Practical Manual

Protected Cultivation & Secondary Agriculture

AAE 332 - 2(1+1)

B.Sc. (Hons.) Agriculture VI semester

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Syllabus AAE 332 – 2 (1+1)

Study of different type of greenhouses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of greenhouse equipment's. Visit to various Post Harvest Laboratories. Determination of Moisture content of various grains by oven drying & infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

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Roof: --

Gable: --

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Gutter: --

Column: --

Purlin: --

Ridge: --

Girder: --

Bracings:

Arches:

Foundation pipe:

Exercise No. 10

Objective: To study the machinery and equipment required for processing plant

A. Processing hall: write down the Machinery and Equipment required for processing hall

S.No.	Machinery and Equipment:	S.No.	Machinery and Equipment:
1.		7.	
2.		8.	
3.		9.	
4.		10.	
5.		11.	
6.		12.	

B. Packing and grading rooms: ……………………………………………………………………………

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C. Store Rooms: ……………………………………………………………………………………………

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D. Administrative block: ……………………………………………..…………………………………

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Draw the diagram for the following:

Refractometer (0-32, 28-62, 56-92^{o}C)		**Fruit grater**

Crown corking machine		Lug cap sealing machine
Vegetable cutter		Fruit pulper
Homogenizer		Paste filling machine

Can seamer		**Can stacking**

Exercise No. 11

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Solar cabinet dryer:

Exercise No. 13

Objective: To study about the determination of moisture content using moisture meter and comparing with oven method

Moisture content …………………………………………………………………………………..………………

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Materials Required……………………………………………………………………………..…………

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Procedure:

Method 1: Using Moisture Meter: ……………………………………………………………………………

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Method 2: Using Air Oven: …………………………………………………………………………………….

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Exercise No. 14

Objective: To study about the estimation of drying time of a commodity

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Rate of drying includes:

1. ………………...………………………………………………………………………..……………………….
2. ………………...……………………………………………………………………………………………….
3. ………………...……………………………………………………………………………………………….

For constant rate drying period the following general expression would apply:

$R_c = dw / dt = w_o - w_c / t_c$ ……………………………………………………………………………… (1)

Where,

w_c = Critical moisture content (kg water / kg dry solid) and t_c = Time for constant rate drying

During falling rate drying, the following analysis would apply:

$dw/dt = R_c / w_c (w)$ or $w_c / R_c \int - dw / w = \int dt$……………………………………………………….… (2)

Where,

the limits of integration are between critical moisture content w_c or end of constant rate drying, t_c and some desired final moisture content, w.

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Exercise No. 15

Objective: To determine engineering properties of a commodity

1. Grain size and shape:……………………………………………………………………………..……
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2. 1000 grain weight:……………………………………………….…………………………..……
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3. Bulk Density:………………………………………………………………………………………..…
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4. Hydration Capacity: ………………………………………………………………………………..…

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5. Swelling capacity: ……………………………………………………………………………………

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6. Porosity: ………………………………………………………………………………………………

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Exercise No. 16

Objective: To determine chemical properties of material

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TSS: ………………………………………………………………………………………………………

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Titratable acidity: ………………………………………………………………………………………

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Ascorbic acid: ……………………………………………………………………………………………

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Phenols: …………………………………………………………………………………………………

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Exercise No. 17

Objective: To determine physical properties of material

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Length: ……………………………………………………………………………………………………

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Breadth: …………………………………………………………………………………………………

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Volume: …………………………………………………………………………………………………

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Specific gravity: ……………………………………………………………………………………

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Exercise No. 18

Objective: To study about different types of driers

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In sun drying: …………………………………………………………………………………………..

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In dehydration: …………………………………………………………………………………………

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Important Pre-treatments

Lye peeling: ……………………………………………………………………………………………

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Sulphuring: ……………………………………………………………………………………………………

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Sweating: ……………………………………………………………………………………………………

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Methods of drying

Air convection driers: ……………………………………………………………………………………

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Kiln drier:……………………………………………………………………………………………………

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Cabinet, Tray and Pan Driers: ………………………………………………………………………….……

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Belt trough drier: ……………………………………………………………………………………..……

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Air lift drier: ……………………………………………………………………………………………

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Fluidized bed drier: ………………………………………………………………………………………

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Spray drier: ……………………………………………………………………………

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Drum or roller drier: ………………………………………………………………

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Freeze drying: ……………………………………………………………………

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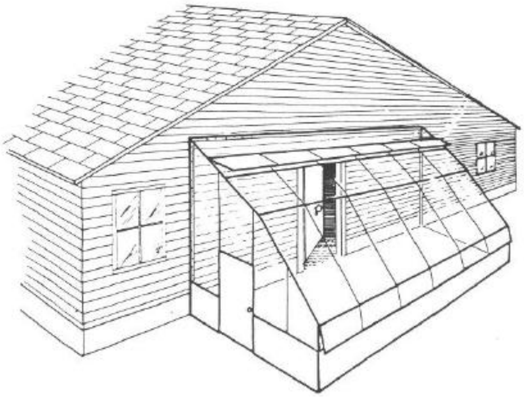
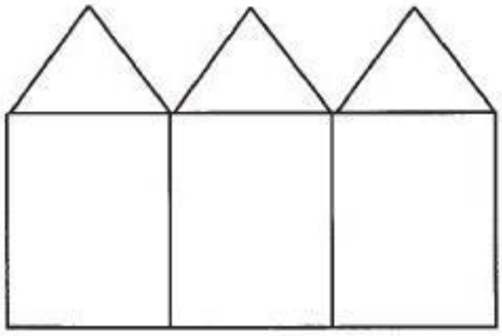
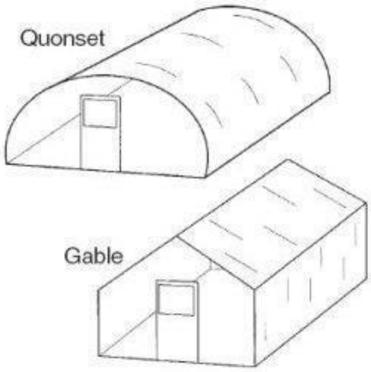
TYPES GREENHOUSES BASED ON SHAPES

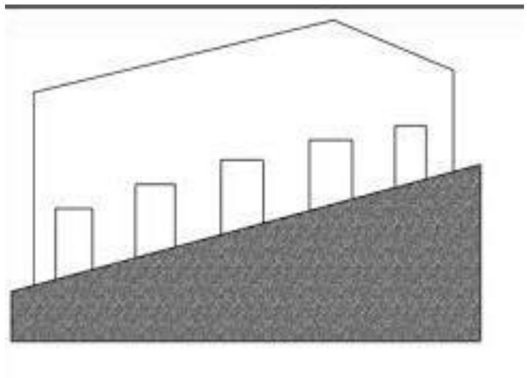


Lean to Greenhouse

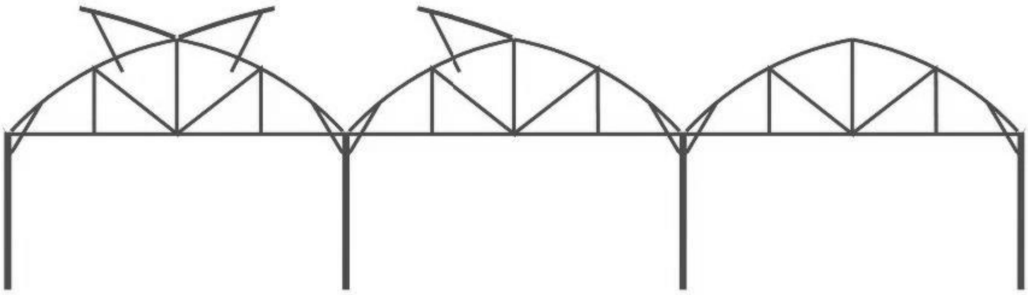


Ridge and Furrow



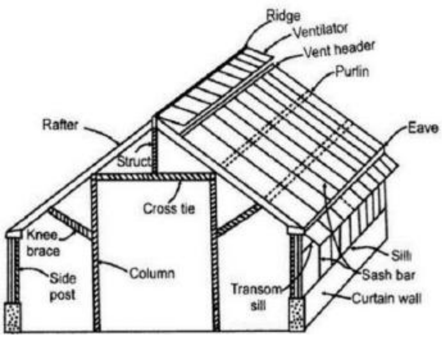


Uneven span type

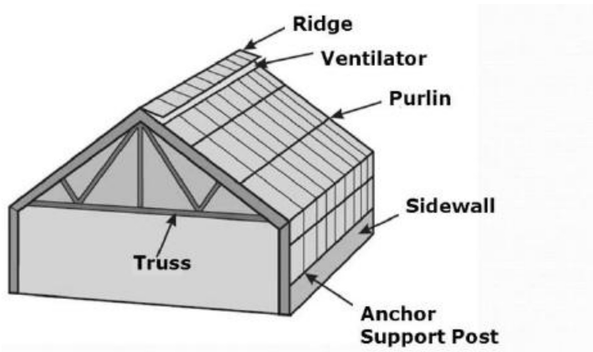


Saw tooth type Greenhouse

TYPES GREENHOUSES BASED ON STRUCTURES



Pipe type



Truss type

Naturally Ventilated Greenhouse: The climatic parameters such as temperature, humidity, carbon dioxide in these polyhouses are maintained and/or controlled through natural air convection without using any additional systems, and are mostly operated manually.

Forced Ventilated Greenhouse: The climatic parameters such as temperature, humidity, carbon dioxide in these polyhouses are maintained and/ or controlled through forced air circulation using fan and pad systems (for hot regions)/heaters (for temperate regions), foggers, curtain actuators (mechanism that makes the system work) that are controlled with automatic sensors. These systems are mostly operated automatically, however, these can be operated manually as well. These structures require continuous power supply and backup.

Types of cladding materials in greenhouses

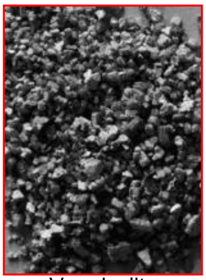
Type of greenhouse	Cladding materials used
Glass greenhouses	Transparent glass
Plastic film greenhouses	Polyethylene, polyester and polyvinyl chloride
Rigid panel greenhouses	Polyvinyl chloride rigid panels, fibre glass-reinforced plastic, acrylic and polycarbonate
Shading nets	UV stabilized shade nets

Media for greenhouses

The organic materials include synthetic (like phenolic resin and polyurethane) and natural organic matters (peat, coconut based and composted organic wastes). Inorganic substrates can be classified as natural unmodified sources (sand, tuff and pumice), processed materials (expanded clay, perlite and vermiculite) and mineral wool (rockwool, glasswool). Based on the surface charge activity of materials, these can be distinguished in active (peat, tuff) or inert (rockwool and sand). Some of the desirable properties of growing media to be used are as follows:

- The medium should be well drained.
- A desirable medium should be a good balance between physical properties like water holding capacity and porosity.
- Highly porous medium will have low water and nutrient holding capacity, affects the plant growth and development.
- Medium which is too compact creates problems of drainage and aeration which will lead to poor root growth and may harbour disease causing organisms.
- The media reaction (pH of 5.0 to 7.0 and the soluble salt (EC) level of 0.4 to 1.4 dS/m is optimum for most of the greenhouse crops).
- A low media pH (7.5) causes deficiency of micronutrients including boron.
- A low pH of the growth media can be raised to a desired level by using amendments like lime (calcium carbonate) and dolomite (Ca-Mg carbonate) and basic, fertilizers like calcium nitrate, calcium cyanamide, sodium nitrate and potassium nitrate.
- A high pH of the media can be reduced by amendments like sulphur, gypsum and Epsom salts, acidic fertilizers like urea, ammonium sulphate, ammonium nitrate, mono ammonium phosphate and aqua ammonia and acids like phosphoric and sulphuric acids.
- The pH of water and mix should be monitored regularly


Cocopeat


Vermiculite


Perlite


Rockwool

PREPARING GROWING MEDIA FOR HI-TECH NURSERY

Growing media in greenhouses are used in containers (organic substrates, perlite etc.). However, sometimes they are used in the form of prepared cubes (rockwool cubes for seedling and transplant production), bags and slabs (peat-based substrates and rockwool, respectively), mats (polyurethane foam) and troughs (rockwool). The last three are also used generally for production in soil-less culture systems.

Commercially available materials like peat, sphagnum moss, vermiculite, perlite and locally available materials like sand, red soil, common manure/ compost and rice husk can be used in different proportions to grow greenhouse crops. These ingredients should be of high quality to prepare a good mix. They should be free from undesirable toxic elements like nickel, chromium, cadmium, lead etc. The most common media used in greenhouse production today are mixtures of peat, vermiculite and perlite. The media are designed to achieve high porosity and water retention while providing adequate aeration. A nutrient charge is added and the pH adjusted to approximately 6.0. A non-ionic wetting agent is generally added to peat media to improve initial wetting. Formulations without wetting agents are available for growing sensitive plants, such as seedlings. Different types of media combination for plug trays hi-tech nursery:

i) Cocopeat: Sand: FYM: vermicompost
ii) Cocopeat: Vermiculite: Perlite (3:1:1)
iii) Fine soil: Sphagnum Peat Moss: Perlite (2:1:2)
iv) Sand: Soil: FYM: Rice Husk Ash (1:1:1:1)

TYPES OF GREENHOUSE BASED ON ESTABLISHMENT COST

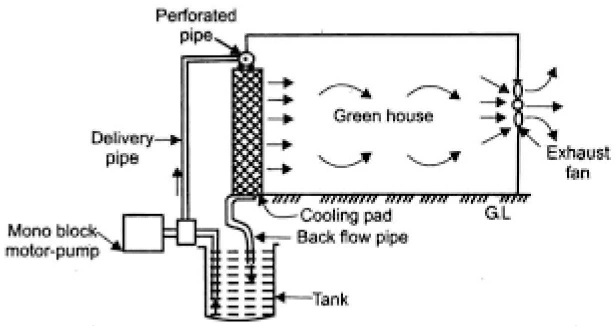
Low-cost greenhouse: It is fabricated mainly using local and low-cost available material like wooden logs or bamboos. The protection of wooden structures from insects and termites is a major challenge. These structures are small in size and have a short life-span. Since the height of the structure is lesser as compared to those with steel frames, maintaining proper temperatures in summer becomes difficult. Therefore, they are recommended mostly in cold climatic zones and low wind speed regions. The approximate cost of establishing such greenhouse units ranges between Rs. 450–620 per sq m.

Medium-cost greenhouse: It is generally fabricated using galvanised iron (GI) square or rectangular or round pipes or lipped channel or their combinations. The whole structure is firmly fixed in the ground to withstand high speed wind up to 140 km/hr. Such greenhouses are suitable for dry and composite climatic zones. The normal height of these structures ranges between 6.5–7 m and these are mostly naturally ventilated. The climate inside the structure is regulated by opening and closing of side curtains (which are rolled above permanently fixed insect-proof net on windows). Thus, air circulation can be regulated. Humidity is maintained through operation of foggers/ misters. Light intensity can be controlled with the use of internal collapsible shading nets. The approximate cost of establishing such naturally ventilated polyhouse unit ranges between Rs. 900–1000 per sq m depending upon the size of the structure.

High cost greenhouse: For the production of sensitive, off-season, exotic or quality crops, high-cost greenhouses are required to deliver the requisite quality. Therefore, high-cost greenhouse structures, which can precisely regulate climatic and nutritional needs of the plants, are required. The greenhouse climate parameters are regulated through passive cooling by operating fan and pad systems and sensor-based controlled systems. The approximate cost of establishing such greenhouse units ranges between Rs.1500– 2500 per sq m depending upon the size of the structure.

Active summer cooling systems: Active summer cooling is achieved by evaporative cooling process. The evaporative cooling systems developed are to reduce the problem of excess heat in green house. In this process cooling takes place when the heat required for moisture evaporation is derived from the surrounding environment causing a depression in its temperature. The two active summer cooling systems in use presently are fan-and pad and fog systems. In the evaporative cooling process the cooling is possible only up to the wet bulb temperature of the incoming air.

Fan-and Pad cooling system: The fan and pad evaporative cooling system has been available since 1954 and is still the most common summer cooling system in green houses. Along one wall of the green house, water is passed through a pad that is usually placed vertically in the wall. Traditionally, the pad was composed of excelsior (wood shreds), but today it is commonly made of a cross-fluted cellulose material somewhat similar in appearance to corrugated cardboard. Exhaust fans are placed on the opposite wall. Warm outside air is drawn in through the pad. The supplied water in the pad, through the process of evaporation, absorbs heat from the air passing through the pad as well as from surroundings of the pad and frame, thus causing the cooling effect. Khus-khus grass mats can also be used as cooling pads.



Fog cooling system: The fog evaporative cooling system, introduced in green houses in 1980, operates on the same cooling principle as the fan and pad cooling system but uses quite different arrangement. A high pressure pumping apparatus generates fog containing water droplets with a mean size of less than 10 microns using suitable nozzles. These droplets are sufficiently small to stay suspended in air while they are evaporating. Fog is dispersed throughout the green house, cooling the air everywhere. As this system does not wet the foliage, there is less scope for disease and pest attack. The plants stay dry throughout the process. This system is equally useful for seed germination and propagation since it eliminates the need for a mist system. Both types of summer evaporative cooling system can reduce the greenhouse air temperature.

The fan-and pad system can lower the temperature of incoming air by about 80% of the difference between the dry and wet bulb temperatures while the fog cooling system can lower the temperature by nearly 100% difference. This is, due to the fact that complete evaporation of the water is not taking place because of bigger droplet size in fad and pad, whereas in the fog cooling system, there will be complete evaporation because of the minute size of the water droplets. Thus, lesser the dryness of the air, greater evaporative cooling is possible.

Active winter cooling systems: Excess heat can be a problem during the winter. In the winter, the ambient temperature will be below the desired temperature inside the green house. Owing to the greenhouse effect the entrapment of solar heat can rise the temperature to an injurious level if the green house is not ventilated. The actual process in winter cooling is tempering the excessively cold ambient air before it reaches the plant zone. Otherwise, hot and cold spots in the green house will lead to uneven crop timing and quality .This mixing of low temperature ambient air with the warm inside air cools the green house in the winter. Two active winter cooling systems commonly employed are convection tube cooling and horizontal air flow (HAF) fan cooling systems.

Convection tube cooling: The general components of convection tube are the louvered air inlet, a polyethylene convection tube with air distribution holes, a pressurizing fan to direct air in to the tube under pressure, and an exhaust fan to create vacuum. When the air temperature inside the greenhouse exceeds the set point, the exhaust fan starts functioning thus creating vacuum inside the green house. The louver of the inlet in the gable is then opened through which cold air enters due to the vacuum. The pressurizing fan at the end of the clear polyethylene convection tube, operates to pick up the cool air entering the louver. A proper gap is available for the air entry, as the end of the convection tube is separated from the louvered inlet by 0.3 to 0.6m and the other end of the tube is sealed. Round holes of 5 to 8 cm in diameter are provided in pairs at opposite sides of the tube spaced at 0.5 to 1m along the length of the tube.

Cold air under pressure in the convection tube shoots out of holes on either side of the tube in turbulent jets. In this system, the cold air mixes with the warm greenhouse air well above the plant height. The cool mixed air, being heavier gently flows down to the floor level, effects the complete cooling of the plant area. The pressurizing fan forcing the incoming cold air in to the convection tube must be capable of moving at least the same volume of air as that of the exhaust fan, thereby avoiding the development of cold spots in the house. When cooling is not required, the inlet louver closes and the pressurizing fan continues to circulate the air within the greenhouse. The process minimizes the temperature gradient at difference levels. The circulation of air using convection tube consumes more power than a circulation system.

Horizontal air flow cooling: HAF cooling system uses small horizontal fans for moving the air mass and is considered to be an alternative to convection tube for the air distribution. In this method the green house may be visualized as a large box containing air and the fans located strategically moves the air in a circular pattern. This system should move air at 0.6 to 0.9 $m^3/min/m^2$ of the green house floor area. Fractional horse power of fans is 31 to 62 W (1/30 to 1/15hp) with a blade diameter of 41cm are sufficient for operation. The fans should be arranged in such a way that air flows are directed along the length of the greenhouse and parallel to the ground. The fans are placed at 0.6 to 0.9m above plant height and at intervals of 15m.They are arranged such that the air flow is directed by one row of the fans along the length of the greenhouse down one side to the opposite end and then back along the other side by another row of fans. Greenhouses of larger widths may require a greater number of rows of fans along its length.

Temperatures at plant height are more uniform with HAF system than with convection tube system. The HAF system makes use of the same exhaust fans, inlet louvers and controls as the convection tube system. The only difference is the use of HAF fans in the place of convection tubes for the air distribution. Cold air entering through the louvers located at the higher level in the gables of the green house is drawn by the air circulation created by the network of HAF fans and to complete the cycle, proper quantity of air is let out through the exhaust fans. The combined action of louvered inlet, HAF fans and the exhaust fans distribute the cold air throughout the greenhouse.

Similarly, to the convection tubes, the HAF fans can be used to distribute heat in the green house When neither cooling nor heating is required, the HAF fans or convection tube can be used to bring warm air down from the upper level of the gable and to provide uniform temperature in the plant zone. It is possible to integrate summer and winter cooling systems with heating arrangements inside a greenhouse for the complete temperature control requirements for certain days of the season.