

Grain Storage Management



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Grain Storage Problems

- Mold
 - Moisture
 - Temperature
- Insects
 - Temperature
 - Cleanliness
 - Grain Protectant
 - Long-term storage



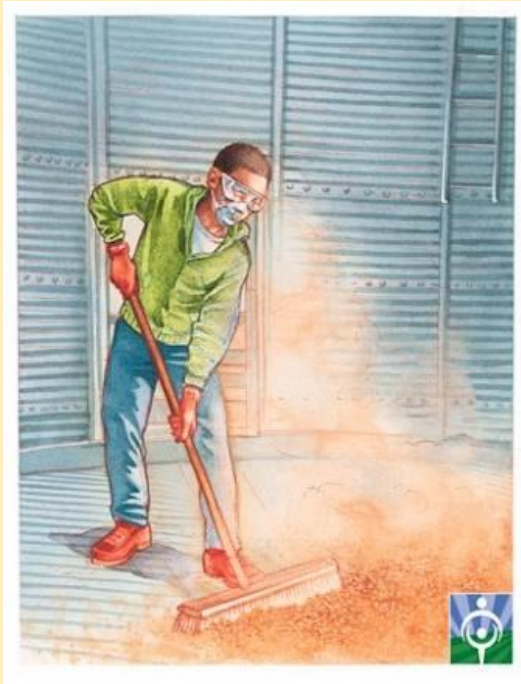
Grain Storage Steps

- Prepare the structure.
- Prepare the grain.
- Manage the stored grain:
 - Monitoring
 - Aeration



Clean the Structure

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Prepare the Grain

- **Grain moisture**
- **Grain temperature**
- **Grain condition-kernel damage**



Moisture Measurement

Representative Sample

Follow Instructions



- Adjust for temperature
- May not be accurate <math><40^{\circ}\text{F}</math>
- Electronic meters more sensitive to outside of kernel
- Meters affected by condensation

- Measure moisture content
- Place sample in sealed container for 6-12 hrs.
- Warm to $\sim 70^{\circ}\text{F}$
- Recheck moisture

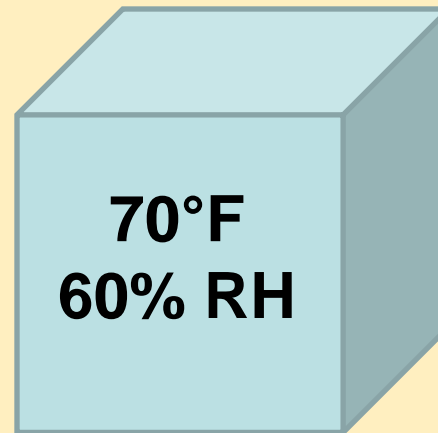


Equilibrium Moisture Content

HRS Wheat



Air



EMC = 13.3%

Recommended Long-Term Storage Moisture Content



EMC @ 70°F & 60% RH



Grain	EMC	Moisture
Barley	11.8%	12%
Canola	8.0%	8%
Corn	12.8%	13%
Flaxseed	8.3%	8%
Soybeans	10.2%	11%
Sunflower		
Non-Oil	9.6%	10%
Oil	7.4%	8%
Wheat	13.3%	13.5%



“Approximate” Allowable Storage Time for Cereal Grains (Days)

Moisture	----- Grain Temperature (°F) -----					
Content	30°	40°	50°	60°	70°	80°
(%)	Approximate Allowable Storage Time (Days)					
14	*	*	*	*	200	140
15	*	*	*	240	125	70
16	*	*	230	120	70	40
17	*	280	130	75	45	20
18	*	200	90	50	30	15
19	*	140	70	35	20	10
20	*	90	50	25	14	7
22	190	60	30	15	8	3
24	130	40	15	10	6	2
26	90	35	12	8	5	2
28	70	30	10	7	4	2
30	60	25	5	5	3	1

* Exceeds 300 days

“Estimated” Allowable Storage Time for Malting Barley (Weeks) (Criterion: Germinability)

		Barley Moisture Content (%w.b.)								
		11%	12%	13%	14%	15%	16%	17%	18%	19%
Temperature		Allowable Storage Time (weeks)								
(°C)	(°F)									
27	80	32	25	16	10	5	3	1.5	1	1
21	70	80	60	38	25	14	7	3.5	2.5	2
16	60	*	*	94	61	37	18	9	6	3.5
10	50	*	*	*	*	90	50	20	14	8

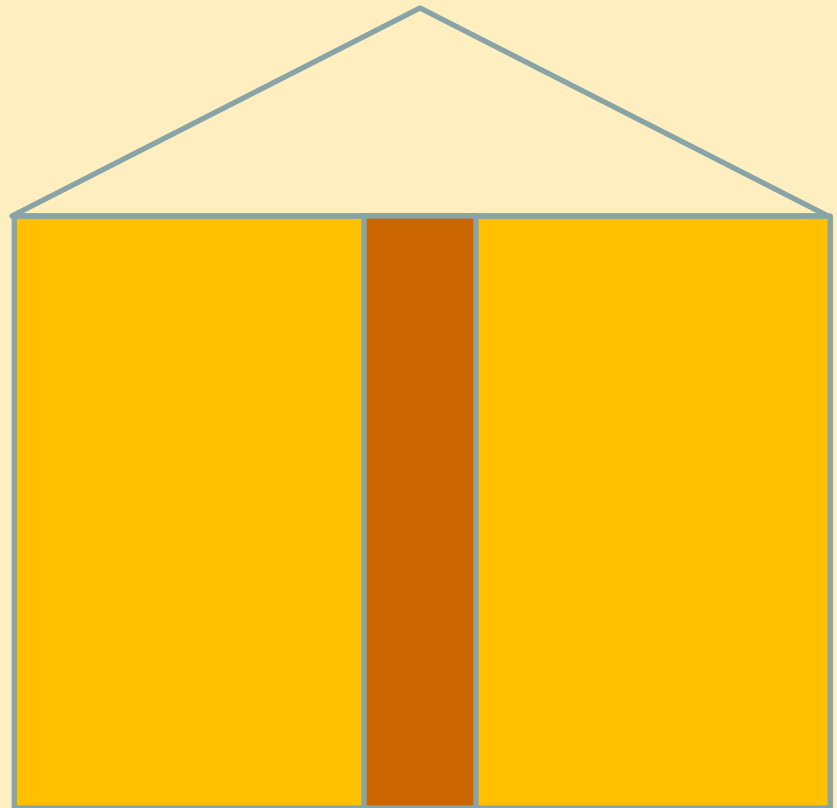
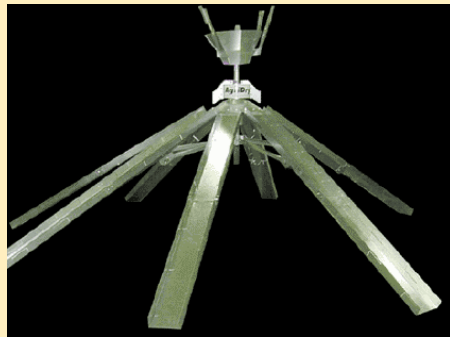
* Allowable storage time exceeds 100 weeks.

Source: Drying Cereal Grains by Brooker, Bakker-Arkema & Hall

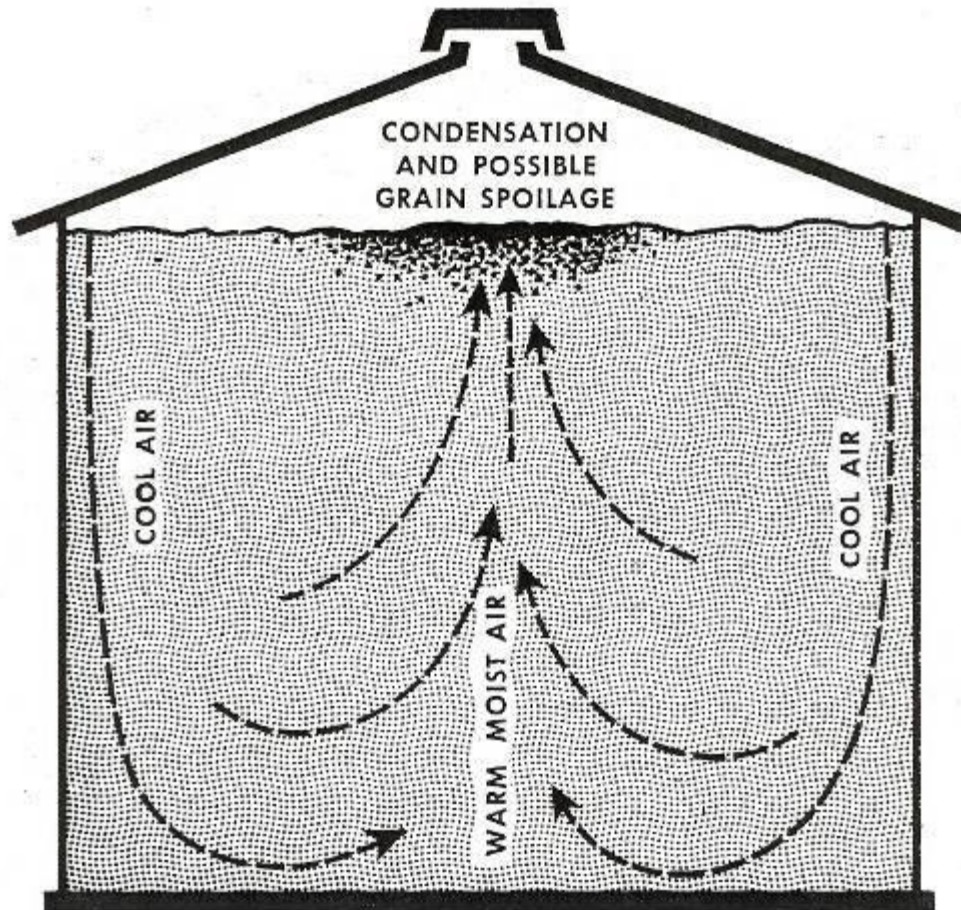
Table developed by Kenneth Hellevang, Ph.D., P.E., 07/16/07



Clean Grain before Storing



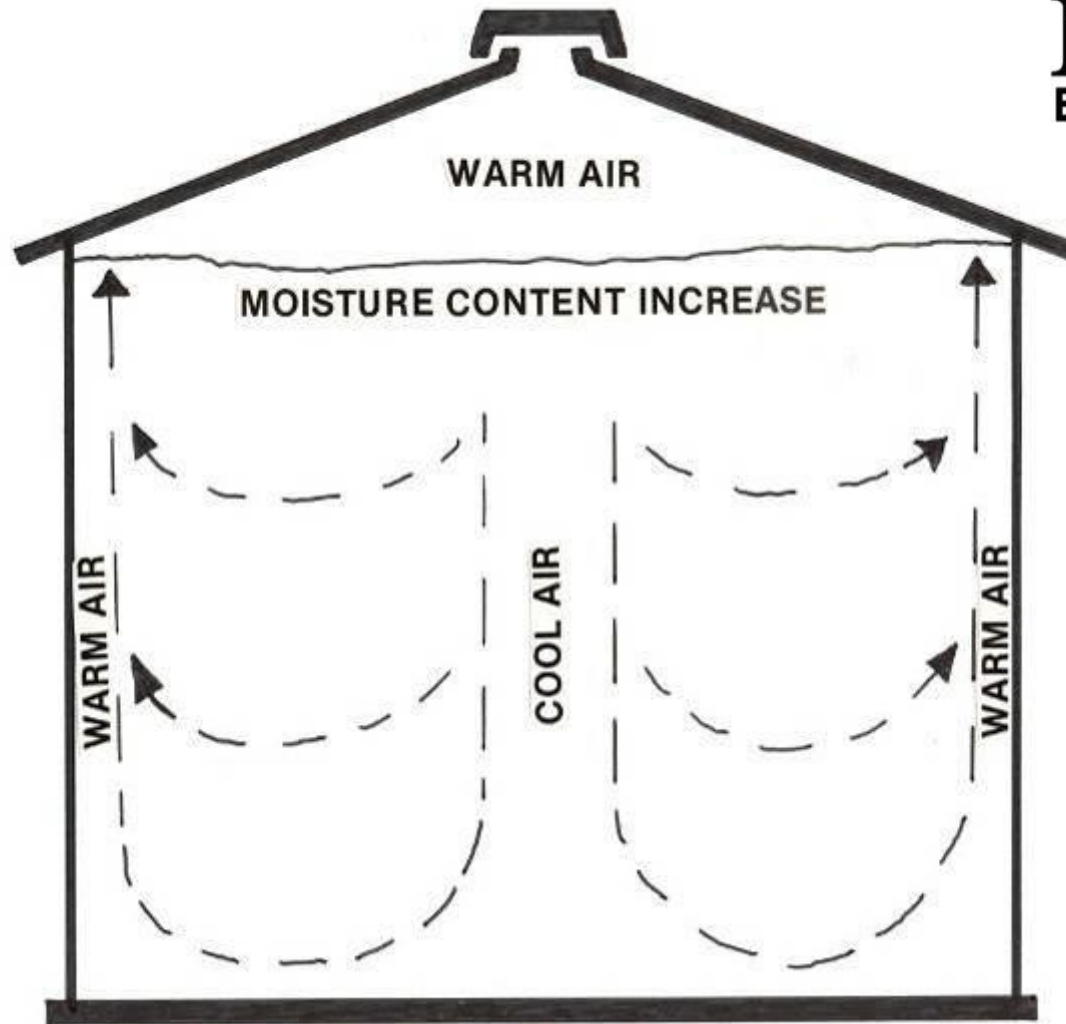
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Fall and Winter Moisture Migration

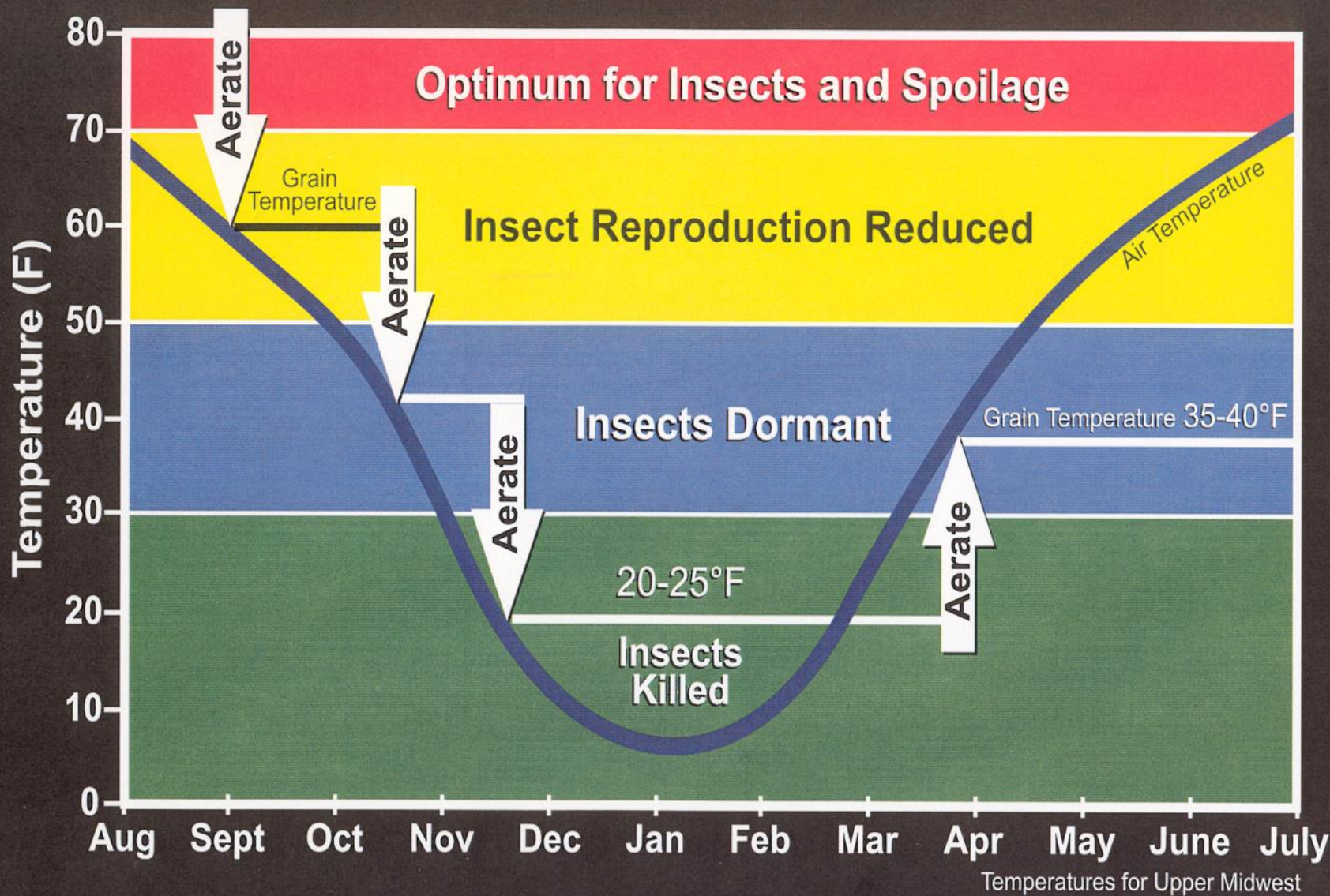
Grain Stays Warm without Aeration





Spring and Summer Moisture Migration

Cool Grain to Prevent Storage Problems



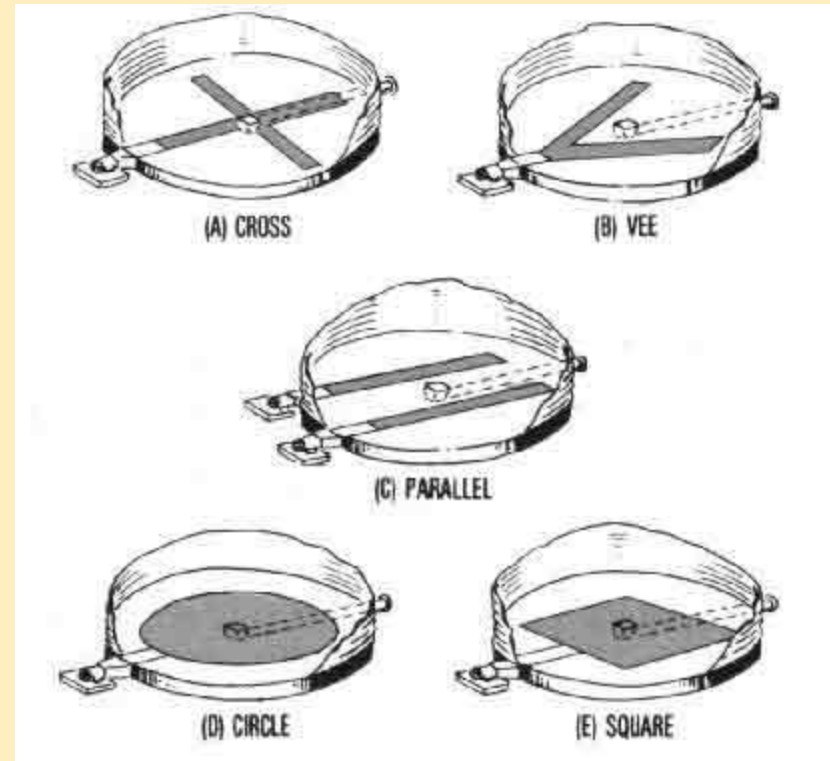
* Prevent crusting due to moisture migration by cooling grain to within 15°F of average outdoor temperatures.

* Cooling grain by 10°F doubles its allowable storage time

Aeration Used to Control Grain Temperature

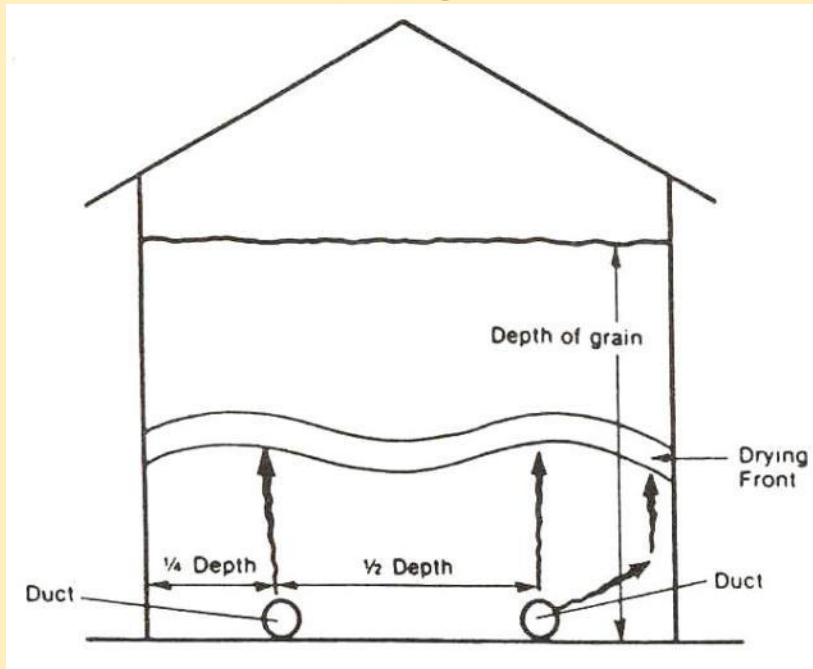


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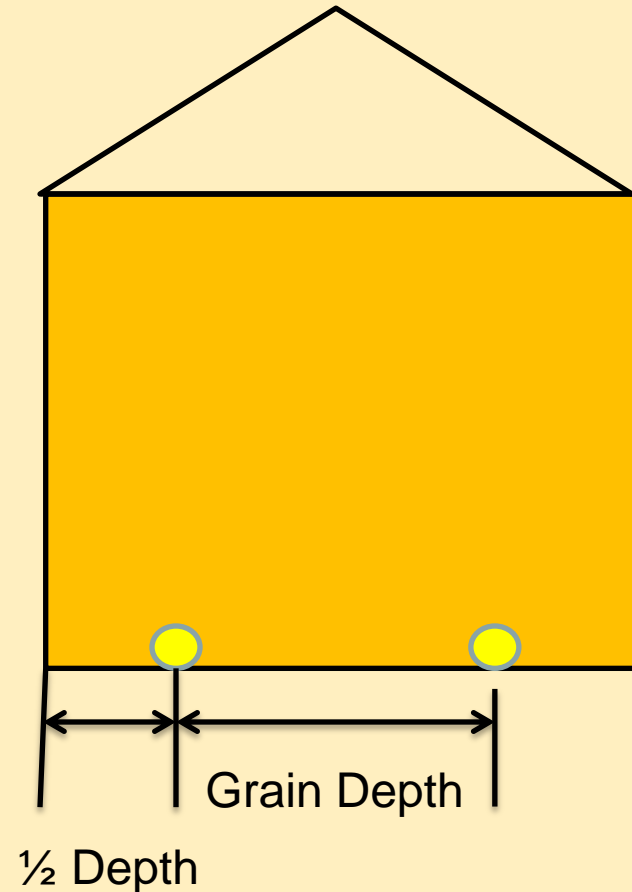


Preferred Duct Spacing

Drying

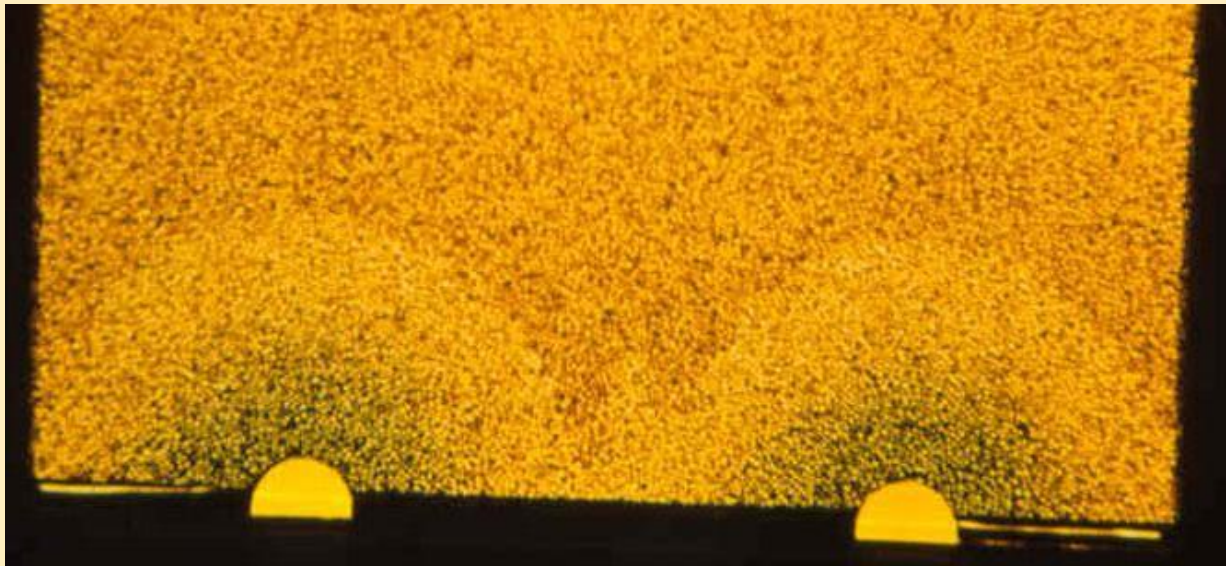


Aeration



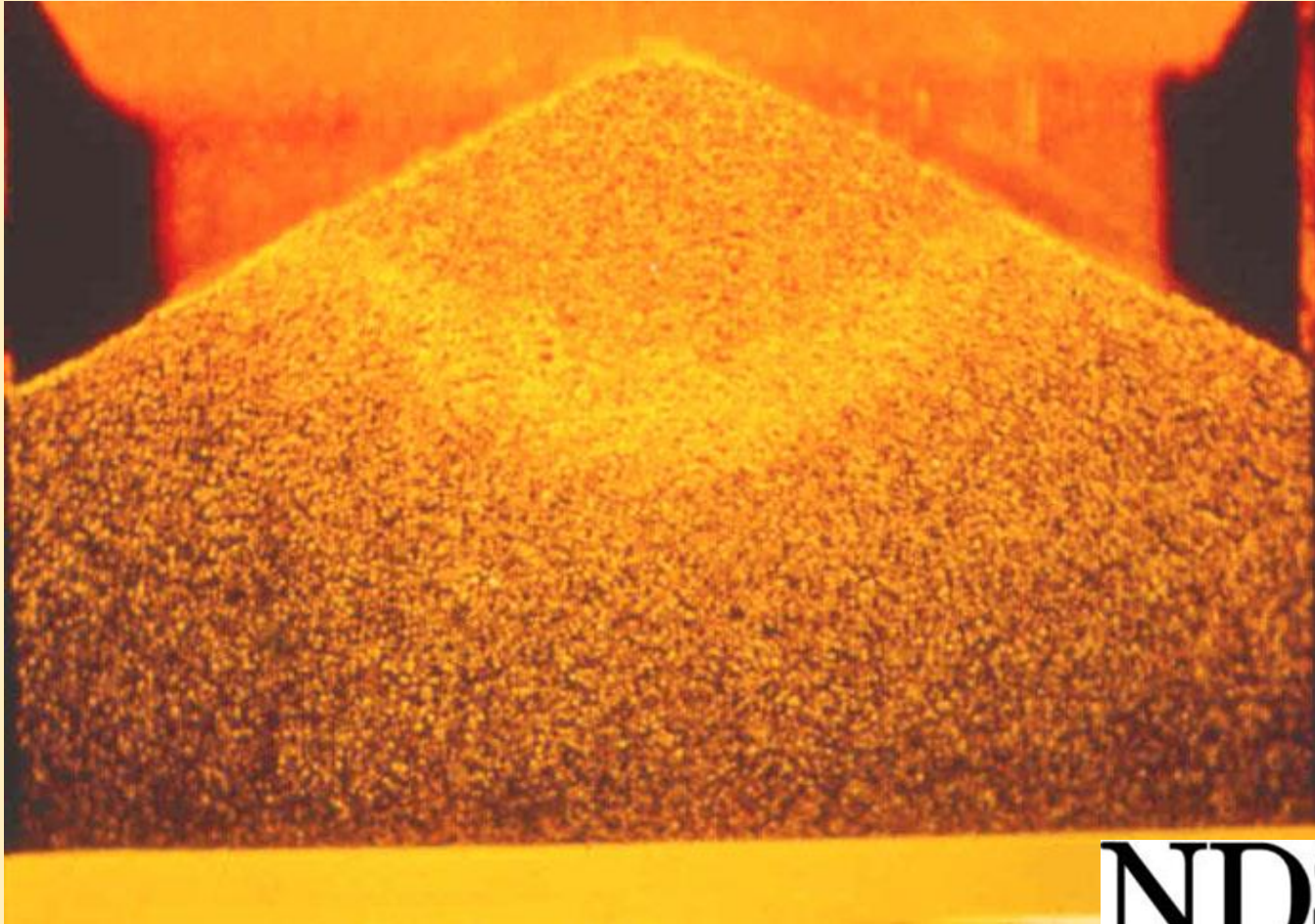
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Fronts Using Air Ducts



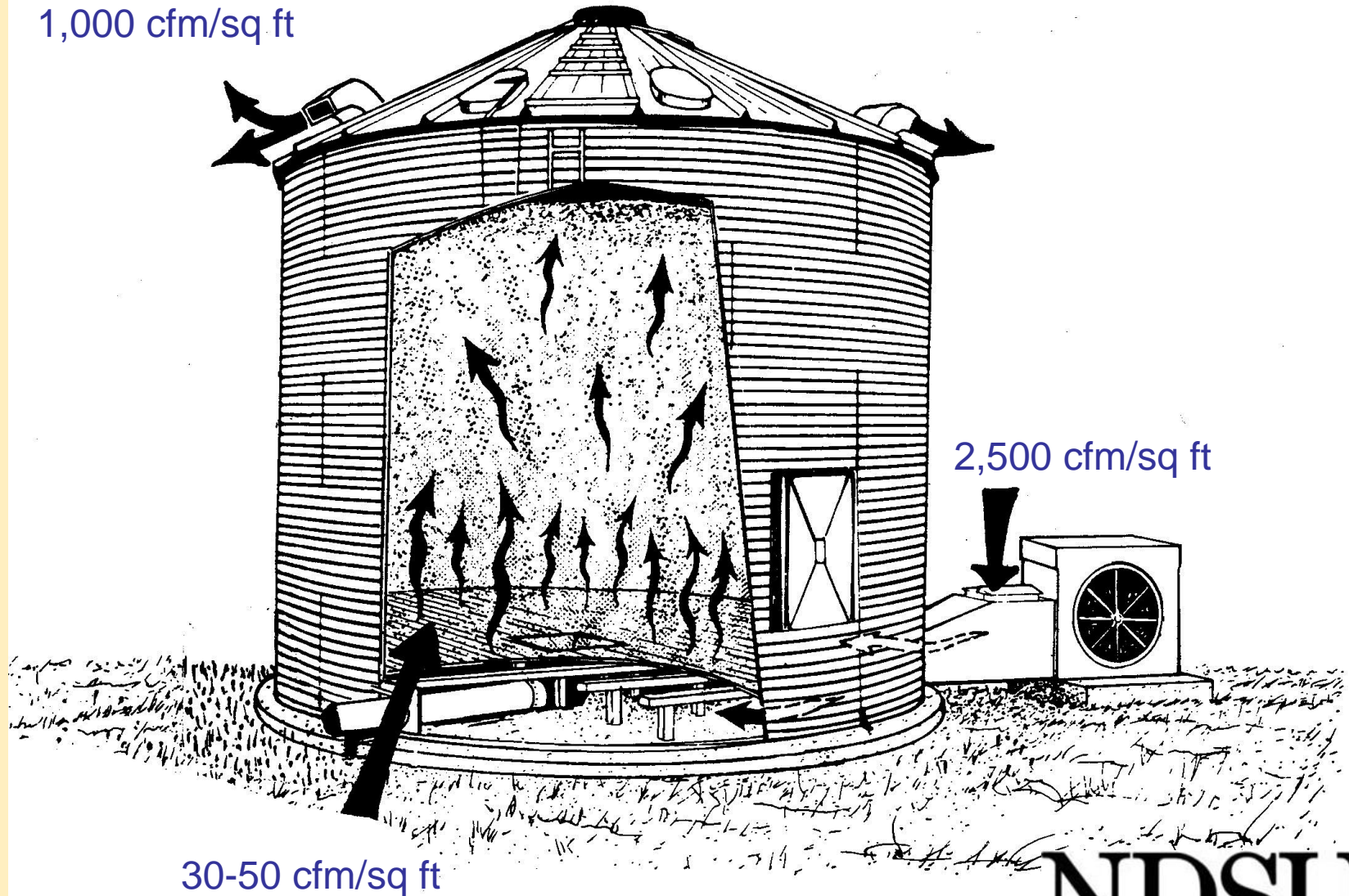
**Airflow is not uniform!
Both between and along ducts.**

Level Bins



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1,000 cfm/sq ft



2,500 cfm/sq ft

30-50 cfm/sq ft

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Aeration Cycle Time

Cooling Time (Barley)

$$\frac{15}{\text{cfm/bu}} \times \frac{\text{Test Weight}}{56} = \text{hrs}$$

$$15 / 0.2 \text{ cfm/bu} \times 48 / 56 = 65 \text{ hrs}$$

Barley - 42 ft diameter, 24 ft depth

3.0 hp, 18-inch axial fan, 0.19 cfm/bu

Cooling time = 68 hrs.



Aeration Investment

42 ft diameter, 26 ft deep, 28,800 bu Barley level full

At 0.17 cfm/bu Cooling time = 76 hrs/cycle

3.0 hp 18-inch Axial Fan, 3 hp fan uses 3.45 kWh/hr

12 cycles x 76 hrs = 912 hrs total/yr

3.45 kWh/hr x 912 hrs = 3,164 kWh

3,164 x \$0.10 kwh = \$314.64

\$314.64 / 28,800 bu = \$0.011/bu

≤1¢/bu – yr for insect and mold protection

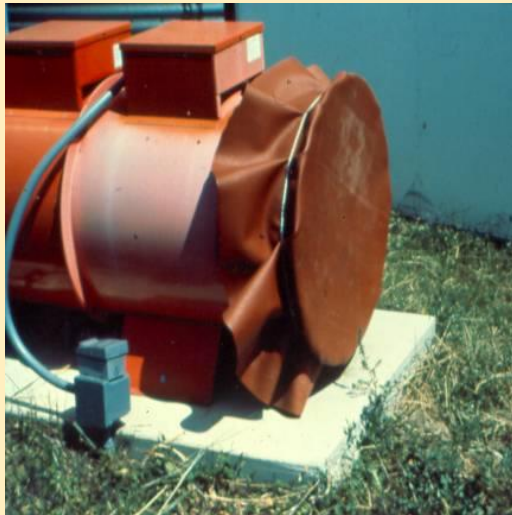


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Fans Off During Snow/Rain/Fog



Cover Fans When Not Operating



- Prevents spring warm-up
- Keep snow & pests out
- Keep damp air out

WARNING

Condensation may freeze over vents when outside air temperatures are near or below freezing



**Leave fill and
access open**



**Iced over vents
will damage bin**

Management



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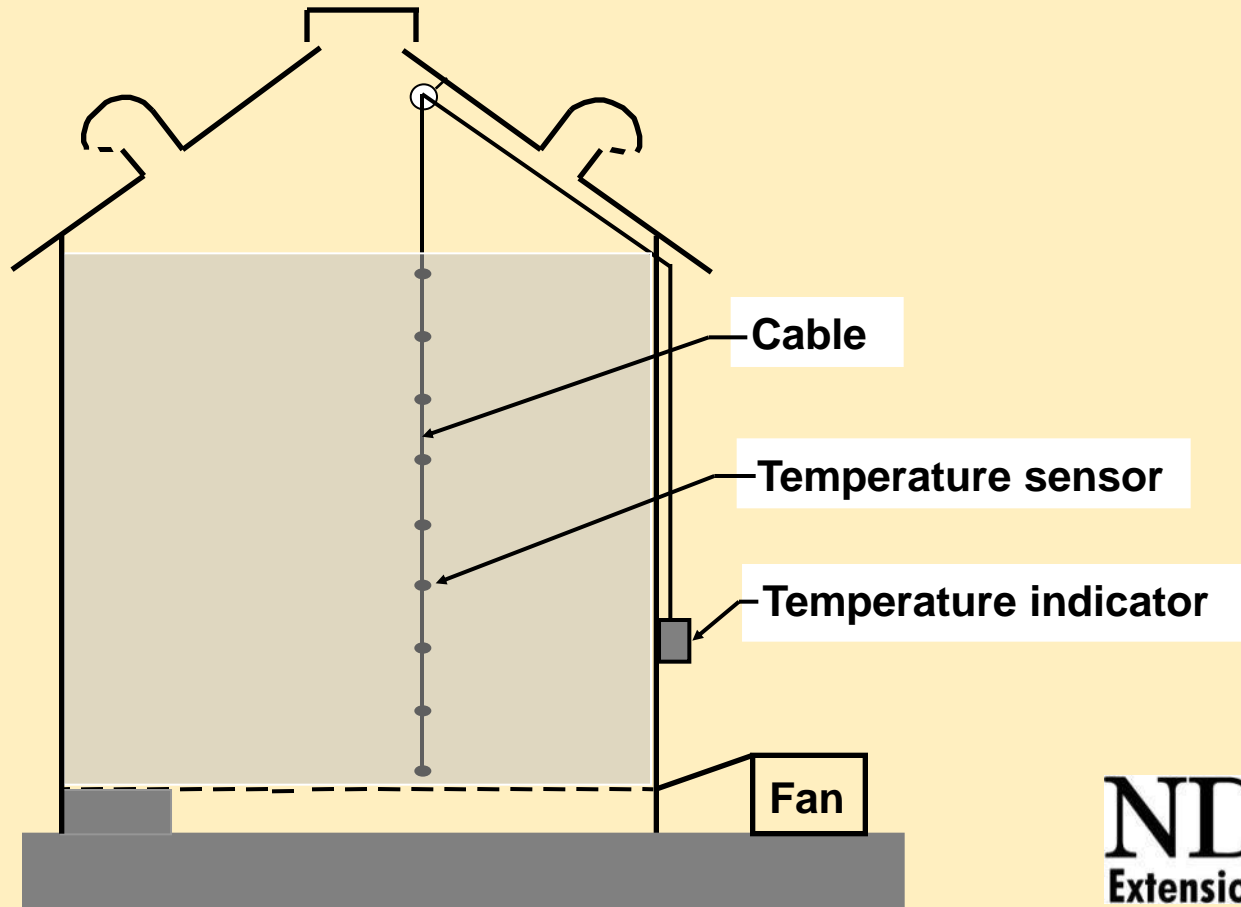
Monitor:

- Temperature
- Moisture
- Insects

How often should I check my grain?

- 2-weeks until cooled
- 2-4 weeks during winter
- 2-weeks spring & summer

Senses only grain near cable





Grain Temperature

Average Maximum Air Temp.

February 1 - 15°

March 1 - 27°

April 1 - 45°

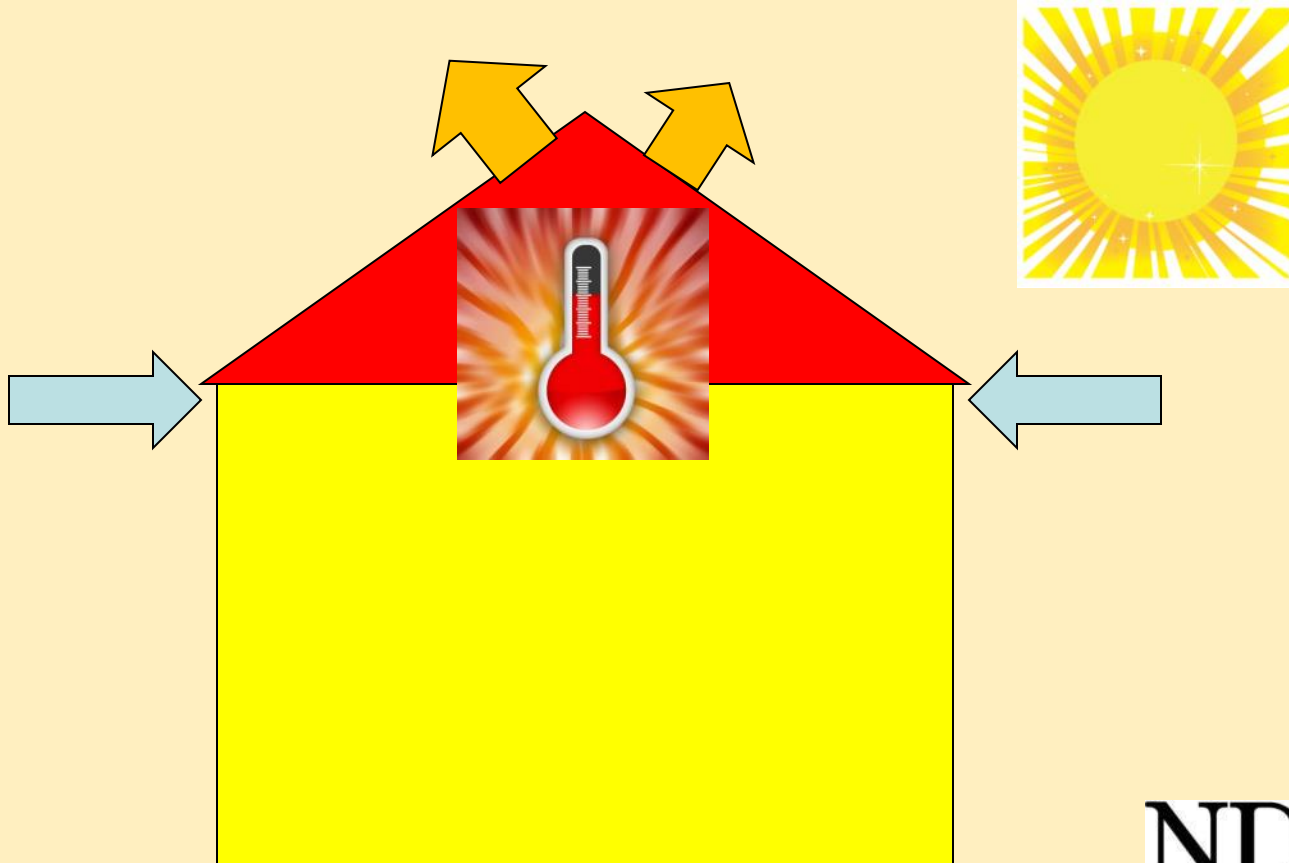
May 1 - 65°



Solar Radiation (Btu/ft²-day)

	<u>Wall</u>	<u>Roof</u>
Feb. 21	1725	1800
Jun. 21	800	2425

Ventilate Bin Headspace



Spring & Summer Cooling

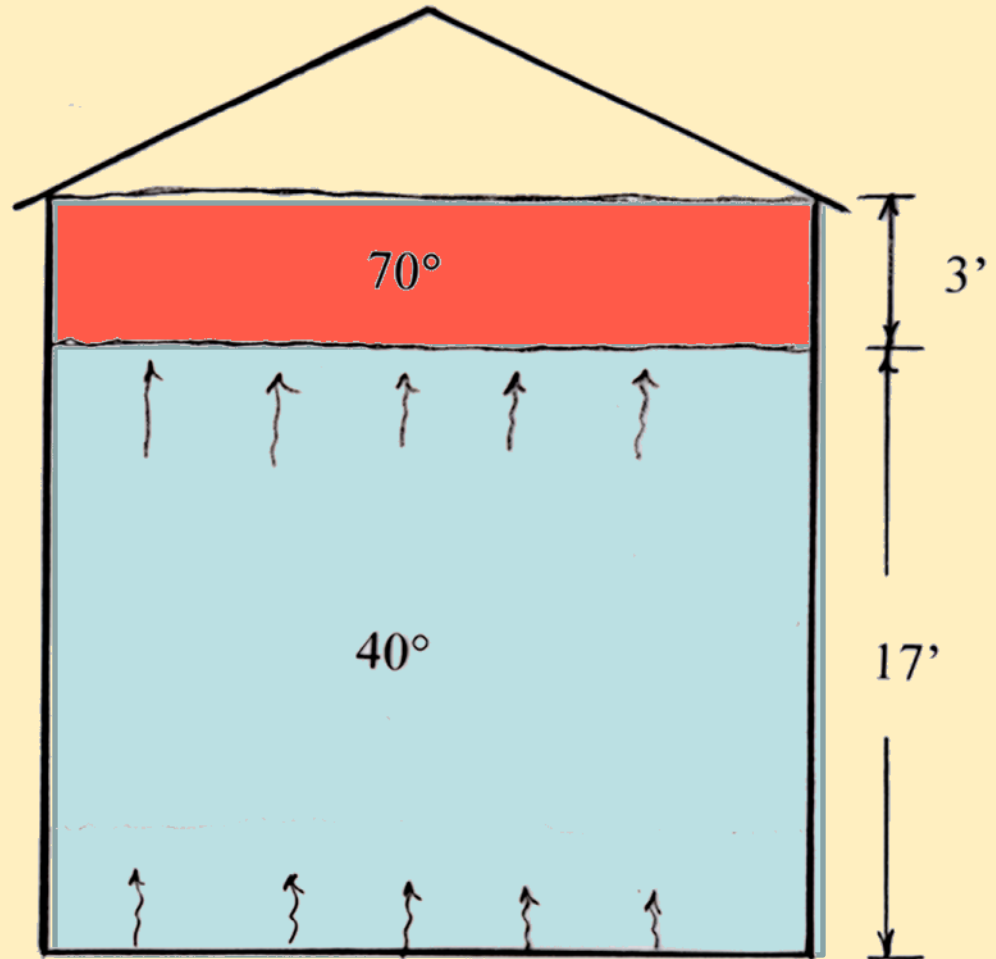
Cooling Time

$$15 / 0.2 \text{ cfm/bu} = 75 \text{ hrs}$$

$$3/20 = 0.15 \approx 11 \text{ hrs}$$

Coolest at sunrise

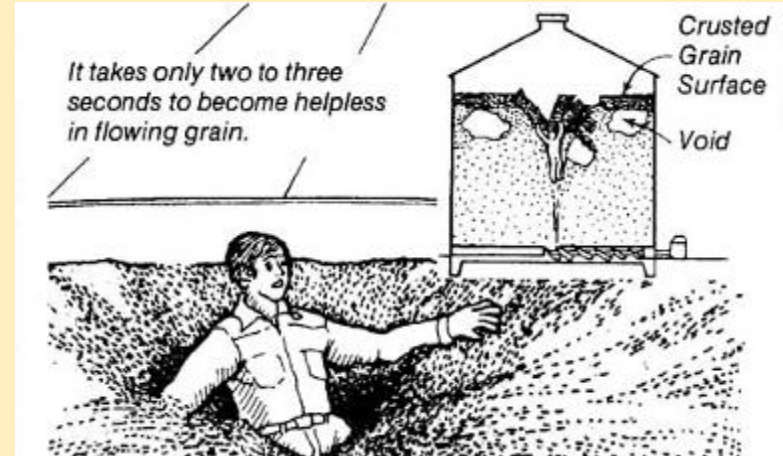
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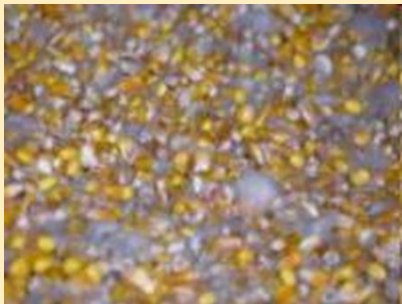
Grain Hazards



Bridging transfers load to the bin wall

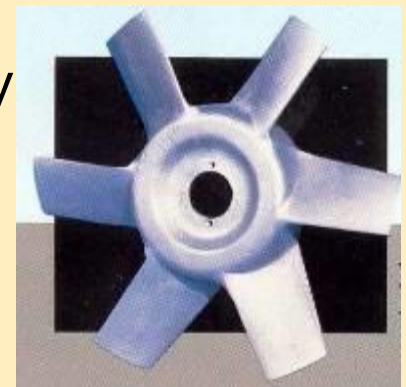


CAUGHT IN THE GRAIN! **AE-1102**



Moldy Grain Health Hazard

Ice on blade may cause it to disintegrate



For More Information



Internet Search: NDSU Grain Drying & Storage

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