Frost Protection Methods in Michigan – Costs and Considerations

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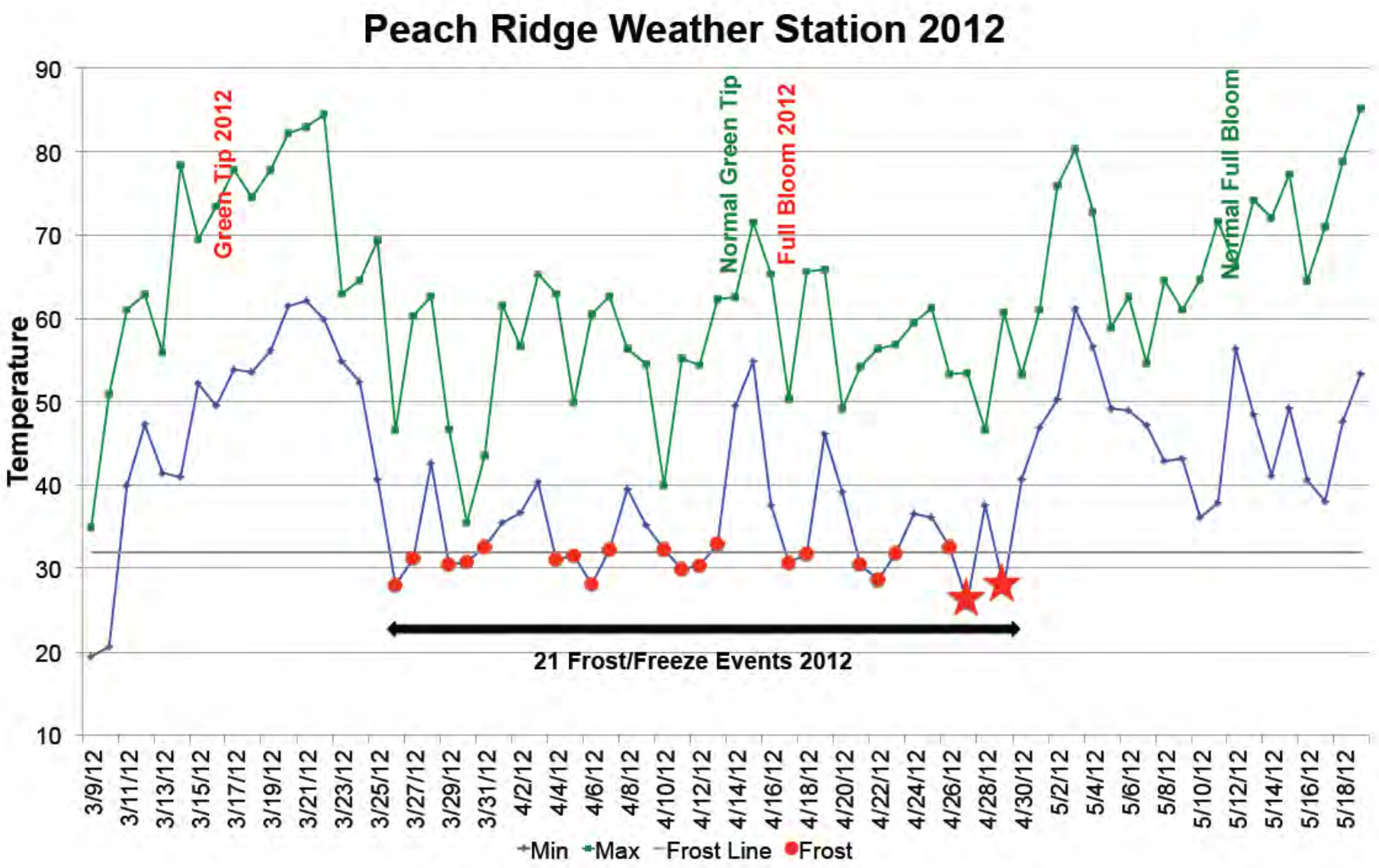
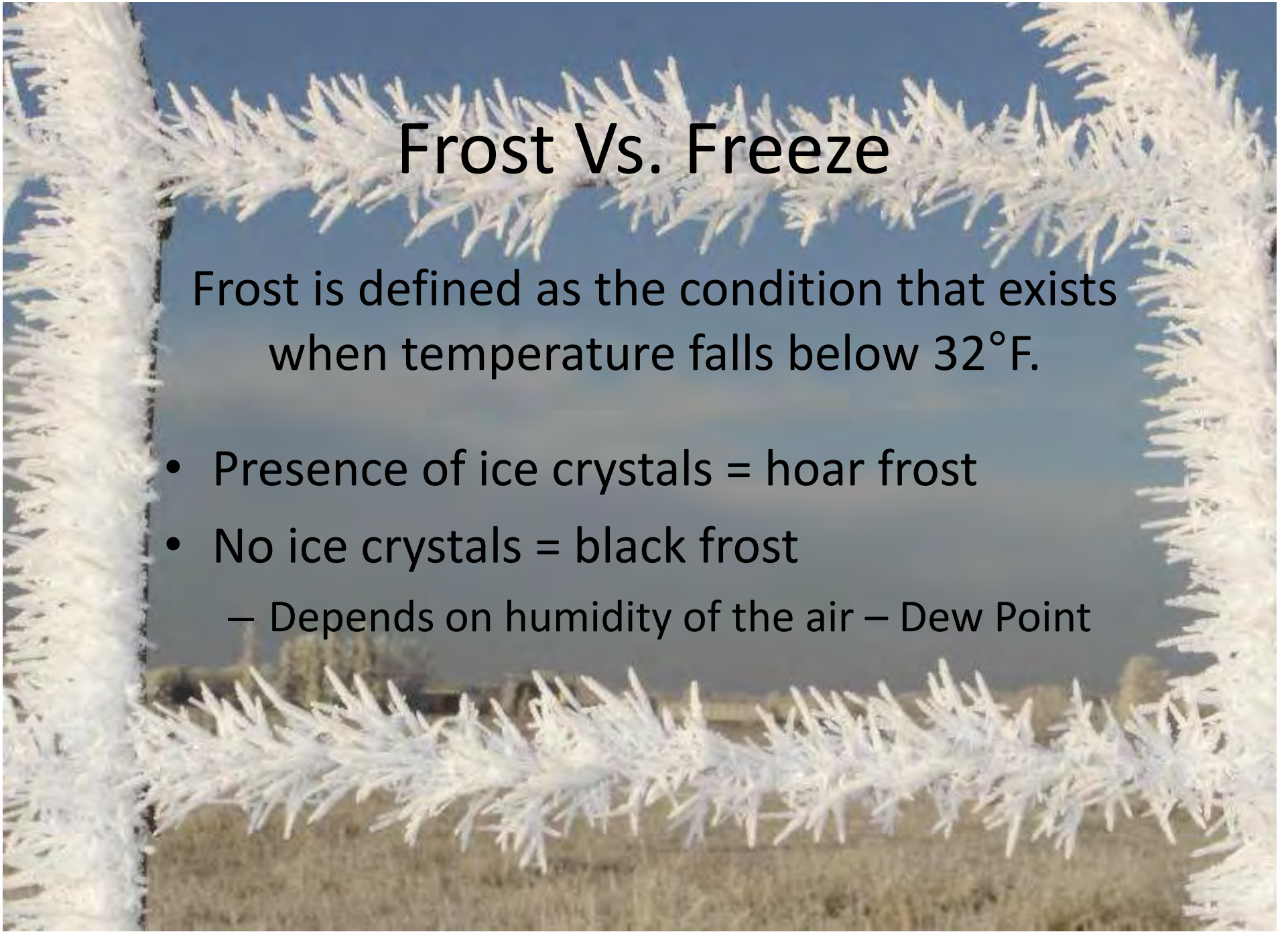


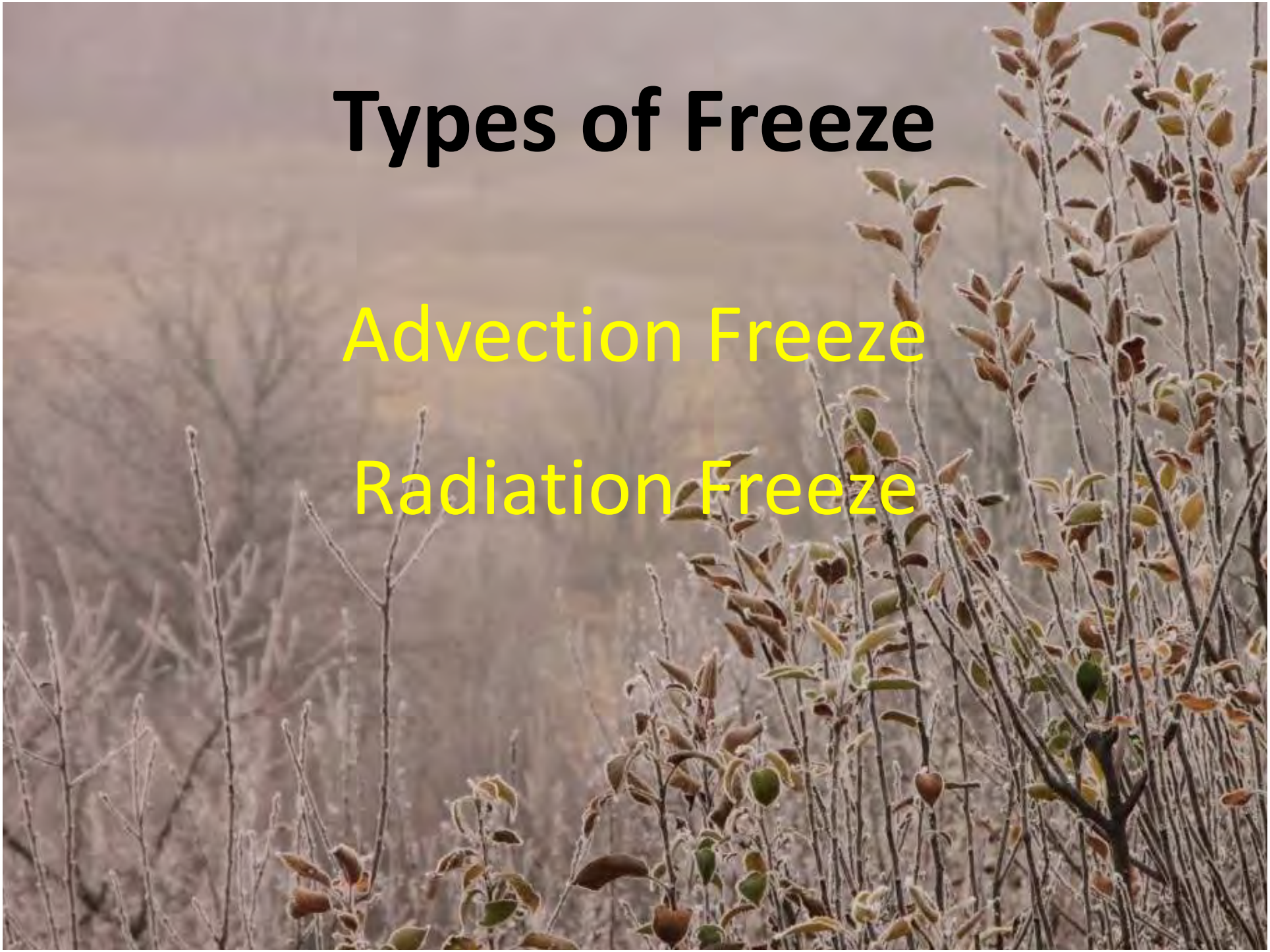
Peach Ridge Weather Poster 2012.pptx
Philip Schwallier, Amy Irish-Brown



Frost Vs. Freeze

Frost is defined as the condition that exists when temperature falls below 32°F.

- Presence of ice crystals = hoar frost
- No ice crystals = black frost
  - Depends on humidity of the air – Dew Point


Types of Freeze
Advection Freeze
Radiation Freeze

Advection Freeze – Windy & Cold

- Occurs under windy conditions
- Associated with a large, dry, cold air mass, several thousand feet thick, moving into an area.
- High pressure cells with NW winds
- Air temperature is often colder than plant temperature.
- Not much can be done – even site has little effect.

Radiation Freeze – Clear & Calm

- Dry, cold air mass settles in with little or no wind.
- Little or No cloud cover overnight.
- Relatively warm during the day, heating soil and plants – this heat is released at night – no wind and an inversion layer forms – warm air (3 to 10°F) 30 to 50 feet about the ground.
- Cool, dense air is trapped beneath warm air; moving toward low areas.
- Dry air holds less heat – dew point.

Factors to Consider

- Coverage
- Power Options
- Unit Cost
- Fuel Consumption for One Hour
- Installation Cost
- Maintenance Costs
- Auto-Start Availability
- Enhancement of Other Frost Protection Methods
- Quiet Factor
- Special Weather Concerns
- Dual Usage Factors
- Years of Usefulness (?)

Systems/Types Included:

- Burning Organic Material
- Heaters
- Cold Air Drain
- Helicopters
- Wind Machines & Fans
- MicroSprinklers
- Sprayable Materials

Handout in the Back

Posted at: apples.msu.edu

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Amy Irish-Brown, Tree Fruit IPM Educator, Michigan State University Extension

[illegible]

	Burning Organic material	Heaters	Cold Air Drain*	Helicopters	Wind Machines / Fans	MicroSprinklers	Sprayable Frost Materials
Coverage	Depends on air movement	Oil-Fueled: 40 heaters/acre Propane-Fueled: 80 heaters/acre	Approx. [illegible] acres	Large = 40 to 60 acres Smaller = [illegible] acres	Approx. [illegible] acres	limited to well size ([illegible])	uniform
Power Options	NA	oil, diesel or propane	Gas, Electric, PTO	fuel	Gas, Electric, PTO, Diesel (most new are propane)	electric	NA
Unit Cost	cost of old hay bales or brush piles is usually minimal	Oil-Fueled: Approx. [illegible] each = [illegible]/acre Propane-Fueled: Approx. [illegible] each = [illegible]/acre	Approx. [illegible]	Rental cost: Large = [illegible] per hour per bird Small = [illegible] per hour ([illegible])	Approx. [illegible]	well, irrigation system plus extra [illegible] per acre for microsprinklers	[illegible] per acre
Fuel Consumption for One Hour	NA	Oil- and Propane-Fueled: 1 gal./hr/heater	Approx. 1 gal./hr	included in rental	Approx. [illegible] gal./hr	electricity cost	fuel for tractor
Installation Cost	cost of old hay bales or brush piles is usually minimal	movement to site	cost to move - grower installed	minimum hours for standby	Cement Pad + Installation (often included in total unit cost)	added on to irrigation system install costs	time of operator
Maintenance Cost	tending to burn	Significant - heaters should be cleaned after [illegible] hours of use	Minimal: Owner Maintained	NA if hired in	can be covered under contract, but mostly minimal unless a gearbox goes	adds more time for microsprinkler care than regular trickle irrigation	some materials are hard on sprayers
Auto-Start Available	NA	NA	Yes	NA	Yes	Yes??	NA
Enhances Other Frost Protection	Yes: Wind Machines	Yes: Wind Machines	Yes: Wind Machines, Sprinklers, Heaters	??	Yes: Heaters	perhaps	perhaps
Quiet Factor	Yes, but can cause smokey conditions	Yes, but can cause smokey conditions	No ([illegible])	Not really	No ([illegible])	Yes	No (sprayer/tractor noise)
Special Weather Concerns	Not in high winds or dry conditions	No	Yes	Less coverage if it is very cold. They can move vertically to find the warm air inversions.	Yes/No	Yes	No
Dual usage factors	recycling	NA	NA	[illegible]	might help with fruit finish	irrigation in summer, cooling effect in dormancy to prevent bud break???	NA
Years of usefulness							

Burning Hay Bales

Photo: Phil Schwallier

Burning Hay Bales

- Cost
  - bales, time to set out and tend
- Effect – little
- Annoying to neighbors
- Not to be used in dry conditions

Heaters/Smudge Pots

Photo: Phil Schwallier

Heaters/Smudge Pots

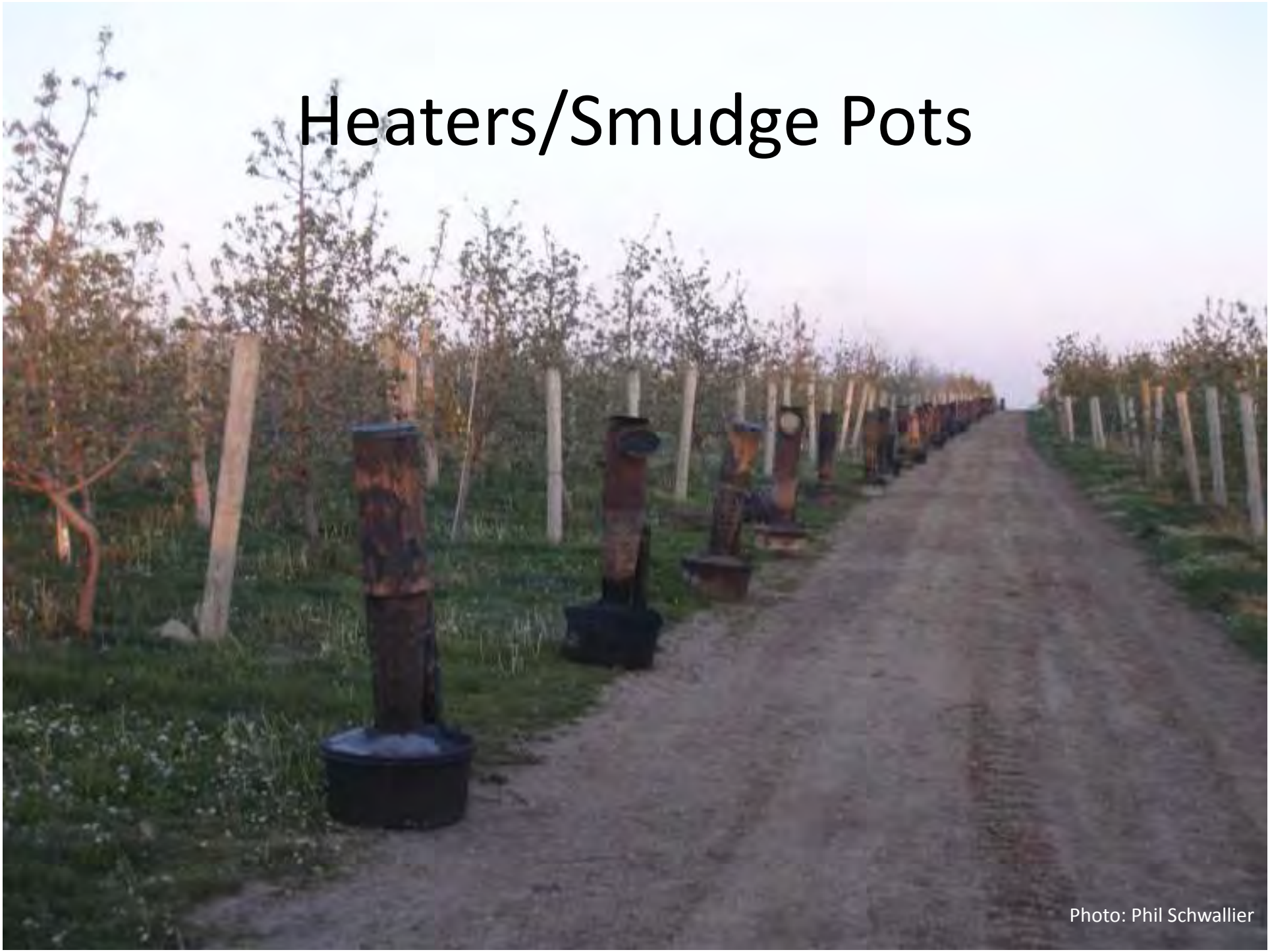


Photo: Phil Schwallier

Heaters or Smudge Pots

- Costs –
  - time to set out, fill and tend
  - $50 each if you can find them ($100 for propane heaters??)
  - Cost of fuel = 1 gal/hour/heater
- Effect – little to some
- Perhaps some benefit when used with fans

Frost Fans/Wind Machines

Photo: Phil Schwallier

Frost Fan Types

Photo: Phil Brown Welding website

Photo: Phil Brown Welding website

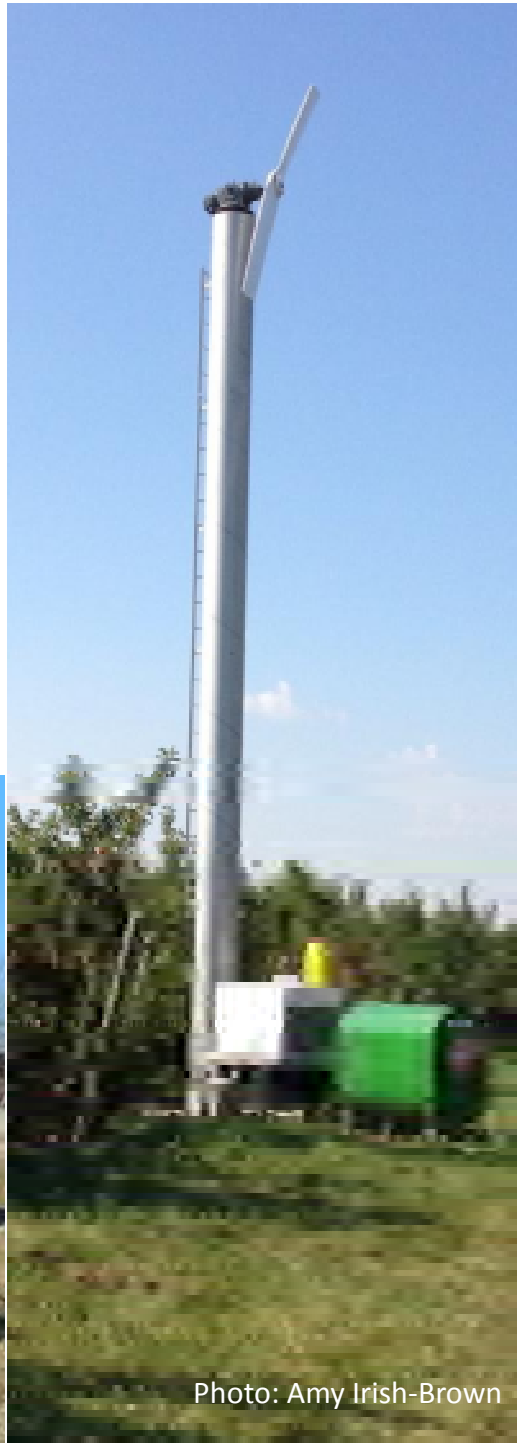
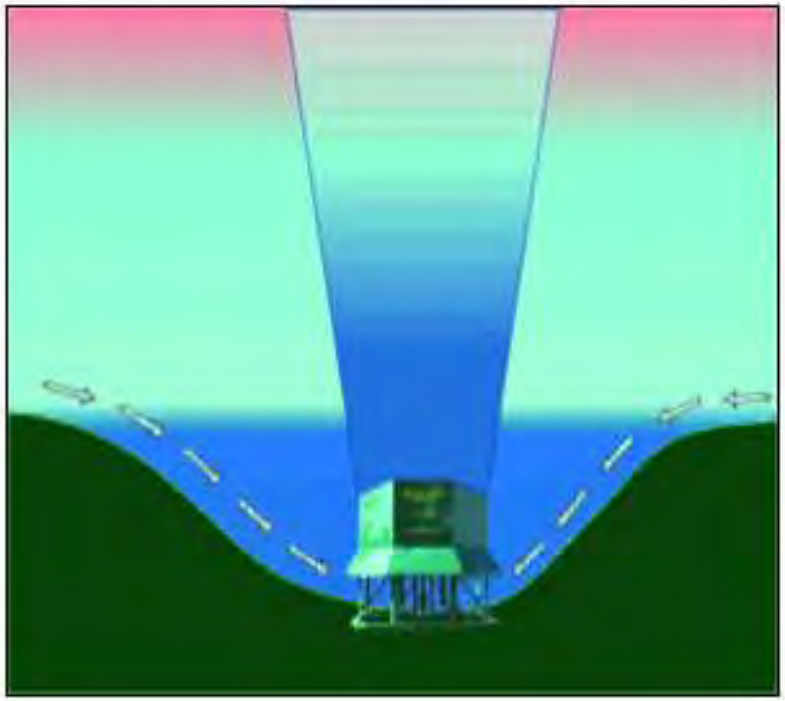


Photo: Amy Irish-Brown

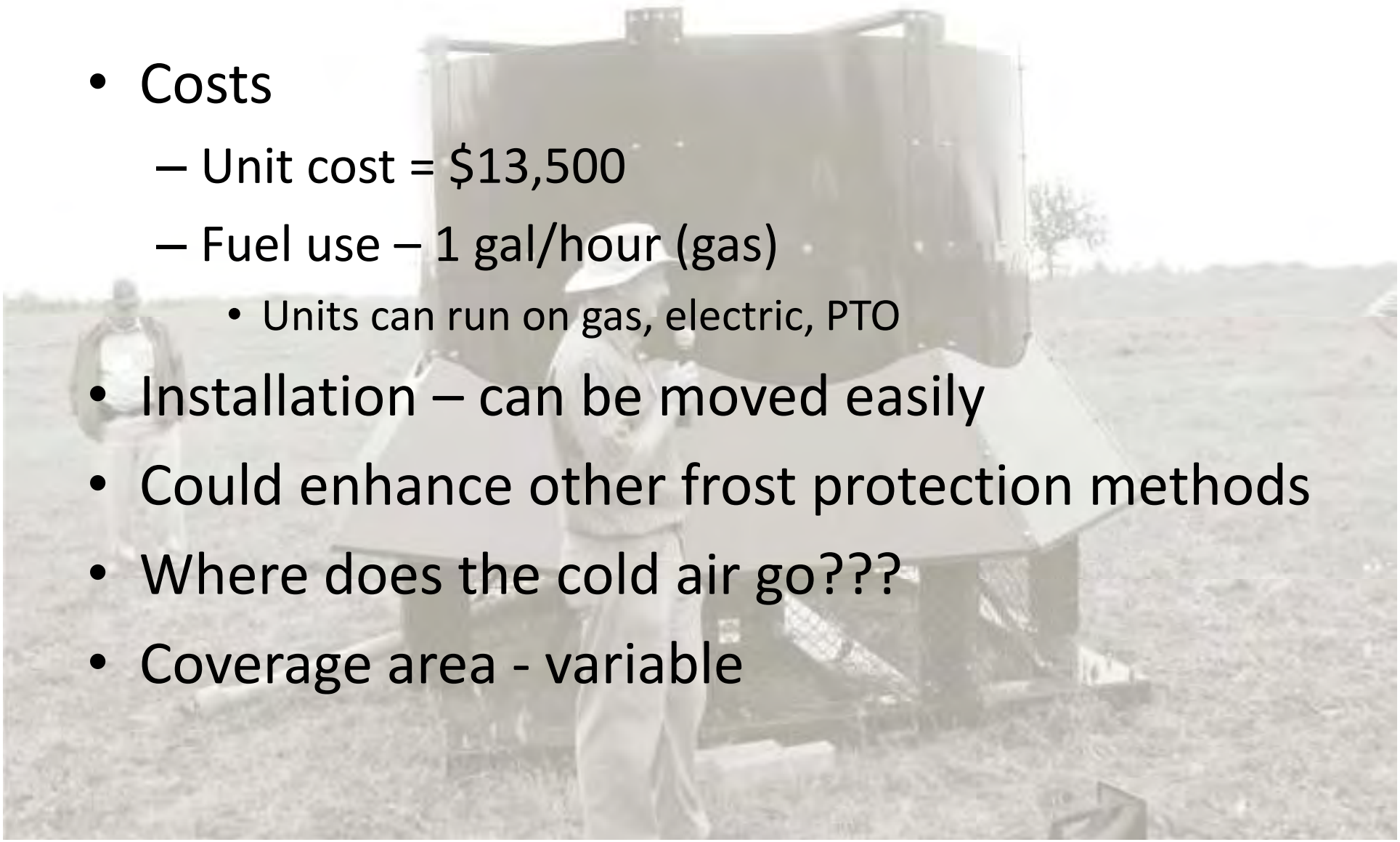
Cold Air Drain Fan

How the Cold Air Drain® Works



Photos: www.shurfarms.com/aboutproduct2010.html

Cold Air Drain Fan

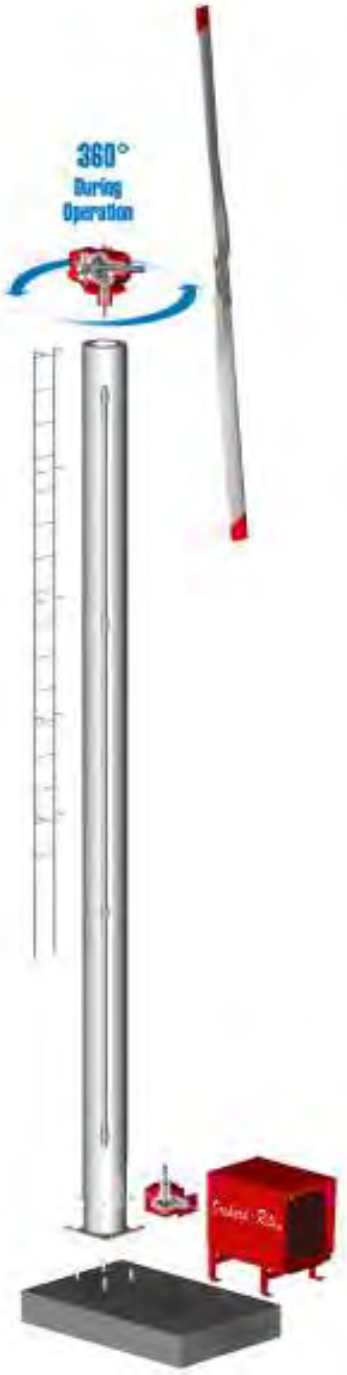


- Costs
  - Unit cost = $13,500
  - Fuel use – 1 gal/hour (gas)
    - Units can run on gas, electric, PTO
- Installation – can be moved easily
- Could enhance other frost protection methods
- Where does the cold air go???
- Coverage area - variable

Frost Fans

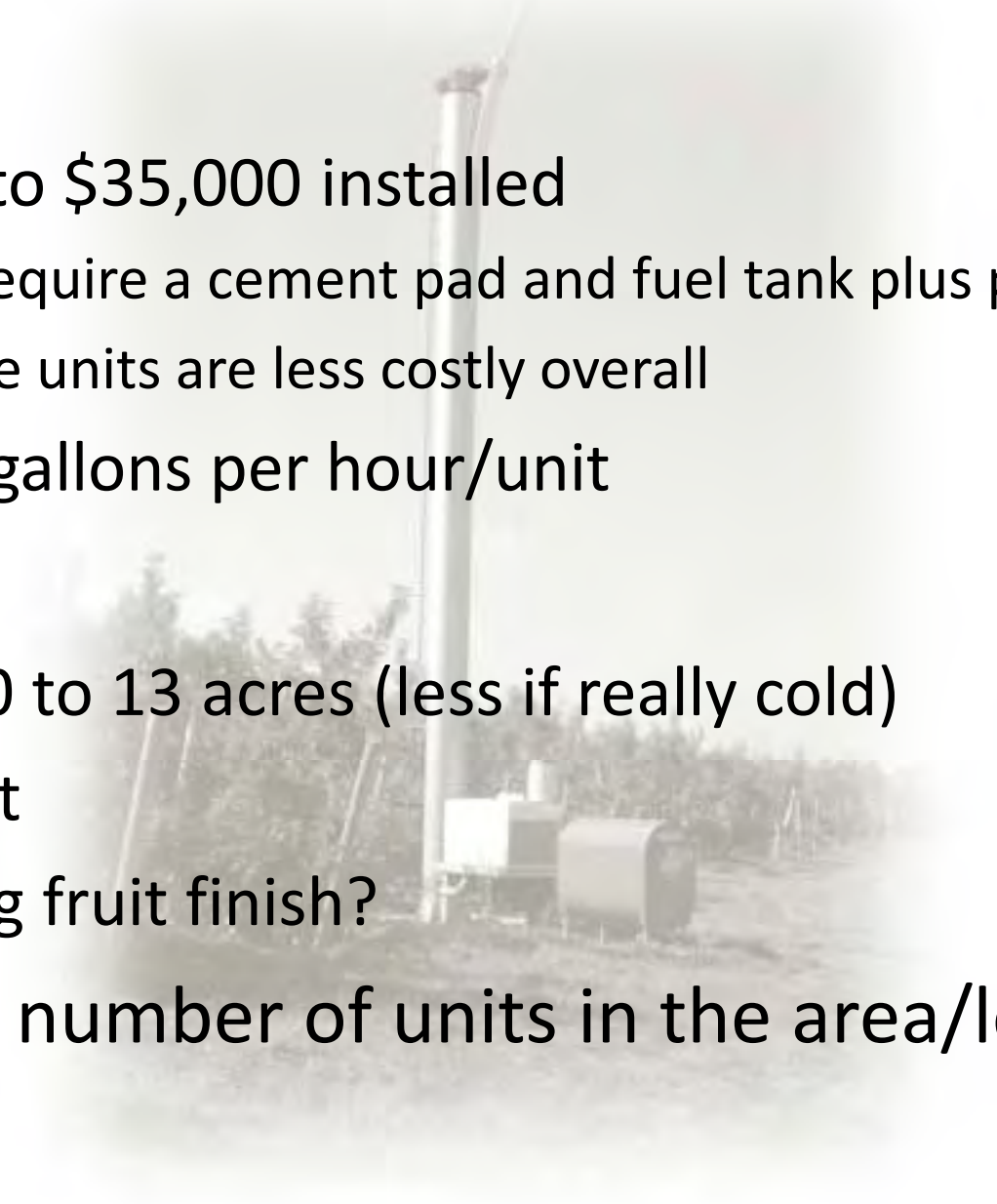
Photo: Phil Schwallier

Photo: Amy Irish-Brown



Frost Fans/Wind Machines

- Costs
  - $16,000 to $35,000 installed
    - Some require a cement pad and fuel tank plus path to refill
    - Portable units are less costly overall
  - 12 to 13 gallons per hour/unit
- Benefits
  - Covers 10 to 13 acres (less if really cold)
  - Auto start
  - Improving fruit finish?
- Limited by number of units in the area/location



Helicopters

Photo: Phil Schwallier

Helicopters

Photo: Phil Schwallier

Helicopters

- Costs
  - $700 to $1600 per bird per hour (4 to 7 hours/night) (+travel time & fueling time)
- Benefits
  - Large area coverage:
    - Large = 40 to 60 acres
    - Smaller = 25 to 40 acres
  - Can move vertically to find thermal layers using infrared cameras
  - Can move from site to site
- Limited by number of units in the area


MicroSprinklers
Photo: Amy Irish-Brown

Photo: Amy Irish-Brown

MicroSprinklers

Photo: Amy Irish-Brown

MicroSprinklers

- Costs
  - Well, irrigation system PLUS $1000 to $1200/acre for microsprinkler heads
  - Electricity to run
  - Maintenance is higher than drip irrigation systems
- Benefits
  - Covers as many acres as your well can cover
  - Dual usage as irrigation & possibly evaporative cooling??
- Water Source Capacity
  - Have to run until all ice is water again.
  - 35 GPM for 10+ hours

Sprayable Materials

- Commercial Materials
  (cryoprotectants, antitranspirants, nutrients)
  – Glacier, KDL, Mega-Fol plus K-Leaf tank mix

- Experimental Materials (delay bud break):
  – Promalin, Kaolin Clay, Latex Paint

- Evaporative Cooling

work still needed on all these before recommendations can be made

Other Protective Measures:

- Proper site selection
- Cultural measures in and around the site
  - Avoid planting in low spots.
  - Plant rows parallel to cold air drainage.
  - Prune trees and vines properly to avoid blocking air movement.
  - Prune out the lower portions of windbreaks
  - Keep air drainage pathways open.
- Nutrition & Orchard Floor Management

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November 1, 2011

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Power Options	NA	oil, diesel or propane	Gas, Electric, PTO	fuel	Gas, Electric, PTO, Diesel (most new are propane)	electric	NA
Unit Cost	cost of old hay bales or brush piles is usually minimal	Oil-Fueled: Approx. $50 each = $2,000/acre Propane-Fueled: Approx. $100 each = $6,500/acre	Approx. $11,000	Rental cost: Large = $1600 per hour per bird Small = $700 per hour (+ travel & fuel time)	Approx. $16,000-$35,000	well, irrigation system plus extra $1000 per acre for microsprinklers	$10 to $20 per acre
Fuel Consumption for One Hour	NA	Oil- and Propane-Fueled: 1 gal./hr/heater	Approx. 1 gal./hr	included in rental	Approx. 15 gal./hr	electricity cost	fuel for tractor
Installation Cost	cost of old hay bales or brush piles is usually minimal	movement to site	cost to move - grower installed	minimum hours for standby	Cement Pad + Installation (often included in total unit cost)	added on to irrigation system install costs	time of operator
Maintenance Cost	tending to burn	Significant – heaters should be cleaned after 20-30 hours of use	Minimal; Owner Maintained	NA if hired in	can be covered under contract, but mostly minimal unless a gearbox goes	adds more time for microsprinkler care than regular overhead irrigation	some materials are hard on sprayers
Auto-Start Available	NA	NA	Yes	NA	Yes	Yes??	NA
Enhances Other Frost Protection	Yes: Wind Machines	Yes: Wind Machines	Yes: Wind Machines, Sprinklers, Heaters	??	Yes: Heaters	perhaps	perhaps
Quiet Factor	Yes, but can cause smokey conditions	Yes, but can cause smokey conditions	No (60-90dB)	Not really	No (90dB)	Yes	No (sprayer/tractor noise)
Special Weather Concerns	Not in high winds or dry conditions	No	Yes	Less coverage if it is very cold. They can move vertically to find the warm air inversions.	Yes/No	Yes	No
Dual usage factors	recycling	NA	NA	for fun if you fly one	might help with fruit finish	irrigation in summer – cooling effect in dormancy to prevent bud break???	NA
Years of usefulness							

What happened in 2012 – 6 strikes

1. Lake Michigan was warmer than normal with almost no ice cover.
2. Mild Fall and Mild Winter.
3. There was little frost in the ground last winter, and little snow cover.
4. The string of warm days in Mid-March was a very unusual, rare event (unprecedented by most climatologic measures).
5. In the timeframe between late-March and the average end of spring frosts (mid-May), there is an average of 6 to 8 frost/freeze events for Kent County - for 2012, there were 22.
6. The final two freeze events were extreme and really the deciding factor(s) in the extreme crop loss. Had we not had that early warm March weather, these events in late April would still have caused some damage to tree fruits (perhaps 30 to 50% losses).

Thank You

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Other Methods – not used in MI

- from Agrofrost nv agrofrost.eu
  - FrostBuster
  - FrostGuard
  - Amarillo Wind Machines


AGROFROST
FROSTBUSTER


PATENTED SYSTEM
agrofrost.be
FrostGuard
GC20

agrofrost nv
The ultimate form of frost protection

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- FrostGuard
  - How does it work
  - Results
  - Models
  - New model 2012
  - Applications
  - Advantages
  - Technical Data
  - Noise Level
  - History
- Frostbuster
- Wind Machines
- Frost Alarm

Technical Data - FrostGuard

Model	Type GC20	Type GC30
		
Dimensions L x W x H (mm)	1700 x 775 x 1200	1700 x 1010 x 1770
Weight without gas cylinders	490 Kg	490 Kg
Average capacity	oval of 50/70 by 90/110 meters	circle of 80 to 120 meters diameter
Drive of fan	Motor Brigss & Stratton, Vanguard, twin-cylinder 16 HP, electrical starter	Motor Brigss & Stratton, Vanguard, twin-cylinder 16 HP, electrical starter
Gas installation	Equipped for 5 or 10 cylinders	Equipped for 5 or 10 cylinders
Average gas consumption	13 to 15 kilograms/hour	13 to 15 kilograms/hour
Burner	Electrical ignition	Electrical ignition
Transport	The FrostGuard can be moved easily by a tractor fork lift.	The FrostGuard can be moved easily by a tractor fork lift.

Model	Type GC20	Type GC30
		
Dimensions L x W x H (mm)	1700 x 775 x 1200	1700 x 1010 x 1770
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