

# USING NATURAL VENTILATION

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Natural ventilation systems operate on the principle that heat is removed by a pressure difference created by wind and temperature gradients. Wind plays the major role. In a well designed greenhouse, wind speeds of one mile/hour are adequate to keep the inside temperature within two degrees of ambient. There are very few days that the wind is less than one mph, especially if the outdoor temperature is above 80 degrees F.

Buoyancy, the effect from heated air rising, also aids ventilation. The trend toward taller greenhouses has helped this in that it gets the hot air higher above the plants.

Shade is also important to reduce the heat load on the greenhouse and the need for ventilation. Exterior shade is best as it keeps the heat out. A retractable system, shade fabric or shade compound can be used. Interior shade is less effective as the heat enters the greenhouse and has to be removed. White porous shade fabric or an aluminized material that allows good air movement is commonly used.

Natural ventilation systems reduce energy costs. Fan ventilation can use from 0.5 to 1 kilowatt hour/sq. ft./year.

## Design Guidelines

Research by Dr. Ted Short, Agricultural Engineer at Ohio State University indicates that the following design considerations are important for the best operation of natural ventilation systems:

- A greenhouse should be orientated to intercept the normal summer wind along the side. Trees and buildings should not obstruct the natural air flow.
- The sidewall should not have any sharp edges, such as a gutter, that will deflect the air high over the greenhouse. Addition of a curved half span section with side vent improves the air pattern.
- For best results, windward side vents should be low to the ground and be sized to be larger than the area of one roof vent.
- Roof vents should be 15-20% of the floor area and open leeward to the wind.
- Seals around vents should be designed to provide tight closure.
- Horizontal air flow (HAF) should not be operated when natural ventilation is being used.
- Insect screening, if desired, must be properly designed.
- Controls should be installed to give high wind protection.

Most greenhouse manufacturers have naturally ventilated designs. The following reviews some of the basic systems.

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## Roll-up sides

One of the least expensive systems is the roll-up or drop-down curtain design. It can be fitted to most hoopouses. These systems work best during the late spring, summer and fall. Thermostatically operated fan ventilation may be needed during the cold weather when only a little cooling is needed.

Both manual and motorized systems are available. Ventilation rate is controlled by the size of the opening. The drop-down system works better in cooler weather as the air is introduced above the plants. Guides are installed to keep the detached sidewall curtain from blowing on windy days.

## Roof and sidewall vents

The rack and pinion mechanism is a common device for opening roof and side vents. It gives positive positioning and can be adjusted in small increments.

In freestanding greenhouses, vent openings should be provided on both sides of the ridge and both sidewalls. Vent operations should be such that the leeward vents are opened to produce a vacuum at the top of the ridge. The combined sidewall vent area should equal the combined ridge vent area and each should be at least 20% of the floor area.

Research has shown that in gutter-connected houses, it is more efficient to have the ridge vents open several feet above the gutter rather than at the gutter. This also prevents freeze-up of the vent during the winter. A windward sidewall vent will provide most of the intake air. Distribution of heated air removal may not be uniform with more air leaving through the roof vents farthest from the intake, but in a well designed greenhouse, temperature at crop level should be no more than 5 degrees F above ambient. In large gutter connected greenhouses, both cool intake air and hot exhaust air will flow through the same roof vents.

## Roll-up roof

Several manufacturers make a roof that opens by rolling up on a shaft that runs the length of the greenhouse bay. Single and double poly systems are available. A light, second framework over the structure secures the plastic from bellowing out during windy weather. Opening and closing the roof can be manual or automatic.

## Retractable roof

Flat or low profile retractable roof systems using cable technology are available with porous or non-porous coverings. They are low-cost (\$0.75-4.00/sq. ft.) and can be erected quickly. Designs are available that will take a heavy snow or wind load. Heating this type of structure can cost 30-40% more than a double layer poly house.

The roof material supported on horizontal cables can be retracted to expose the plants to direct sunlight and outdoor temperature.  
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