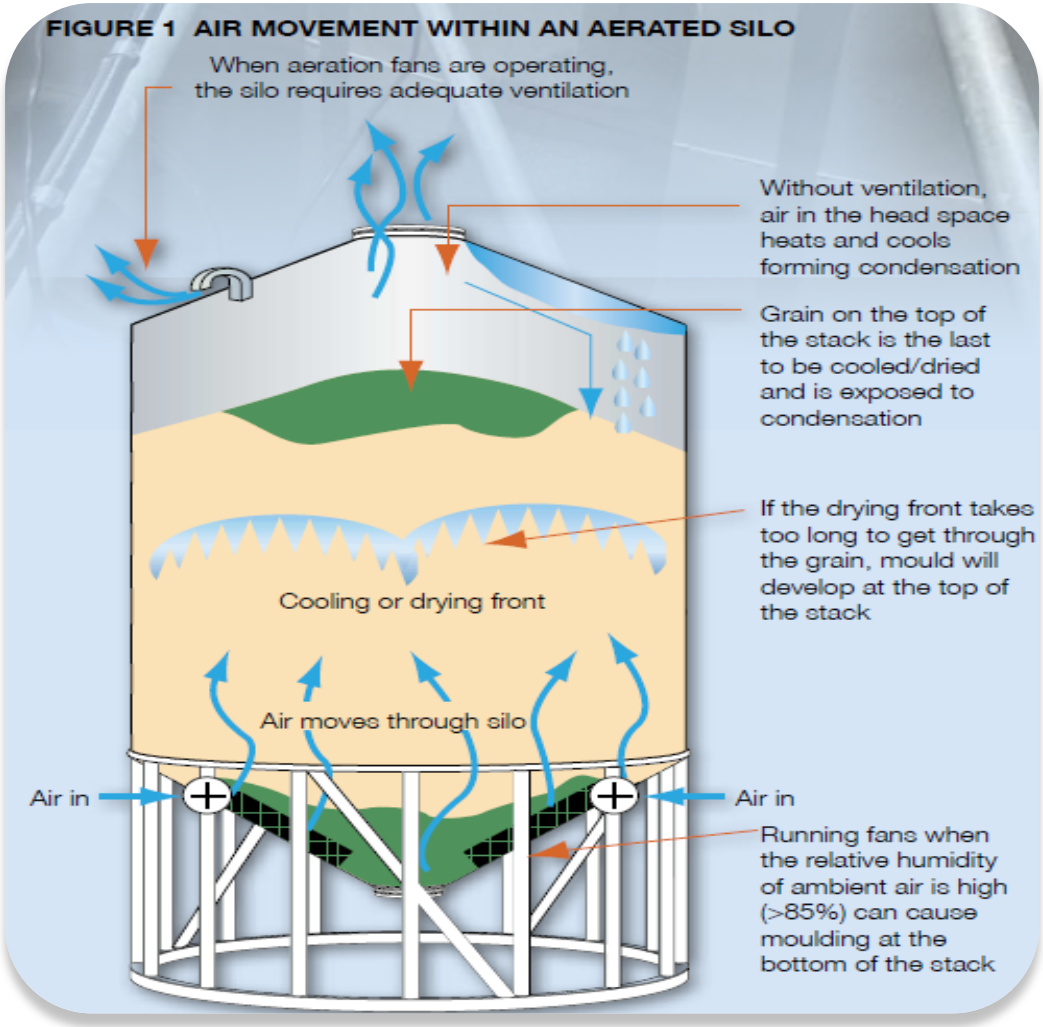
√ **Ventilation system:** centrifugal fans or chillers.

√ **Exhaust fans:** to prevent condensation.

√ **Over-head cone:** This system allow a FIFO flow system, guaranteeing that all grain will remain inside the silo the same period.



Ventilation System



Storage Process – Ventilation System

EMC -Equilibrium Moisture Content

RH of air	Temperature of air °C						
	10	20	24	28	32	36	40
50%	11,8	11,3	10,9	10,7	10,5	10,2	10,0
55%	12,3	11,9	11,5	11,3	11,0	10,8	10,6
60%	12,9	12,5	12,2	12,0	11,6	11,4	11,2
65%	13,5	13,1	12,6	12,4	12,2	12,0	11,8
70%	14,1	13,7	13,3	13,1	12,8	12,6	12,5
75%	15,0	14,5	14,0	13,8	13,6	13,4	13,2
80%	15,9	15,2	15,0	14,7	14,5	14,3	14,0
85%	17,2	16,4	15,9	15,7	15,5	15,3	15,1
90%	18,4	17,6	17,2	17,0	17,0	16,8	16,5

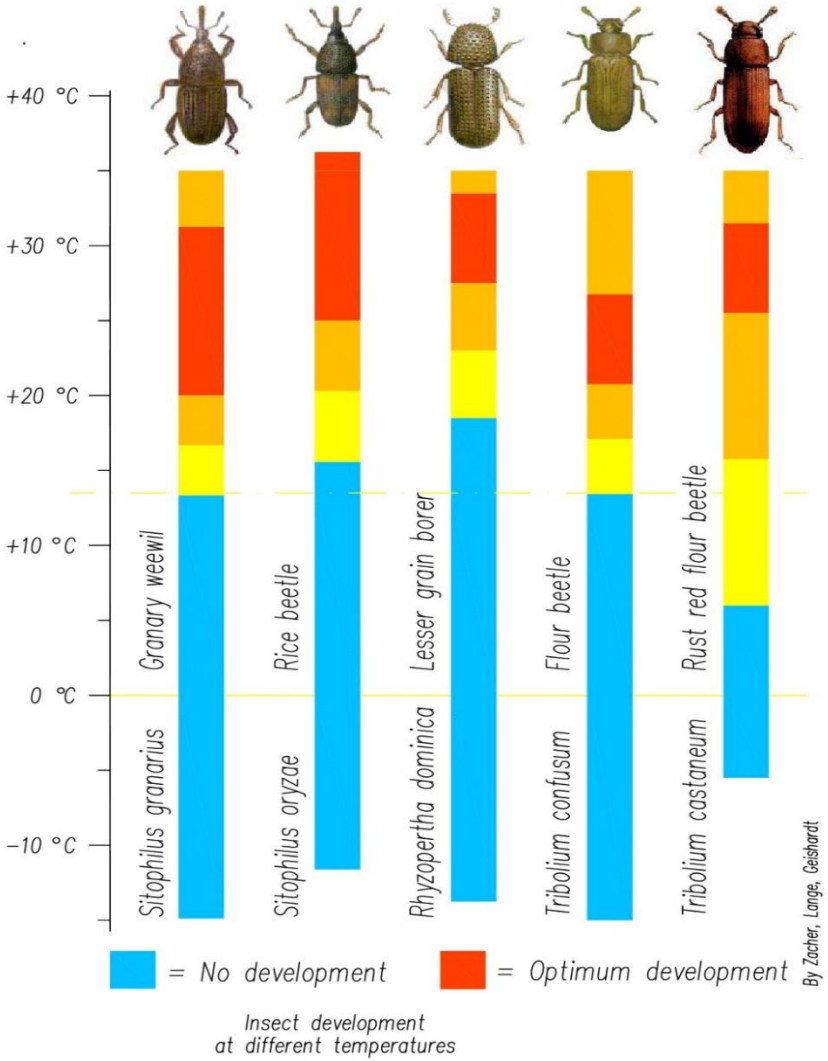
Storage Process – Ventilation System

Mold	Minimun % of moisture to sprout	Growth temperature		
		Minimum °C	Optimum °C	Maximum °C
Alternaria	91	-3	20	36-40
Aspergillus canditus	75	10	28	44
A. flavus	82	6-8	36-38	44-46
A. fumigatus	82	12	37-40	50
A. glaucus	72	8	25	38
A. restrictus	71-72	-	-	-
Cephalosporium acremonium	97	8	25	40
Epicoccum	91	-3	25	28
Fusarium moniliforme	91	4	28	36
F. graminearum	94	4	25	32
Mucor	91	-3	28	36
Nigrospora aryzae	91	4	28	32
Penicillium funiculosum	91	8	30	36
P. oxalicum	86	8	30	36
P. brevicompactum	81	-2	23	30
P. cyclopium	81	-2	23	30
P. viridicatum	81	-2	23	36

Storage Process – Ventilation System

Insects	Growth temperature (range)	Appearance
Grain weevil	15 – 35 °C	 
Rice weevil	17 – 38 ° C	 
Borer	20 – 32 °C	
Flour moth	15 – 28 °C	
Flour beetle	22 – 32 ° C	 

Storage Process – Ventilation System



Insect development
at different temperatures

Storage Process – Ventilation System

Because of the tropical climate of some counties, ventilation systems using centrifugal fans is no longer sufficient but it becomes necessary cooling systems

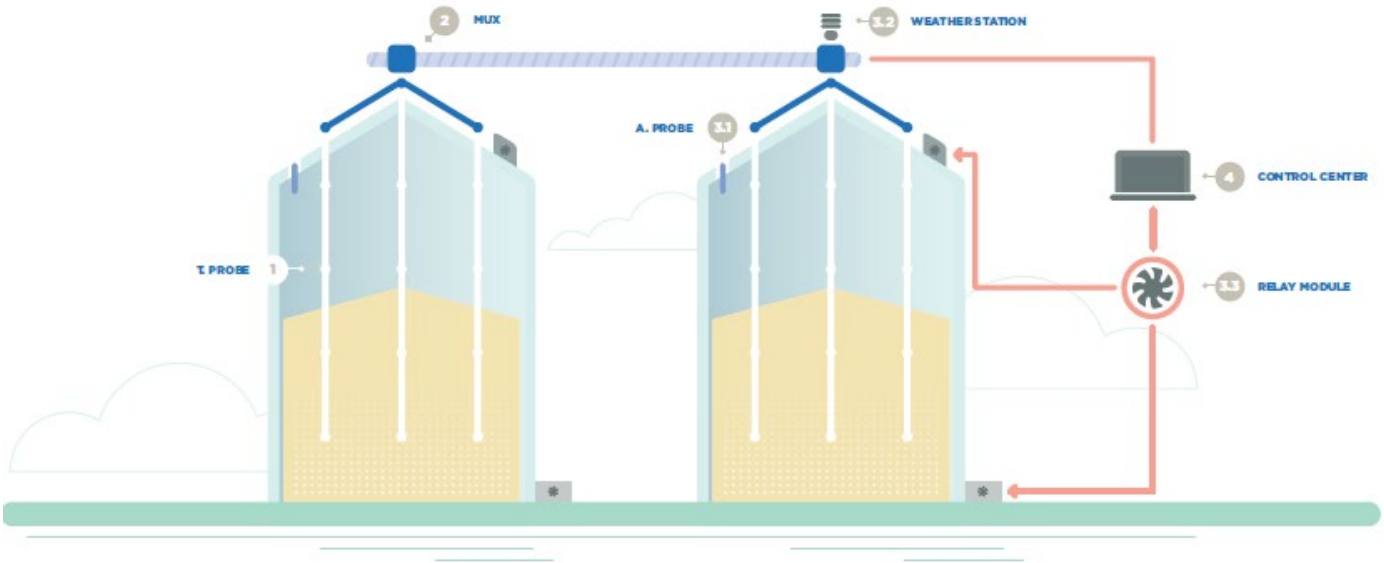
Coolers or centrifugal fans can be used in steel silos, concrete silos and warehouses.

Considerations:

- √ Grain column height.
- √ Priority ventilation paths.
- √ Ventilation grills.
- √ Exhaust fans.

Storage Process - Temperature Monitoring System

Simple and accurate device made up of three elements: control center, probes and electronic module of multiplexation



Cereal Warehouses

Temperature probes can be installed in **metal silos**, **concrete silos** or **cereal warehouses**.

CTC Software

It shows you the **temperature** of the cereal stored on different levels, controls the **stock levels** and the automatic **ventilation** according to th environmental conditions.

Storage Process

Traditional methods of grain storage:

- √ Warehouse – gunny bags stacked
- √ CAP – Covered and Plinth in open space
- √ Silos – Bulk grain stored in silos:
  - ◇ Concrete silos
  - ◇ Galvanized steel
  - ◇ Silo Bag

Storage Process

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	Unpredictable
GRAIN HANDLING	Mechanized	Mechanized	Manual – Mechanized	Manual - Mechanized
DESIGN	Simple design, simple to erect	Complicate: rebar placement, concrete quality, longer commissioning	Simple	Simple
OPERATIONAL COST	Relatively low, (initial investment)	Relatively low, (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, termites, pets, fungi, mold, fermentation, etc.	Fungi, mold, fermentation, insects, et.

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This document is just a recommendation about how to store properly paddy rice in Sri Lanka. All the recommendations given throughout this file should be part of an integrated approach to any quality maintenance program of grain processing companies.

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