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Technology | Before retrofitting a greenhouse to natural ventilation the system needs to be designed and installed properly and the payback calculated.

By John W. Bartok Jr.

How to reduce ventilation energy

Skyrocketing electric bills have some growers searching for measures that will reduce electricity use. Installing compact florescent bulbs (CFLs), replacing motors greater than 1 horsepower with National Electrical Manufacturers Association premium efficiency ones and adding electronic controls can help. Some growers are looking at the economics of replacing their fan ventilation system with a vent system.

The cost of fan ventilation

Until recently, fan ventilation has been a primary method of cooling greenhouses. At 8-10 cubic feet of air per square foot of floor area this system gives about one volume air change per minute, adequate to keep a production area within a few degrees of the outside air temperature. Its main advantage is that it provides a positive flow of air through the crop with the fans exhausting heated air from the greenhouse and replacing it with cooler air from outside.

One disadvantage is that it creates a 7°F to 12°F differential between the shutter end and the fan end of the greenhouse which can affect plant growth. Another disadvantage, and one that is of concern now that electricity costs have increased, is that it raises the electric bill considerably.

Fans usually operate about 2,000 hours per year. Depending on the installed capacity, the efficiency of the fans and desired daytime temperature of the greenhouse, this can amount to 0.5 to 1 kilowatt hour per square foot per year.

According to the U.S. Energy Information Administration, current commercial electricity rates are between 6.48¢ per kilowatt hour in Idaho to 17.9¢ per kilowatt hour in Massachusetts with a U.S. average of 10.32¢ per kilowatt hour. If the average cost is used and it is assumed that the fans will use ¾ of a kilowatt hour per square foot the cost will be 7.74¢ per square foot or $223 for cooling a 30- by 96-foot greenhouse for the year.

Ventilation considerations

Greenhouses with roof and sidewall vents 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, a wind speed of 2–3 mph provides 80 percent or more of the ventilation, so orientation of the greenhouse is important. Wind passing over the roof creates a vacuum that sucks the heated air out of the vent. Cool outside air enters through sidewall vents, open doors or through the bottom of the roof vent.

Bouyancy, the effect of warm air, also aids ventilation. Heavy cool air near the floor becomes lighter as it is heated and rises towards the roof. On cool days, the large temperature difference creates excellent air exchange. On hot days, when the temperature difference is only 5°F-10°F, the buoyancy effect is minimal.

The trend toward taller greenhouses has helped to get the hot air up above the plants. Horizontal airflow fans should be shut off to avoid destratifying the warm air and also to save on electricity.

Roof and side vents need to be large enough to provide good air movement. American Society of Agricultural and Biological Engineers recommends that roof and sidewall vent areas should be of equal size and each should be 15-20 percent of the floor area. In large gutter-connected greenhouses, it isn't possible to get adequate sidewall vent area so roof vents should be larger. The best orientation for the greenhouse is to have the normal summer wind direction blow over the ridge so that it creates a vacuum on the leeward ridge vent.

If a greenhouse is designed properly with large enough vents or roll-up sides, the temperature will be much more uniform throughout the greenhouse than a greenhouse with fan ventilation. This is an advantage where single crop production is being done.

Retrofitting costs

Some growers are considering retrofitting their greenhouses with a natural ventilation system. For poly covered hoop houses, this is fairly simple and involves adding a splice rail 4-5 feet above the ground and a drop down or roll-up curtain system the length of the sidewalls. Cost of the materials is about $10 per linear foot. The system can be motorized for another $500.

Adding roof vents to a hoop house or gutter-connected greenhouse is more involved. The existing glazing has to be cut and the edges secured. A separate frame to support the glazing needs to be installed. A rack and pinion drive, gear motor and controls are also needed to adjust the amount of opening. There are good systems available from some of the greenhouse manufacturers and equipment suppliers.

The cost of retrofitting to natural ventilation will depend on the size of the vents and the mechanism and controls used. For a large gutter-connected greenhouse installation the materials will be $1-$1.50 per square foot of vent area and the labor about $0.75 per square foot. In smaller houses the cost will be higher.

The operating cost of a natural ventilation system is much less than with fans. The vent motors should operate no more than ½ hour per day to make adjustments to the vent opening.

The gear motors are very small, usually 1/20th to 1/5th horsepower. This makes the operating cost only a few cents per day.

Calculate the payback

To determine if a retrofit is viable and a good investment, the payback should be considered. Simple payback is cost divided by savings. This will depend on the cost of electricity, the efficiency of the fans and the hours they operate.

The payback was 8.7 years for retrofitting a large gutter-connected greenhouse in Massachusetts for which I ran the calculations. This greenhouse would have a longer payback in other areas of the country where the electric rate is lower as the savings is not as large. Drop down or roll-up systems, being less expensive, usually have a shorter payback.

It is desirable to leave one operating, thermostatically controlled fan in each hoop house or one per bay in a gutter-connected greenhouse to provide a small amount of ventilation air when the vents aren't open. It is important to have a fan in a hoop house with manual roll-up sides to prevent overheating.

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