

High Tunnel and Greenhouse Ventilation: Challenges, Practice, and Trends

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Temperature, Humidity, and Soil Moisture

Healthy plant growth and production requires:

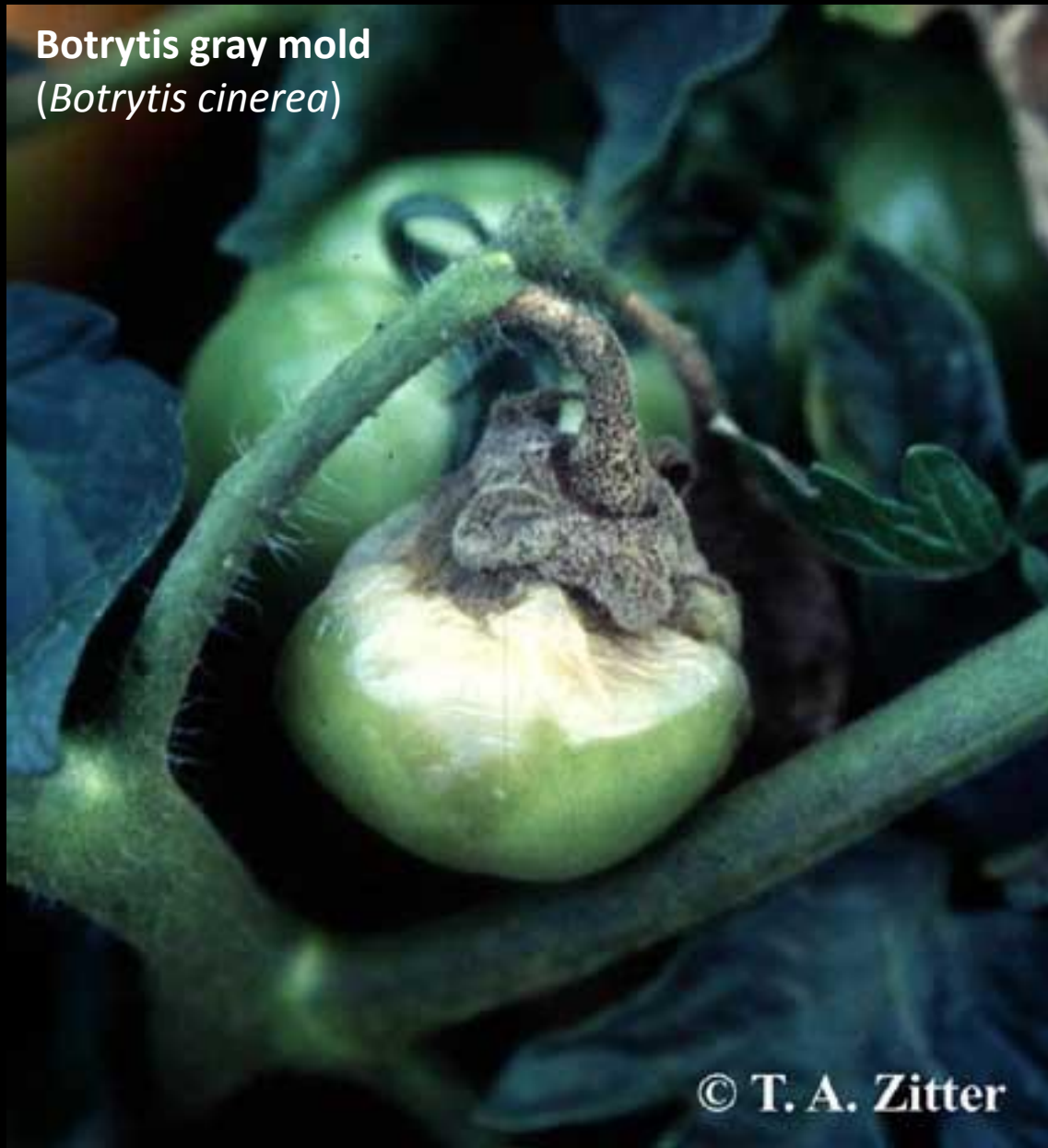
- Control of temperature
 - cooling, heating, or retaining heat
- Control of humidity
 - typically, removal
- Adequate soil moisture
- Soil, nutrients, light, etc.

This may seem flipped!

Most high tunnel questions I receive relate to:

- Excessive temperatures (spring/summer, tomatoes)
- Excessive humidity (winter/spring, greens)

Botrytis gray mold
(*Botrytis cinerea*)



© T. A. Zitter

Tomato Leaf Mold
(*Fulvia fulva* syn. *Cladosporium fulvum*)



©T.A. Zitter

Reference: "In High Tunnels, Diseases Are What You Make Them" T. Zitter, Cornell Veg MD Online.
<http://vegetablemdonline.ppath.cornell.edu/NewsArticles/HighTunn.htm>.

Powdery Mildew on Lettuce



Photo: Amy Ivy, via Margaret McGrath

Powdery Mildew on Kale



Photo: Teresa Rusinek, via Margaret McGrath

Reference: **“Diseases Occurring in Winter Greens and their Management”** Margaret McGrath, Cornell Veg MD Online, <http://vegetablemdonline.ppath.cornell.edu/NewsArticles/winter-greens.html>

Downy Mildew in Spinach



Photos: Teresa Rusinek, via Margaret McGrath

Reference: "**Downy Mildew Developing in Spinach in Northeastern U.S.**" Margaret McGrath, Cornell Veg MD Online, <http://vegetablemdonline.ppath.cornell.edu/NewsArticles/SpinachDownyMildew.html>

Molds and Mildews

Temperature 40-60 °F

Relative humidity (RH) > 90%



Temperature & Humidity

- Knowing what you have – Measure and Monitor
 - Overall
 - Different places
- Controlling what you have – Heat, Cool, Ventilate



Temperature & Humidity

Very limited visibility into what existing conditions are.

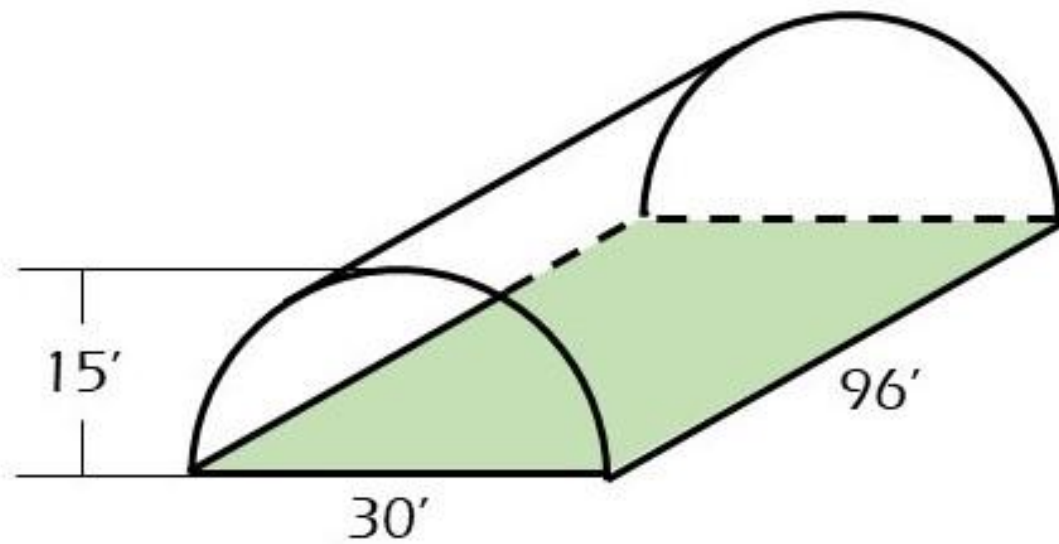
Consider increased measurement and monitoring.

Remote monitoring has become quite accessible.

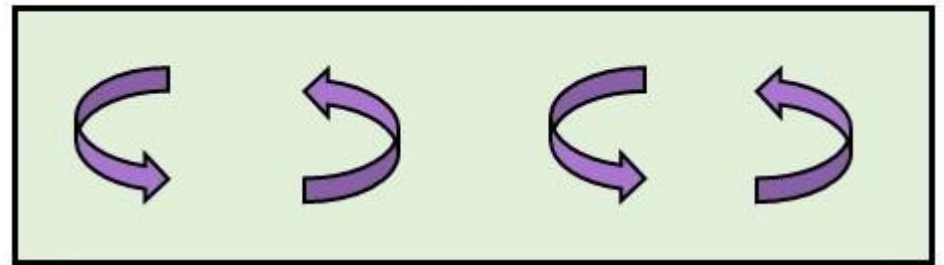
Systems and Parts

Ventilation vs. Circulation

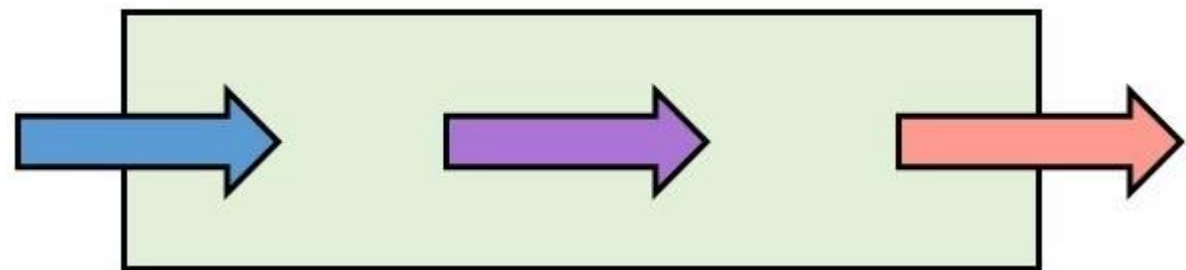
Options



Circulation



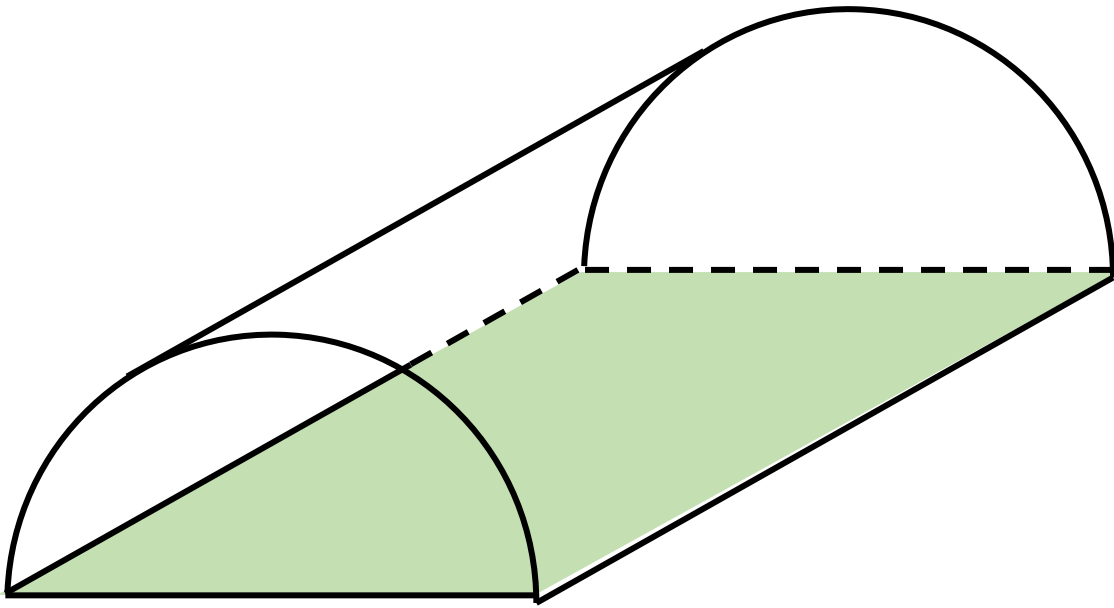
Ventilation





HAF Fans **circulate** (mix, stir, distribute)

HAF Fans do not **ventilate** (exchange air with outside)



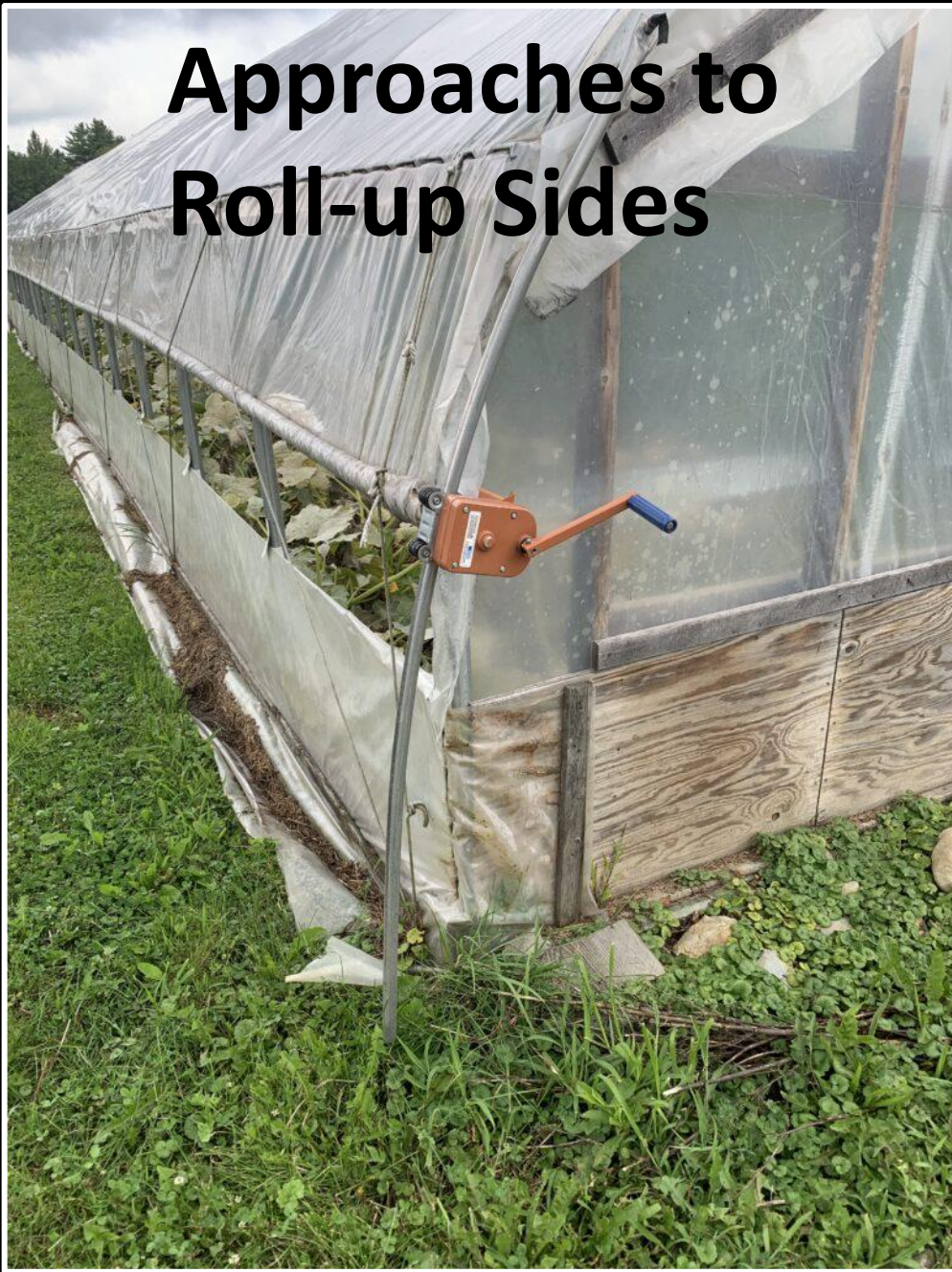
What's the first thing you'd do to ventilate a tunnel?



Roll-up sides

Doors

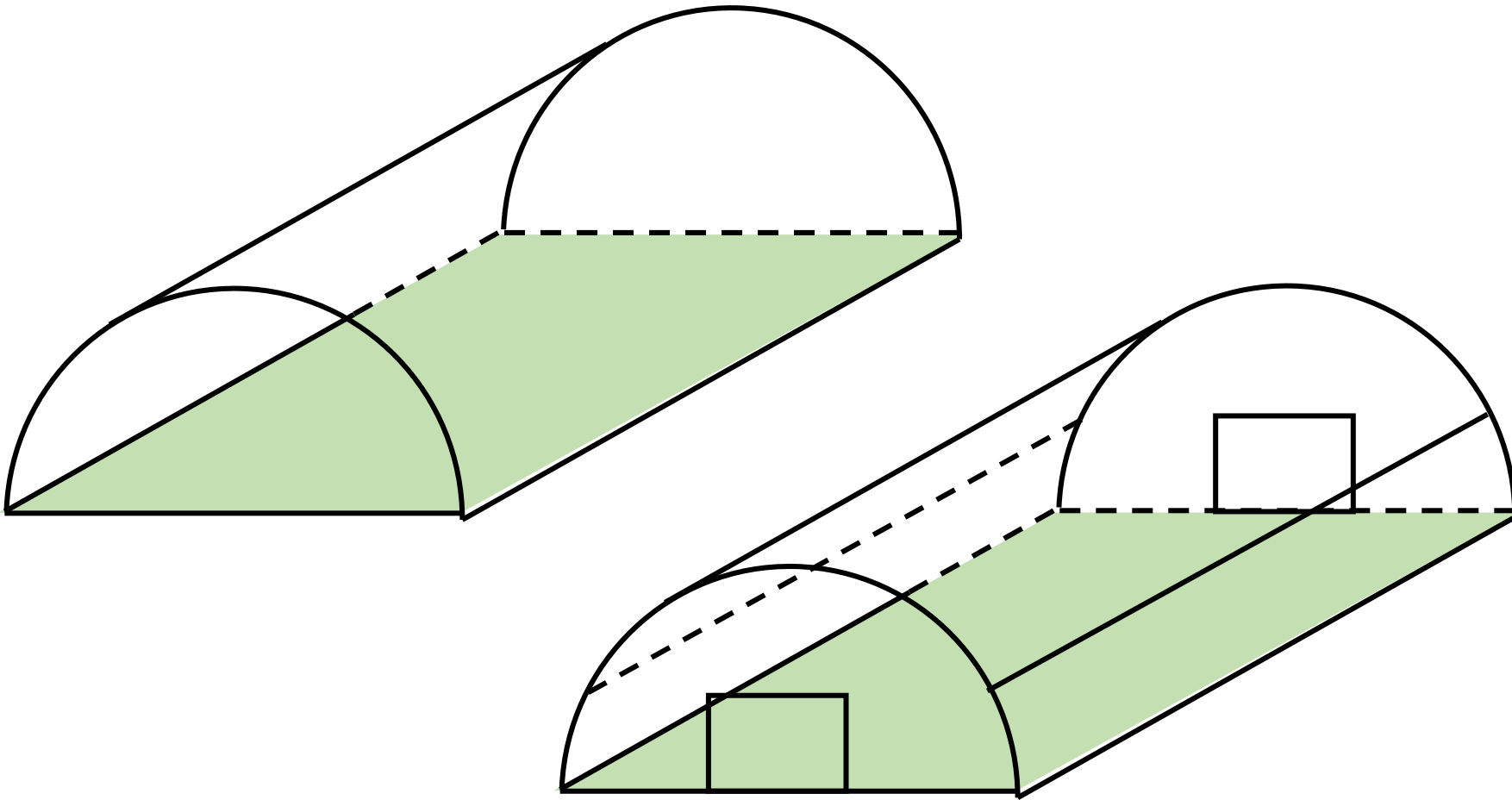
Approaches to Roll-up Sides



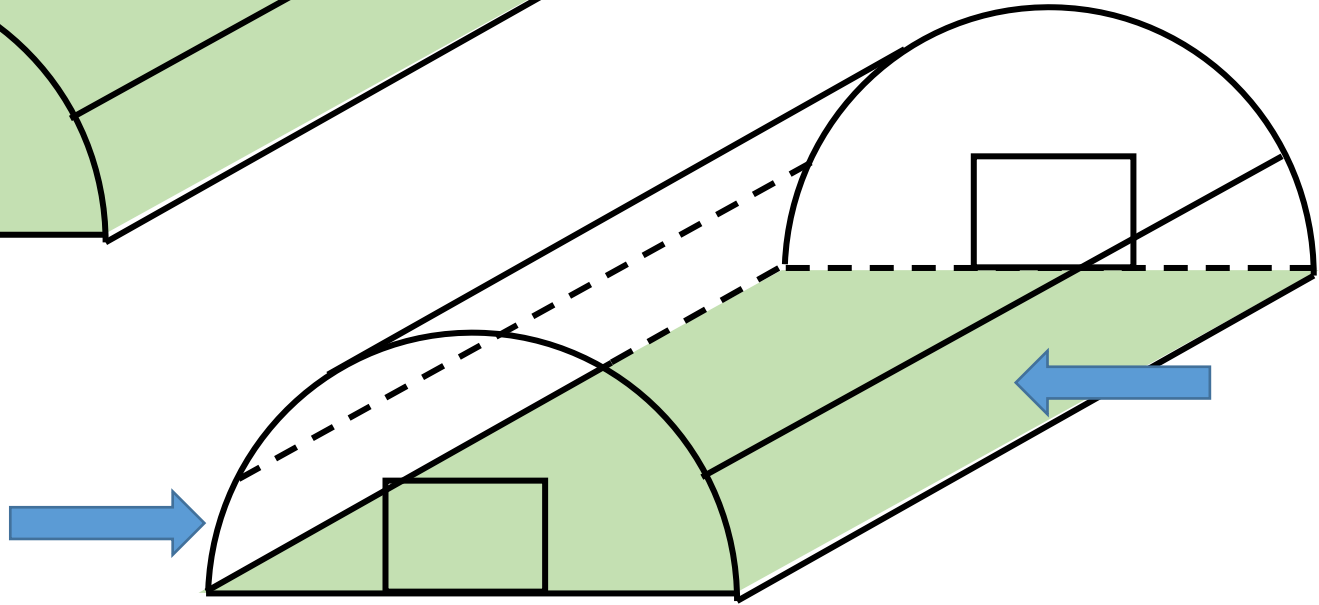
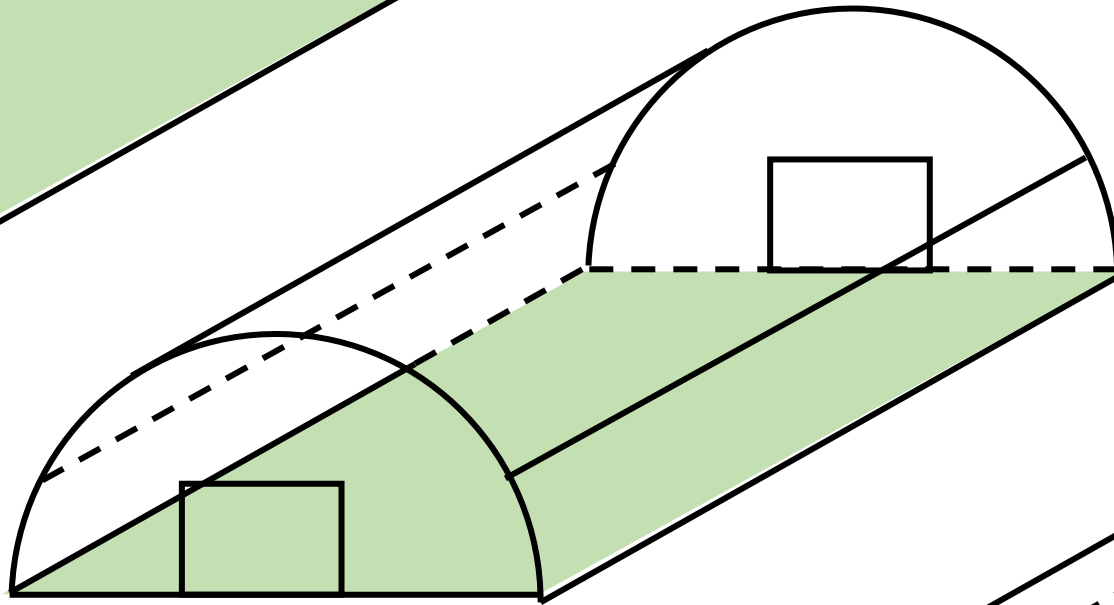
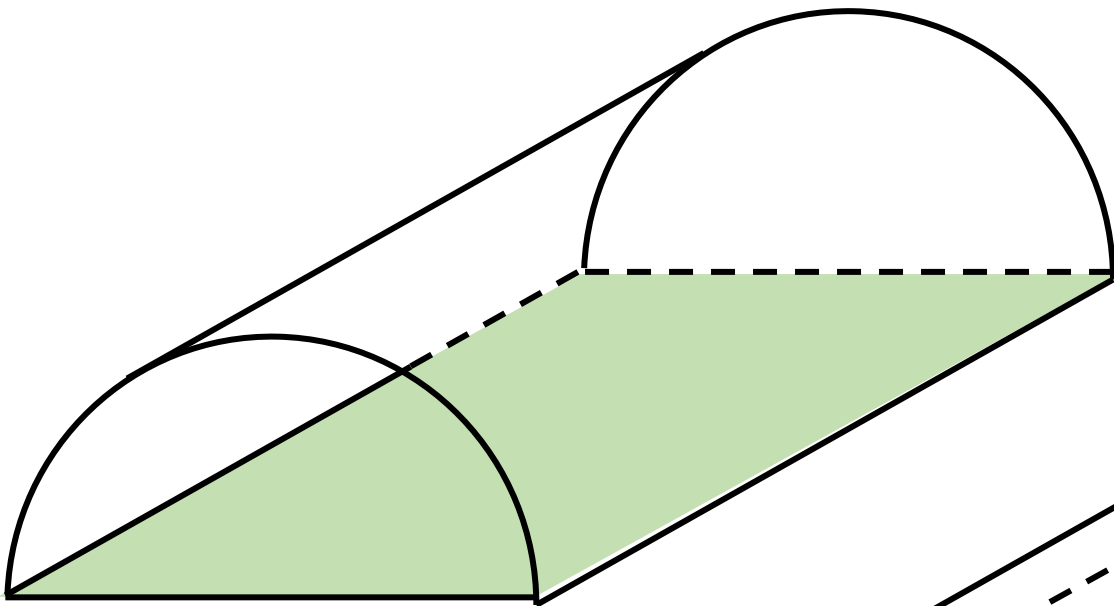


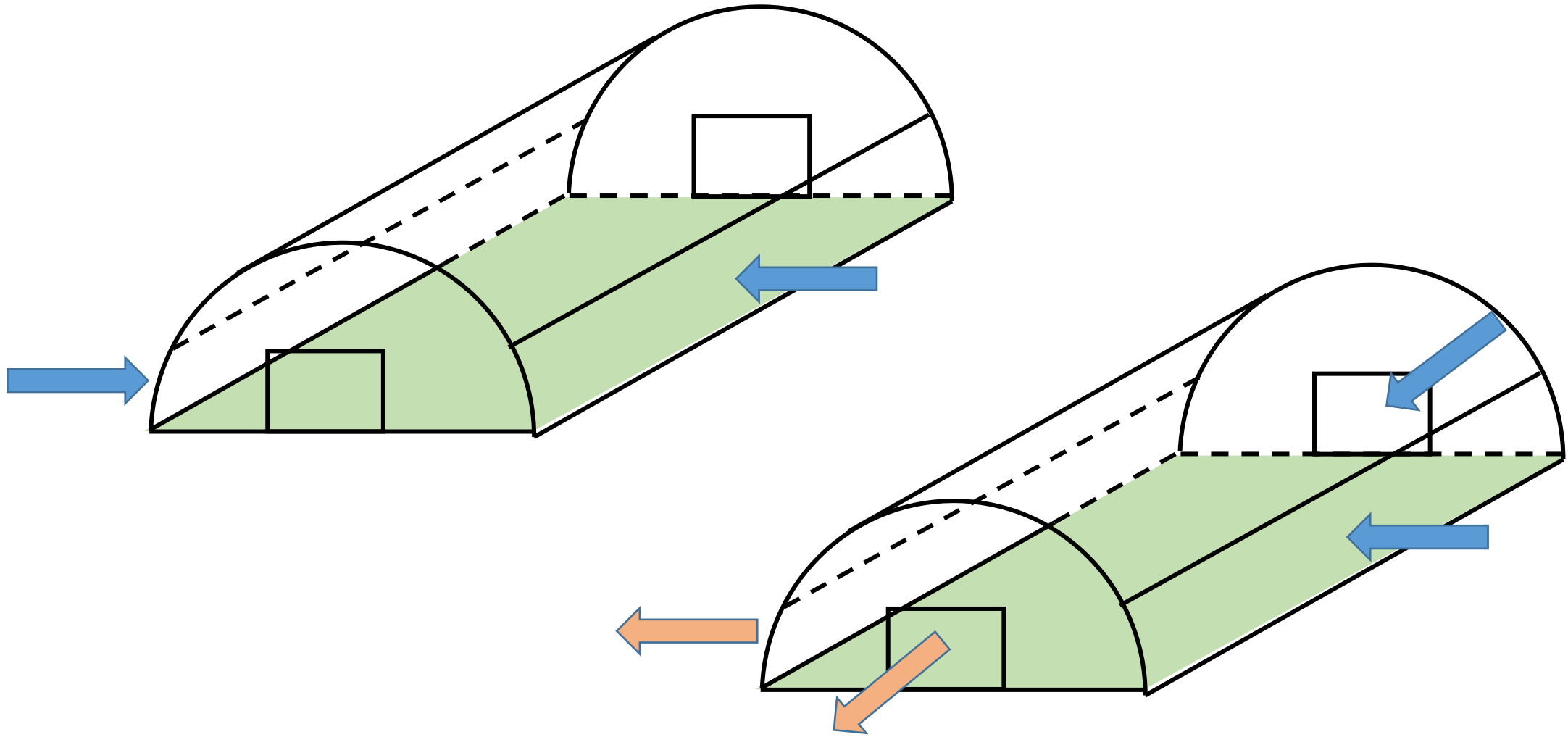
**Roll-down
sides**



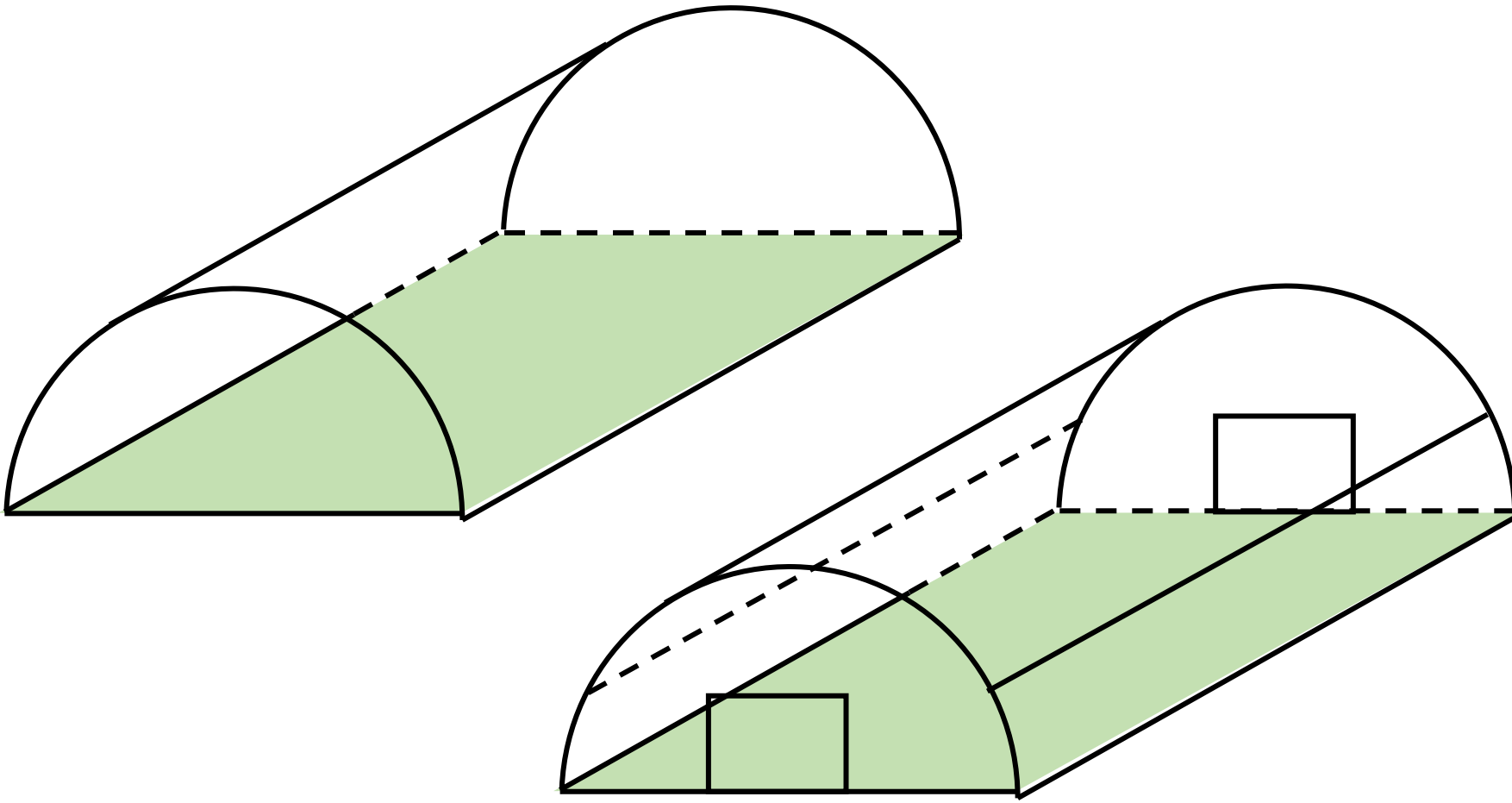


Does this ventilate?
How?





On a good site with reasonable cross wind, roll-up sides & doors will ventilate.



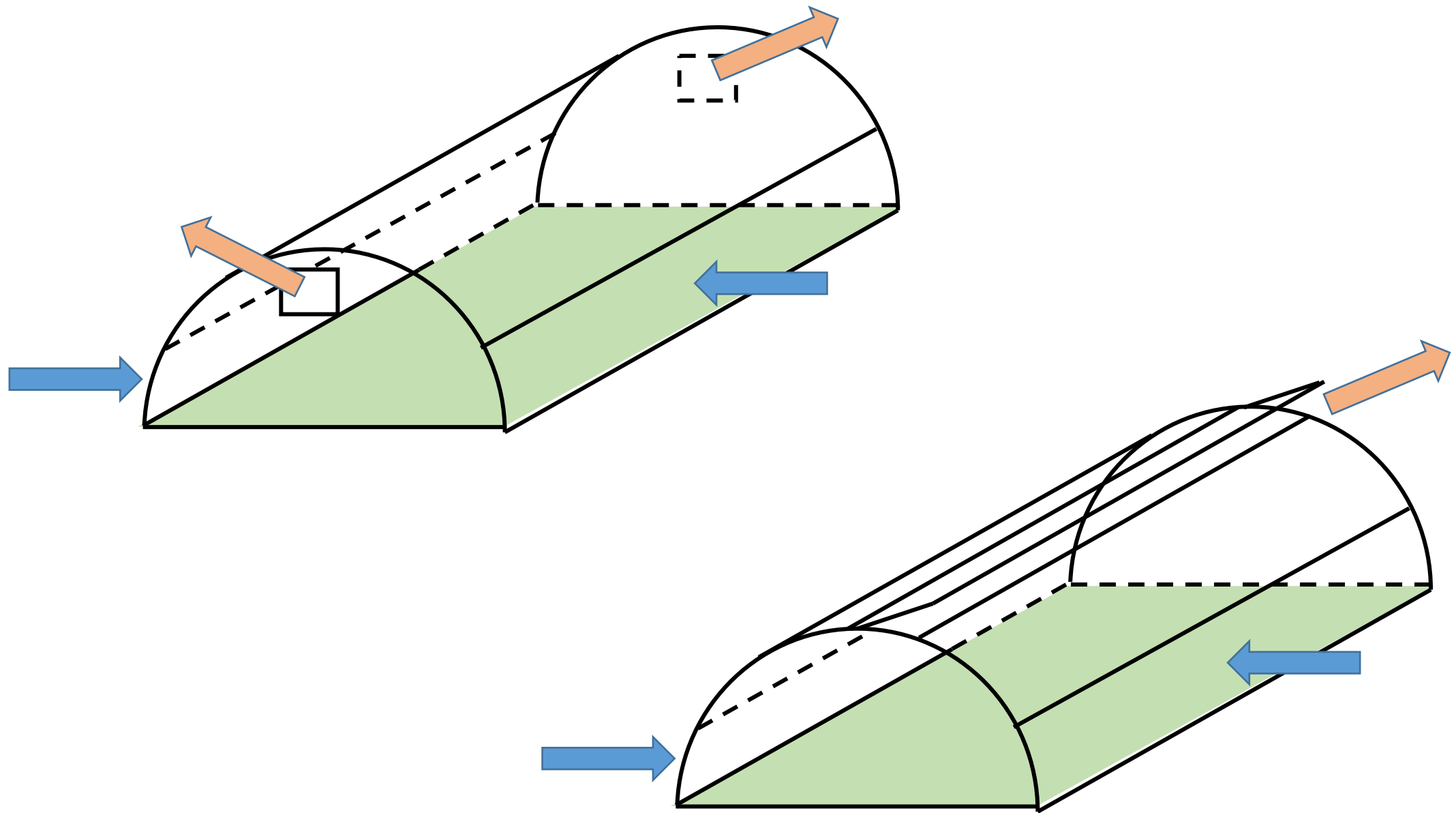
What else can we do to improve ventilation?

Gable Vents



Ridge Vent





Provide an outlet up high!

And... fans and louvers!
(air heat, ground heat,
thermostats...)



VVBGA Lister's Thoughts

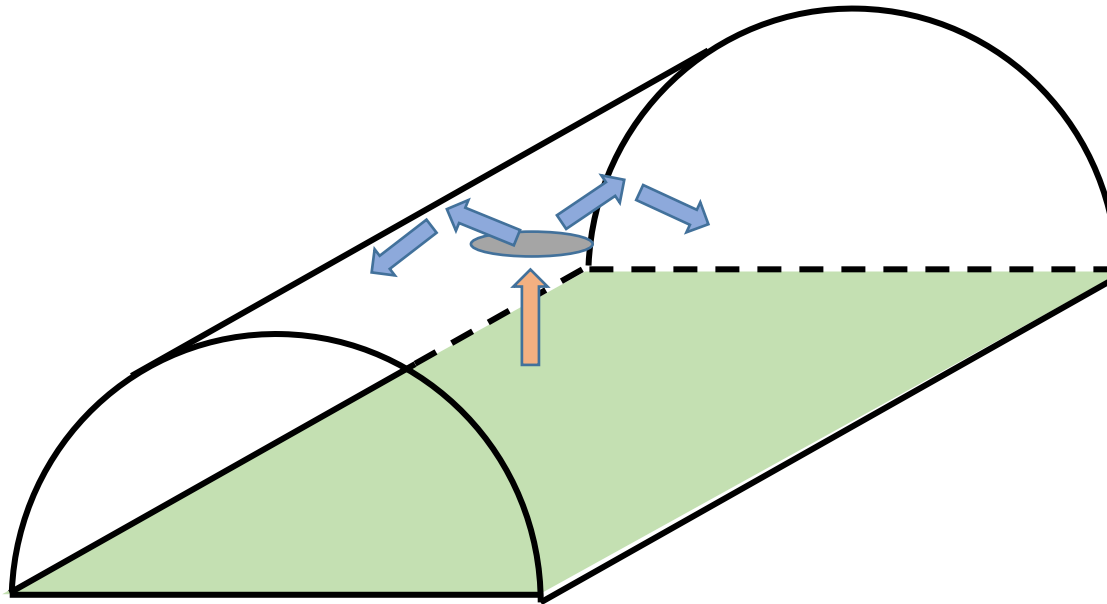
- Ridge vents
- Location of vent inlets
- Automation
- Bottom heat
- Noise
- Higher ground posts and more head space
- Off-grid, zero electricity, and passive options
- Vertical vs. horizontal air flow is being explored for circulation
- Positive pressure ventilation
- Exclusion netting



Vertical Air Flow (VAF)



\$800



<https://www.vostermans.com/hubfs/Multifan%20V-FloFan%20Greenhouse.jpg>



The University of Vermont

Positive Pressure Ventilation



https://horti-generation.com/wp-content/uploads/2020/07/IF-T1216_4.jpg



https://www.ugaatbouwen.com/sites/default/files/HS%20Jet%20Tubes_oben.jpg



Troubleshooting

Symptom	Issue / Resolution
High temperature <u>everywhere</u> in the house (e.g. wide-spread plant stress)	Poor <u>ventilation</u> . Ensure air exchange between inside and outside, consider outlet vents up high (gable, ridge, peak vents).
High humidity <u>everywhere</u> in the house (e.g. wide spread fungal pressure)	
High temperatures <u>locally</u> (e.g. plants in corners, or around perimeter suffer most)	Poor <u>circulation</u> . Ensure mixing of air within the tunnel by using HAF's or other mixing fans. Confirm circulation flow with leaf movement or flags / survey tape.
High humidity <u>locally</u> (e.g. spotty observation of molds and mildews in corners or center of tunnel)	



Summary

Very limited visibility into what existing conditions are.

We can measure and monitor more pretty easily and cheaply

I believe we are under-ventilating tunnels.

High temperatures, High RH

There are passive solutions that can help.

Gable vents, ridge/peak vents



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Keep in touch

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