Reducing Grain Drying Costs

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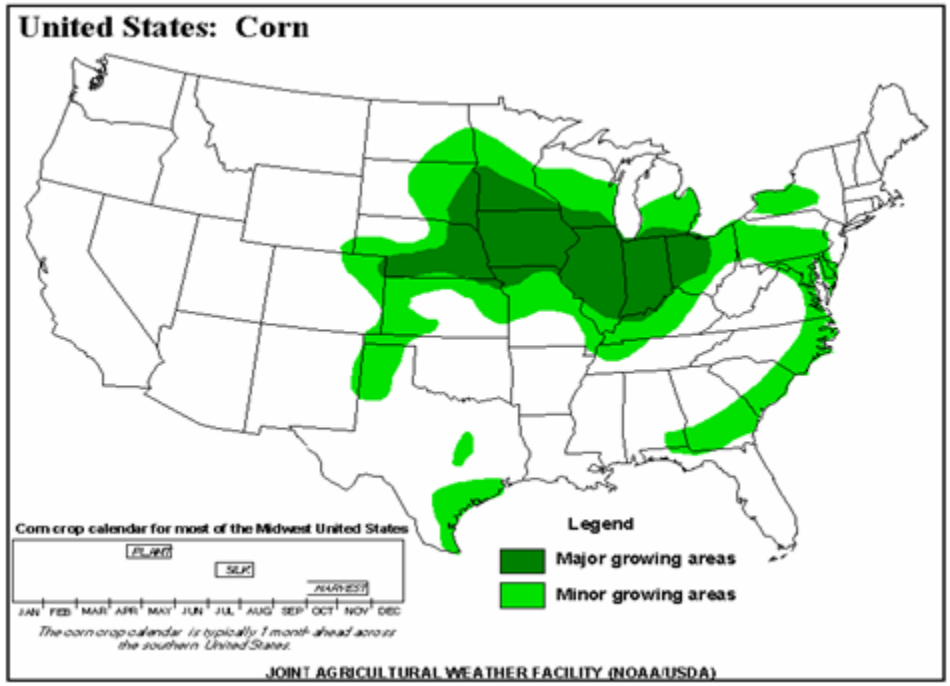
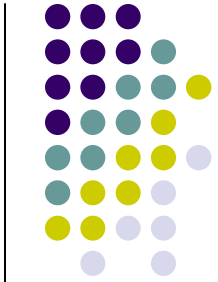
Background



- Corn
  - US production 2004
    - 11,807,217,000 bushel
    - 73,632,000 acres
    - 160 bushels per acre
    - Average Market Price: $1.95 per bushel
- L.P. Gas (rural areas), Natural gas & Electricity
- Drying costs
  - 2005 – 30 to 35% higher than 2004
  - 2004 – 25% higher than 2003
- Record diesel fuel prices
- Low cash prices – $1.40 to 1.77 per bushel

Why Dry?

Reduce moisture content so grain will not spoil.



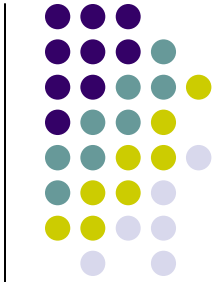
Storage Period	Corn	Soybeans	Small grains
Fed by early Spring	18%*	13%	13%
Fed or marketed by June	15.5%	13%	13%
Stored up to one year	14%	12%	13%
Stored more than one year	13%	11%	13%

* If maintained at temperatures less than 40 F

Dry Clean Grain

- Screen before drying
- Screen before storage
  - Less volume to dry
  - Increased air flow in dryer
  - Less materials to plug screens and aeration floors

Dryer Energy Efficiency



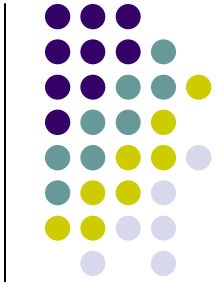
- No dryer performance standards
- Limited independent dryer test data
- Limited research data

- Buyer beware!

- Rule of thumb fuel usage
- - High Temp. dryer w/o heat recovery
  - 0.02 gallon propane/ bushel / % moisture removed
  - 0.018 Therms NG / bushel / % moisture removed
  - 0.01 kWh Electricity

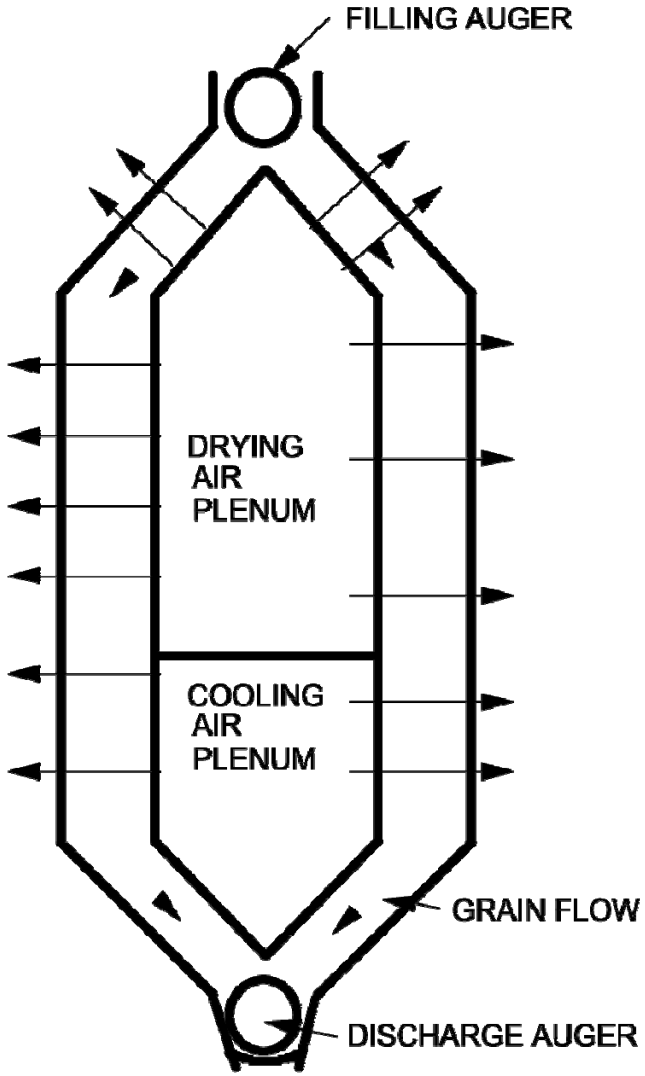
Types of Dryers

Names reflect air flow pattern



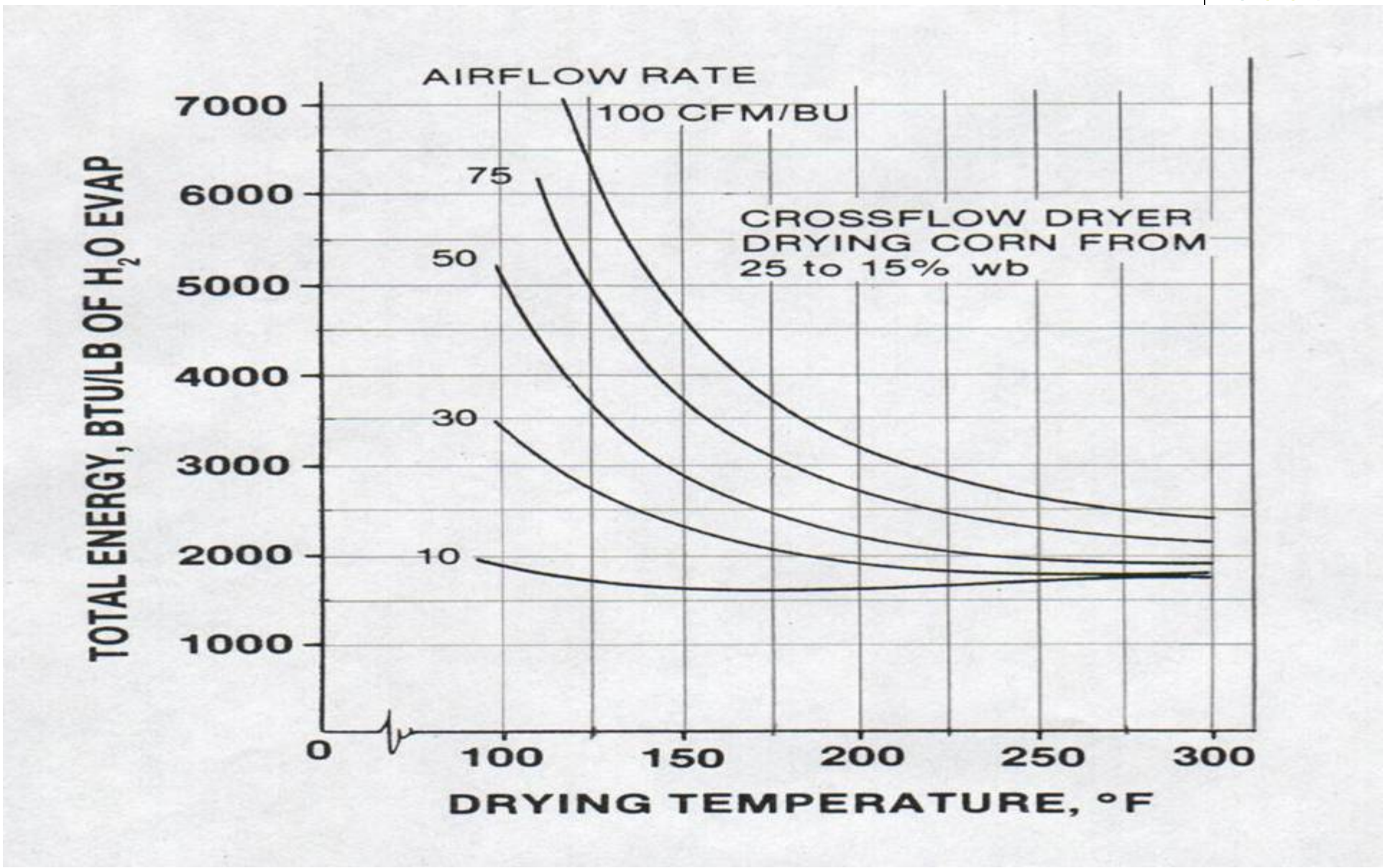
- Cross-Flow Column Dryer
  - (batch and continuous)
- Batch bin dryers (high temperature)
  - Bin Dryers
  - Roof Dryers
- Mixed-flow dryers (Counter and concurrent flow)
- In-Bin Continuous flow dryers (Counter-flow)
- Ambient Air / Low temperature bin dryer

  (10ºF increase in air temperature)
- Combination drying



Conventional Crossflow Column Dryer
In-Dryer Cooling

Cross-Flow Column Dryer



Cross-flow Column Dryer
Heat Recovery Options

Scavenge Heat from hot corn to pre-heat inlet air to dryer

- Reduces energy usage 10 to 20%

- Duct exhaust air from cooling section to air intake of heater

And (optional)

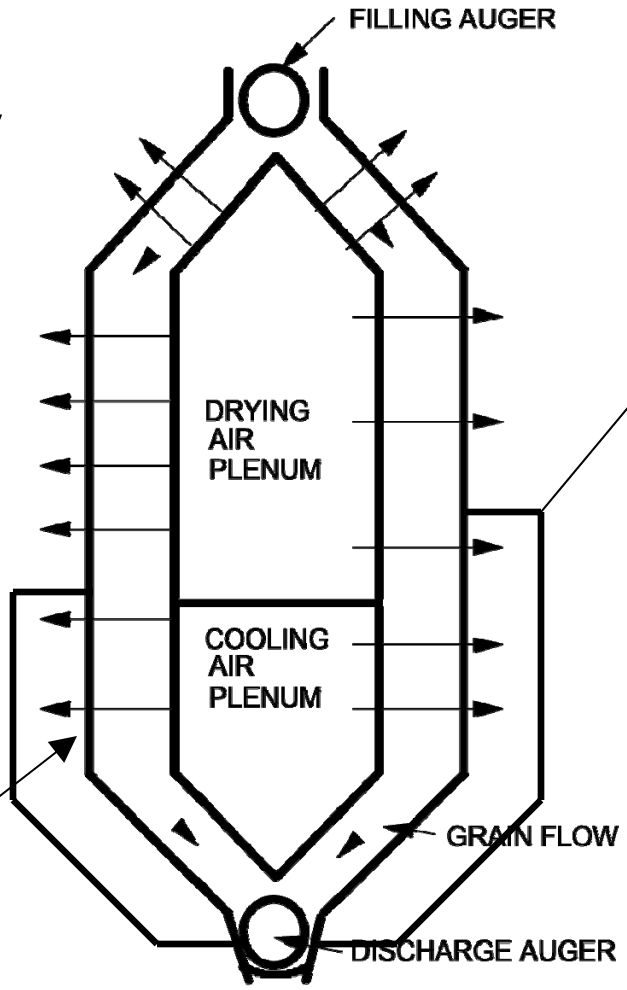
- Recovered from lower portion of drying section of dryer

Or

- Reverse air flow through Cooling Section of dryer

Duct Work for Heat Recovery

Retro-fitting Dryer with Heat Recovery



Duct to Dryer Air Intake

Heat Recovery Cooling section

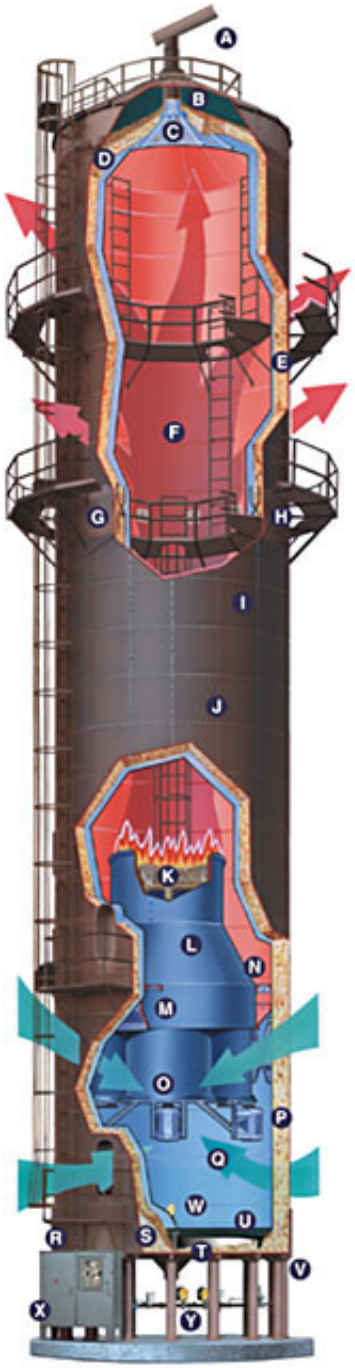
Heat Recovery Lower Heating Section

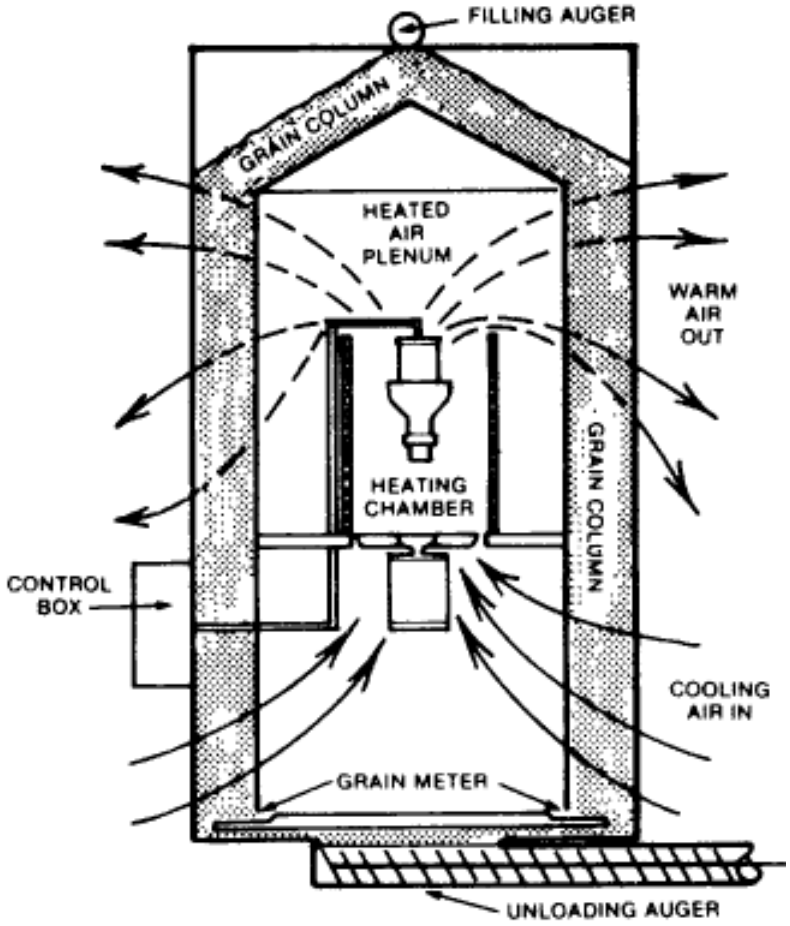
And

Cooling Section

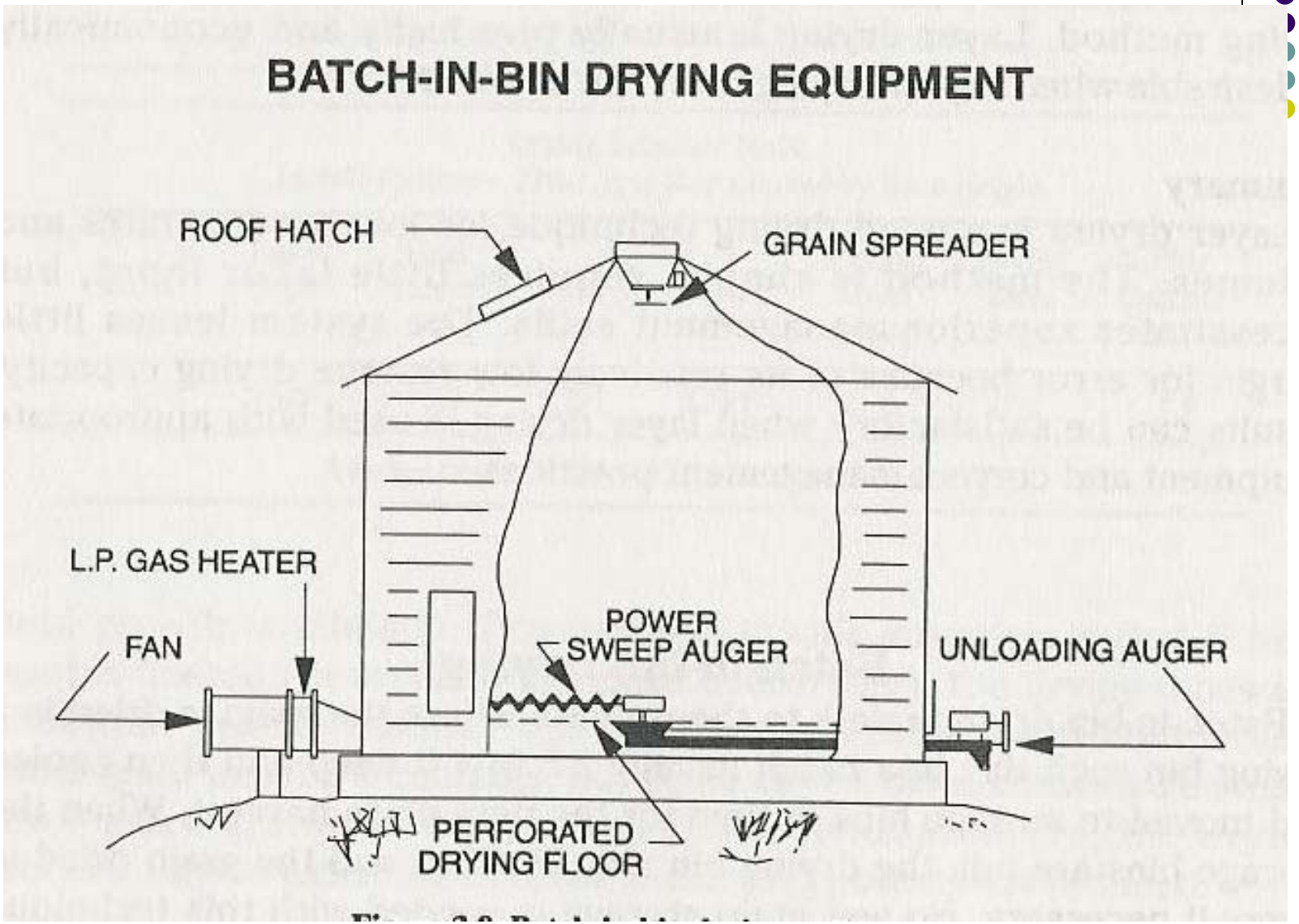
Access needed for cleaning screens

Reverse Flow Cooling





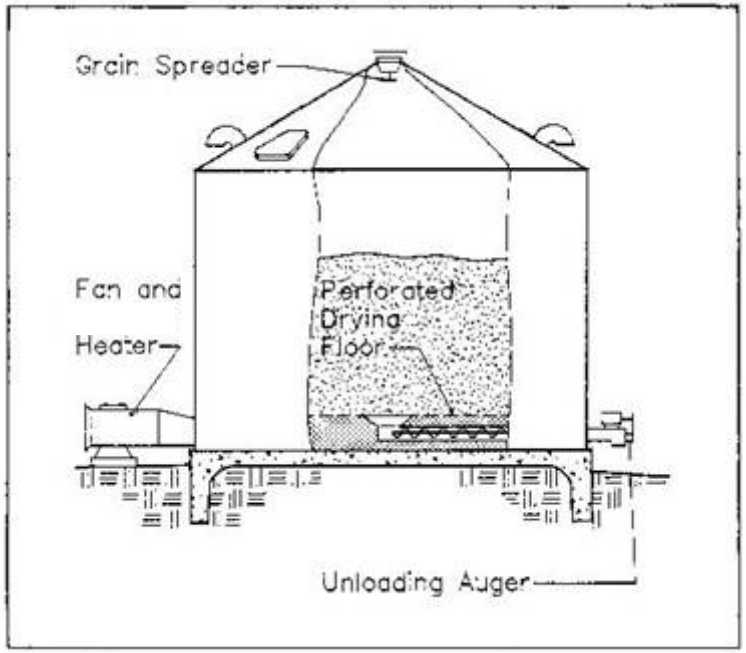
Courtesy of Zimmerman Dryers



Reference: On-Farm Drying and Storage System, ASAE Publication

Batch Bin Dryers

- High temperature dryer
  - Typical drying temperatures 100 - 160°F
  - Stirring device
    - Reduce drying costs by up to 25%
    - Reduces over-drying
    - Run continuously during drying
    - Remove fines from floor before next batch
  - Important to screen out fines
    - Restricts air flow through floor



Bin Dryer with stirring device

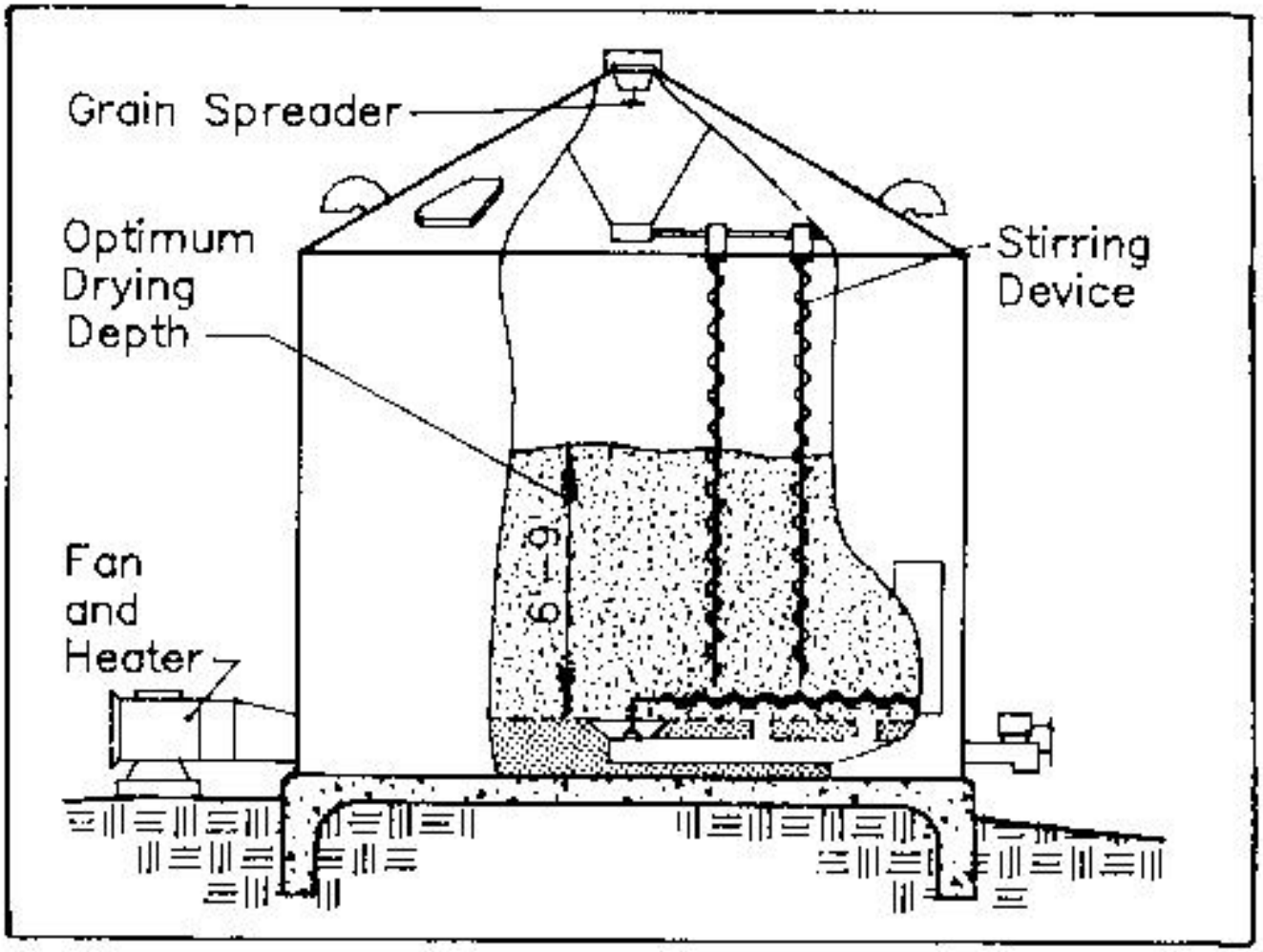
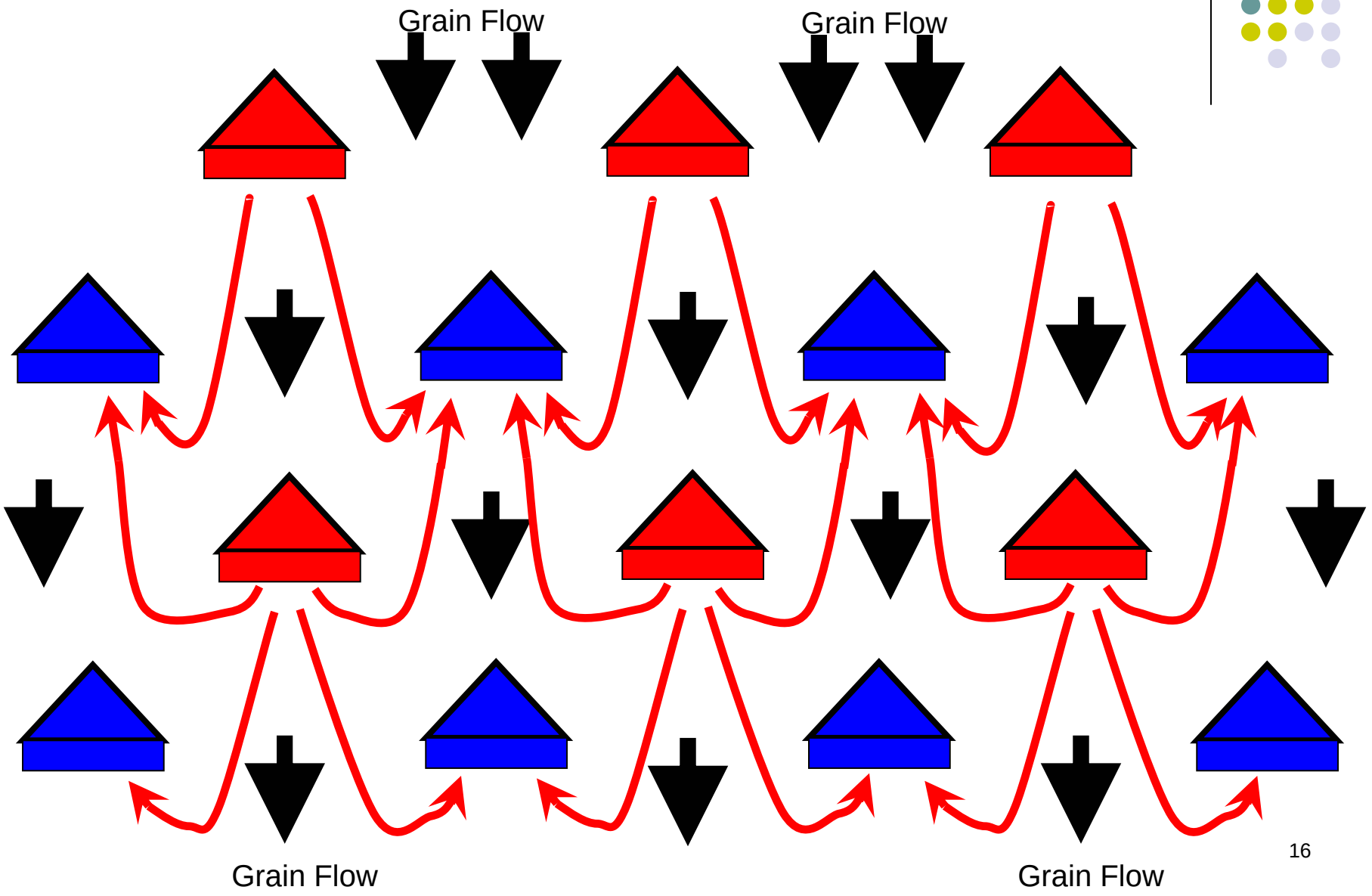


Fig 3-14. Batch-bin dryer with stirring.

Mixed-Flow Dryer

Mixed Flow Dryer - Air Flow Patterns



IN-BIN CONTINUOUS FLOW DRYING EQUIPMENT

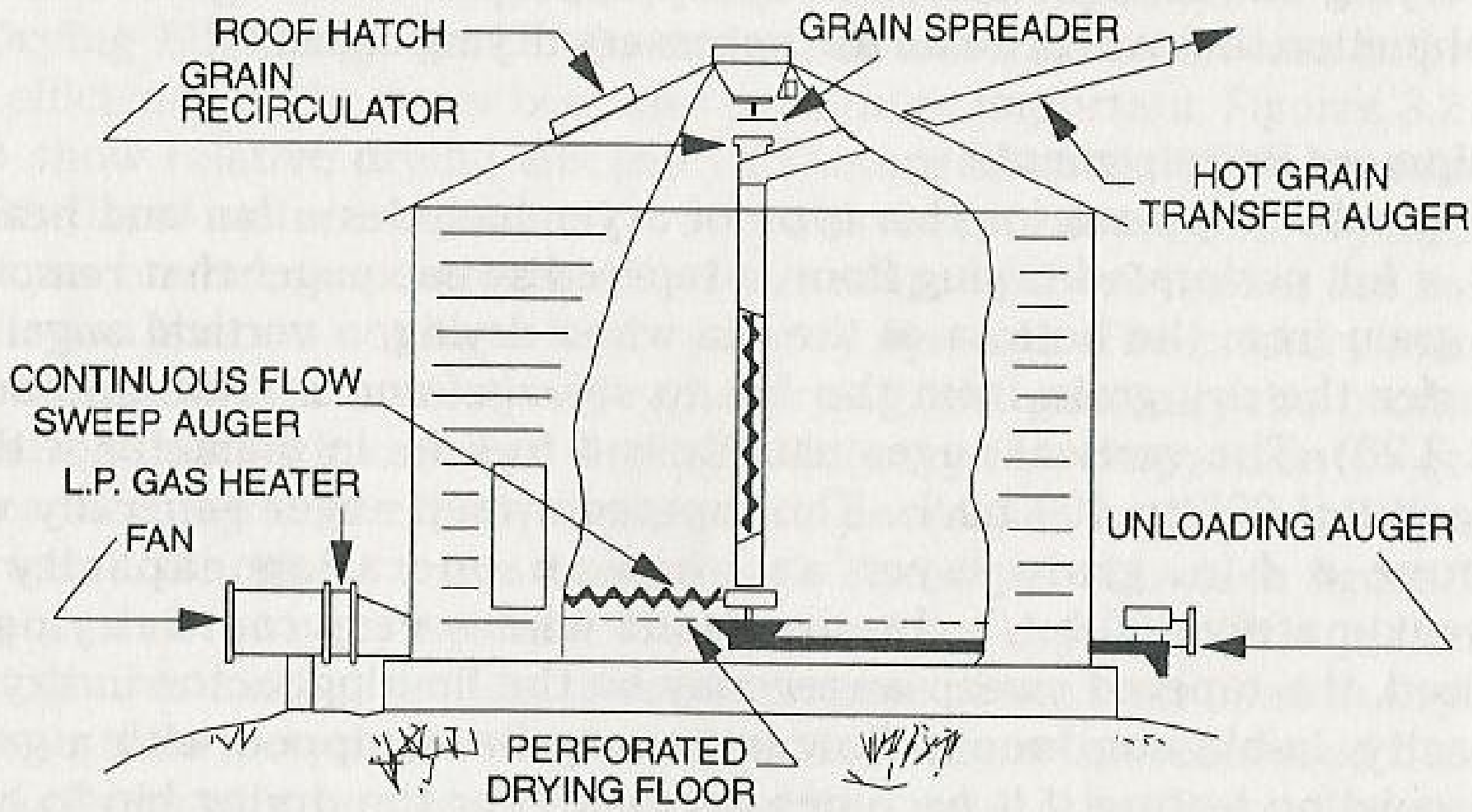


Figure 3.26–In-bin continuous flow drying equipment.

Reference: On-Farm Drying and Storage System, ASAE Publication

In-Bin Continuous Flow Dryer Options

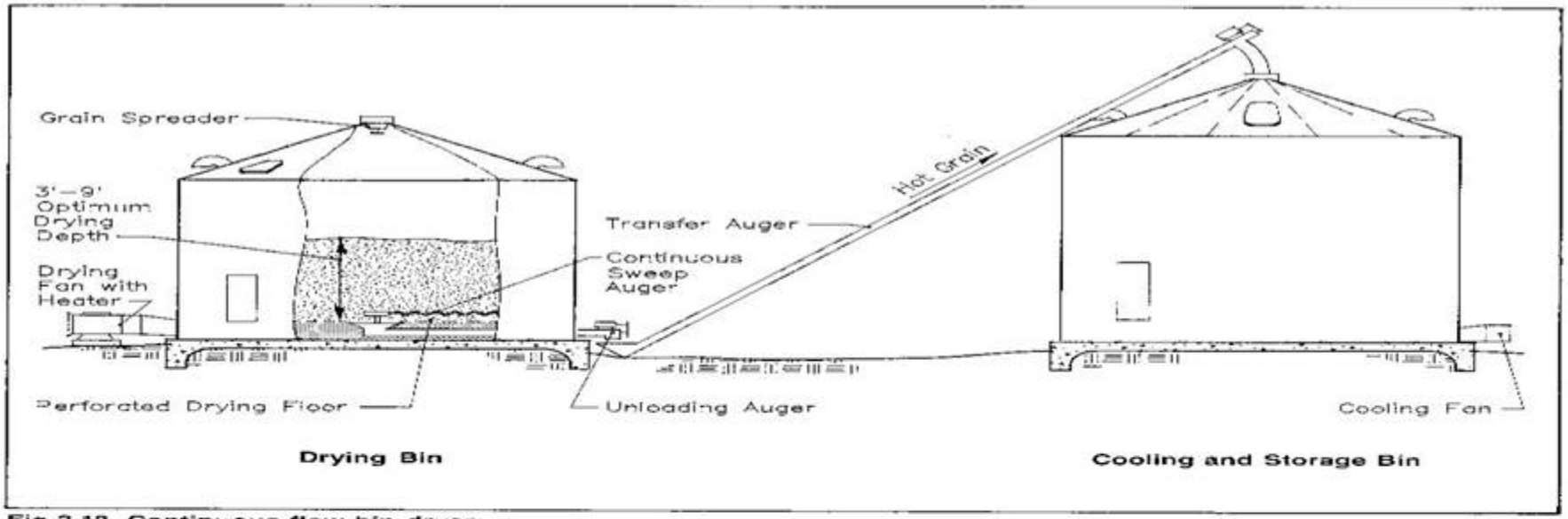


Fig 3-18. Continuous flow bin dryer.
A transfer auger moves grain intermittently to cooling in storage bins.

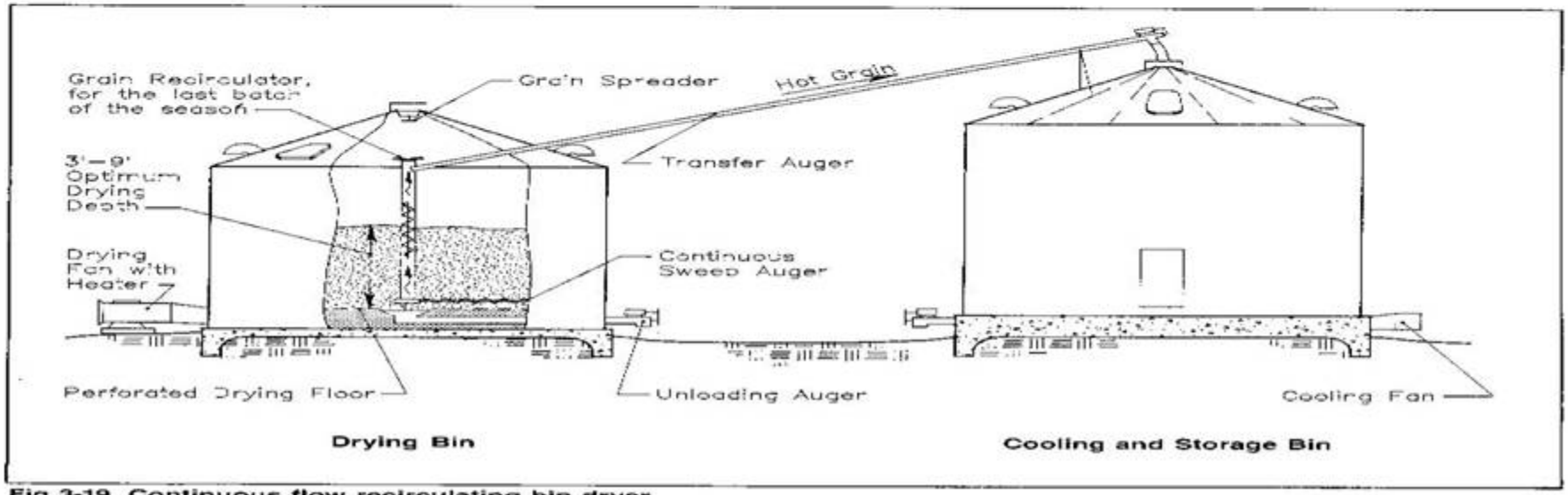


Fig 3-19. Continuous flow recirculating bin dryer.
At least one more storage bin equipped to properly cool hot grain is common.

In-Bin cooling

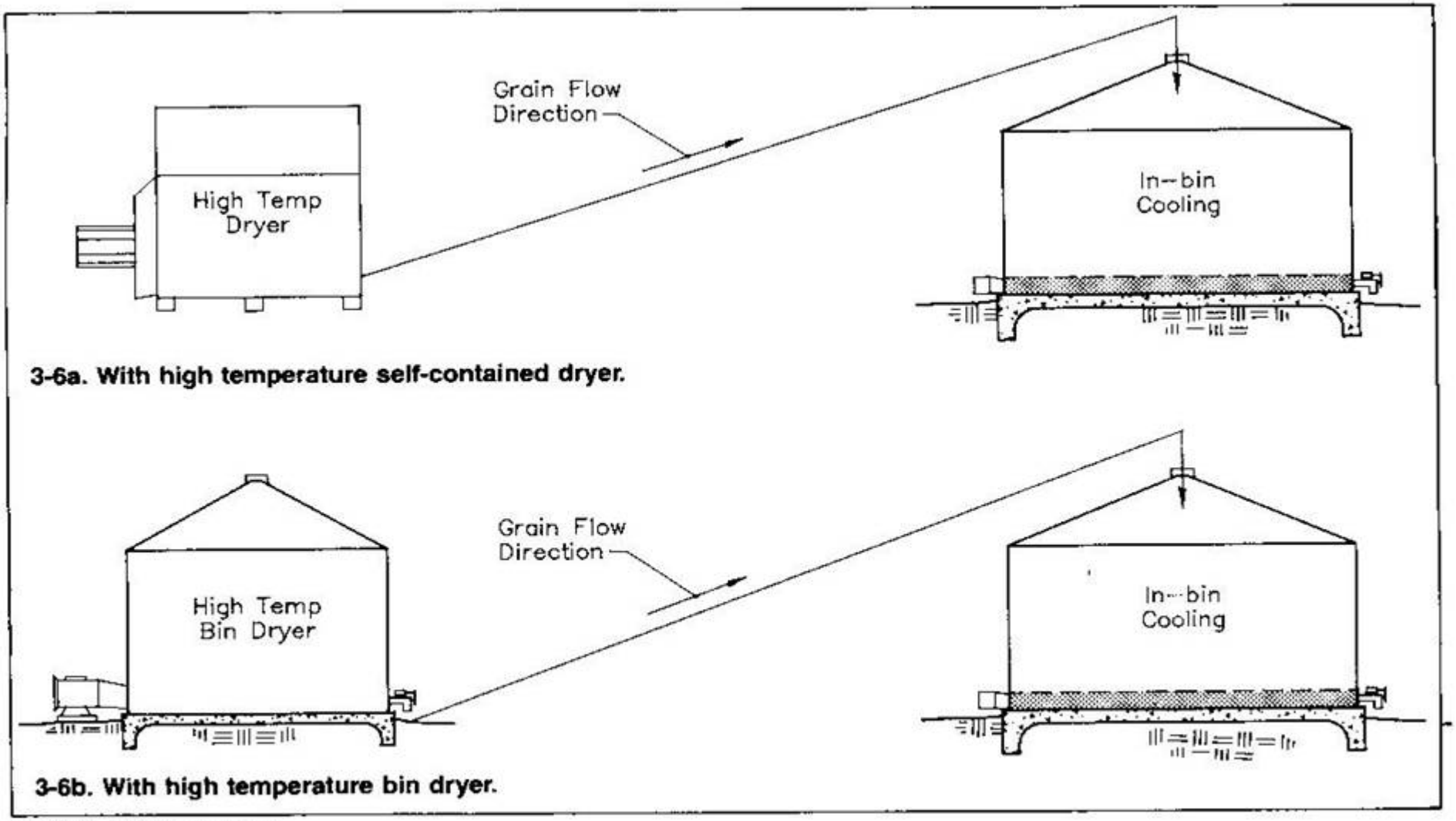
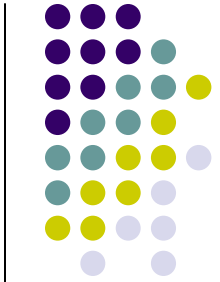


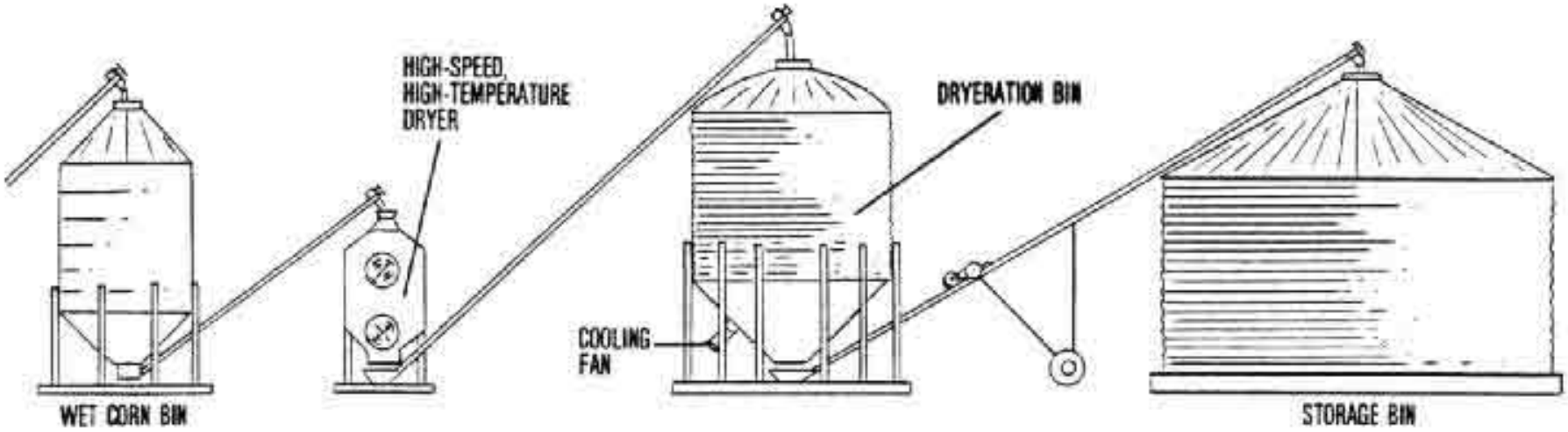
Fig 3-6. In-bin cooling.
Grain dried in a high temperature dryer or bin and cooled in a separate storage.

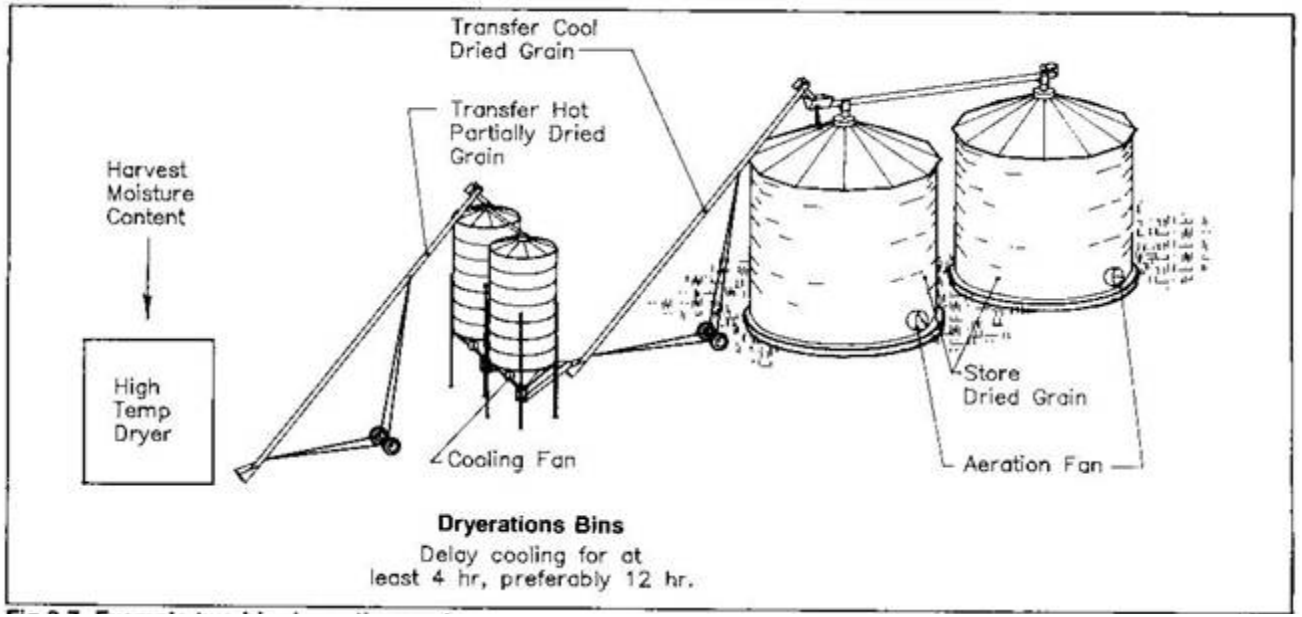
In-Bin Cooling



- Used with high-temperature full-heat dryer
  - Continuous-flow or batch
- Transfer hot grain (120 to 140°F) to storage bin
- Moisture: 1 to 1.5% above desired storage moisture
  - Remainder of drying occurs as grain cools
  - Moisture reduction: ~0.2% per 10°F of temperature decrease
- Start cooling fans immediately
- Reduce fuel costs at least 10-15%
- Increase dryer capacity about 33%
  - Batch dryer – reduces batch time by 15-30 minutes
  - Continuous-flow - ~50% more area for drying

Dryeration


HIGH-SPEED,
HIGH-TEMPERATURE
DRYER
DRYERATION BIN
COOLING
FAN
WET CORN BIN
STORAGE BIN


Transfer Cool
Dried Grain
Transfer Hot
Partially Dried
Grain
Harvest
Moisture
Content
High
Temp
Dryer
Cooling Fan
Store
Dried Grain
Aeration Fan
Dryerations Bins
Delay cooling for at
least 4 hr, preferably 12 hr.

Dryeration

- Transfer hot grain (120 to 140°F) to cooling bin
- Moisture: 2-3% above storage moisture content
- Grain allowed to “Temper” for 4 to 12 hours
- Cool grain
  - Remainder of drying occurs as grain cools
  - Moisture reduction: ~0.4% per 10°F of temperature decrease
- Transfer grain to storage bin

- Energy savings: 15% - 25%
- Dryer capacity: increases up to 70%
- Improved grain quality
  - Fewer stress cracked kernels and breakage

	Cracks	Breakage
Rapid cooling	43.6%	11.3%
Dryeration	7.6%	6.7%

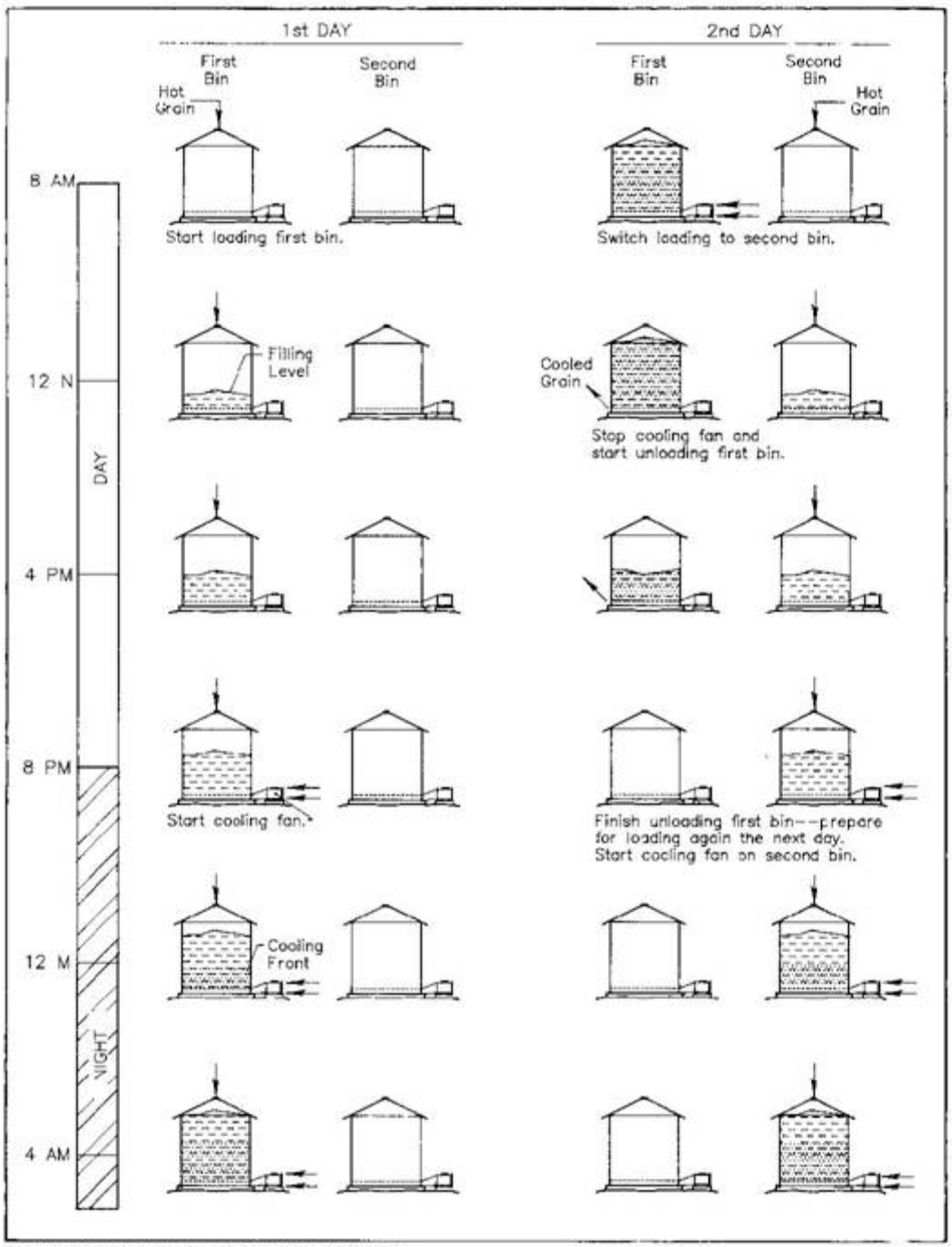
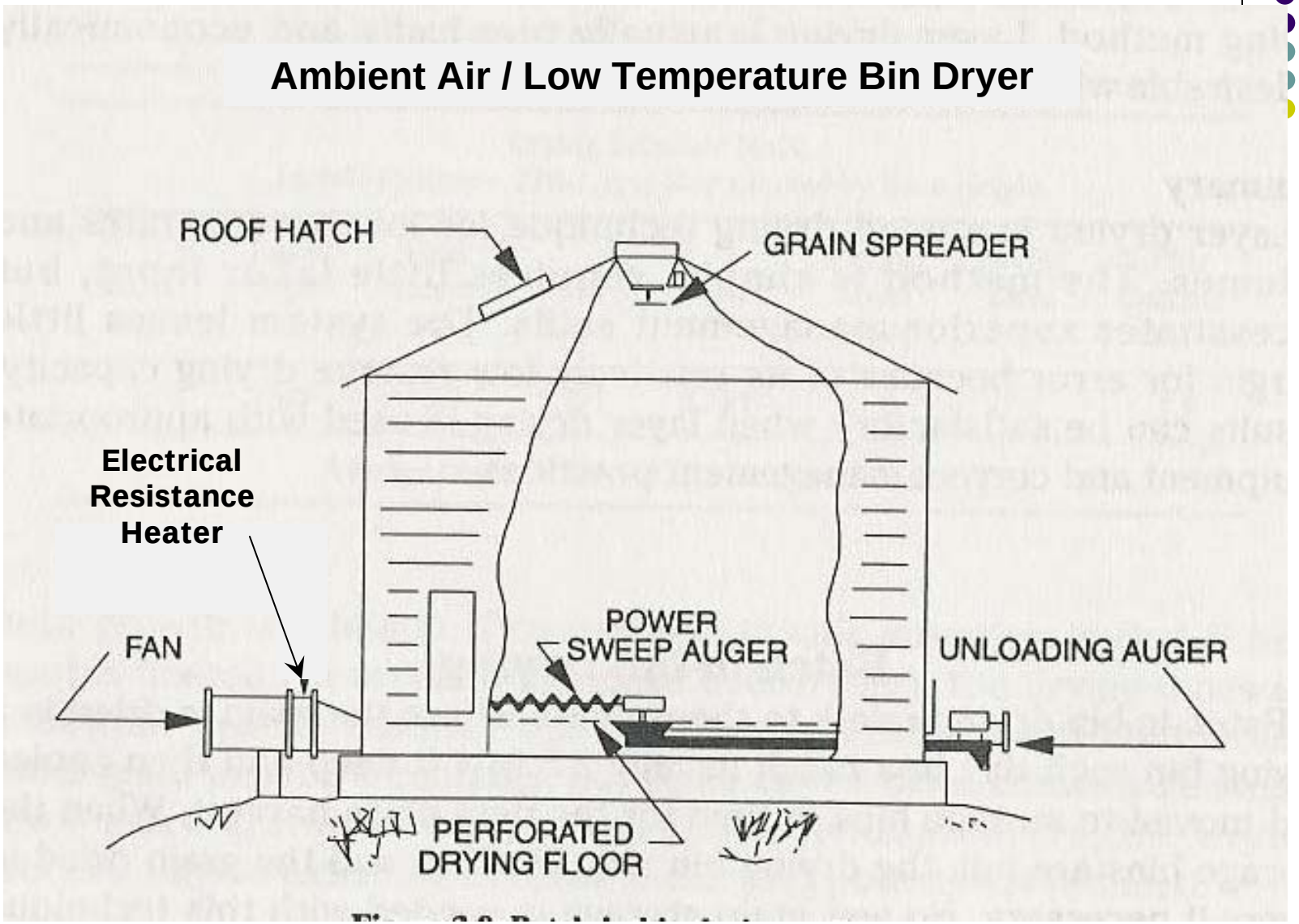


Fig 3-8. Typical dryeration 24 hr cycle with 2 bins.

Ambient Air / Low Temperature Bin Dryer

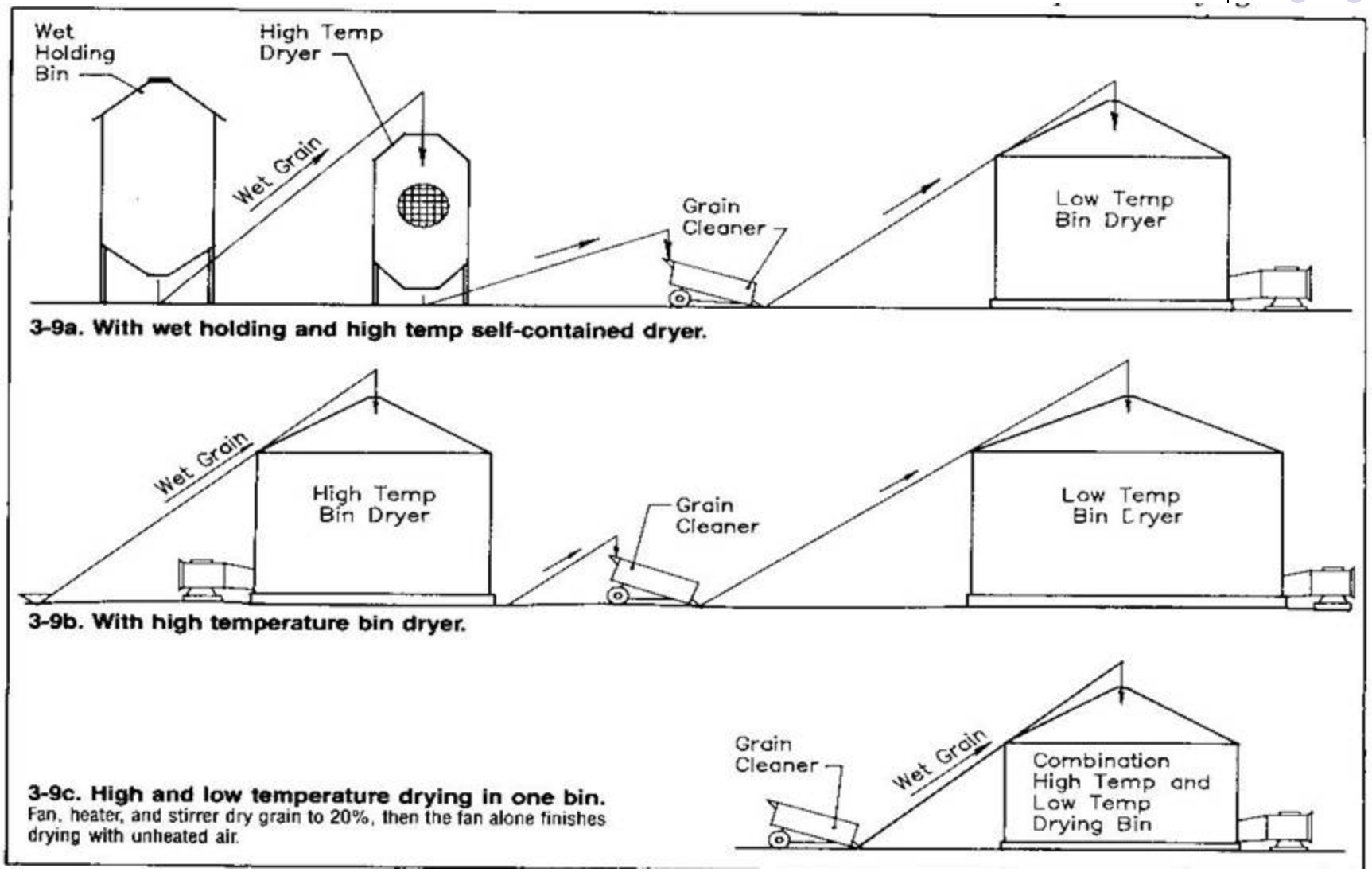


Reference: On-Farm Drying and Storage System, ASAE Publication

In-Bin natural or low heat drying

- Forces ambient or warmed air (10°F temperature rise) through grain bed
- Batch / layered drying
- Energy efficient if dry weather
  - Early harvest advantageous
- High fan horsepower requirement over extended time
  - Three 10 HP blowers for 10,000 bushel bin
  - 30 to 45 with good weather - 90+ days if wet
  - 1.25 cfm per bushel minimum
- Energy: 100% electricity
- Maximum grain moisture ~ 22% - 24%
- Only handle grain once
- Stirring device – saves 20 – 25% in energy costs
  - Reduces over-drying
  - Increases air-flow
  - Stirring 2 or 3 times maximum recommended
  - Over stirring can reduce air flow

Combination drying

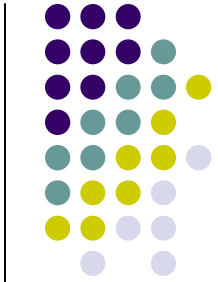


3-9a. With wet holding and high temp self-contained dryer.

3-9b. With high temperature bin dryer.

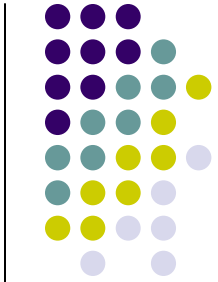
3-9c. High and low temperature drying in one bin.
Fan, heater, and stirrer dry grain to 20%, then the fan alone finishes drying with unheated air.

Combination Drying



- High Temperature drying down to 20-22% moisture
  - Continuous-flow or batch
- Transfer hot grain to low temperature bin dryer
- Start fans immediately and dry using natural air
  - Don’t Delay fan start!!!
- Capital cost higher – fans needed on all bins
- High drying capacity
- High quality grain
- Uses more electricity but less LP or natural gas
- High energy efficiency –
  - ~ 50% of energy use for cross-flow dryer
  - ~ 75% LP gas or Natural gas
  - ~ 25% electricity

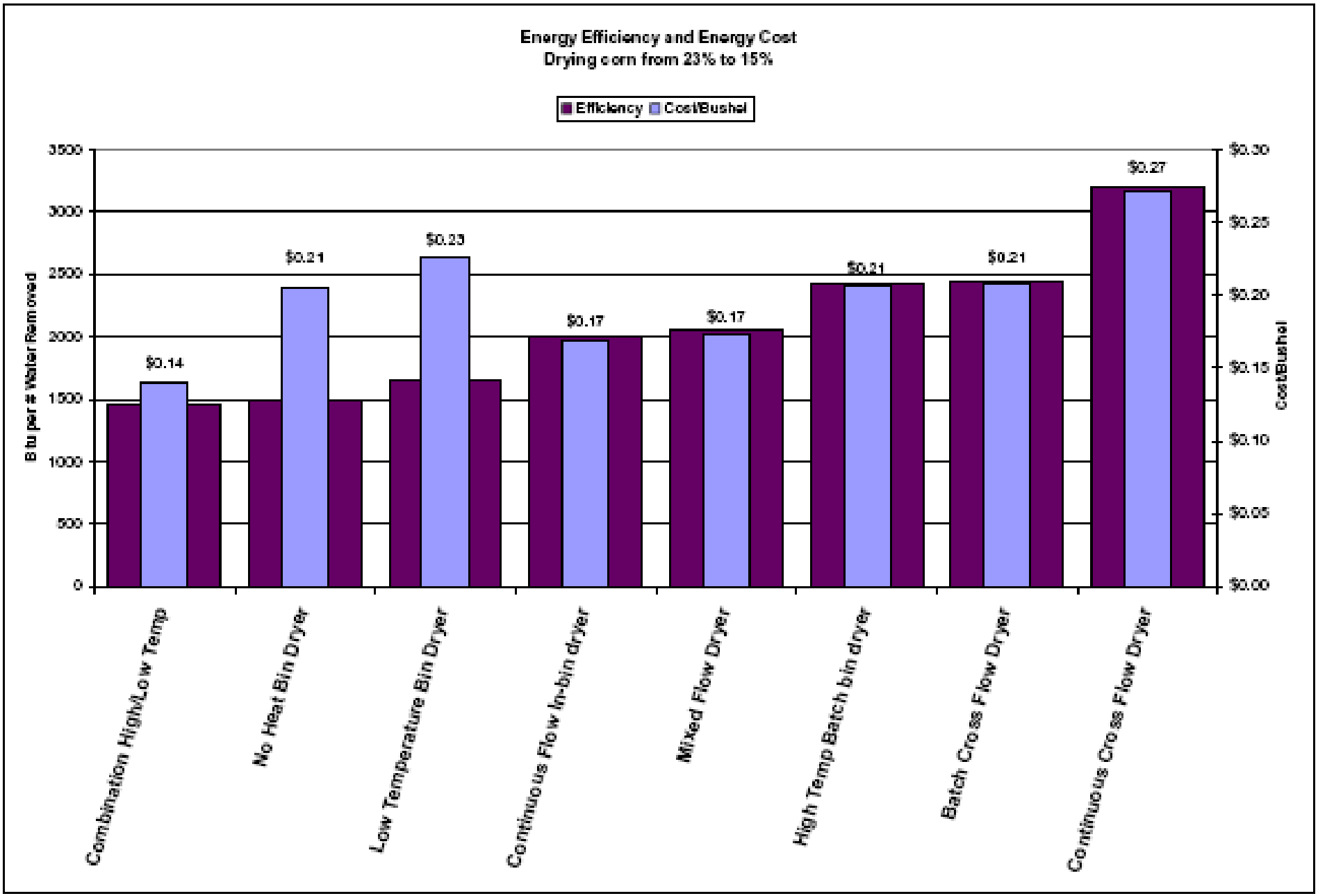
Comparison of cooling / drying methods



• In-dryer cooling	$28.85 / 100 bu	
• In-bin cooling	$25.18 / 100 bu	(12%)
• Dryeration	$20.90 / 100 bu	(27%)
• Combination drying	$18.85 / 100 bu	(35%)

- Assumptions:
  - Corn dried from 25.5% to 15.5%
  - Energy Costs only
  - Electricity $0.085 / kWh
  - LP gas $1.40 / gallon

(Reference: Midwest Plan Service, MWPS-13, 1987)

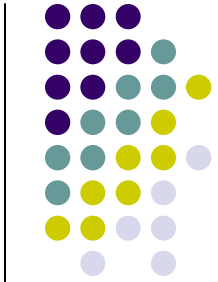


Assumptions: LP Gas cost = $ 1.40/ gal
Electricity = $ 0.085/ kWh

Dryer Maintenance

- Keep screens and aeration floors clean
- Check and tighten belts
- Check burner operation – blue flame
- Calibrate moisture sensors and testers
- Check that bearing mountings are tight
- Lubricate as recommended by mfg.

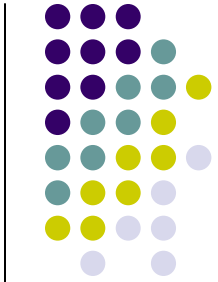
Moisture Sensors / Testers



- Inaccurate readings
  - Spoilage / Overdrying
- Replace battery before season
- Testers not accurate
  - Above 22%
  - underestimate hot grain (above 90F) by at least 1 to 2 %.
- Checking Calibration:
  - Compare to certified unit (coop or feed mill)

Refer to Purdue U Fact Sheet #14

Contact Information



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