

# Regional Training on Protected Agriculture Technology in Asian Countries

22-29 Jan 2018  
Nanjing Province, P.R. China

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MALAYSIAN AGRICULTURE RESEARCH AND DEVELOPMENT INSTITUTE

# PROGRAM PERTANIAN TEPAT (ER03)

## PENGARAH



ZOLKAFLI BIN ARIS

## TIMBALAN PENGARAH



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## PEMBANTU PENYELIDIK



LATIMAN YASSIN

# PRESICION FARMINGPROGRAMME TRUST

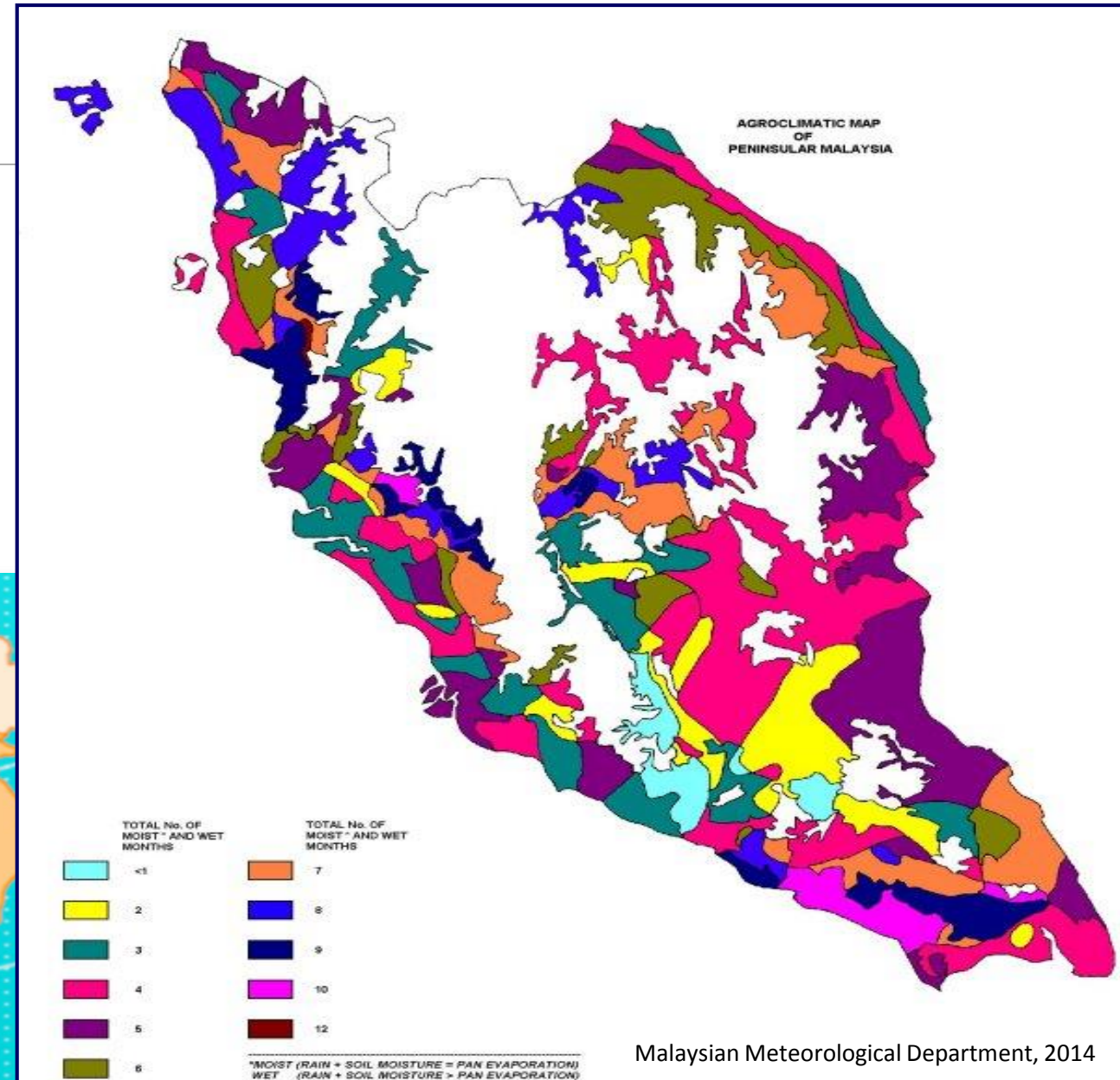
## AREAS:

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1. Precision agriculture systems in agriculture production
2. Intelligent systems for agriculture management
3. Detection and management technology for automation systems in agriculture production
4. Semi-robotics in agriculture production
5. Structures and intelligent control systems for the production of high value crops

# Map of Malaysia

- Located in equatorial region
- Hot and humid throughout the year
- Temp 25 – 35°C
- Rainfall 2500 mm/year
- Highland < 25°C
- Day length about 12.5 hours.



# OVERVIEW

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- ❑ Malaysian agricultural sector largely produces cash crops and little food
- ❑ Cost of producing food crops such as rice and vegetables is high in Malaysia compared to neighbouring countries
- ❑ Area planted with vegetables- 65,899 ha, production at 1.373 million tons (2015)
- ❑ Commonly cultivated in open field production system, involves heavy use of inputs and manual labour
- ❑ Per capita consumption of vegetables is 58.5kg/year in 2014

# Main issues and justification

- ❑ Import of vegetables (esp. temperate crop) are increasing
- ❑ Uncertainty weather condition
- ❑ Highland suitable agriculture area is scarce, conflicted with environmental issue and pollutions
- ❑ Extension of cultivation from highland to lowland and increased production from opening up new areas as well as increased productivity from existing farm
- ❑ Heavy use of chemical pesticide due to high incident of pest and disease attack
- ❑ Heavy rain causing crop damage
- ❑ Cultivation systems which are environmental friendly while ensuring high productivity gradually expanding in lowlands where more space is available for protected horticulture

# Protected Cultivation in Malaysia

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- ❑ Majority of the crops under protected cultivation was flowers (chrysanthemum, roses, orchids, anthurium) with few being vegetables (tomatoes, bell pepper)
- ❑ In open cultivation erosion was occurred at 80 t/ha/year compared to cultivation under rain shelter in Cameron Highlands which is less than 1 t/ha/year (Midmore et. al., 1996)
- ❑ The results suggested that, open vegetable farming in the highlands is not sustainable due to erosion subjected to slope and hilly farming condition

- ❑ In Malaysia, high value vegetables (e.g chili, tomato, cauliflower, broccoli) are planted under rainshelters
- ❑ Production under rainshelter is more expensive (infrastructure) than in open field cultivation, but is economically viable because it enables limitations of the climate to be overcome
- ❑ In the lowlands the rainshelter protect crop damage from heavy rain, and provides shade to the crops against effects of excessive solar radiation





# Main Purpose of Protected Cultivation

## 1. Reduce disease incidence which normally spread in the rain

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- Particularly so for the brassicas (cabbage, cauliflower, broccoli, Chinese cabbage, chinese kale) and solanaceous vegetables (chilli, tomato)
- The plastic roof of the rainshelter protects the crop from rain water, reducing the incidence of diseases which normally spread during wet periods, thus keeping chemical usage to a minimum
- Under the rainshelter serious bacterial diseases like soft rot and white rot on cabbage can be reduced since the soil is not entirely wetted by the rain
- Choanephora and anthracnose problems in chilli can be overcome without much fungicide sprays

## 2. Reduce damage from insects, pests and other predators

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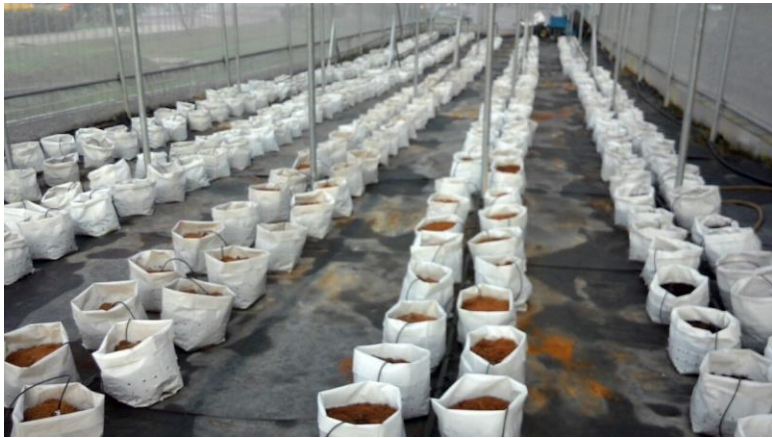
- Major pests of the brassica vegetables are the Plutella, Hellula, Spodoptera and flea beetles
- Heliothes, Dacus spp., thrips, aphids and mites are chili and tomatoes
- Various insecticides used to control these pests, some of the common ones being deltamethrin, permethrin, profenofos, cypermethrin and propargit
- This practice, though able to control the pests to a certain extent, is harmful and also uneconomical
- This situation can be improved when crops are grown under rainshelters fitted with insect-proof screen

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- ❑ The insect-proof screen of the rainshelter prevents entry of most insect pests
  - ❑ Tiny pests such as thrips, mites and aphids can still enter through the netting, affecting crops like chilli and tomato
  - ❑ However, any insecticide required is very much less than that normally practiced in the open field
  - ❑ In general, under the rainshelter there is 50-70% reduction in insecticide usage compared to open field planting (Illias and Rezuwan, 1997).

### 3. Weed Control

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- ❑ Under rainshelters weeds are not a serious problem due to a lack of excessive moisture in the soil that would otherwise be made available by rain
- ❑ Besides, the use of drip irrigation system only wets the root zone of the crop while keeping the rest of the area dry, thereby reducing weed growth



Geo Mat



Plastic Mulch



Crusher run

## 4. Increase yield, improve product quality, and preserve resources

- Vegetables grown under protected structure can give high yields and quality produce
- Year round production is also possible since most field operations are not hampered by wet weather conditions
- Shading of 20-30% from full rays of the sun is beneficial to the crop, improving growth leading to high yield and quality produce
- Vegetable produce from planting under protected structure will be low in pesticide residues or even pesticide-free
- Normally, achieving all these goals requires a greater investment than in conventional open field cultivation, as well as more inputs per unit surface area

# Technologies cultivation under protected structure

## Soil-based system with conventional fertilizer application

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- Vegetables are planted on raised beds using seedlings or direct seeding
- Planting beds sometime are covered with plastic mulch to prevent weed growth and to conserve soil moisture
- Irrigation is through the drip system
- Compound or granular fertilizers such as NPK 12:12:17:2+TE are applied around the plants

# Practices of Soil-based conventional system



# Soil-based system with fertigation

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- ❑ Plants grown on the raised soil beds are fertilized through a technique called fertigation where nutrients required by plants are supplied through the irrigation system
- ❑ Many vegetables can be grown using this system, such as cabbage, cauliflower, chilli and tomato
- ❑ Fertigation is an effective tool to control placement, timing and type of fertilizer needed according to the soil fertility status and growth stage of the crop



# Practice of Soil-based Fertigation System





# Fertigation in the soilless system

- ❑ Small acreage owned small growers may not allow them enough space for crop rotation as a way to combat pest problems. Since rainwater is excluded from the cropping area, salt build-up from repeated fertilizer application may be a potential threat for continuous cropping
- ❑ Thus, container culture where crops were grown in pots, boxes or bags filled with soilless media come as a solution.
- ❑ In the soilless system, plants are grown in containers containing growth media such as cocopeat or cocopeat + burnt paddy husk.
- ❑ However, polybags are most commonly used due to cheaper, available in the market and easy to handle
- ❑ This technology improves fertilizer use efficiency (FUE) and minimizes nutrient losses due to volatilization, leaching and fixation in less available forms



# Fertigation in the soilless system

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- ❑ Irrigation technique can be practiced using simple methods without sophisticated equipment, or using complete computerized automated systems to control fertilizer formulation, time, duration and frequency of fertilizer application
- ❑ This technique is popular for fruity vegetables particularly chilli, tomato, bell pepper and melon. It can also be practiced for other vegetables such as cabbage, cauliflower and lettuce

# Practice of Soilless Fertigation system

Fertigation in Netafilm Trough



Fertigation In polybags



Fertigation in pots



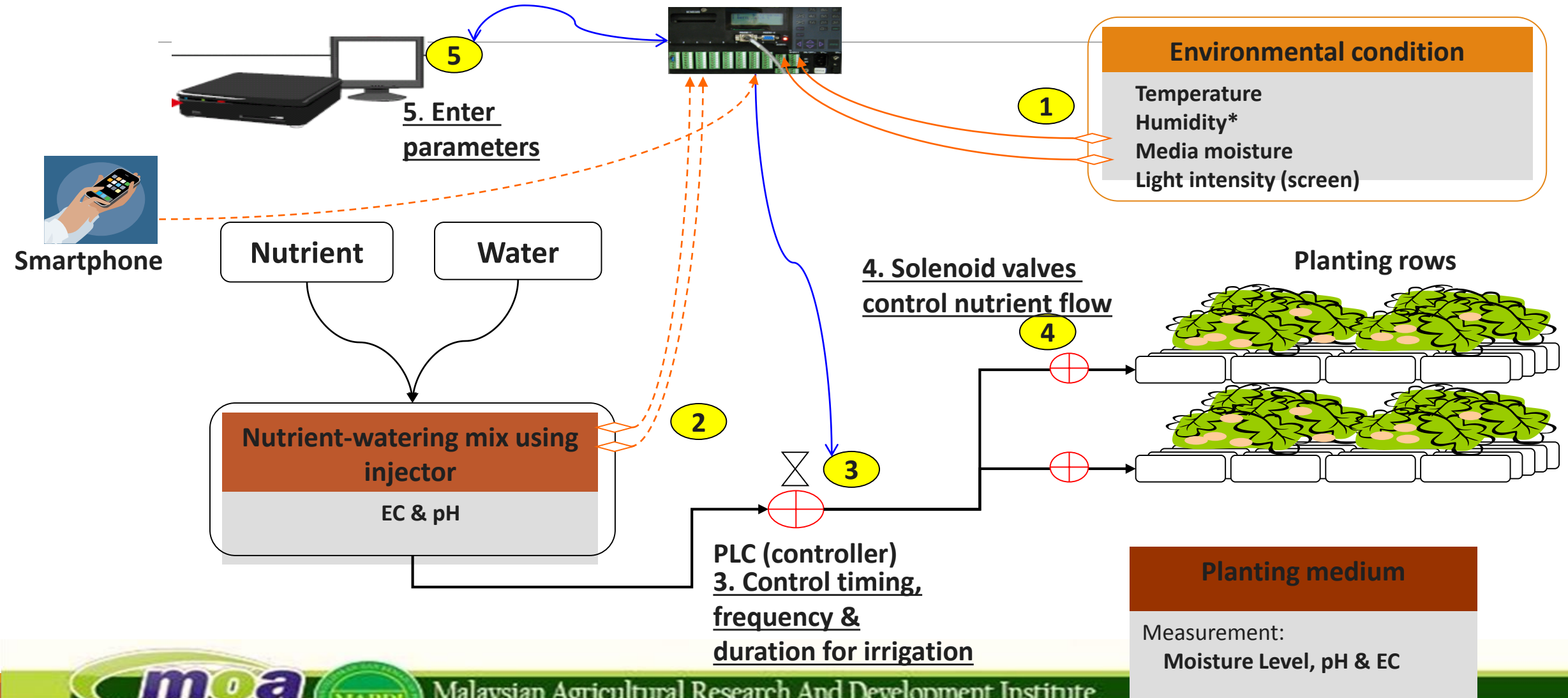
# Practice of Soilless Fertigation system



**Multilayer & Multi crop**

# TECHNOLOGY IN USE (Hi-END)

The Fertigation Control & Management system:



# TECHNOLOGY IN USE (Low-END)

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Manually mix  
the fertilizer  
stock into  
solution tank



Deliver to  
the plants



# MARDI's Technologies on Soilless Cultivation System under Protective Structure

Vertifarm

-leafy vegetables, space optimization, maximize production



TUBE Plot



Multilayer Self Watering

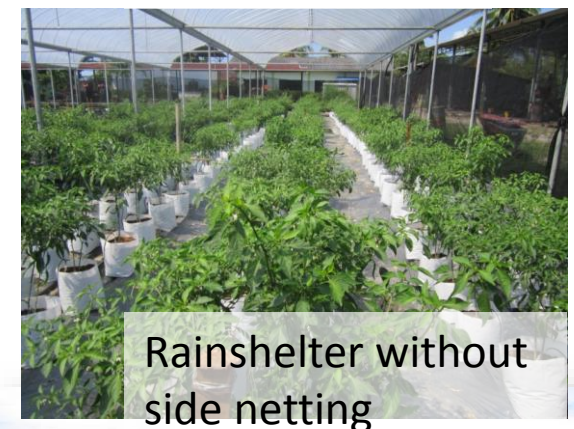
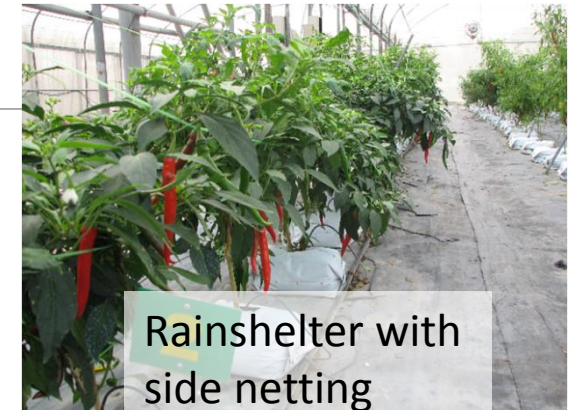


Table 1. Comparison between yield of selected vegetables under rain shelter and open field (t/ha)

Vegetables	Rainshelter (with side netting)	Rainshelter (without side netting)	Open field planting
Cabbage (soil-based)	37	33	28
Cauliflower (soil-based)	12	8	5
Tomato (soiless fertigation)	NA	80	40
Chilli (soiless fertigation)	22	27.7	18

(Illias et.al., 2010; Farahzety et.al., 2012; Yaseer et.al., 2016; Rahayu et.al., 2017)

- ❑ Yields under netted structures are high and of good quality since they are free from damage due to pests and mechanical damage due to heavy rainfall.
- ❑ However, chillies cultivated under shelter with side netting produce lower yield compared with cultivated under shelter without side netting due to poor pollination.



# Organic production

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- ❑ Organic production is a system of farming which avoids the use of chemical fertilizers, pesticides, growth regulators, feed additives and other chemicals
- ❑ Under the rainshelter crops are grown organically on raised soil beds. The practice of organic farming under the rainshelter with side netting is more assured of success since the crop is protected from insect pests while disease incidences are reduced without total dependence on pesticides
- ❑ Biopesticides, natural enemies and cultural/sanitation practices commonly employed in organic farming are more effective when used or carried out under rainshelter structures.

# Practice of Organic production system



Netted structure



Rainshelter with side netting

# Hydroponics

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- Leafy vegetables are preferable
- Hydroponics is free from soil contamination, it uses water and dissolved nutrients in a plastic trough or container
- A trough made of plastic or opaque material which does not absorb heat and not rust can be used as container
- Nowadays, indoor farming using hydroponic become more popular
- Problems associated with hydroponic systems are disposal wastes of growing media and liquids

# Practice of Hydroponic System



Deep flow Technique



Nutrient Film Technique



Autopot

Multilayer DFT for Indoor



# Production economics

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- ❑ The use of protective structures, especially rain shelters, in vegetable production involves high investment costs
- ❑ The wooden type rain shelter is cheaper in construction and may be within reach of most farmers
- ❑ The galvanized iron tunnel type is more expensive and may become an obstacle to its adoption. However, it lasts longer, can withstand strong winds, and usually gives higher crop yield and quality
- ❑ With the availability of cheaper local materials, the costs of these rain shelters can be significantly reduced. Although expensive, the high values crops with high yields and quality will make profitable returns



Medium- high end

Low end

High end

# Rain shelter design



Medium-low end



Medium end



# PLANT FACTORY - Next Generation of Protective Cultivation System



- **Beginning stage (lab scale)**
- Fully artificial control environment
- Hygienic produce
- Pesticide free
- High efficient of water & fertilizer used
- Consistently produce without affecting of weather condition

# CONCLUSIONS

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- ❑ Agriculture is highly dependent on environment, and it's very difficult to get favorable climatic conditions for crop growth thus by providing protection to the crops attain sustainable production
- ❑ Production of vegetable crops under protected conditions provides high water and nutrient use efficiency under varied agro climatic conditions
- ❑ However, protected cultivation technology requires careful planning and attention about timing of production and moreover, harvest time to coincide with high market prices eg. rainy season

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- ❑ Protected vegetable cultivation technology is highly relevant under the era of changing climatic conditions and can be well adopted for not only supplying high quality vegetables in the markets but also stabilizing the huge fluctuations in market prices of fresh vegetables in almost every year in Malaysia
  - ❑ Regardless of where protected cultivation structures occur, the challenge is to develop a greenhouse product whose value in terms of yield, quality or consistency can justify the added cost of production in controlled environments

# Way forwards

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- Design and materials – technically & economically viable
- Suitable high value and economic crop – updating crop evaluation and economic of production
- Planting & irrigation system– increase efficiency of production and maximize volume per area
- Alternative growing media- costly, imported



**Thank You for your kind attention**

THANK YOU FOR YOUR KIND ATTENTION



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