



Grain Storage Management (SLAM) & New Technologies

Hudson Valley Grain School

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see blue.
in everything we do.

UKREC @ Princeton, KY



Grain Storage Management



1. GS 101 – Basic relationships
2. Managing grain in storage (S.L.A.M.)
3. Safety considerations
4. Resources

GS 101

Factors that impact grain quality

- Moisture content
- Temperature
- Initial Condition (BC & FM)
- Oxygen availability

Allowable Storage Time for Corn

MC %	Temperature				
	40	50	60	70	80
16	763	339	151	85	47
18	291	130	58	32	18
20	144	64	29	16	9
22	85	38	17	10	6
26	42	19	8	5	3

Time before corn loses ½% in dry matter.

Source: ASABE

Losses Caused by Insects and Molds



- Heating
- Weight loss
- Decreased germination
- Mycotoxins
- Price discounts
 - Infested - 5¢
 - Musty - 10¢
 - Sour - 10¢

Insects Like to be Warm

Temp. range	Effect
< 32	Death in minutes
40 – 60	Death in days
66 – 77	Sub-optimum
82 – 90	Optimum
95	Development stops
122	Death in minutes

Source: P. Fields, USDA 1992

Molds Also Like Moisture

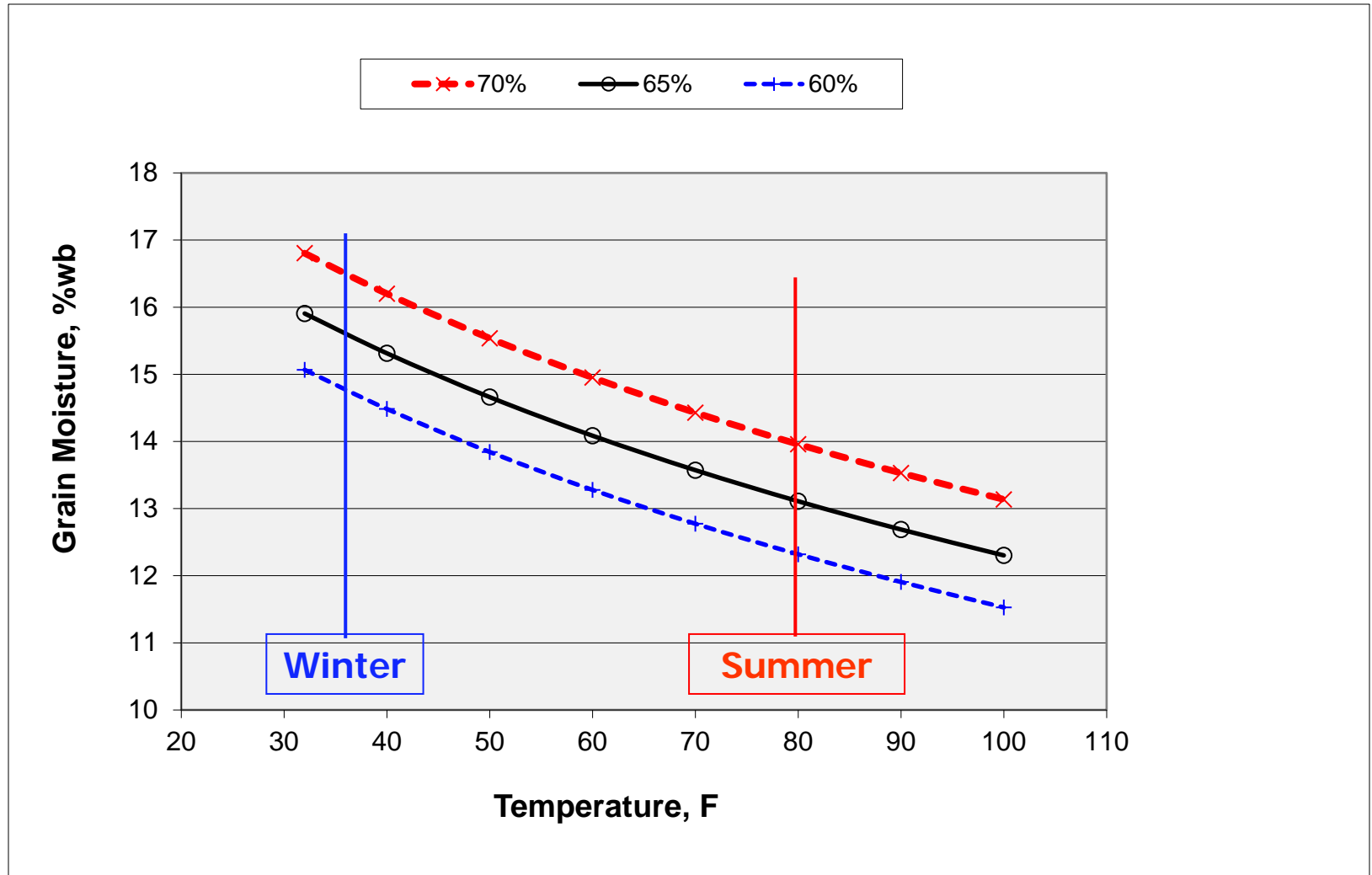
Fungus	Minimum RH (%)
<i>Aspergillus restrictus</i>	70
<i>Aspergillus glaucus</i>	73
<i>Aspergillus candidus</i>	80
<i>Aspergillus ochraceus</i>	80
<i>Aspergillus flavus</i>	85
<i>Penicillium</i>	80 - 90

Equilibrium Moisture Conditions for Corn

Temp.		Relative Humidity (%)							
C	F	30	40	50	60	65	70	80	90
-1	30	10.6	12.1	13.7	15.2	16.1	17.0	19.1	22.1
4	40	9.9	11.5	12.9	14.5	15.3	16.2	18.3	21.3
10	50	9.4	10.9	12.3	13.8	14.7	15.5	17.6	20.5
16	60	8.9	10.3	11.8	13.3	14.1	15.0	17.0	19.9
21	70	8.4	9.9	11.3	12.8	13.6	14.4	16.4	19.4
27	80	8.0	9.4	10.8	12.3	13.1	14.0	16.0	18.8
32	90	7.7	9.1	10.5	11.9	12.7	13.5	15.5	18.4

Source: ASAE Data D245.4 / Average of two Prediction Eqns.

Safe Storage Conditions for Corn



Safe Storage Moisture Contents

Grain	Max. MC, % wb		
	Fall	Spring	Summer
Corn	15.0	14.0	13.0
Sorghum	14.0	13.5	13.0
Soybeans	13.0	12.5	12.0
Wheat	13.5	13.0	12.5

Cost of Storage (¢/bu)

Pts. < Market	Corn	Wheat	Soybeans
1.0	4.7	5.7	11.3
2.0	9.4	11.3	22.7
3.0	14.1	16.8	34.0
\$/bu	4.00	5.00	10.00

Storage Tips to Control Risks



- Check grain moisture and temperature going into storage
- Minimize broken kernels
- Screen grain for mycotoxins
- Clean grain prior to binning
- Practice S.L.A.M.

Sanitation

Equipment

- Combine(s)
- Carts/truck beds
- Handling equipment
- Dryers
- Bins



Sanitation + Sealing

Inspect bins

- Look for daylight through holes in roof and walls – repair as needed
- Inspect/clean debris off roof vents



Sanitation – Outside

Outside the bins

- Remove spilled grain
- Mow weeds to reduce rodent activity



Sanitation – Outside

Outside the bins

- Inspect fan transitions and bottom ring
- Seal with expanding foam as needed



Sanitation – Outside

Outside the bins

- Clean electrical boxes – dryers & bins
- Inspect drive assemblies



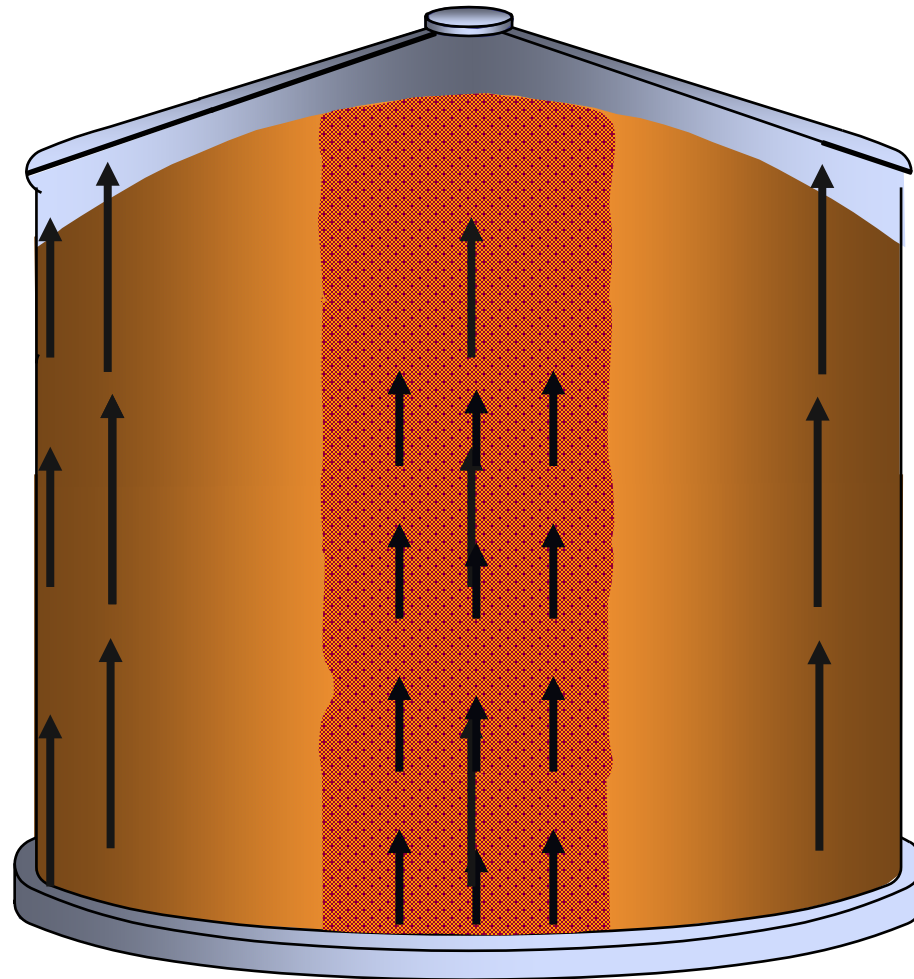
Bin Loading – Don't Overfill



Bin Loading

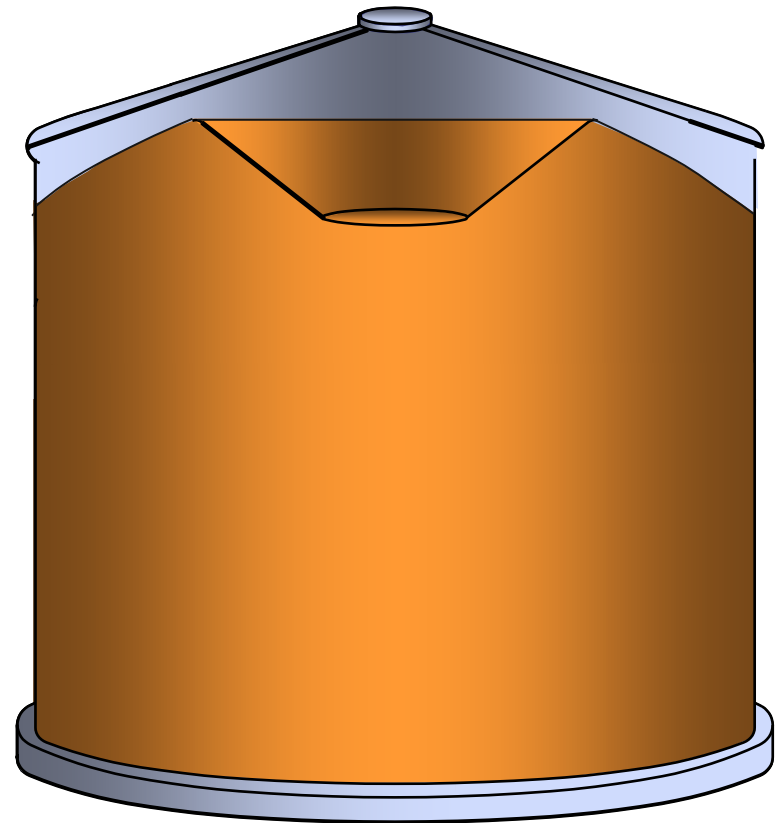
- **Manage trash and fines**
 - **Control grain damage by combine**
 - **Run augers full and ASAP**
 - **Clean grain before storage**
 - **Use a spreader to fill small bins**
 - **Core the bin to remove fines/trash from the center**

Manage Trash and Fines

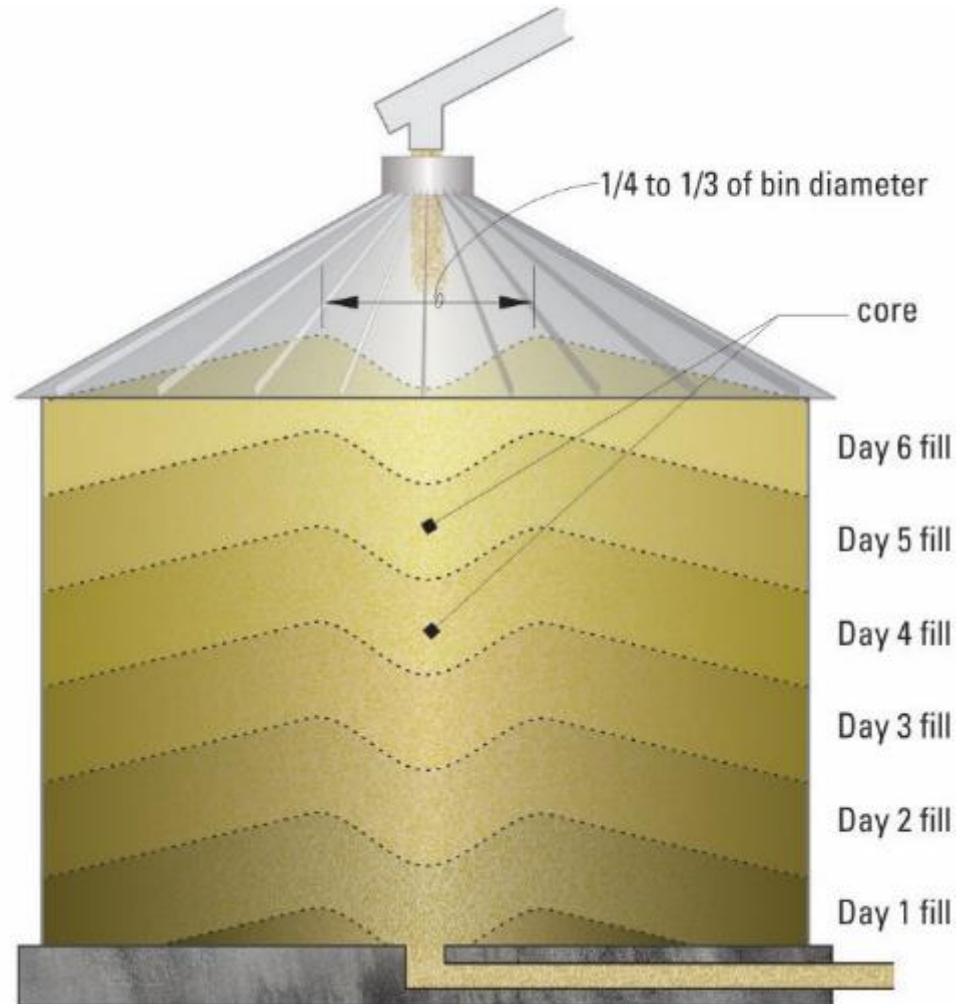


Core Small Bins after Filling to Remove Trash and Broken Kernels

1. Core $\frac{1}{3}$ to $\frac{1}{2}$ bin diameter
2. Reduce height of grain peak
3. Removes center core of BCFM
4. Improves airflow in center of bin
5. Provides space for monitoring grain surface



Core Large Bins Daily to Remove Trash and Broken Kernels

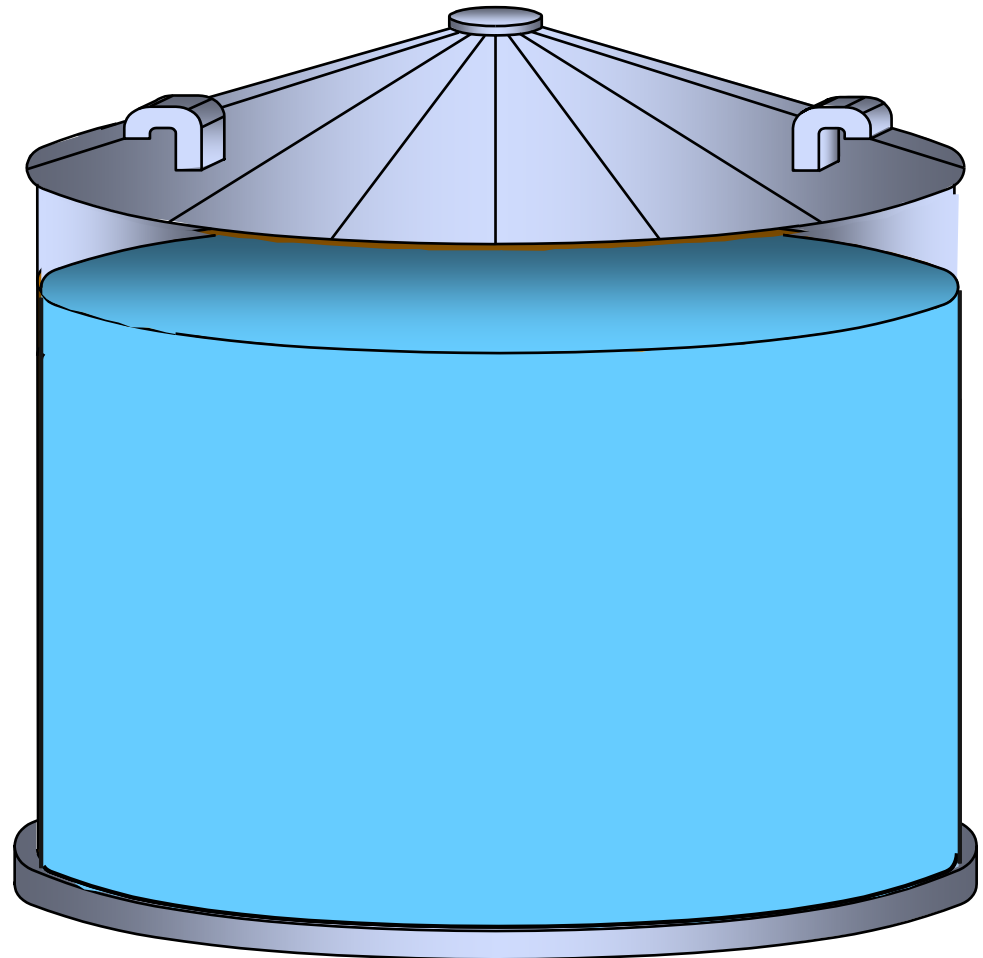


Aeration Cooling Cycle

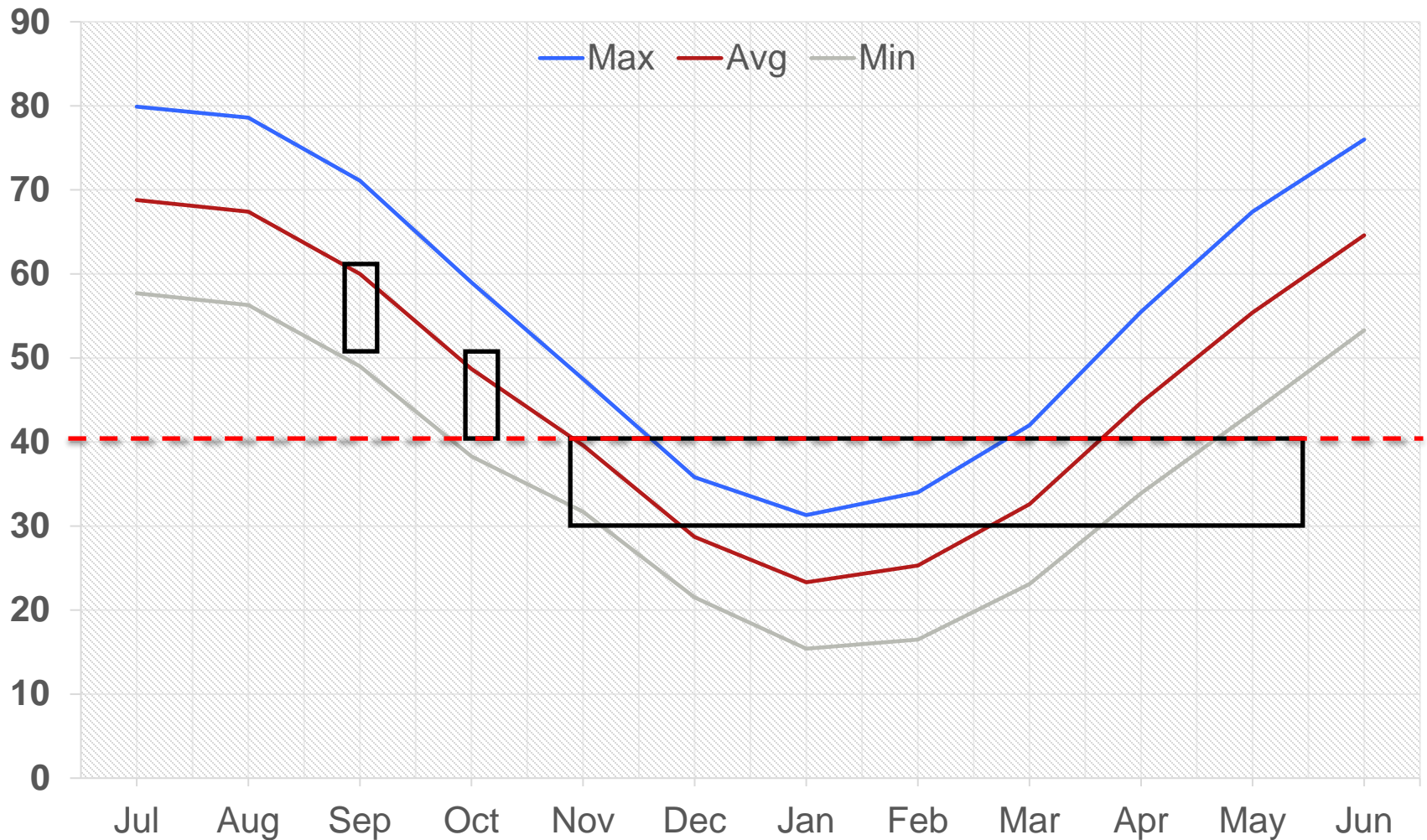
Airflow cfm/bu	Hours to cool	Mode
0.1	150	C
0.5	30	C
1.0	15	I

Rule of thumb:

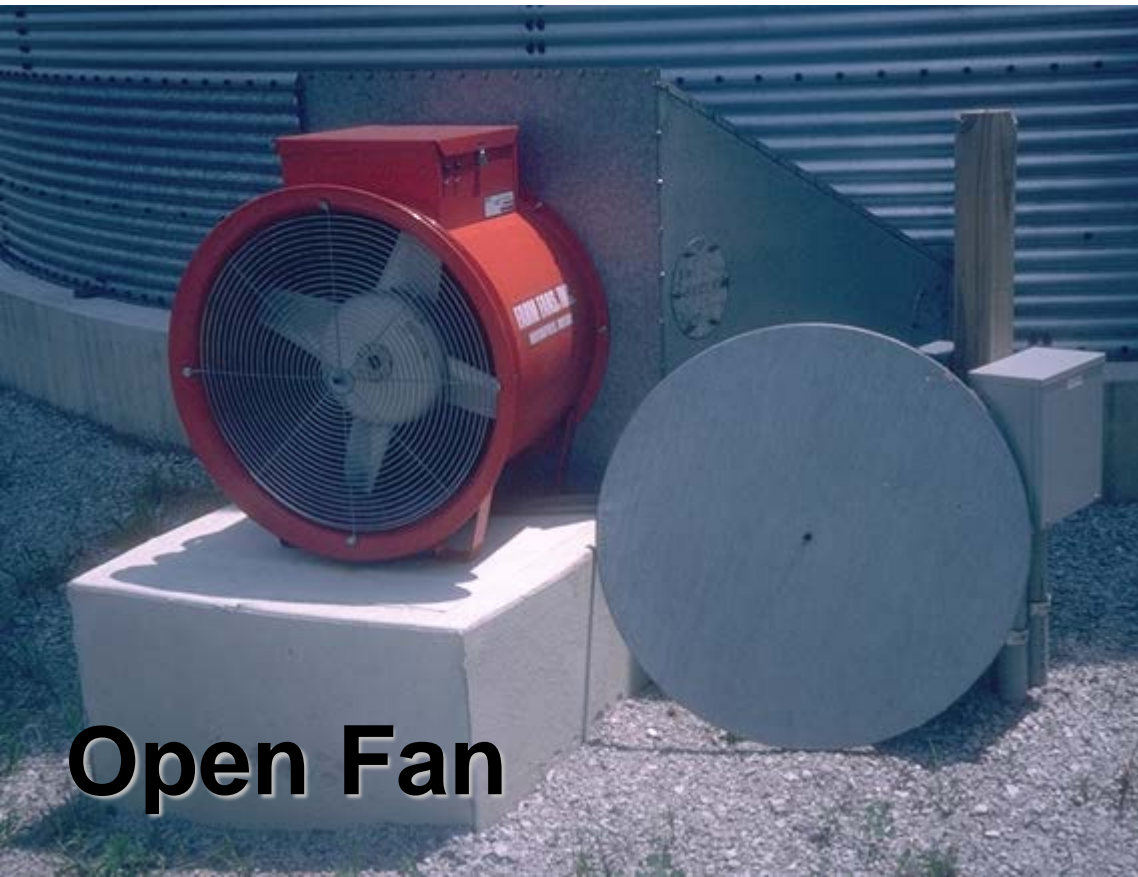
$$AT = 15 / \text{cfm/bu}$$



Stored Grain Temperatures in NY



Seal Fans After Final Aeration Cycle

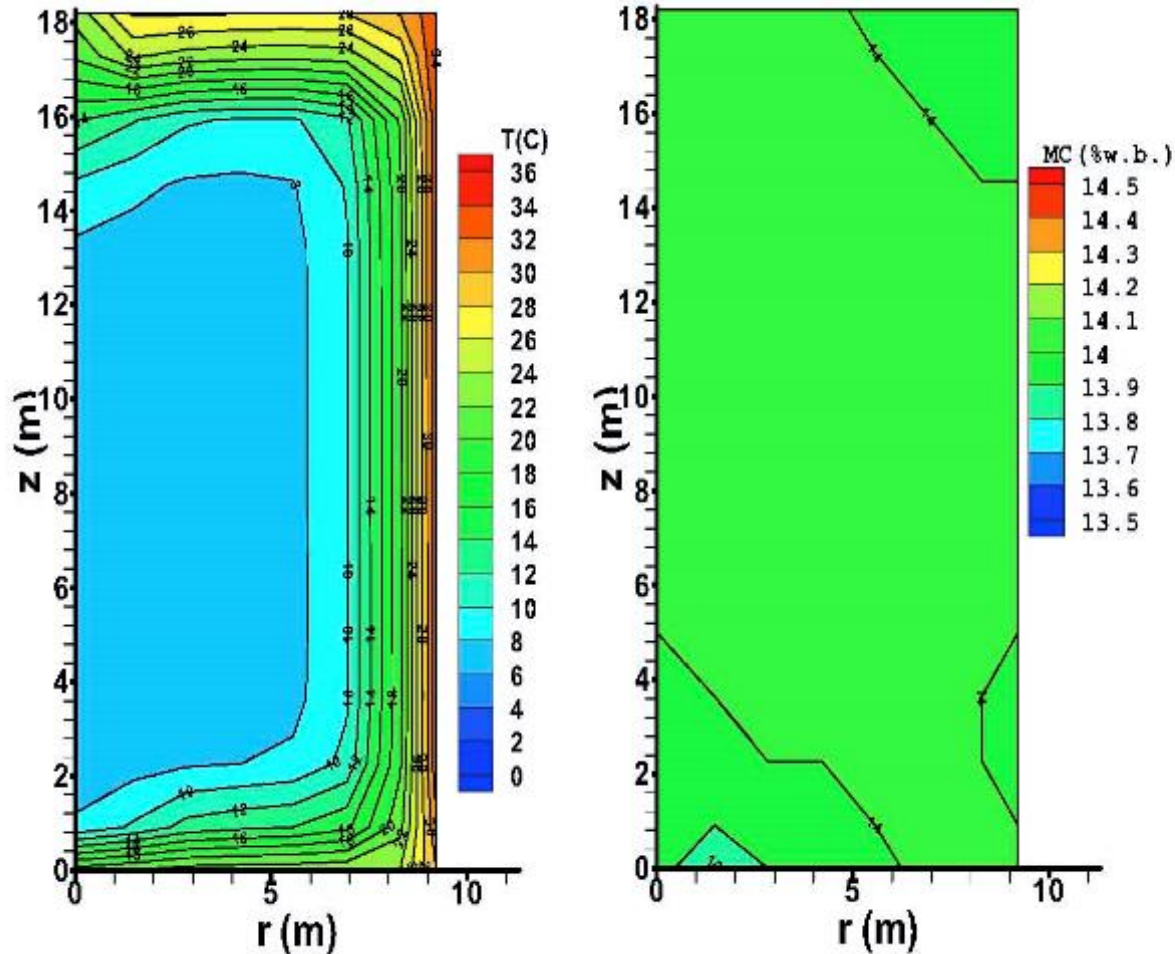


Open Fan



Sealed Fan

135,000 bu Bin of Corn during Summer Storage in Indiana – Non-aerated on 7/28/89



UMN Fan Program

<https://bbefans.cfans.umn.edu>



- What do you need to know?
 - Bin
 - Diameter, height and type of floor
 - Desired airflow (cfm/bu)
 - Grain type
 - Fan (s)
 - Motor size and fan type...select from ~400 fans
 - Specify fan arrangement
- What does the program do?
 - Bushels, airflow, and static pressure at 3-ft increments
 - Table or graph forms

Department of

Bioproducts and Biosystems Engineering

Sustainable Use of Renewable Resources – Enhancement of the Environment

University of Minnesota Fan Selection for Grain Bins

- Home
- About Us
- Undergraduate Programs
- Graduate Program
- In the News
- People
- Research
- Career Resources
- Extension and Outreach
- Giving
- Contact Us

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Bin and Crop Inputs

Select a crop:

Floor Type: Full Duct

Bin Diameter, feet:

Grain Depth, feet:

Desired airflow (cfm/bu):

Estimated Fan Requirements

[Show Table](#)

(to get desired airflow when bin is full)

Bin capacity (bushels):	47,772
Total airflow (cfm):	23,886
Estimated static pressure (inches of water):	5.08
Estimated fan power needed (hp):	31.79

Fan Selection

[Show Fan Data](#)

Select a fan:

Fan arrangement: Parallel Series

Number of fans on bin:

Depth	Bushels	Airflow cfm	Airflow cfm/bu	S. P. in H2O
3	4,343	34,670	8.0	0.8
6	8,686	33,370	3.8	1.5
9	13,030	32,270	2.5	2.1
12	17,370	31,180	1.8	2.7
15	21,715	30,160	1.4	3.2
18	26,060	29,180	1.1	3.7
21	30,400	28,230	0.9	4.1
24	37,445	27,180	0.8	4.4
27	39,090	26,220	0.7	4.7
30	43,430	25,360	0.6	5.0
33	46,770	24,760	0.5	5.3

Airflow for **Corn** vs **Wheat**

Depth	Bushels	Airflow cfm	Airflow cfm/bu	S. P. in H ₂ O	Airflow cfm	Airflow cfm/bu	S. P. in H ₂ O
		Corn			Wheat		
6	8,686	33,370	3.8	1.5	29,170	3.4	3.7
12	17,370	31,180	1.8	2.7	23,910	1.4	5.8
18	26,060	29,180	1.1	3.7	20,665	0.8	7.3
24	37,445	27,180	0.8	4.4	17,485	0.5	8.0
30	43,430	25,360	0.6	5.0	14,860	0.3	8.3

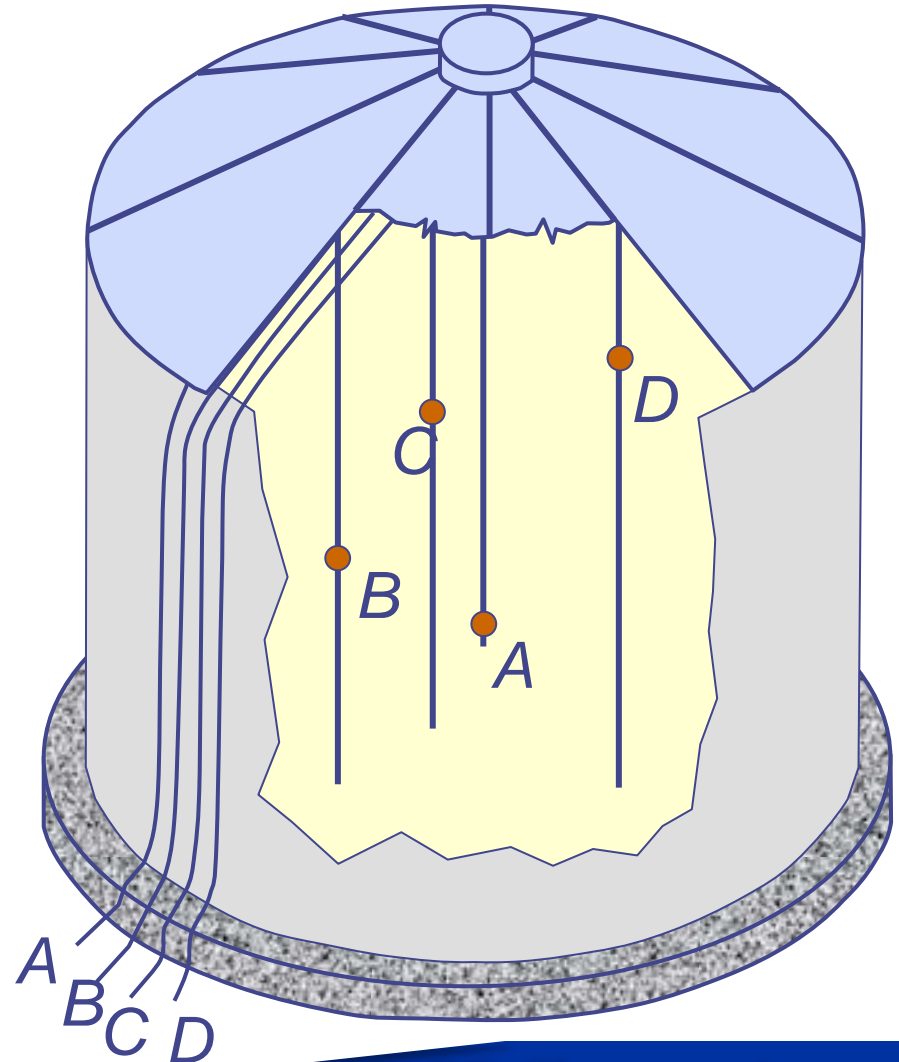
Cost of Aerating Grain

Fan HP	Airflow cfm/bu	Time Hours	Cost \$	Cost ¢/bu
3	0.10	450	\$ 135	0.29
7.5	0.25	180	\$ 135	0.29
30	0.50	90	\$ 270	0.57

**Three aeration cycles for 47,000 bu
Electricity at 10 cents/kwh**

Temperature Cable System

1. Thermocouple sensor cables
2. Cable suspension system
3. Leadwire extension
4. Readout plug
5. Display instrument



Temperature Cable System

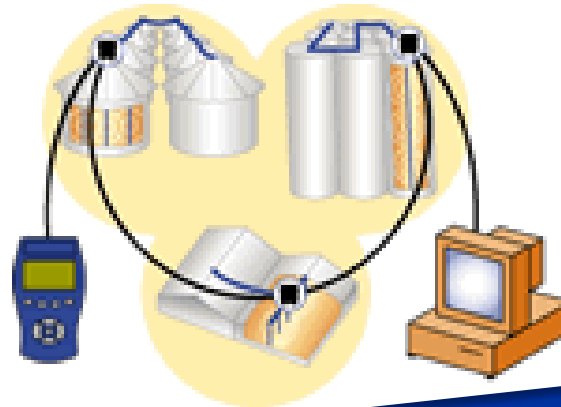


Insect Monitoring Tools

1. Grain probe
2. Pitfall trap
3. Automated system



Automated Insect Monitoring



opisystems.com

Commercial Fan Controllers



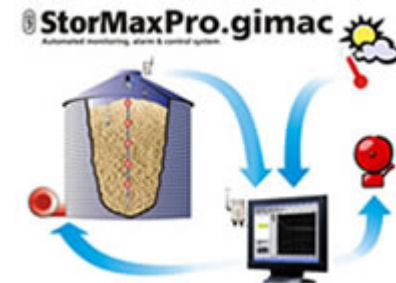
stepsgms.com



grainsystems.com

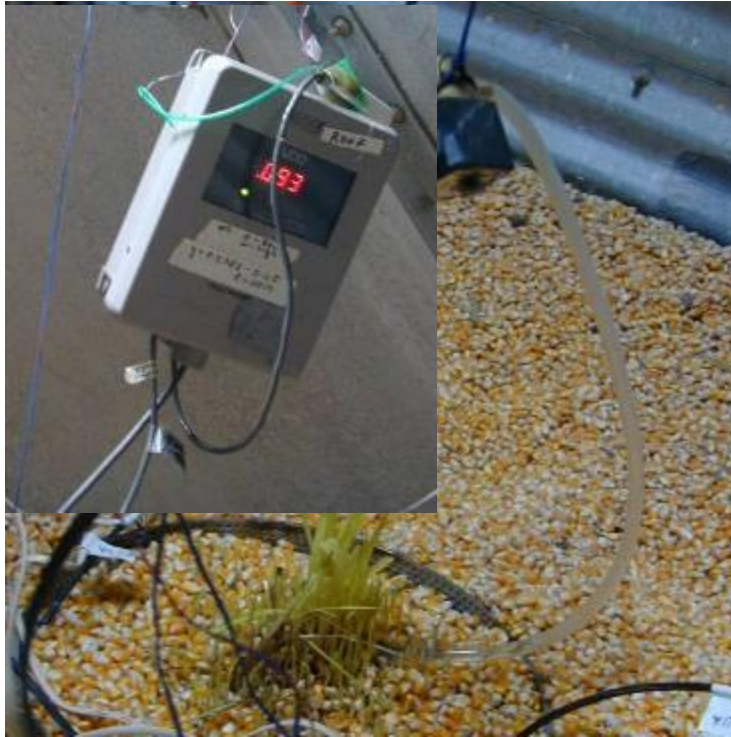


intellifarms.com



advancedgrainmanagement.com

CO2 - Early Spoilage Detection



grainpro.com/grainpro-co2-analyzer



Temp and RH Monitoring



□ Partial list of vendors

- AgSense (agsense.com)
- Amber Agriculture (amber.ag)
- BinCheck (intellifarms.com)
- Bin-Sense (binsense.com)
- CMC Industrial Electronics (cmciel.com)
- GSI /GrainViz (grainsystems.com)
- Govee Wireless (amazon.com)
- Integris/OPI (advancedgrainmanagement.com)
- SafeGrain (safegrain.com)
- Smart Switch (stepsgms.com)
- The Boone Group (rolfesatboone.com)
- Tri-State Grain Conditioning (tsgcinc.com)



Approximate Costs

- Temperature Cables:
 - 0.5 – 1.5 ¢/bu
- Fan Control Circuits:
 - 0.3 – 1.5 ¢/bu
- Aeration Systems:
 - 10.0 – 20.0 ¢/bu

Be Alert When Inspecting Stored Grain



When Inspecting Stored Grain Always Work in Pairs !!



Bin Rescue in Spring 2005



Coffer Dams Retard Grain Flow



Grain Handling Safety



If you must enter a bin use extreme caution...

1. Shut off and lock-out unloading conveyers
2. Use a climbing harness and safety line
3. Use a respirator
4. Position someone outside the bin to monitor activity
5. Avoid the center of the bin
6. Have a coffer dam on site

University Resources

Agricultural Engineering Departments in Midwest

1. Iowa State University | extension.iastate.edu/grain
2. Kansas State University | grains.k-state.edu/
3. North Dakota State University | ag.ndsu.edu/graindrying
4. Oklahoma State University | bae.okstate.edu
5. Purdue University | engineering.purdue.edu/ABE/engagement#PostHarv
6. University of Arkansas | bio-ag-engineering.uark.edu/
7. University of Kentucky | uky.edu/bae/grain-storage-systems
8. University of Tennessee | <https://bess.tennessee.edu/>

Other Resources

1. American Society of Agricultural and Biological Engineers (asabe.org)
2. Midwest Plan Service (mwps.org)
3. NC-213 (oardc.ohio-state.edu/nc213/)
4. USDA Grain Lab in KS (ars.usda.gov)
5. GEAPS (geaps.org)
6. GrainNet (grainnet.com)



GRAIN DRYING,
HANDLING,
AND
STORAGE
HANDBOOK

MWPS-13 THIRD EDITION

Dirk Miller · Samuel McNeill · Kenneth Hellberg

Thank You and Stay Well!



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