Technical
Nursery Papers

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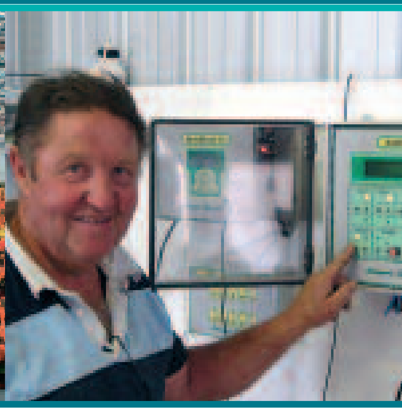


Greenhouse design structures vary considerably, from Gable and Sawtooth to Tunnel and Raised Dome options. In addition, many environment control options also exist.

However, greenhouses fall into three broad categories:

- **Low technology greenhouses,** such as the traditional 'tunnel house'.
- **Medium technology greenhouses** offer a compromise between cost and productivity, and
- **High technology greenhouses** offer an impressive range of crop and environmental performance features.

This *Nursery Paper* describes the advantages and disadvantages of various greenhouse options and provides a process to help determine which sort of greenhouse is right for you.

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Greenhouse design

The basic function of a greenhouse is to provide more uniform and reliable plant growth, safer and easier work conditions and to minimise impact on the environment. While there are many different greenhouse design and climate control options available, it is helpful to consider greenhouses under three broad technology categories; being low, medium and high.

Low technology greenhouses

Low technology greenhouses are relatively inexpensive structures, easy to erect with little or no automation. They are usually clad with a single skin plastic film, are less than 3 metres tall and generally do not have vertical walls.

The traditional 'tunnel house' is a common example of a low technology greenhouse offering minimal control over growing conditions. As a result, pest and disease control is often structured around a chemical spray program.

Low technology greenhouses are relatively cheap and easy to build. However, they offer minimal control over the growing environment.

Medium technology greenhouses

With an eave or gutter height of less than 4 metres and a total height of less than 5.5 metres, medium technology greenhouses typically have vertical walls and varying degrees of automation with roof and/or side wall ventilation. They may be clad in either single or double skin plastic film or glass.

Medium technology greenhouses offer a compromise between cost and productivity and offer a greater opportunity to use effective non-chemical pest and disease control measures.

Medium technology greenhouses offer a good balance between cost and ability to control the growing environment.

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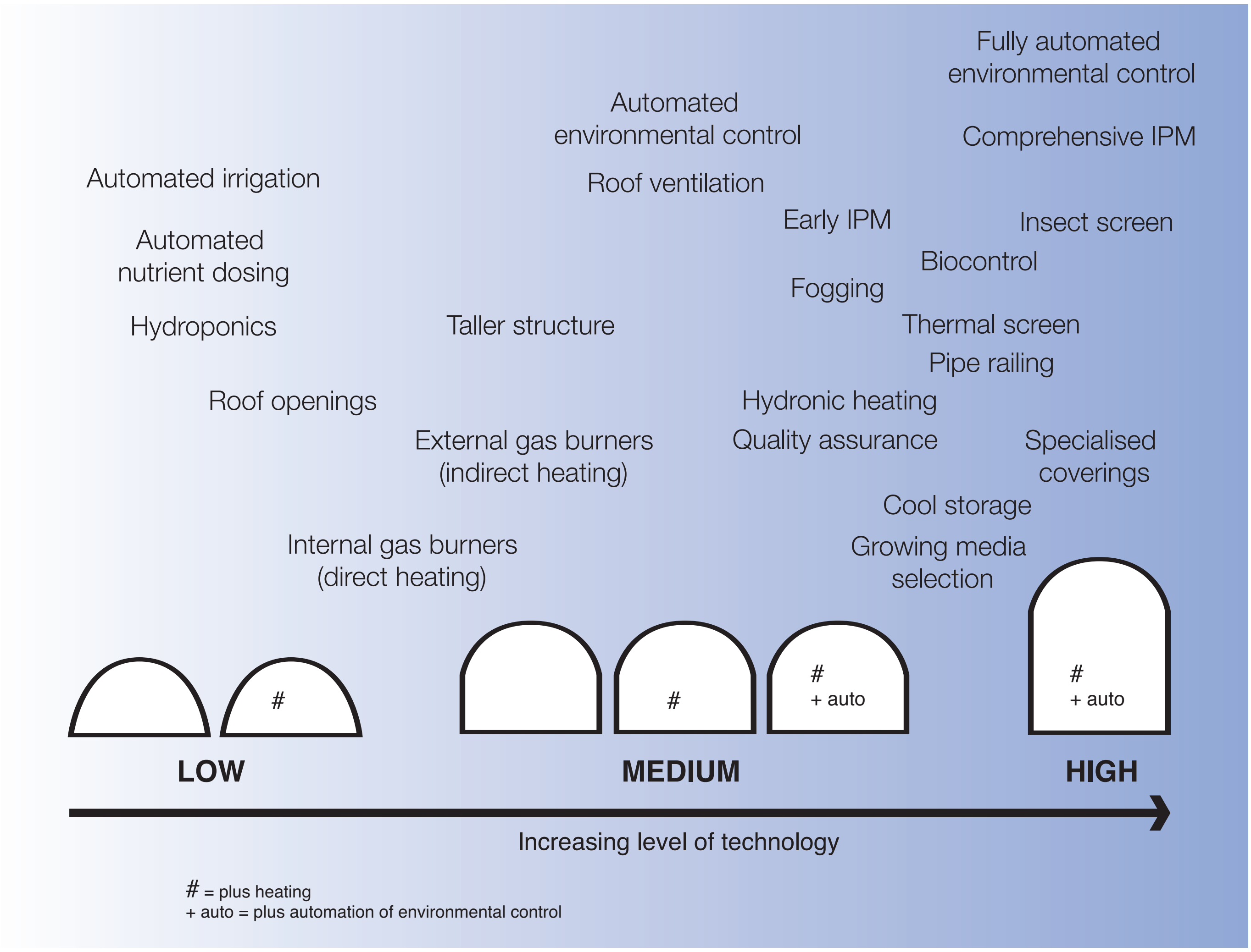
High technology greenhouses

High technology greenhouses have a wall height of at least 4 metres and a total height of up to 8 metres. They will have roof ventilation and may also have sidewall vents and active air exchange. They are often clad in double plastic film, polycarbonate sheeting or glass.

These high technology greenhouses offer an impressive range of crop and environmental performance features. With fully automated environmental controls and the opportunity for comprehensive Integrated Pest Management (IPM), these structures offer substantially greater productivity per unit area.

High technology greenhouses offer the greatest control over the growing environment and therefore provide the potential for maximum productivity.



Increased levels of technology in a greenhouse provide greater environmental controls

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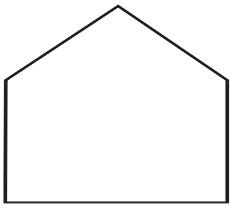
Types of Greenhouse Structures

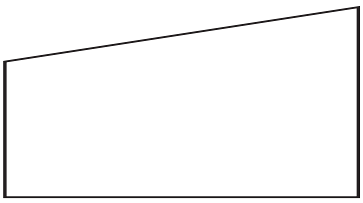
The shape of the greenhouse structure influences;

- The amount of light transmitted
- The amount of natural ventilation
- The useable internal space
- Efficient use of structural materials
- Condensation run-off
- Heating requirements.



Gable

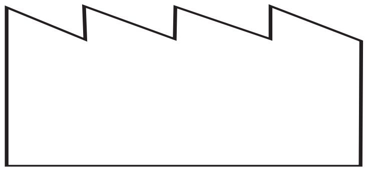
Provided that the greenhouse has sufficient vents in the roof, a gable shaped roof is very effective for natural ventilation and enables good light transmission. The pitch of the roof should be at least 23 degrees so that condensation will not drip onto the crop below.



Skillion

The flat roof of the skillion design transmits the least amount of light over the course of a year. This is because more light is reflected when the sun is low in the sky, however lower light conditions may be preferable for certain crops. Passive vents need to be located at the highest point to naturally remove heat.

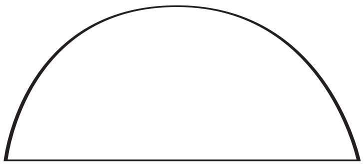
Taller structures, such as 'Raised Dome', provide more air volume above the crop enabling greater control over the climatic conditions at crop level.



Sawtooth

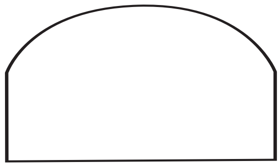
The sawtooth design provides effective, natural venting of hot air. However, light levels can be lower due to the additional structure above the crop. The vertical walls of the gable, skillion and sawtooth designs maximise the useable internal space.

Curved roof designs offer the greatest annual light transmission, but depending on where vents are located, the flat 'apex' can trap hot air and may result in condensation forming droplets which fall onto the crop causing damage and providing infection sites for disease.

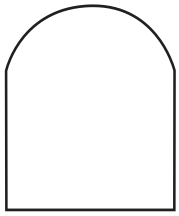


Tunnel (igloo)

The most common curved roof design is the 'tunnel' house. These structures are not usually the best option for crop production as the low height of the structure limits the internal air volume, therefore reducing the ability to manage the greenhouse environment.

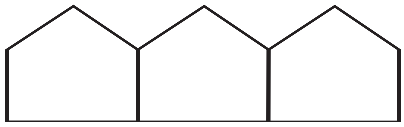


Flat Arch



Raised Dome

The flat arch and raised dome designs are a superior design to the tunnel. The vertical walls work well with benches, enabling improved air circulation around the crop, and the taller structures provide a greater ability to manipulate the greenhouse climatic environment.



Multispan (gable)

Multispans make more efficient use of materials and are more energy efficient. They have less surface area from which to lose heat compared to a number of single span structures providing the same production area.

A particular consideration with multispan structures is the potential for overheating in the centre of the greenhouse. Active ventilation, roof ventilation and/or circulation fans are needed to make sure that sufficient ventilation and air movement occurs.

The ability to manipulate climatic conditions within a greenhouse is directly related to the volume of air within. The larger the volume of air above the crop, the greater the capacity is to manipulate climatic conditions. As a result, taller structures are preferable even though heating costs increase with larger air volumes. Energy efficiencies in taller structures can be obtained with the use of internal thermal screens.

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Covering materials

The type of material used to cover a greenhouse affects the amount of light, temperature and energy efficiency. Greenhouse coverings can be divided into three groups; glass, plastic sheeting and plastic films.

Glass has very good light transmission properties (provided it is kept clean) and minimises the transmission of ultra violet (UV) light. It is very durable, has low maintenance costs and has good heat retention at night. However, glass is the most expensive material in terms of up-front cost as only specific standards of glass can be used for safety reasons. Consideration also needs to be given to the risk of hail. The weight of glass means that the greenhouse structure has to be more robust, adding to the cost.

Plastic sheeting may be polycarbonate, acrylic (polymethyl methacrylate) or fibreglass. Plastic sheeting products are more durable than plastic films and have fairly good heat retention, good light transmission and low UV light transmission. Also, plastic sheeting is relatively light weight and generally resistant to hail. However, discolouration may occur over time with some products, reducing light transmission.

Plastic films are the most common and lowest cost type of covering material. The types of film available are polythene (polyethylene), EVA (ethyl vinyl acetate) and PVC (poly vinyl chloride). Additives to the plastic determine characteristics such as durability, heat loss, droplet formation, transmission of particular wavelengths of light and how easily it gets dirty. Plastic films usually need to be replaced every 3–5 years.

Twin skin plastic covering refers to a double layer of cladding where two sheets of plastic film are used. An air pocket is maintained between the films with small fans. The "twin skin" improves heat retention and therefore can reduce energy costs, but it also reduces light transmission. Resistance to hail is increased compared to single skin greenhouses.

While glass provides better light transmission than most plastic options, its heavier weight requires more substantial structures resulting in shadows that may affect the crop.

Deciding what type of Greenhouse

The most important factor in deciding what type of greenhouse to invest in is to know the optimal growing conditions for the crops that are to be grown in it. This includes light requirements, temperature preferences and humidity.

The next step is to know what will happen to the crop if the desired conditions are not maintained. For example, will the plant shut down for a couple of hours until conditions improve or will it be permanently damaged?

The third step is to assess production risk. This involves determining the likelihood of adverse conditions occurring at your location and the technology needed to maintain optimum growing conditions.

Production risks include the possibility of an environmental condition becoming a problem, for example high temperature, low temperature or very high humidity. It maybe possible to allocate dollar amounts to the potential damage (severity) that would occur in a given extreme event and historical weather data can be used to work out the possibility (likelihood) of such an event happening.

Assessing the production risk involved with different levels of greenhouse technology can help determine the most appropriate level of greenhouse technology.

The final step is to cost a greenhouse with your chosen technology, calculate the likely net income (gross income minus operating costs) from the crops being produced and assess the financial return.

Other business risks should also be assessed, which involves determining both the likelihood and severity of particular events happening such as market failure. Events identified as being likely to happen and resulting in severe damage indicate a high-risk venture.

For more information

Practical Hydroponics and Greenhouses is a bi-monthly magazine, www.hydroponics.com.au

Ball Red Book 17th edition, Volume 1 Greenhouses and Equipment (2003), edited by Chris Beytes

Greener Greenhouses (2003) by Keith Garzoli

Greenhouse Operation and Management (1998) 5th edition by Paul V Nelson

Acknowledgements

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