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Story of Greenhouse



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Contents

- Introduction
 - Greenhouse - a booming industry
- Types of structure for Agriculture
- Greenhouse for various purposes



Terminology

- Greenhouse NOT “Green House”
- Net house NOT Nethouse
- Glass Greenhouse → Glasshouse
- Plastic Greenhouse → Plastic house

- Protected Horticulture/Agriculture
- Facility Horticulture/Agriculture



Functions of net house/greenhouse

- | | |
|--|--|
| <ul style="list-style-type: none"> • Net house <ul style="list-style-type: none"> – Prevent from <ul style="list-style-type: none"> • strong wind • Heavy rain – Reduced damage from <ul style="list-style-type: none"> • Insects | <ul style="list-style-type: none"> • Greenhouse <ul style="list-style-type: none"> – All features of net house – Capability to control the environment |
|--|--|



Function of a Greenhouse

- Wind breaker
- Insect Net
- Rain shelter
- Shade to the Sun reducing excess heat
- Energy/water conserved
- Environmental controlled
 - Aero-environment and root zone



Greenhouse is very good for the production of ...

- | | |
|----------------|-----------------------------|
| • Tomato | • Eustoma (lisianthus) |
| • Cucumber | • Orchids |
| • Pepper | • Rose |
| • Sweet pepper | • Mum |
| • Melon | |
| • Eggplant | • Non-short-term vegetables |

• Larger in size, longer in time, strong in light intensity



Annual production per unit area kg/m²/year

Plastic GH with no roof vent

↓


Natural ventilated plastic GH
with roof vent

Forced ventilated glass GH
With CO₂ enriched and
supplemental light

Natural ventilated plastic GH
At high altitude with high light

↓

GH1	GH2			GH3			GH2
Leafy Greens	melon	Tomato	Bell pepper	melon	Tomato	Bell pepper	Tomato
0.9	14	20	12	65	60	27	41



Plastic greenhouse with no roof vent

- Annual Production per unit land
0.9 kg/m²/year







Open field production of lettuce



< 3 kg/m²/year



Greenhouse



69 kg/m²/year


Forced ventilation
Evaporative cooling

< 30 kg/m²/year

Natural Ventilation only



Huge number of greenhouses in suburban area forms another world

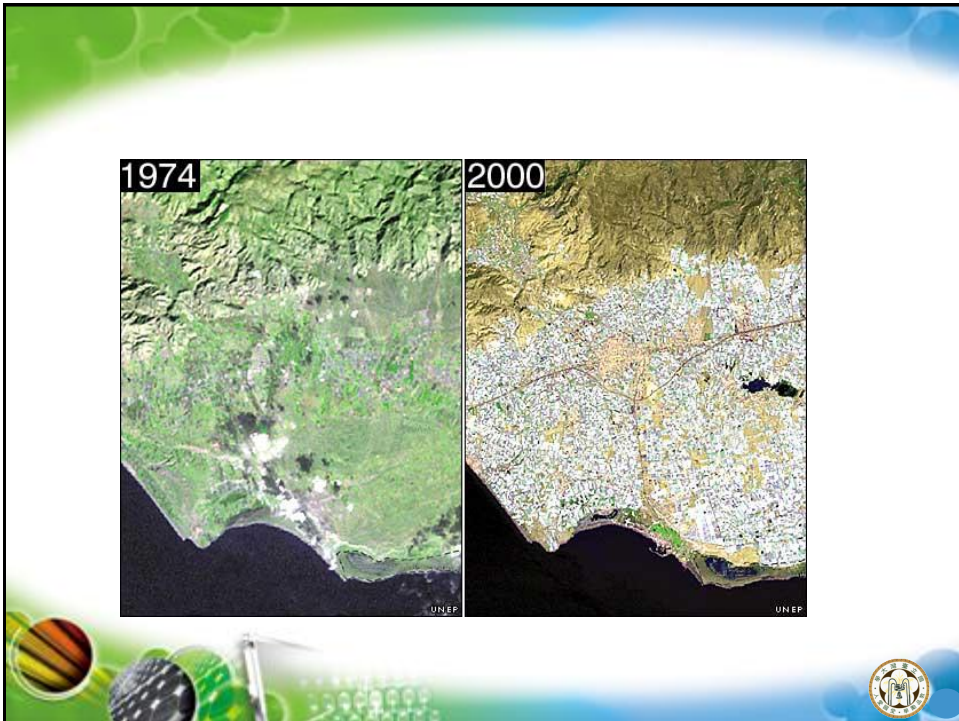


Weifang, China



Wei FANG and friends in Weifang City





Almeria, Spain



Almeria, Spain

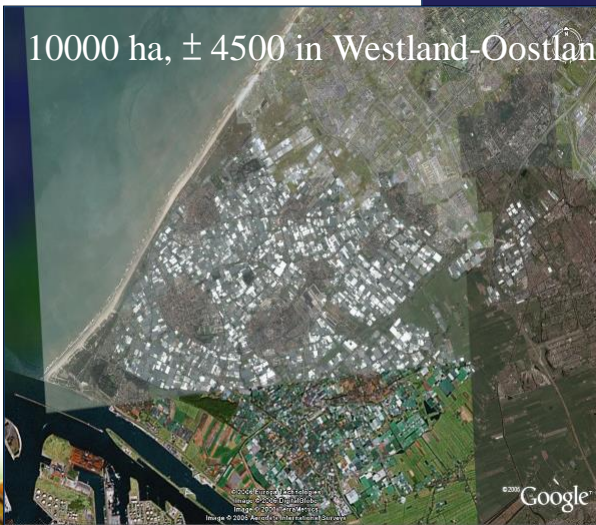


Almeria, Spain – 29000 ha, 2013



Greenhouse

10000 ha, ± 4500 in Westland-Oostland









GREENHOUSE AGROSYSTEMS EXTREME OPTIONS

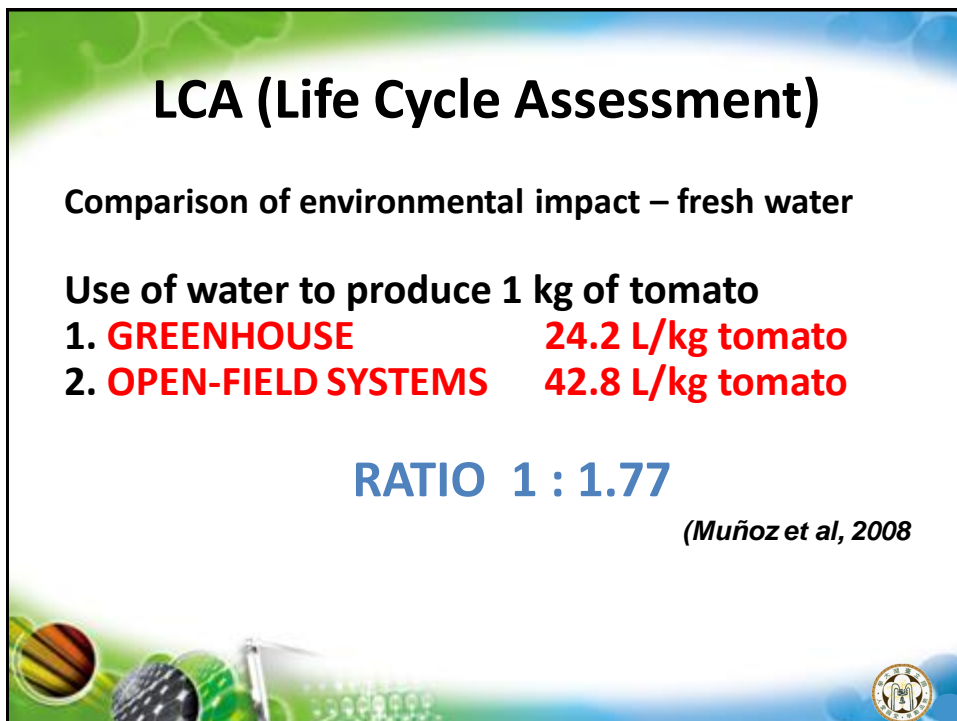
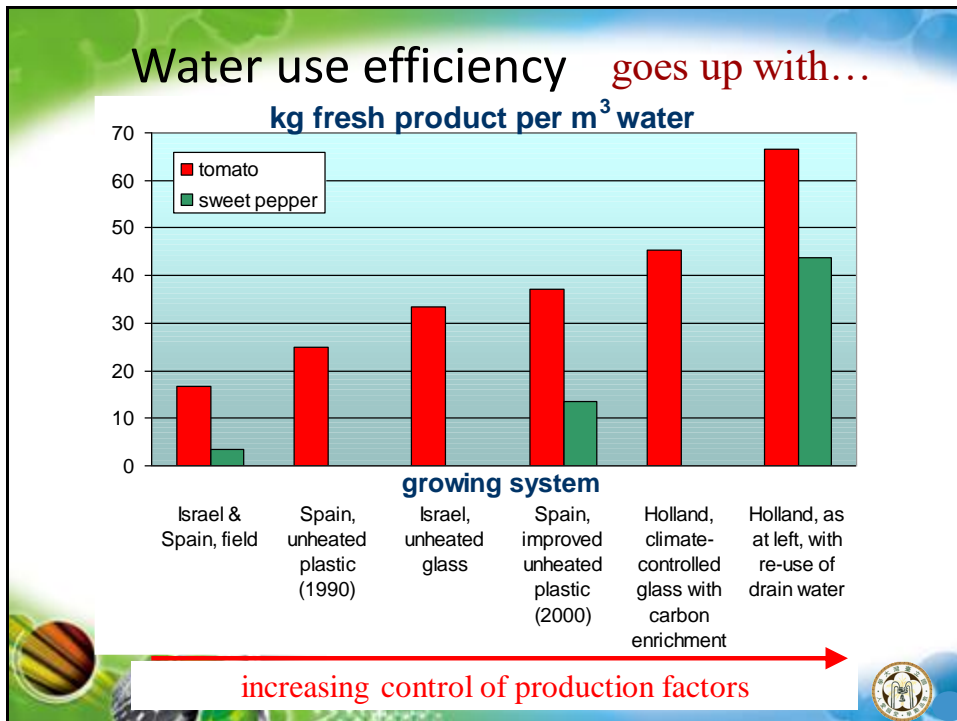
OPTION 1 PASSIVE CLIMATE CONTROL

LIMITED YIELDS
GOOD QUALITY IN LIMITED PERIODS
IRREGULAR PRODUCTION
LOW COSTS

OPTION 2 SOPHISTICATED ACTIVE CLIMATE CONTROL

HIGH YIELDS
GOOD QUALITY ALMOST YEAR-ROUND
REGULAR PRODUCTION
HIGH COSTS





ENVIRONM. ISSUES

Greenhouse energy consumption

Per year and m²

Netherlands
Sophisticated glasshouse
43 m³ natural gas/m²
> 12 euros/m² (2005)

Main use: Heating and CO₂

Spain
Unheated plastichouse
0.10 euros/m² (2005)

Considering the location of two Nations, this is not a fair comparison.

Development of plastichouse in Spain

ORIGINAL: FLAT ROOF



A-TYPE, SINGLE SPAN



SYMMETRIC MULTISPAN PARRAL



ASYMMETRIC MULTISPAN PARRAL



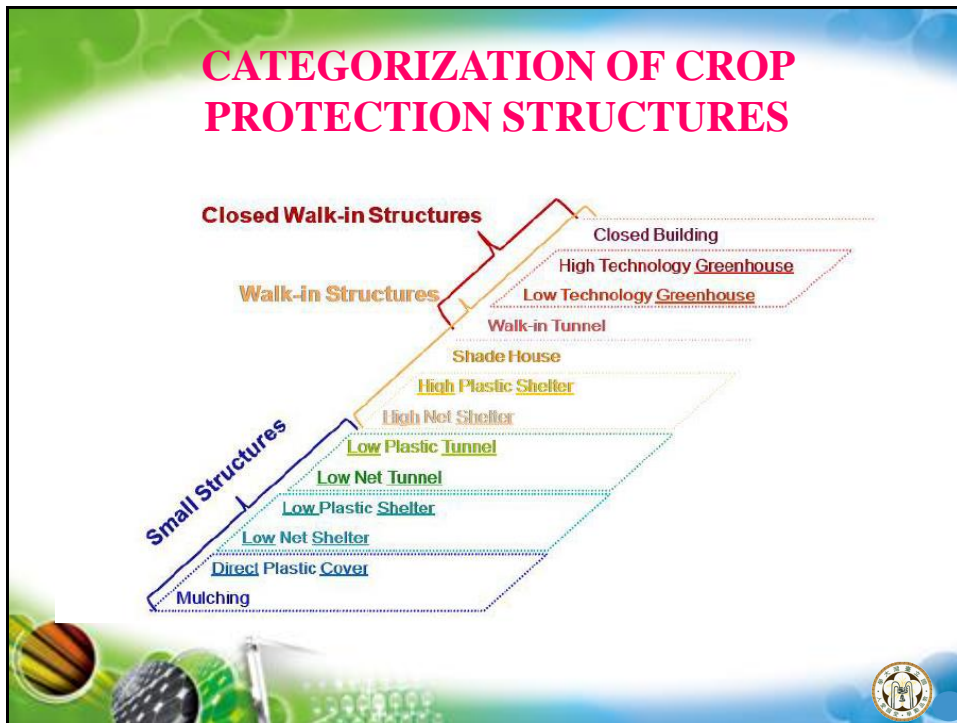
Not suitable for locations with strong wind



GH for Tropical and subtropical regions

	Taiwan	Thailand	Malaysia	Vietnam	Indo.	Lao
heavy rain	✓	✓	✓	✓		
Strong wind	✓	✓		✓		
Shading	✓	✓	✓	✓		
Ventilation	✓	✓	✓	✓		
Cooling	✓					
Heating	✓					
Insect	✓	✓	✓	✓		

CATEGORIZATION OF CROP PROTECTION STRUCTURES



Effects inside greenhouse



Greenhouse effect
 Shading effect
 Windbreak effect
 Oasis effect
 Umbrella effect

Types of Structure for Agriculture

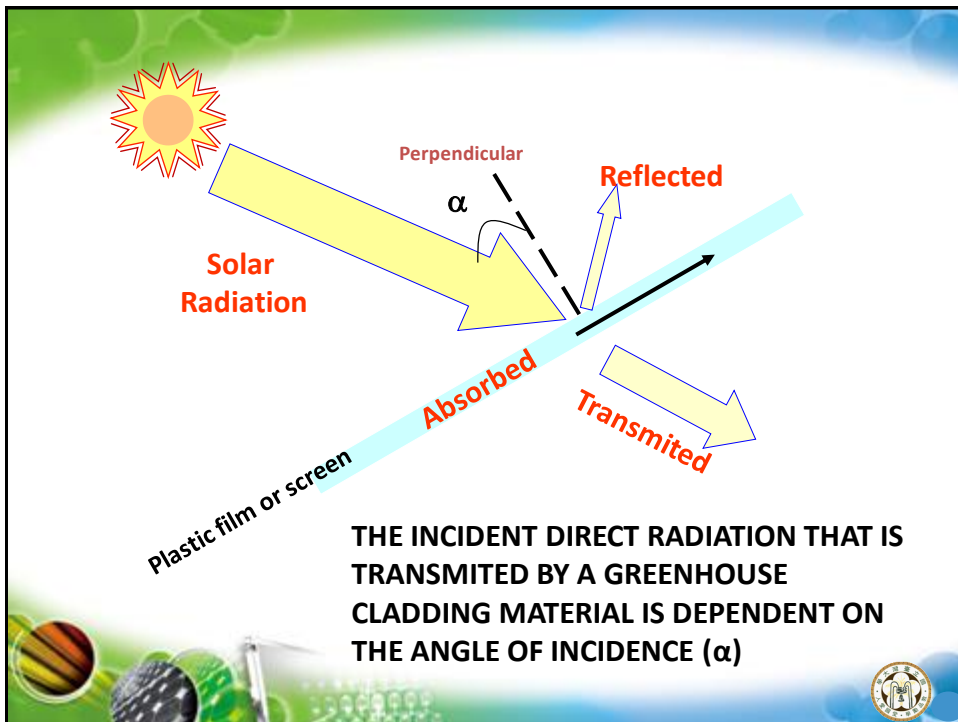
- PFAL/PF inside Greenhouse
- **Greenhouse/Greenhouse with solar cell**
- **Net house**
- **High tunnel**
- **Rain shelter**
- **Tunnel**
- **Floating mulch/ floating row cover/ floating cover**
- **Mulch**
- **Frost umbrella**

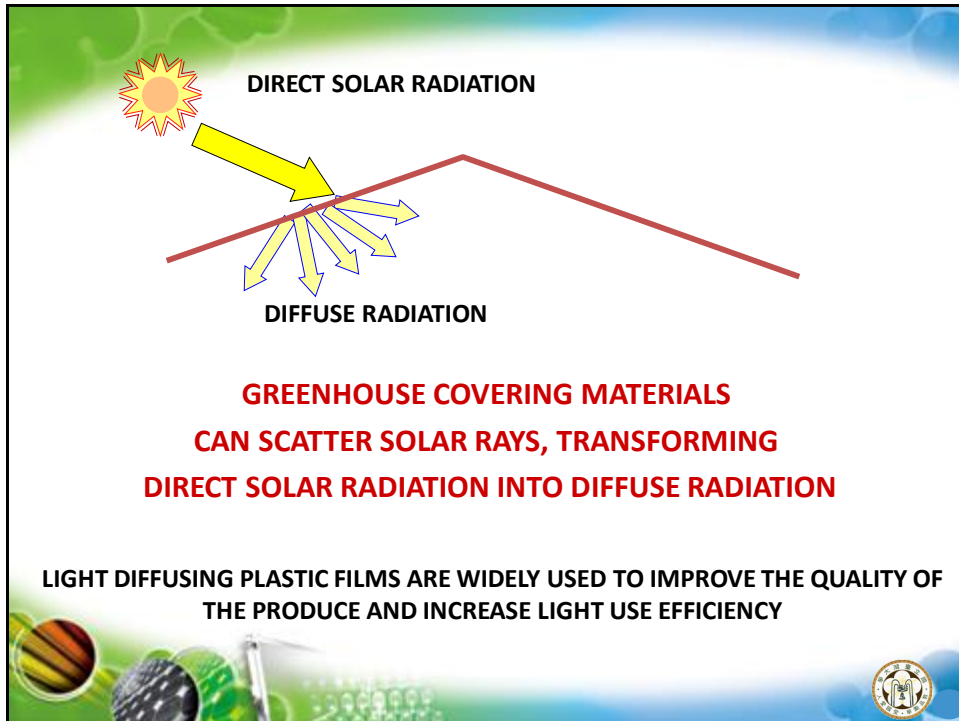


Solar aided PF in Taiwan



Solar cell on top of GH in Taiwan





Glass GH for orchid production in Taiwan



Plastic GH for orchid production in Taiwan





Tomato glass GH in Taiwan

懸掛式栽培系統 離地栽培，可大幅降低病蟲發生率。配合放蔓操作，可延長栽培期。



雙層玻璃 保溫、隔熱、氣密效果佳。

軌道作業 便於垂直操作與移動。

GREENHOUSES COMPARED

Gothic arch multi-tunnel



PEP film, diffuse thickness 200 μm

Average roof angle of 27°

Ventilator/greenhouse areas ratio 37.3%

Venlo



Standard glass 4 mm thickness

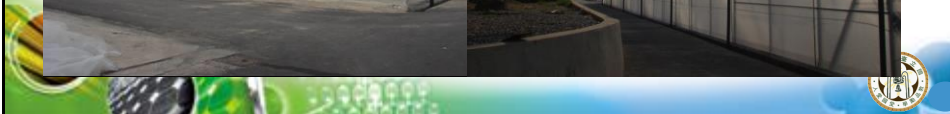
Roof angle 22°

Ventilator/greenhouse areas ratio of 13.4%

Plastic greenhouse w/o roof vent



Plastic greenhouse with roof vent



Plastic greenhouse with roof vent in Taiwan



Adequate roof opening
for natural ventilation



Poor selection of nets
for roof vent opening



Plastic greenhouse with roof vent in Taiwan Natural Ventilation



Better nets for roof vent opening



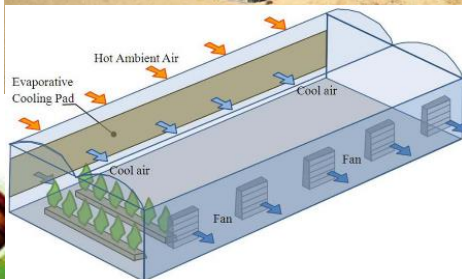
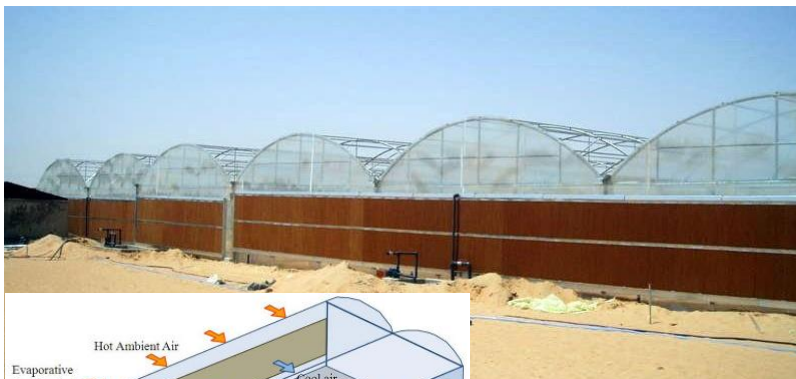
Greenhouse with forced ventilation



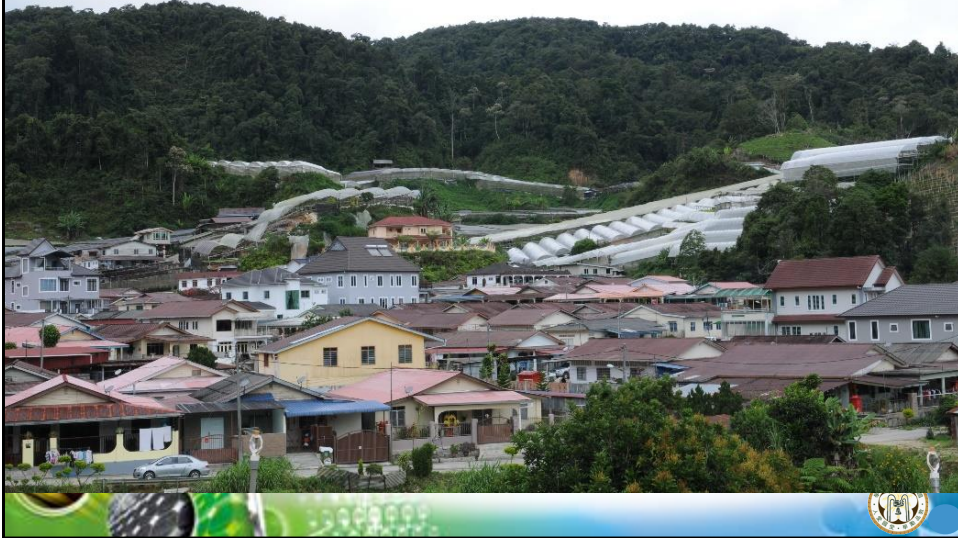
GH w/ natural and forced ventilation



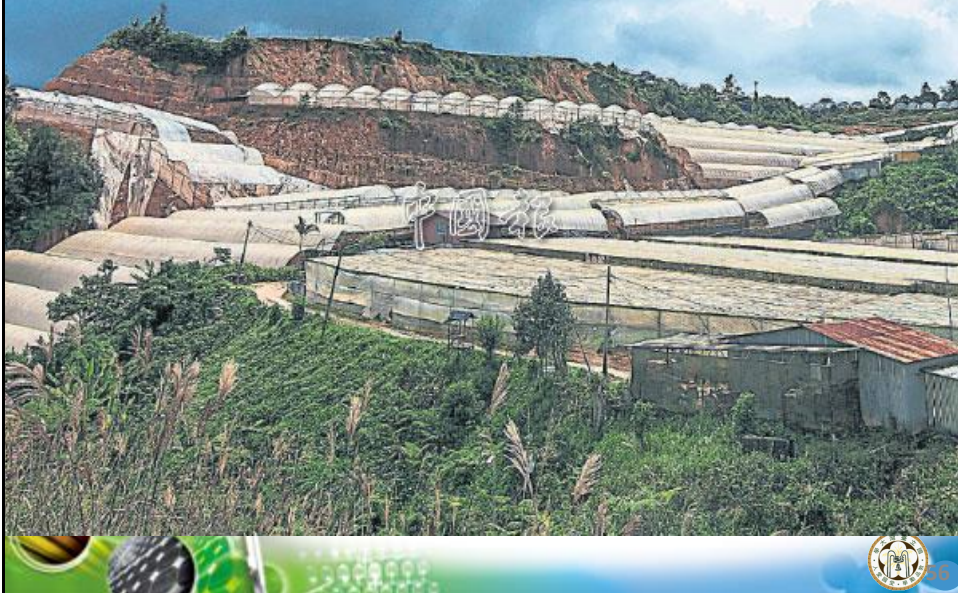
Greenhouse with pad and fan system



Rain shelter in Malaysia



Rain shelter in Malaysia





Net house in Taiwan



Net house in Spain

- SHADE CROPS
- PROTECT FROM WIND & HAIL
- IMPROVE T. & HUM. REGIMES
- SAVE IRRIGATION WATER
- EXCLUDE INSECTS & BIRDS



Net house in Malaysia



Need good design and management to prevent from insect attack

- Net mesh size
- Double door design



Double entries for all greenhouse and net-house

Single entry



High tunnel in US



High Tunnel System

Easy to build, maintain, and move, they provide an energy-efficient way to extend the growing season and improve plant health and vigor.



Floating row cover in Taiwan



Floating row cover in US



Tunnel in Taiwan



Mulch in Israel



colored mulch in Israel - tomatoes



covers on colored plastic in Israel - potatoes



Frost umbrella in US



GH for different purposes

- 花之鄉 Floral
- 苗之圃 Seedling
- 菜之田 Leafy greens
- 果之園 Fruit
- 芽之屋 Sprout
- 菇之舍 Mushroom
- 樹之室 Tree

What else?



Floral



Seedling



Leafy Vegetable/leafy greens



Fruit



Sprout

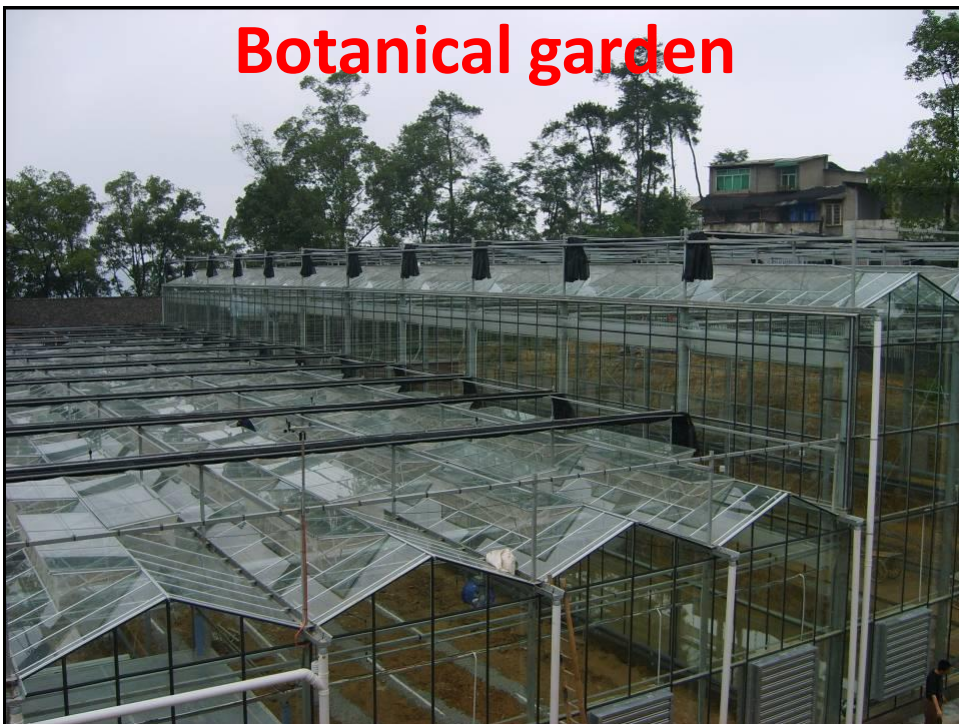


Mushroom



Also for tree















Environmental controlled equipment in this GH

- Air conditioning
- Artificial light
- Shading from outside
- Fan and Pad (not shown)



Thank you for your attention

