Grain Cleaning, Drying, and Storage Systems

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Organic Growers' Research Information Sharing Network &

Natural Organic Farming Association – New Jersey

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Agenda

- Grain System Considerations
- Comparison of Some Capital Costs
- Pictures & video tour of Langdonhurst Farm
  - Q & A with John Langdon
- Pictures & video of Hudson Valley Hops & Grains
  - Q & A with Stuart Farr
- Video discussing grain storage in sacks
- Pictures & video of other drying & cleaning machinery
- Discussion

Grain System Considerations

- Costs – capital and variable
- Efficiency *($25/hr labor minimum?)*
- Longevity
- Management – SLAM
  - Sanitation
  - Loading
  - Aeration
  - Monitoring
- Safety
- FSMA (Food Safety Modernization Act)

Recent Recalls Due to Pathogens in Flour

- Cold Stone Creamery – 2005 (Recall)
  Cake Batter Ice Cream - Salmonella
- Nestle – 2009 (Recall)
  Refrigerated cookie dough products
  E. coli 0157:H7
- Rich Products – Various – 2013 O121 (Recall)
- Pizza Ranch – March 2016
  13 illnesses – E Coli 0157
- Gold Medal Flour – 2016 (Recall – 3)
  63 illnesses – E. coli 0121/026
- Flour – Canada – Ardent March 2017 (Recall)
  Robin Hood & others
  30 Illnesses – E. coli O121
- Flour – Canada – Rogers Foods – May 2017 (Recall)
  6 illnesses – E. coli O121 (Costco)
- Flour – E Coli – Smuckers of Canada – Feb 2018
  No Illnesses
- Duncan Hines Cake Mix - October 2018 (Recall)
  5 illnesses – Salmonella
- Flour – January 2019 (Recall)
  No Illnesses – Salmonella
- Gold Medal Flour – January 2019 (Recall)
  No Illnesses Salmonella
- Pillsbury Flour – March 2019 (Recall)
  No Illnesses – Salmonella
- Aldi Flour (exp to King Arthur, Pillsbury, Brand Castle) May 2019 (Recall)
  21 Illnesses – E. coli O26
- Gold Medal Flour – September 2019 (Recall)
  No Illnesses – E. coli O26
- King Arthur Flour – October 2019 (Recall) [Expansion of May]
  No Illnesses – E. coli (Also Robin Hood in US)
- Wild Harvest Flour – November 2019 (Recall)
  No Illnesses – E. coli
- Hodgson Mill Flour – November 2019 (Recall)
  No Illnesses – E. coli

	Grain Storage Systems Comparison		
Type of System	**Capacity**	**Dimensions**	**Capital Cost**
Flat Bottom Bin	14,112 bu	30ft dia X 22ft H	$39K, $2.76/bu
Flat Bottom Bin	5613 bu	21ft dia X 18ft H	$24K, $4.28/bu
Flat Bottom Bin	2785 bu	15ft dia X 18ft H	$17.5K, $6.28/bu
Hopper Bottom Bin	945 bu	9ft dia X 26ft H	$10K, $10.58/bu
Hopper Bottom Bin	1470 bu	12ft dia X 22 ft H	$12K, $9.52/bu
Hopper Bottom Bin	9373	24ft dia X 13 ft H	$40K, $4.27/bu
20ft Shipping Container	1044 bu	8ft W X 8 ½ ft H	$2900+, $2.77/bu
40ft Shipping Container	2116 bu	8ft W X 8 ½ ft H	$3900+, $1.83/bu
Kilbros Grain Box only	205 bu (72 bu/ft rise)	88 ½ “ X 12 ft	$3300, $16.10/bu $3400, $12.27/bu
Kilbros Grain Wagon	205 bu (72 bu/ft rise)	8 ton running gear	$6500, $31.70 $6600, $23.83
Pallet Bins, hopper bottom	16 bu	57”X45”X32”H	$381, $23.81/bu
Pallet Bins, hopper bottom	47 bu	57”X45”X65”H	$529, $11.25/bu
Home-made wood bin			????
50# Nylon Bags	50 lbs?	24” X 40”	$0.80 ea
50# Burlap Bags	50 lbs?	24” X 40”	$2.00 ea
1 ton Totes	45 bu	42”X42”X55” spout	$47, $1.05/bu
LABOR $25/hr			

Component	Capacity	Price
screw in aerator fan tube	???	$98 - $270 $124+
GTE 245 Batch Dryer	140 bu/hr 2.2 mil BTU/hr 10,800 CFM	$29,000 (290K bu @$0.10; ~5800 acres to cover capital cost
4” corrugated drainage pipe	100 ft	$66
Rocket Bin Dryer for hopper bottom bins		??
4” X 10ft auger, motor, boot		$800
4” X 20ft auger, motor, boot		$950
6” X 10ft auger, motor, boot		$1,100
6” X 20ft auger, motor, boot		$1,400

Tour of Langdonhurst Farm & Discussion

Tour of Hudson Valley Hops and Grains & Discussion

Video of Clipper Grain Cleaner & Discussion

Tour of Storing Grain Bags in Insulated Trailers & Discussion

Refrigerated seed storage unit, Lamar Stauffer, New Holland, PA

Used 9 ft X 21 ft refrigerated trailer

Lamar grows wheat, spelt,
hulless oats, barley, and einkorn

Can also use an air-conditioner converted to a “Cool-Bot”

Totes & bags stored,
Space for eighty 50-lb bags

Keep temperature <55^{O} and
< 50% humidity, no bugs

High Meadows Farm

- 20 ft shipping container (13 tons feed); 40 ft (24 ton)
- Space inlet based on natural slope of piled grain
- Gets very hot in the summer
- No moisture migration or spoilage (feed out grain continually)
- Exhaust vent for drying

A bulk head is needed to open doors and hold the grain.
This slot can be used to construct a bulk head.

With innovation you can layout drainage pipe or build/install an aeration floor, fit a fan, and auger out most of the grain.

- ***The area of slots in 100ft of 4" drainage pipe = to the area of the pipe cross-section area (12.56 in^2), but labor efficiency??***

Hudson Valley Farm Hub

- Minimizing temperature change will reduce moisture migration
- Locating storage in a building or at least minimizing direct sun can be beneficial
- Grain in sacks will take on moisture from humid air

B & W portable aerator

- Not rated for air flow (CFM), so experience is needed to understand it capacity
- For drying grain ***only*** a couple points of moisture.
- Depends on which grain, initial grain temperature, initial grain moisture, amount of chaff, humidity, etc

Hickory Hill Farm

- The pipe is a loop, not dead ended, to equalize pressure better
- Attach pipe to a plenum might increase the air flow

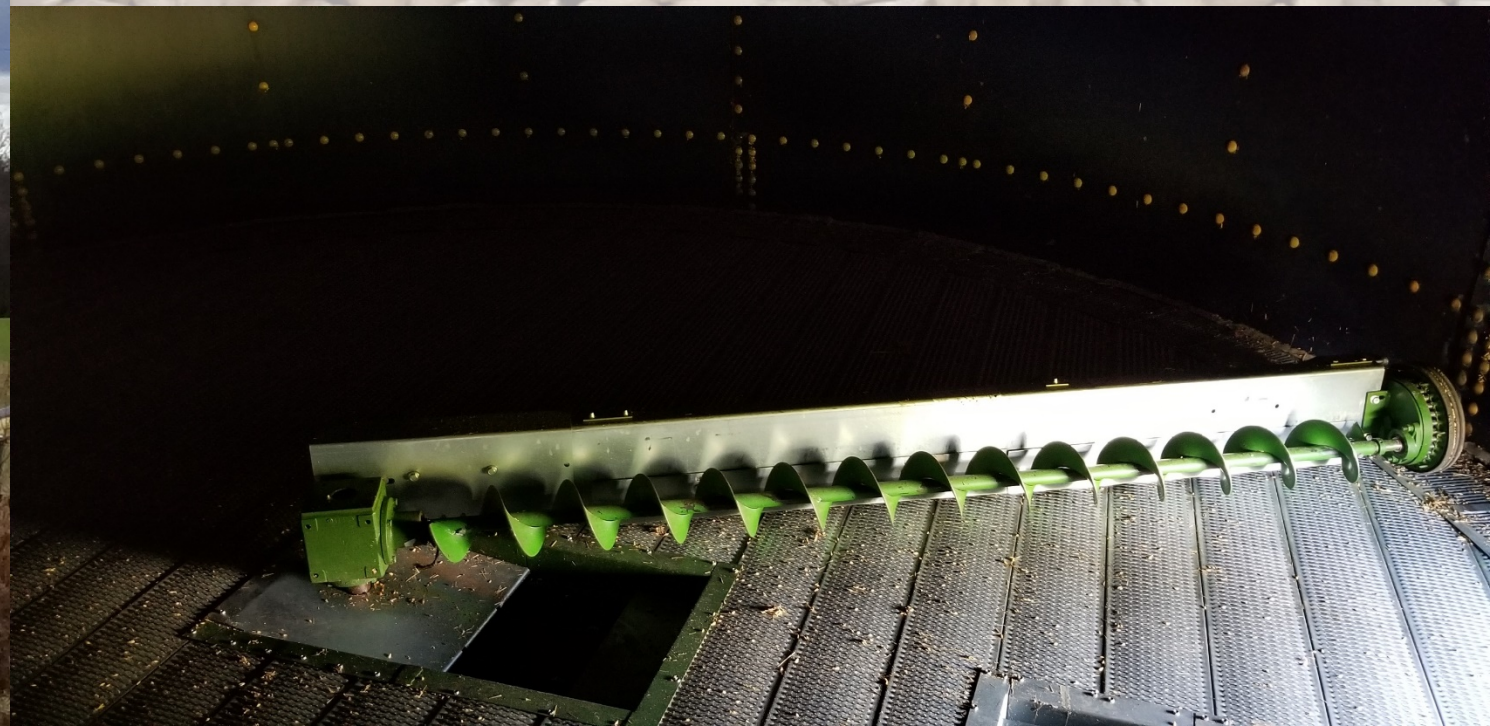
Renauld Farm

- 4 - 5 tons rye in a grain cart
- Auger or gravity flow into a loader bucket, then dump into the customers truck
- Some rodents and squirrels (think FSMA)
- No storage mold (moisture test at harvest and mix field edges with dry areas)

Migliorelli Farm

- 16 ft X 48 ft, 148 tons barley, 7716 bu
- Flex sealed all seams & bolts
- Roof needed work. Blue roof is better

- Grain sweep needs to be lifted up before filling bin. It runs over the top of the pile



Migliorelli Farm

- Grain Vac does a great job of filling the bin
- Concrete silos can also be converted to store grain if they are in excellent condition
- An engineer is needed to evaluate and design the conversion

Corn Cribs

- Corn needs to get air to dry out, so dimension are important
- The older publication, “Storing Corn” is available with other resources for this meeting, and has information about constructing corn cribs

Principles – Grain Drying
Moisture Front

- **In a bin or bag, air moving in one direction carries and concentrates moisture in that direction.**

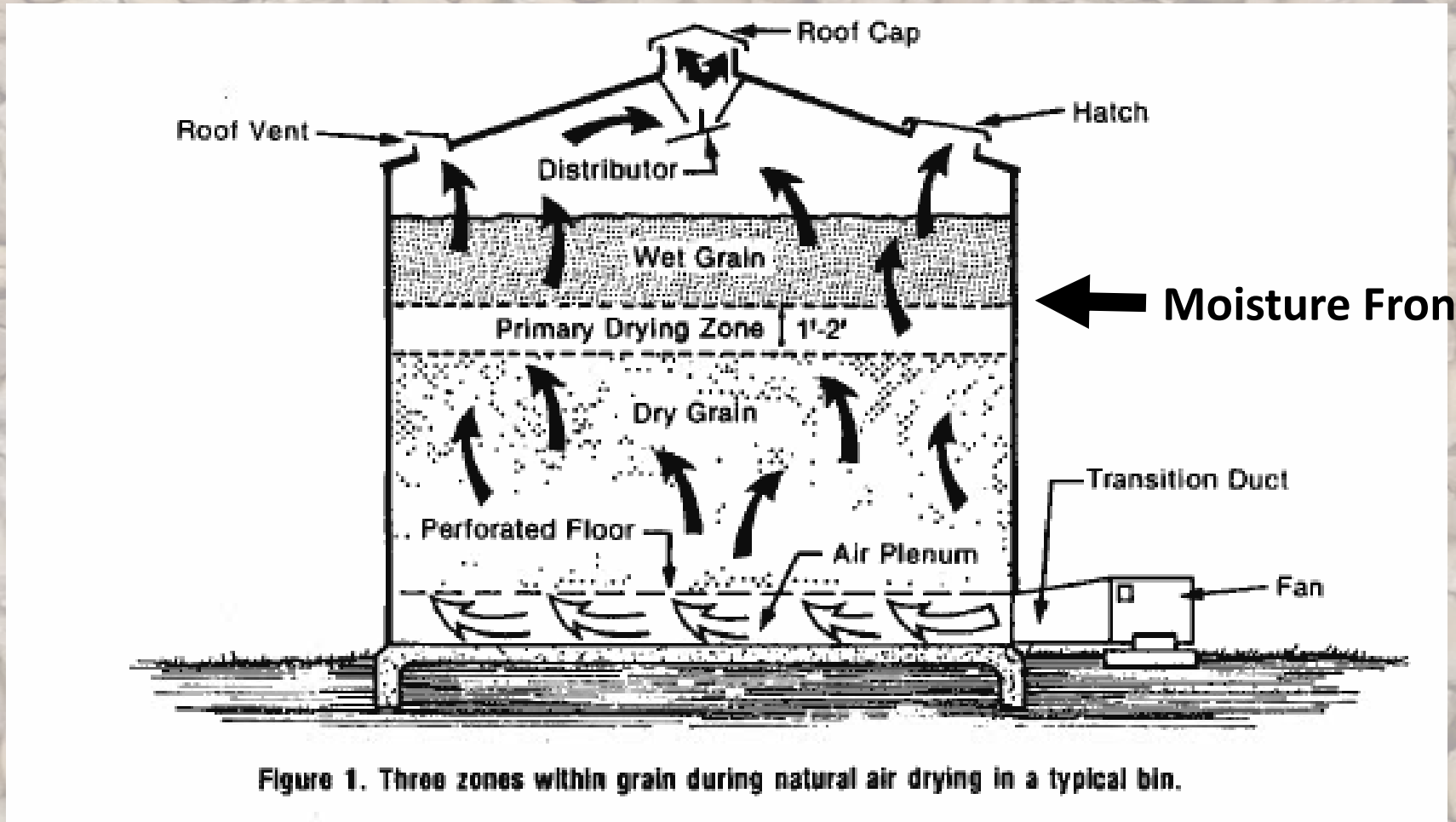


Figure 1. Three zones within grain during natural air drying in a typical bin.

Principles – Grain Drying
Moisture Migration

Condensation occurs when there is >15^{O} difference in temperature between grain and air.

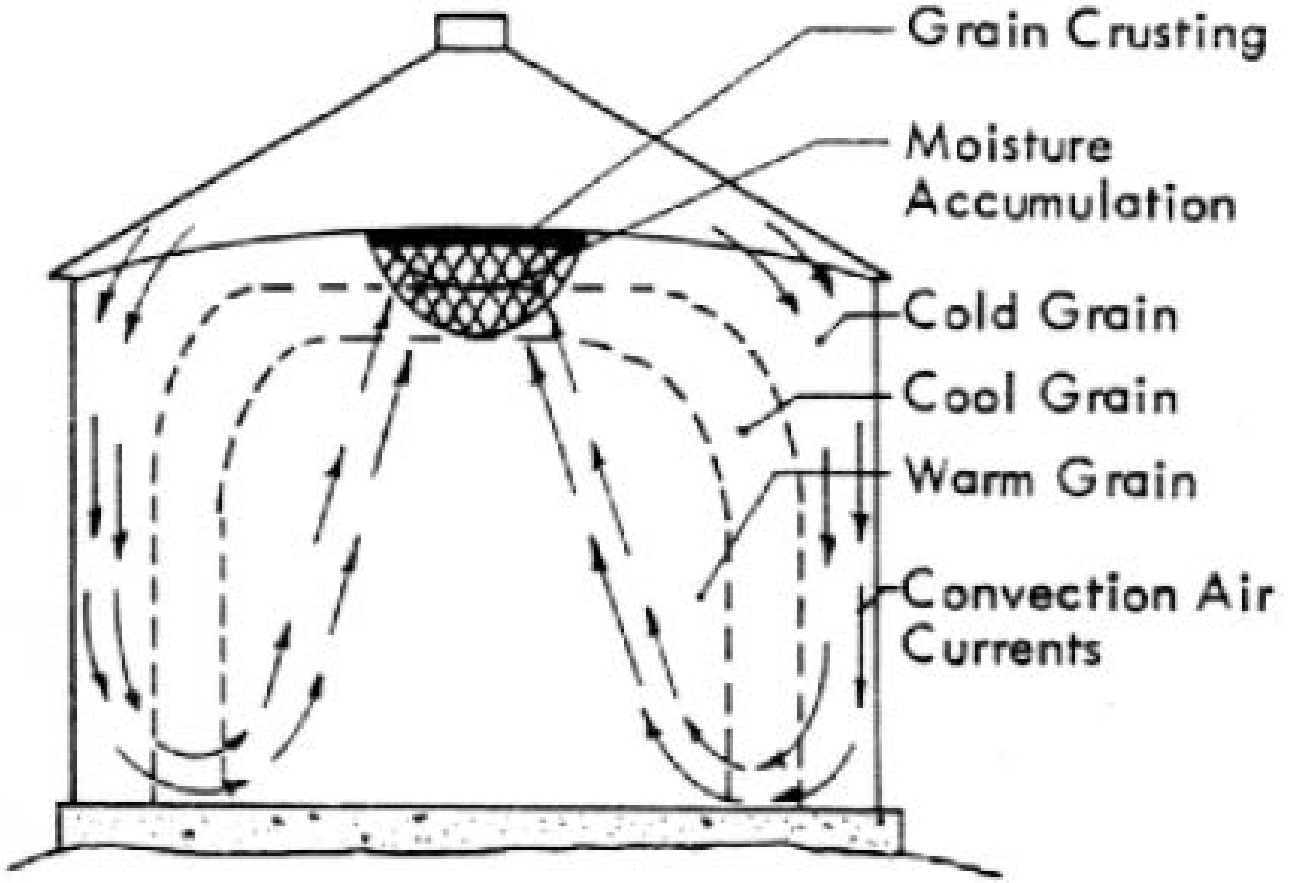


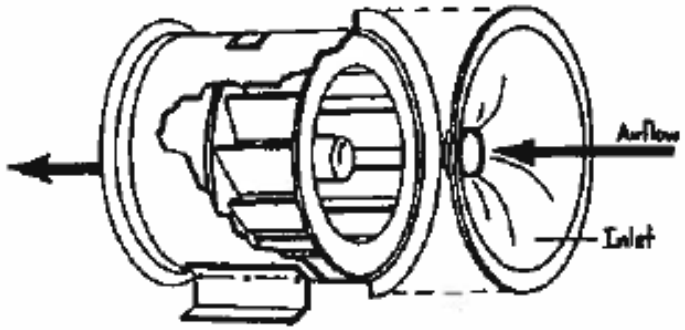
Fig 1. Winter grain temperatures and moisture migration

Principles – Grain Drying

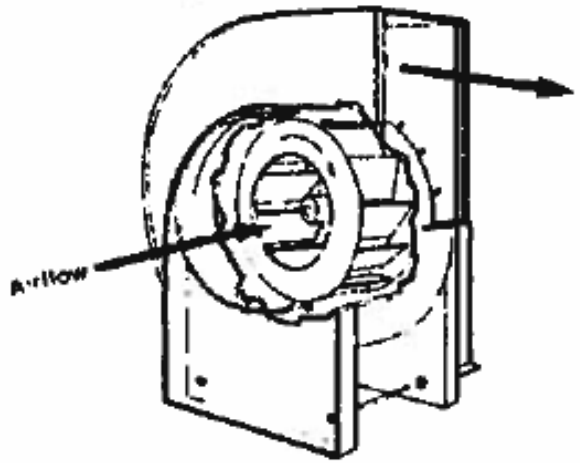
Fans perform differently

- All fans should have manufacturer's performance data: CFM @ different static air pressures

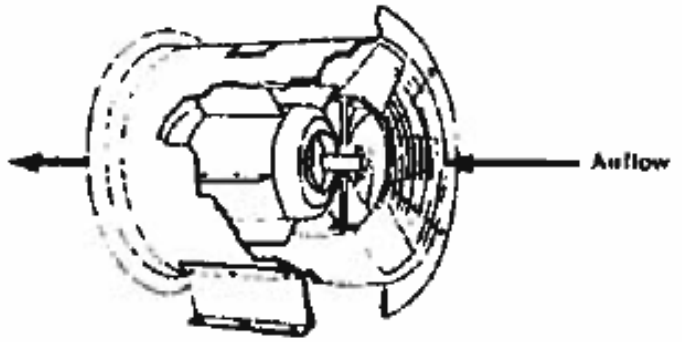
COMMON FANS USED ON GRAIN SYSTEMS



In-line centrifugal fans develop higher pressures than an axial-fan at a lower cost than a normal centrifugal fan.

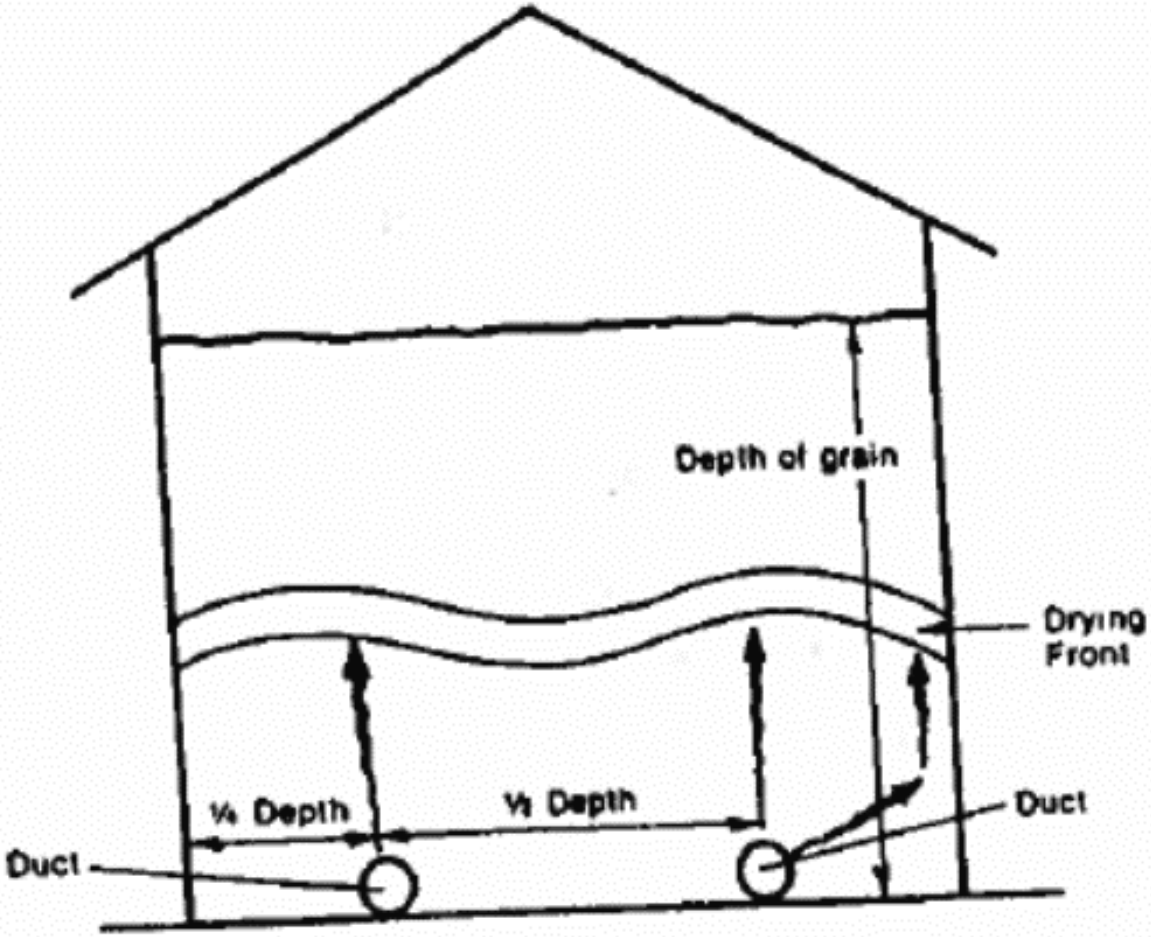


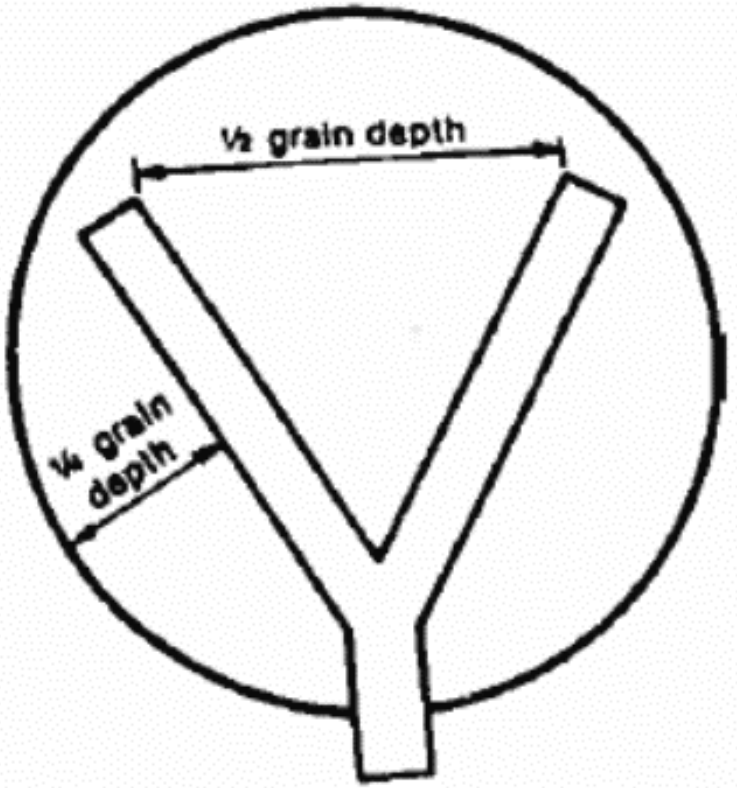
Centrifugal fans require higher investment than axial-flow fans, but are more efficient at higher static pressures and are quieter. They normally operate at 1,750 or 3,500 rpm.



Axial-flow fans operate most efficiently at static pressures below 3 to 4 inches of water. Noise can be a problem.

Principles – Grain Drying





Tools for monitoring moisture and temperature

Hudson Valley Hops and Grains

- 3 HP centrifugal fan
- 5 KW electric dryer (not show here)
- 28 ton / 1144 bu bin (933 bu soybean, 1000 bu wheat, 1144 bu barley)
- 9 ft diameter, 7 rings (31 ft to overall height)
- Metal building for cleaning, new building will be for processing
- ***Only clean and process as needed. No inventory to avoid pest build up.***

Heating Grain Bins

- Electric and propane heaters in-line with the bin fan
- Heat empty bins (140^{O} for 15 min.) to kill insects beneath the floor

Portable Radiant Heater

Arrowood Farm – batch dryer

Wilbur Knoll Farms

Top-bin Dryer

A wood heater supplements the propane top-bin dryer

- **6 – 8 cords/corn crop**
- **Saved $10K first year**
- **Propane burner stays on low**
- **Used for 15 years**

Like drying hay bales, bags of grain can also be dried

- An older publication, “Drying and Storing Grain on the Farm” is available with other resources of this meeting.

Fig. 1-A A large lot of wheat being dried with a hay drier fan. The fan is located just inside the barn door. The air duct inside the pile of bags is about 4 feet wide and 4 feet high. The depth of grain over the duct is the same as the width on each side of the duct.

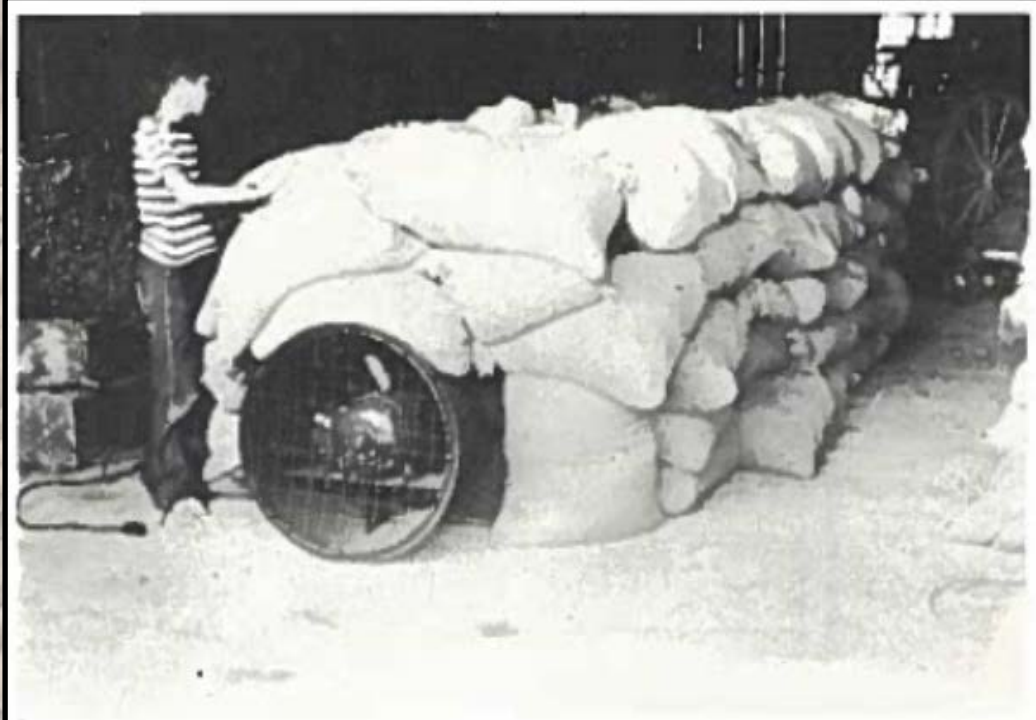


Fig. 2-A A small lot of grain being dried with a small fan. The duct in this case is the size of the fan outlet.

Red Rooster Farm – Portable Grain Dryer

SARE Project - Final report FNE16-854

- Culvert on a pallet
- Elevated aeration floor with port to blow in air

wooden barley bins

Argyle Craft Malts and Hops

Slits cut with circular saw

Argyle Craft Malts and Hops

A simple bagger

Seed Cleaning

Size / density / shape / texture / stickiness / pubescence

- Seeds bounce differently too. An interesting old patent for a farmer fabricator https://patents.google.com/patent/US3036707

Kukon Brothers

- Any time you move bulk grain, there is an opportunity to clean it

grain cleaner incorporated into the bucket elevator to remove chaff.

Cyclone on back side of the grain cleaner

LMC size shaker

Carter-Day Uni-flow Separator

Migliorelli Farm

- More than one cleaner may be needed
- Use fans at every opportunity to remove light chaff
- The Uni-flow separates 90% of vetch seed from rye, *slow*

Against the Grain Farm

- Running grain through a batch dryer without heat is a good way to clean it

Sosnowski Grain Cleaner

- “uses unique air flow to clean grain”
- No screens to keep clean
- https://www.graincleanersoh.com/ws-grain-cleaners

Double Spiral Separator

Single Spiral Separator

Spiral Separators

- Used by Hawthorne Valley Farm – said that it is slow

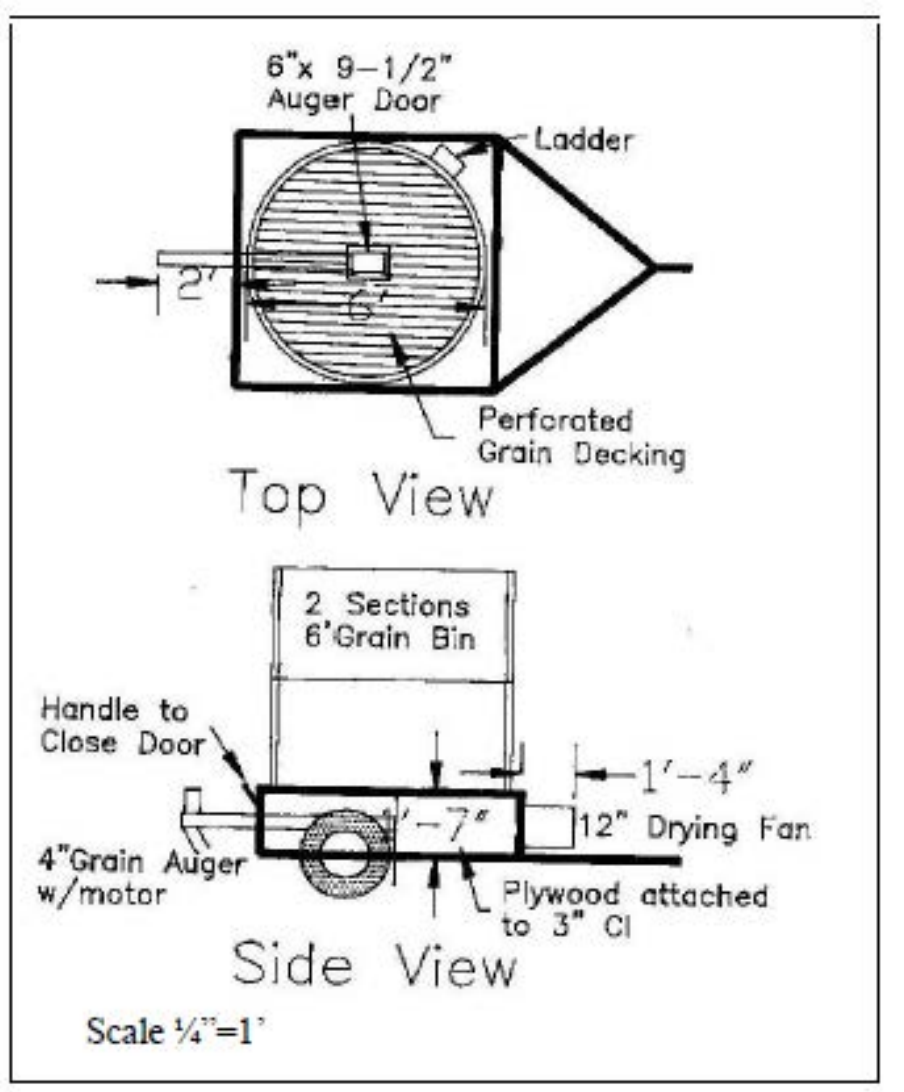
https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.hoffmanmfg.com%2Fproducts%2Fspiral-separators%2F&psig=AOvVaw26_j6MKZrKkzyUJBiPg6-L&ust=1603503036617000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCMDFubnIyewCFQAAAAdAAAAABAH

www.RealSeeds.co.uk

- Open-source plans for seed cleaner
- Designed for small amounts of garden seed
- Can be adapted to bounce seed down a shaft and add air to clean larger quantities of grain???

Portable Grain Dryer

Jack Lazor, Butterworks Farm



Mechanical Seed Cleaning and Handling

Agricultural Handbook #354

- 58 pages
- >20 types of seed cleaners described
- 7 types of seed handling machines
- https://www.roguenativeplants.org/mechanical-seed-cleaning-and-handling-agricultural-handbook-no-354/

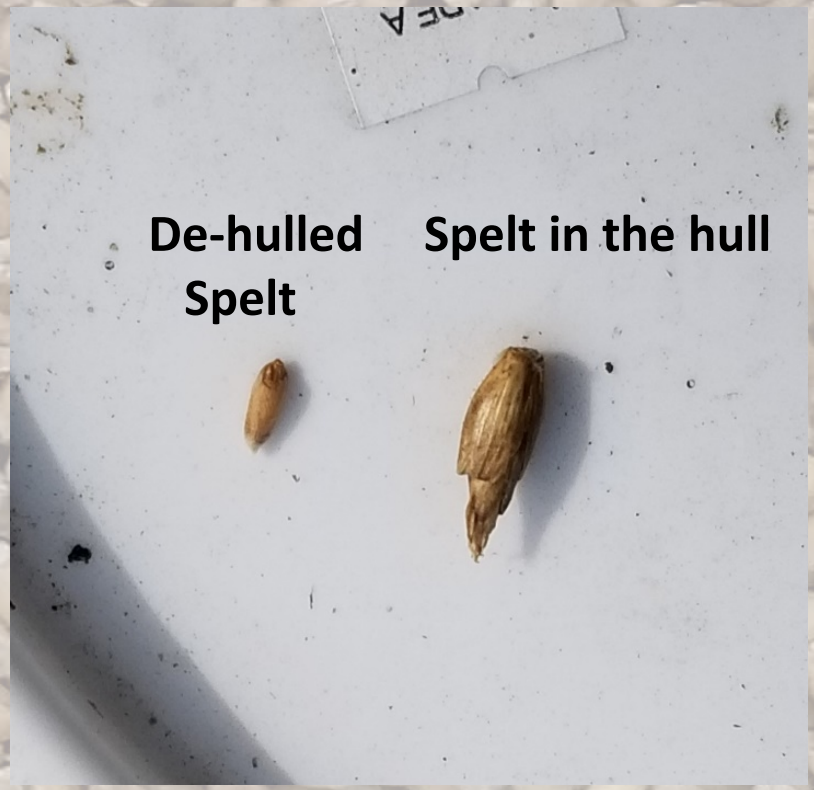
Fanning Mill type cleaner

- Two shaking screens and a blower
- Old equipment is laying around barns un-used waiting to be found

Grain Storage, Cleaning, and Drying

Know the characteristics of your grain

- **Air flows better through spelt with hulls**
- **Spelt with hulls moves slowly through augers**
- **Etc.**



Manuals on Grain Storage and Drying

- Grain Drying, Handling, and Storage Handbook, MWPS-13
- Dry Grain Aeration Systems Design Handbook, MWPS-29
- Managing Dry Grain in Storage
- @ https://www-mwps.sws.iastate.edu/catalog/grain-handling-storage

- North Dakota State University website, https://www.ag.ndsu.edu/graindrying
- University of Nebraska, https://lancaster.unl.edu/ag/crops/storage.shtml

- Resource page for this webinar,

Websites for Do-It-Yourselfers

- https://www.farmshow.com/
- https://farmhack.org/tools

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