

## On-Farm Equipment Efficiency Improvements Greenhouse HAF System



### Introduction

A greenhouse horizontal air flow (HAF) system is a system of fans installed to create a horizontal air circulation pattern within a greenhouse

This practice provides energy efficient air movement and heat distribution for minimizing temperature, carbon dioxide and moisture gradients.

This practice applies to the installation of HAF systems in heated single span, ridge and furrow and overwintering greenhouses and high tunnels. It also applies to all types of plant production including floor, bench, hydroponic and hanging basket systems. Reduced fan pressures, reduced maintenance (no tubes to replace) and lower initial cost make this a more efficient method of air circulation and/or heat distribution compared to the perforated tube system.

### General Specifications

Plans and specification for designing and installing a HAF system shall be in compliance with this specification guide and shall show the size and location of individual fans and method of control.

### General Criteria

Design, installation and operation of a HAF system shall comply with the National Electric Code (NEC) and Occupational Safety and Health Administration (OSHA) regulations.

### Fan Selection

The fans selected shall be circulating fans, not exhaust fans. Circulating fans operate at very little static pressure. Select fans to provide a minimum total air flow of 2 cubic feet per minute per square foot ( $\text{cfm}/\text{ft}^2$ ) of floor area. In crops such as tomatoes, cucumbers and roses that create more air flow resistance, provide a minimum total air flow of  $2.5 \text{ cfm}/\text{ft}^2$  of floor area. The fan capacity shall be sized only large enough to overcome turbulence and friction losses of the air movement.

Fans shall have large diameter blades (12" to 24"). Fan motors shall be permanent split capacitor (PSC) motors with low power output (1/15 to 1/10 horsepower).

Fans with shrouds or venturi that produce a longer "throw" distance shall be used where there are heavy plant canopies.

Fans shall have a guard to protect workers and meet OSHA requirements.

### Fan Mounting

Mount fans perpendicular to the ground, at least 2 feet above the plants, and 6 to 10' above the floor. They shall not be located less than 12" from the roof. In greenhouses with hanging baskets, a fan location between the floor or bench crop and the hanging baskets will give the best air movement.

In single span greenhouses, the system shall be designed to move the air in a horizontal circular pattern, down one side of the greenhouse and back the other. Install fans with their axis parallel to the long dimension of the house at a

distance of  $\frac{1}{4}$  of the house width from the sidewall.

In ridge and furrow greenhouses, direct the circulation down one or two bays and back through adjacent bays. A fan location in the center of the bay supported from the energy truss is best.

Locate the first fan from 15 to 20 feet from one endwall to allow the air movement at the end of the greenhouse. Space each additional fan 20 to 25 times the fan diameter down the length of the greenhouse. Greater distance may cause short circuiting of the air across to the other side. Locate the last fan no closer than 50 feet from the endwall to reduce turbulence. On the opposite side of the greenhouse, a similar pattern of fan location shall be used.

### **Control**

Control fans by a separate electric circuit and an on-off switch. If an environment controller or computer is used, connect the fans to operate during the heating, set point and low stage of ventilation.

To reduce air turbulence, HAF fans shall be shut off when the exhaust fan ventilation system or vent system is in operation.

### **Considerations**

Air velocity should be between 50 to 100 feet/minute (fpm). This can be checked with a smoke bomb or fogger placed behind one of the fans. Watch for speed of smoke movement and for any short circuiting of air across the greenhouse or bay.

### **Operation and Maintenance**

Fans should be controlled to operate continuously except when the vents are open or the exhaust fans are operating.

Fan blades and guards should be cleaned at least twice a year to improve efficiency.

### **References**

*Heating, Ventilating and Cooling Greenhouses*, American Society of Agricultural and Biological Engineers, ANSI/ASAE EP406.4, Jan 2003.