

# Wheat Drying and Storage Tips

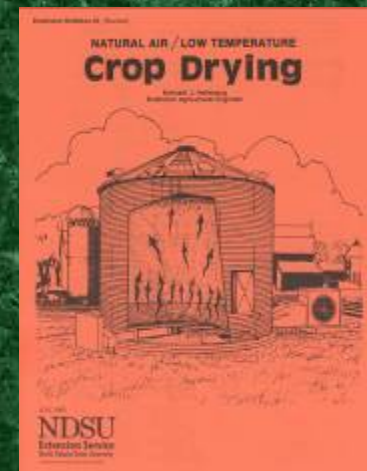
**Kenneth Hellevang, Ph.D., P.E.  
Extension Engineer, Professor  
Agricultural & Biosystems Engineering**

**NDSU**  
**Extension Service**

# Airflow Rates and Drying Times natural air drying wheat

air at 69° and 60% relative humidity, average North Dakota condition for August.

Moisture Content	Airflow (cfm/bu)	Fan Time	
		Hours	Days
18%	1.25	480	20
	1.00	600	25
17%	1.00	552	23
	0.75	744	31
16%	1.00	504	21
	0.75	672	28
15%	0.50	1,008	42
	1.00	480	20
	0.75	648	27
14%	0.50	960	40
	1.00	408	17
	0.75	544	23
	0.50	816	34



# Water Holding Capacity of Air

10,000 lbs. – 129,000 cu.ft. @ 50°F

Relative Humidity Increases from 60% to 85%

Temperature (°F)	Lbs. Water	% of 70°F
70	39.6	100
60	27.7	70
50	19.2	48
40	13.0	33
30	8.6	22
20	5.4	14

**Directly related to drying speed**

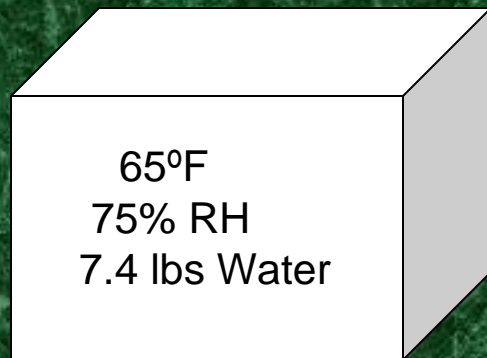
# Wheat Drying Time

17% initial M.C., 0.75 cfm/bu, +3°F fan

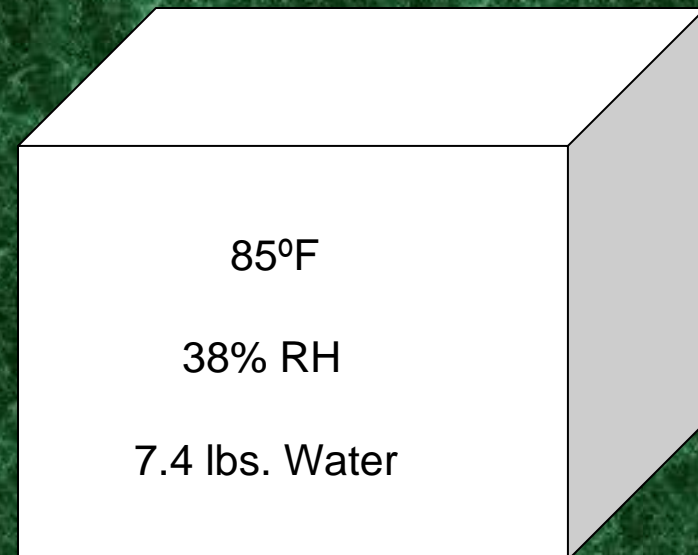
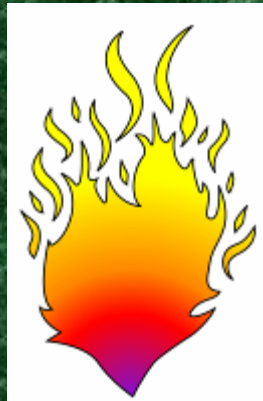


Month	Temp.	RH	+3° Temp	+3° RH	EMC	Days	%↑
Aug.	69	60%	72	54%	12.6%	26	
Sep.	58	65%	61	58%	13.5%	31	20%
Oct.	47	65%	50	58%	13.9%	39	50%
Nov.	27	73%	30	63%	15.6%	75	300%

10,000 cubic feet of air



EMC = 15.8%



EMC = 10.0%

**Heat reduces relative humidity & grain moisture content**



# Effect of Supplemental Heat Drying Wheat



17% initial M.C., 0.75 cfm/bu, 10,000 bu Bin, \$0.03 electric heat

	Temp (°F)	RH (%)	EMC (%)	Drying Time (Days)	Shrink Cost	Heat Cost	Overdry Cost
Ave Sep	58	65	14.4	--			
+3° Fan	61	58	13.5	31			
10° + 3°	71	41	10.8	27	\$1,050	\$470	\$1,520
Ave Oct Cold Sep	47	65	15.0	--			
+3° Fan	50	58	13.9	39			
10° + 3°	60	40	11.0	37	\$1,141	\$639	\$1,780
Humid Sep	58	75	16.1	--			
+3° Fan	61	67	14.6	40			
10° + 3°	71	47	11.6	28	\$735	\$484	\$1,219
5° + 3°	66	56	12.9	32	\$245	\$242	\$487

# Williston Environment

Ambient Conditions			Equilibrium Moisture Content (EMC)			
Month	Temp (°F)	Relative Humidity	Wheat	Corn	Oil Sunflower	Soybeans
Aug	69	56%	12.8			
Sep	57	60%	13.9			
Oct	46	64%	15.1	15.1	8.6	12.1
Nov	28	73%	17.3	18.1	10.1	15.2

Warm Air 5°F			Equilibrium Moisture Content (EMC)			
Month	Temp (°F)	Relative Humidity	Wheat	Corn	Oil Sunflower	Soybeans
Aug	74	47%	11.5			
Sep	62	50%	12.3			
Oct	51	53%	13.1	12.5	7.3	9.4
Nov	33	58%	14.6	14.5	8.2	11.0

# Fargo Environment

Ambient Conditions			Equilibrium Moisture Content (EMC)			
Month	Temp (°F)	Relative Humidity	Wheat	Corn	Oil Sunflower	Soybeans
Aug	70	66%	14.0			
Sep	59	72%	15.5			
Oct	47	71%	16.0	16.1	9.1	13.6
Nov	28	76%	17.2	18.7	10.4	15.8

Warm Air 5°F			Equilibrium Moisture Content (EMC)			
Month	Temp (°F)	Relative Humidity	Wheat	Corn	Oil Sunflower	Soybeans
Aug	75	55%	12.5			
Sep	64	60%	13.5			
Oct	52	59%	14.0	13.5	7.8	10.5
Nov	33	61%	15.2	15.2	8.6	11.7

# NDAWN for RH info

The screenshot shows the NDAWN website interface. At the top, there's a browser window with the URL <http://ndawn.ndsu.nodak.edu/>. Below the browser window is the NDAWN Center logo and a navigation menu on the left with options like Home, What's New?, Overview, Help, Disclaimer, Weather Data, Monthly Report, Applications, ND State Climatologist, Contact Us, Links, and Log In.

The main content area features a map titled "NDAWN Station Locations (2006-01-11)" showing various weather stations across North Dakota with their names and distances from towns. Below the map is a key: "Key: Station Name 9S = 9 Miles South of Town".

At the bottom of the map area, there's a table titled "Select Weather Variable for January 11, 2006:" with the following data:

Select Weather Variable for January 11, 2006:		
Stations	Wind Speed	Solar Radiation
Temp: Air Max/Min	Wind Direction	Relative Humidity
Temp: Air Avg	Wind Chill	Dew Point
Temp: Soil	Rainfall	Potential ET

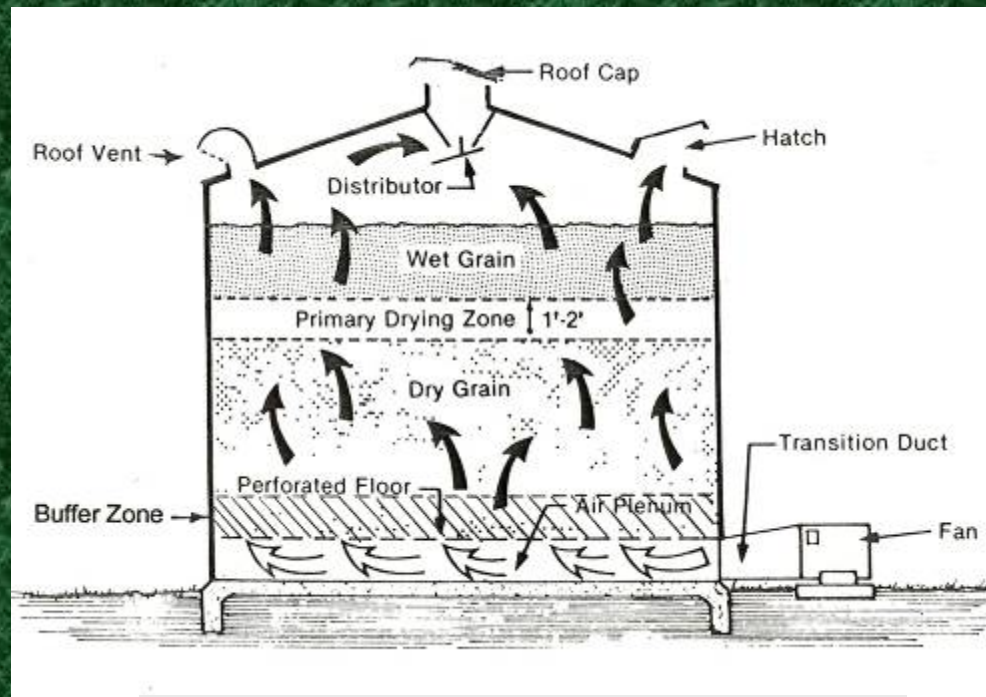
Navigation buttons for "< Previous Day" and "Next Day >" are also visible.

Relative Humidity  
Meter



<http://ndawn.ndsu.nodak.edu/>

# Running Fans at Night



<b>Condition</b>	<b>Temp. (F)</b>	<b>Relative Humidity</b>	<b>E.M.C</b>
<b>Afternoon</b>	<b>80</b>	<b>43%</b>	<b>10.7%</b>
<b>Night</b>	<b>60</b>	<b>85%</b>	<b>17.9%</b>
<b>Ave. Aug.</b>	<b>70</b>	<b>60%</b>	<b>13.3%</b>

# Management

- Airflow direction
- Drying fronts stopping
- Fan operation during wet weather
  - Fog vs. Rain
  - 20% m.c. wheat vs. 15% m.c.
- Stirring
  - High Temperature Drying  $>5^{\circ}$

# Fan Control (Off Peak)

- 17% wheat 0.75 cfm/bu  
Drying time = 31 days  
AST= 45 days  
Control time = 14 days = 336 hrs= 45%  
Fan restart  
Do not control continuous for several days
- 18% wheat 0.75 cfm/bu  
Drying time = 33 days  
AST = 30 days  
Control time = 0

# Drying Cost

21 ft bin    18 ft depth    4,988 bu.

17% moisture Wheat    0.75 cfm/bu,

Drying time = 31 days = 744 hrs. (Sept.)

Fan 5 hp Centrifugal    4.5 Kw

Electrical usage = 3,348 Kwh

@ \$0.07 = \$234 = \$0.047/bu = \$0.011/bu-pt.

@ \$0.03 = \$0.02/bu. = \$0.005/bu-pt.

High Temperature @ \$1.30 propane ~  
\$0.029/bu-pt.

# Horsepower required increases with airflow rate

<u>Cfm/bu</u>	<u>Hp</u>	<u>Static Pressure</u>
0.5	5	3.5
0.75	11	5.6
1.0	20	8.0
1.25	33	10
1.5	50	13
2.0	100	19



30 ft diameter bin with wheat 17.5 ft deep



## Horsepower required increases with grain depth

<u>Depth (ft)</u>	<u>Hp</u>	<u>Static Pressure (in. H<sub>2</sub>O)</u>
15	7	4.0
17	10	5.2
19	14	6.7
21	19	8.3
23	26	10.1
25	44	12.2

21 ft diameter bin with 0.75 cfm/bu airflow rate

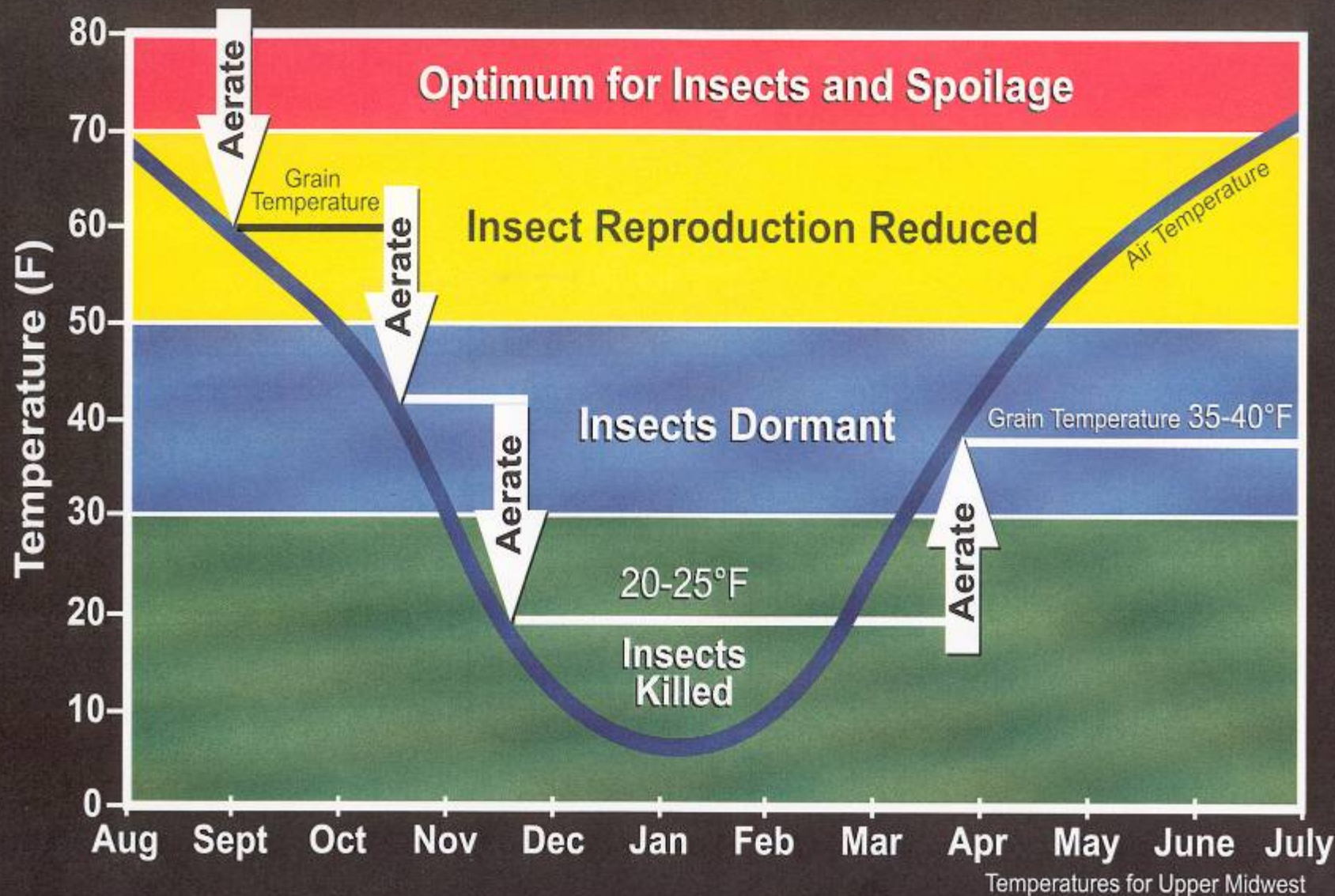


## Additional Fans are Expensive

Fan Hp	Cfm/bu	Drying Cost	Days	SP
1 x 7.5	0.86	\$0.065	27	6.5
2 x 7.5	1.20	\$0.094	19	9.8
3 x 7.5	1.45	\$0.117	16	12.4
4 x 7.5	1.57	\$0.143	15	13.7
5 x 7.5	1.62	\$0.174	14	14.3

HSC Fan, Drying wheat 17% to 13% mc, electricity \$0.06 Kwh

# 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

Dr. Kenneth J. Hellevang, Ph.D.  
NDSU Extension Service

# Cover Aeration Fans



# Moisture Measurement Factors

- Representative Sample
- Grain Variety
- Geographic Location: Corn study  $\pm 0.8\%$  m.c.
- Weathering
- Kernel Composition (oil content)
- Physical Damage
- Temperature
- Density
- Moisture Uniformity

# Outdoor Storage



Drainage (1" rain 100' x 400' = 25,000 gal)  
Will water flow away from the grain pile  
Will area flood

Prepared Storage Surface

Crowned

Compacted

Reduce permeability

lime, fly ash, cement, asphalt



# Uncovered Piles?

**1-inch rain increases moisture content of  
1 ft of grain by 9 points**

**Keep Surface Smooth to aid run-off?  
43% voids, crust?**

**Wet Grain Expands increasing wall  
pressures**

# Aeration

Fans



Ducts

perforations, placement,  
Intake/exhaust



Perforated wall



# Questions?

<http://www.ag.ndsu.nodak.edu/abeng/>

**Crop Postharvest**

**NDSU**  
**Extension Service**