UNIT 5
THE PRINCIPLES AND PRACTICES IN FARM ESTABLISHMENT

Introduction

Farm establishment involve planning and consideration of a few factors which will be discussed in the topics.

Objective

1. To discuss the process of establishing a farm
Topic 1: Planning

Important Content

- Three important consideration
  - Ecology
  - Economic
  - Management
- Ensure the farm is profitable
- Annual crops
  - Mistake done in the first year can be improved in the following year for better yield and profit
- Perennial crops
  - Any mistake done in the initial stage will result a long term negative effect (the entire life spent of the crops)

Ecological consideration

- Soil
- Climate
- Location and planting site
- Water
- Nutrient availability

Soil

- Planting media
- Support/holding the plants
- Hold water
- Main source of plant nutrient
- Pores are filled with air and water
- Soil physical and chemical characteristic influence plant growth
- Preferable deeper top soil layer
  - At least 1 - 1.5m
• For better root growth and anchorage (especially for fruit trees)
• Good aeration and drainage
• Avoid soil with hard pan layer
• Optimum pH 5.5 – 6.5
• Soil texture and structure are stable
• High organic materials, fertile
• Soil physical properties and location are more important than soil fertility (Why?)

Soil management
• Improve soil physical and chemistry properties
• Apply soil amendments
  – Organic: compost, manure …
  – Inorganic: sand, lime stone
• All soil can be planted, depends how you manage it.

Soil fertility
• Amount of nutrient which can be taken up by plants
  – Excessive → toxicity
  – Deficit → low growth rate, abnormalities
  – Balance → optimum growth and reproductively
• Fertility level influence by:
  – Erosion
  – Leaching
  – Taken up by plants

Sustain a fertile soil
• Mulching
• Organic matter
• Liming
• Crop rotation
• Contour planting
• Apply fertilizer
Climate

- Uncontrollable when dealing with big trees (unable to cultivate under greenhouse)
- Determine types of crops to produce
  - Sub-tropical
  - Tropical
- Amount of rain and raining pattern determine suitability for planting certain crops in certain location.
- Drought season is needed for some plants to induce flowering and fruiting.

Location and planting site

- Preferable flat area – ease management
- Slope area
  - difficult to manage (especially for annuals and non-seasonal fruit crops)
  - plant seasonal fruit crops with long juvenile period
  - Difficult for traffic, maintenance, P&D control operation and harvesting
  - Erosion
- Avoid area with continuous strong wind
- Plant wind breaker at windy location

Water

- Water source
  - Underground water (well)
  - River
  - Lake or pond
  - Municipal water
- Irrigation system
  - Rain fed irrigation
  - Manual
  - Overhead sprinkle
  - Ebb and flow
  - Drip irrigation
- Depends on water usage of the crops, cost, climate and location
Nutrient availability

- Tropical soil usually low in pH and nutrient content specially N, P, K, Ca and Mg.
- Plant nutrient deficiency symptoms as an indicator of soil fertility.
- Preliminary soil analysis provide the guide for the individual nutrients requirements.
- Nutrient requirements varies between
  - Crops: fruit crops > flowering crops > foliage and leafy crops
  - Soil: sandy soil > mineral soil
  - Growth stage: reproductive > vegetative

Economical consideration

- Financial strength
- Type of land ownership
- Farm size
  - Depends on
    - Market –big (local and wholesale) or small (local only)
    - Transportation –duration and cost
    - Modern technology – more practical in large farm
- Type of commodities
  - Consumer preference and price
  - P&D resistant
  - Shelf life
  - Seasonal or non-seasonal

Management consideration

- Knowledge
- Man power
- Technology
Topic 2: Site preparation

Important Content

- Site clearance for planting horticultural crops including:
  - Clearing, slashing, drying
  - Leveling
  - Cleaning and collecting debris, second leveling
  - Construct road and drainage system
  - Planting system, lining, planting bed preparation
  - Dig planting hole (for fruit trees)
  - Install irrigation system
  - Planting main crop
  - Planting cash crops/inter cropping
  - Fencing
  - Replacing dead plants

Lining

- Objective: to obtain a straight, tidy and systematic planting
- Need to know planting system, plant arrangement and planting distance before lining.
- Mark planting point with bamboo stick.

Plant density

- Number of plants per unit area (plant population) determine by distance between plants (planting distance) and plant arrangement.
- Plant density influence
  - Total yield
  - Crop size
- Yield per unit area increase with population until a certain point beyond which further increase in population will cause yield reduction.
  - Decrease spacing between plants → increase plant population
but at the same time increase chances of competition between adjacent plants \( \rightarrow \) reduce yield

- Little decrease in yield once ceiling level has been reached.
- Increase in plant population \( \rightarrow \) decrease plant size.
- By manipulating plant population can produce commodities of desirable size to meet specific market requirement.

**Topic 3: Planting**

**Important Content**

- Direct sowing/planting
  - For plants with high resistant to pest and disease
  - Tuberous crops
  - Crops with short juvenile period
  - Seeds are big, cheap, easily obtained
- Plant in nursery before transplant to the field or planting bed
  - For plants which susceptible to P&D
  - Slow/hard to germinate
  - Slow growth, long juvenile period
  - Need shade
  - Seeds are fine, expensive, hard to obtain
- Planting on bed
  - For vegetable and cut flower production
  - Land being ploughed to
    - Control weed and pest
    - Break the soil, loosen the top soil (30-60cm)
    - Increase organic matter in the soil
    - Leveling the soil
  - Build planting bed (15-30cm in height)
  - Harden the plants/seedlings before planting
  - Plant according to plant arrangement and spacing
– Water and mulch the plants after planting

**Hardening**

• Prepared/acclimatized the seedlings or plants for exposure of stress in the field.
• Prevent transplanting shock.
• If this is not done, the seedlings or plants will easily wilted and die when planted in the field.
• This is done by reducing the shades, water and nitrogen stage by stage in the nursery.
• Hardened plants: dark green, strong stem, high carbohydrates (CHO) content
• Over hardened: yellowish plant, take time to recover

**Mulching**

• A layer which covering the soil surface.
• Materials:
  – Organic matters
    • Free from weed seeds, P&D
    • Dry leaves, coconut husks, paddy straws, paddy husks, dry grasses, coconut fronds, EFP, compost, weed mat
  – Synthetic materials
    • plastic
• The importance of mulching
  – Increase soil moisture
    • Reduce water evaporation 10-50% depends on materials and thickness
    • Increase water holding capacity (organic matter)
  – Weed control
    • Reduce or prevent weed grow
    • More effective for synthetic materials
  – Improve soil texture
    • Prevent soil from becoming hard and compact
    • Increase organic matter in soil
  – Control erosion
– Biological aspect
  • Increase activities of microorganism
  • Reflective plastic mulch prevent or reduce insect attack

How to mulch?
• Organic matter
  – After sowing the seeds
  – After building the planting beds and fertilized with base fertilizer
  – Place thicker layer in between rows
  – Fruit plants: around the plants
• Plastic
  – For high value crops with long production period
  – Plagued the soil and apply base fertilizer → wet the soil → place plastic

Planting fruit trees
• Dig planting holes (0.6m X 0.6m X 0.6m) one or two weeks earlier.
• Dig shallower in area with wet soil conditions.
• Top soil removed is place near to the planting hole as backfill during tree planting.
• Fertilizer is not needed to mix into the top soil.
  – A good establishment of tree/seedling depends on new roots.
  – New roots may get burn when in contact with the fertilizer.
  – Peat or compost can be mixed with the top soil.
• Trees/seedlings should be harden for a few days or weeks before planting.
• Before planting, plants should be well watered to avoid drying of the roots.
• The planting depth should be slightly less or same as the rootball.
• Allow the graft union 5-8cm above ground
  – Critical for trees on dwarf rootstock
  – If graft union below soil level, scion variety form roots, the tree will become a standard size tree
• Polybags should be fully removed before planting.
• Trim off any broken, damage and circling roots before planting.
• Place the tree in the center of the hole, make sure the depth is correct, hold the tree straight and start filling the hole with the native top soil.
• Pack the backfill in the hole by gently stamping it with your feet to ensure no air pockets remain.
• After the hole is filled, water the tree with two to five gallons of water, poured slowly to avoid water run off.
• Stake the tree with a strong permanent stake to ensure a straighter tree.
• Staking is important for trees planted in a wind-blown site and for dwarf fruit trees.
• Mulching – place 7-8cm layer of mulch around the tree, do not pile mulch directly against the tree trunk.
• Shade the seedlings for the first two weeks using coconut fronds, fertilizer bags or bamboo basket.
• Strict irrigation schedule is necessary for tree survival.
  – Daily for 1 month; every other day for 3 months; weekly until established.
• Important planting notes:
  – The best soil amendment for successful planting is water. Research has shown no benefit to use other soil amendments.
  – Place no soil over the rootball at planting. Deep planting kills trees.

Plant arrangement
• Square
• Rectangular
• Triangle
• Quincunx
• Modified rectangle
• Double lines
• Multiple lines
• Contour

Multiple cropping
• Produce a few types of crops a year per unit of area.
• Objectives:
  – Maximum utilization of space, light & labor (taking advantage of slow-growth phase)
• Increase food production
• Help minimize weed problem
• Reduce risk of crop failure

• Mixed cropping
  – More than one type of crops planted in the same area at the same time.
  – Suitable for difference plant habits/behaviors

• Intercropping
  – All crops are planted systematically.
  – Planted in certain density.
  – Plant short term crops (annuals, leafy vegetable) while waiting for the harvest from the main crops (usually perennials, crop with long juvenile period, fruit trees).
  – Chose crops that are from different family or do not share the same pest and disease (P&D) with the main crops.
  – Avoid heavy feeder crops (tapioca).

• Crop rotation/successive cropping
  – Plant more than one type of crops in the same area in different time.
  – Each type of crops have different nutrient requirement and do not share the same P&D.
  – Well manage of P&D and soil nutrient.
  – Commonly practice in vegetable farm.
  – Legume crops → leafy vegetable → fruiting vegetable → tuberous crops

• Relay cropping
  – Planted in between plants or rows of the existing crops.
  – Widely spaced crops.
  – Second crops are planted before the first crops being harvested.
  – save time
  – utilize residual nutrients
  – utilize labor intensively
  – practice under good management farm
Key to success in multiple crops planting system

- **Plant characteristic**
  - Plant height
  - Growth rate: fast, moderate, slow
  - Rooting system: deep, shallow

- **Maturity**
  - Time to harvest (short or long)
    - Lettuce: 4 weeks; ginger: 8-9 months
  - Short term crops are harvested before long term crops
  - Yield from long term crops are not affected by short term crops

- **Sensitivity to shade**
  - Ensure plants not over shade each other, yield are not affected
  - Mixed cropping, intercropping and relay cropping

- **Sensitivity to P&D**
  - No common P&D, different family
  - Use resistant variety
  - Not a host of P&D for the other crops

- **Soil fertility**
  - Nutrient requirement
  - Ability to fix nutrient

**Topic 4: Soiless culture**

**Important Content**

- Planting without soil
- Hydroponic – water which work (Greek)
  - Hudor – water
  - Ponos – work
- Essential plant nutrients in water soluble form
- Planting media as physical support and holding moisture
Advantages of soilless culture

- Ease planting and production
  - Not limited by soil and topography
  - Protected from uncertain weather condition
- Ease management
  - Irrigation and fertilization was given at the same time
  - Weeding and plaguing not needed
- Less pest and disease problem
  - Free from soil-borne disease
  - Planted under insect-proof netting
- Year round production
- High productivity
  - 3 – 4 times greater yield than soil base culture
  - Better and faster growth – balance nutrient provided
  - Grow under control environment
  - Produce continuously
  - Use water and nutrient efficiently
- High quality yield → higher price
  - Uniform growth
  - Clean and minimum pesticide residual

Disadvantages of soilless culture

- High investment cost
  - Equipments, building structure
- High input cost
  - Electric, nutrient solution
- Need technical knowledge
  - Different crops, different growth stage, different nutrient requirement
  - pH, EC, temperature influence nutrient uptake
- Difficult to control once disease outbreak
  - Spread by water, fast
- Limited to certain crops
  - Only suitable for small seasonal or annual crops
Basic need in soilless culture

- Rain shelter (with/without insect proof netting)
- Nutrient solution container
  - Store nutrient solution
  - Hold supporting media
  - Varies according to planting system: polybags, pots, gutters etc.
  - Materials:
    - Not react with solution
    - Light proof
    - Plastic, fiberglass, wood …
    - Copper, metal → Not suitable
- Supporting media
  - Holding the plants
  - Aggregate, non-aggregate, mix media
  - Physical support for plants
  - Criteria:
    - Able to hold moisture
    - Not easily decayed/high CN ratio
    - Not emit poisonous materials
    - Good aeration
    - Good drainage
    - Not react with nutrient solution
    - Low Ca content
    - Clean and pathogen free
  - Size
    - Corse (>3mm) – dry faster
    - Fine (<3mm) – keep more moisture
  - Materials
    - Aggregate: rock or mineral fragments, pebbles, broken bricks, gravel, sand, perlite, vermiculite
    - Non-aggregate: not from rock or mineral
    - Organic: rice husk, coconut coir, cocopeat
    - Non-organic: rockwool, plastic chips
    - Mix media: mixture of aggregate and non-aggregate materials
- Cocopeat + sand

- Nutrient solution
  - Provide plants with macro and micro nutrient from soluble chemical compounds
  - Macro nutrient: C, H, O (from atmosphere); N, P, K, Ca, Mg, S (mineral)
  - Micro nutrient: Fe, Mn, B, Zn, Cu, Mo (mineral)
  - Source: soluble chemicals
  - N: calcium/potassium nitrate, urea(NH$_4$NO$_3$)
  - P: monopotassium phosphate (KH$_2$PO$_4$)
  - K: potassium nitrate, potassium sulphate
  - Ca: calcium nitrate, calcium chlorite, calcium sulphate
  - Mg: Magnesium sulphate
  - Mn: Mangan sulphate
  - Fe: Ferum EDTA, Ferum sulphate

- Formulation of nutrient solution
  - Average quantity given (mg/L):

<table>
<thead>
<tr>
<th>Macro</th>
<th>Micro</th>
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<tbody>
<tr>
<td>N: 150-250</td>
<td>Fe: 4.0-6.0</td>
</tr>
<tr>
<td>P: 30-60</td>
<td>Mn: 1.0-4.0</td>
</tr>
<tr>
<td>K: 300-500</td>
<td>B: 0.3-0.5</td>
</tr>
<tr>
<td>Ca: 150-300</td>
<td>Zn: 0.05-0.2</td>
</tr>
<tr>
<td>Mg: 50-100</td>
<td>Cu: 0.01-0.1</td>
</tr>
<tr>
<td>S: 30-50</td>
<td>Mo: 0.01-0.05</td>
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- Formulation in market
  - Hoogland formulation (1940)
  - Chua and Teoh formulation (1975)
  - Cooper formulation (1979)
  - Wye formulation (1981)
  - Sachs formulation (1985)
  - Yeow formulation (1993)
Stock solution
- Dissolve chemicals according to desire concentration
- Separate chemicals contained Ca → unable to dissolve with chemicals contained sulphate
- Stock A (contained Ca and Fe) and Stock B

Operating system
- Circulating /close system
  - Recycle the nutrient solution
  - Automatic feeding and drainage system
- Non-circulating/open system
  - Nutrient solution are not recycled
  - Timed electrically operated device
  - Example: drip fertigation

Planting system in soilless culture
- Nutrient solution culture system
  - Planted with nutrient solution only
  - Deep water culture, nutrient film technique (NFT), aeroponic
- Aggregate culture system
  - Use media as support and for root growth
  - Water and nutrient was hold around root
  - Aggregate, non-aggregate or mix media
  - Drip fertigation, ebb and flow technique

MARDI formulation (1997)
Topic 5: Organic farming

Important Content

- Traditional cultivation
  - widely practiced before the green revolution
- a system that excludes the use of synthetic fertilizers, pesticides, and growth regulators
- emphasize on high nutritional quality produce without causing any harmful effect to environment and consumers
- not using synthetic chemicals.
- work to improve the quality of the soil to provide plants with the best possible growing conditions.
- to develop a natural balance within the farm by attracting wildlife to help combat pests and to pollinate plants.

Principles of organic farming

- No use of synthetic chemicals
  - pesticide, fertilizer, herbicide
- Use renewable resources
- Maintain healthy soil and sustainable future – high organic, less use heavy machines, less erosion, ideal for soil organism
- Maintain natural biodiversity in ecosystem
  - natural predators, pollinators, N fixer
- Environmental friendly agricultural practices – minimum ground and air pollution
- avoid all forms of pollution that may result from agricultural operations
- Higher price - 10-30% premium in the marketplace (Why?)
### Organic vs Conventional farming

<table>
<thead>
<tr>
<th>Organic</th>
<th>Conventional</th>
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<tbody>
<tr>
<td>Excludes the use of synthetic chemicals</td>
<td>Heavily depends on synthetic chemicals</td>
</tr>
<tr>
<td>Relatively small-scale, independent operations</td>
<td>Large-scale</td>
</tr>
<tr>
<td>Low use of purchased fertilizers and other inputs and low mechanization of growing</td>
<td>Intensive chemical programs and mechanized production</td>
</tr>
<tr>
<td>Labour intensive</td>
<td>Reduce usage of labour through investment in machinery and chemicals</td>
</tr>
<tr>
<td>Mostly local, direct to consumer or direct marketing</td>
<td>Wholesale, with wide market</td>
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UNIT 6
FARM MANAGEMENT

Introduction

Farm management is the most important aspect to ensure the farm productive and profitable. Management of each farm is different as it affected by location, climate and types of crop produced.

Objective

1. To discuss the farm management activities
Topic 1: Fertilizer

Important Content

Several types of fertilizer for horticultural crop

- Pallet fertilizer – complete fertilizer (NPK 15:15:15)
- Liquid fertilizer – easily dissolves in water
  - sprayed on the surface of leaves (Wellgrow)
- Powder form fertilizer (Baja debu) – apply/mix into media (Malameal)
- Slow release fertilizer – nutrient is gradually released for plant needs (AgroBlend)

Methods of Fertilizing

- **Surface Application**
  - Fertilizer is applied under plant canopy
    ~1 meter from base of tree to ‘drip line’
  - Easy, suitable for shallow rooted plants – ground covers, annuals, shrubs, small trees
  - Effective for N element
  - Not suitable for P & K which moves slow in the soil

- **Soil Incorporation**
  - Fertilizer is applied into dug hole so that it reaches the root zone
  - Depth of hole: 15-30 cm
  - Distance between holes: 60-90 cm
  - Holes are made according to drip line
  - Suitable for P & K elements
Foliar Spray
- Liquid fertilizer is sprayed on leaves
- To provide nutrient in minimum amount
- Suitable for micronutrients (Fe, Zn, Mn)

Fertigation
(fertigation + irrigation)
- Liquid fertilizer is drained through drip irrigation
- Suitable for ornamental plants in pots/plots

Rate of fertilizer
- According to nutrient need of plants
  (depending on type, age, size, location etc.)
- Lack of information on ornamental plants need locally

Guideline for fertilizing:
1. All type of plants
- During planting: Phosphorus fertilizer ‘triple super phosphate (TSP) or ‘double super phosphate’ (DSP) is incorporated with media (rooting promoter)
- In the early stage (~6 months)
  Fertilizer with balance nutrient for instance NPK 15:15:15
- In the maturity stage – type of fertilizer according to plant needs
  Example:
  Flowering and fruiting plants – needs high element K

General Guidelines:
- **Trees**
  - 500 g of fertilizer is applied for every 50 mm diameter of plant stem
  *except for slow release fertilizer
- **Shrubs/Potted plants**
  - 10-30 g for every tree
  - Once in 2 months
- **Groundcovers**
  - 1-2 kg fertilizer for every 100 sq.m
Topic 2: Watering

Important Content

Frequency of Watering

- Depends on:
  - Species, age of tree, type of media.
- Example:
  - Trees: in the first 6 months, water plants everyday except for rainy days, after that watering can be minimized/stopped
  - Potted plants: water everyday – volume of media is limited
  - Annuals and leafy vegetable: water more frequently, however minimum amount of water is needed (shallow roots)
  - Sandy soil, hot weather – water more frequently

Watering Techniques

- Depend on:
  - Types of planting (on bed/plots/in pots)
  - Amount of water, water source
  - Terrain

- Hand watering
  - Garden hose
  - Waste of water
  - Not suitable for wide area

- Sprinklers
  - For plants on plots, in pots, groundcovers, turf grass
  - Water in the morning so that leaves dry up faster – avoid fungal diseases
  - Disadvantages – Water wastage, high humidity
  - Automatic watering system – for public parks, commercial landscapes
• Drip / trickle irrigation
  - Direct watering to the root area
  - Suitable for fertigation
  - Advantages: save water, cheap, easy to install, minimize weeds and leaf diseases
  - Problem: microtubes easily get block
  - For trees, shrubs, potted plants
  - Can be modify for groundcovers

**Topic 3: Planting media**

**Important Content**

Advantages of growing plants in containers:

- The type of media used, fertilization and watering can be controlled – resulting in uniform & even growth of plants
- Containers can be easily moved around to a more suitable location
- Potted plants can be used as house plants for indoor decoration
- The containers can be decorative

**Container medium**

- **Soil-based medium**
  - One advantage of soil-based medium is its high CEC. Nutrient retention is increased hence it is useful for long term crops (e.g. stock plants, cut flowers planted in ground beds, foliage plants)
  - Example of soil-based media: John Innes potting mix (7 parts top soil : 3 parts organic matter: 2 parts sand)

- **Soilless medium**
  - has consistency, excellent aeration, low bulk density
  - lower CEC and hence require more fertilizer than soil-based media
  Examples:
1) University of California mix (sand & peat moss)
2) Cornell University mix (vermiculite & perlite)
3) 3 : 1 (cocopeat : sand)

Examples of soilless potting-mix components:
- sand
- coconut coir dust (cocopeat)
- peat
- rice hulls
- Sawdust
- Vermiculite
- perlite

Components of potting media

**Soil**
- Can vary in mineral content and ratio of clay, silt and sand
- the use of soil as potting medium has decreased due to variable supplies, weight and low aeration
- excellent water holding capacity
- CEC : very high
- bulk density : high
- aeration : poor

**Sand**
- the heaviest component (100-120lb/ft³)
- low CEC & water holding capacity
- good aeration
- bulk density : very high
- pH : neutral
- quantity used ~ 25% of volume of media

**Peat**
- excellent water holding capacity & aeration
- CEC : medium to high
- pH : low (acidic)
- bulk density: low
- C:N ratio moderate
- Cost : high

**Coconut coir dust (cocopeat)**
- used to reduce or replace peat
- can have high levels of soluble salts (Na, K)
- excellent water holding capacity & aeration
- CEC : medium to high
- pH : 4.5 – 6.9
- bulk density: low
- C:N ratio moderate
- Cost : moderate

**Sawdust**
- best used after being composted. Fresh sawdust has very high CN ratio (1000:1) and will tie up the N in the medium and cause N deficiency
- quantity used : not more than 20% of volume of media

**Rice hulls**
- Low bulk density, CEC, and water holding capacity
- CN ratio : high
- aeration : good

**Perlite**
- volcanic mineral, alumino-silicate rock
- characteristics similar to sand & used as low-weight replacement for sand
- low bulk density, water holding capacity
- CEC : very low
- aeration : excellent
- pH : neutral
- **Vermiculite**
  - Manufactured from aluminum-iron-magnesium silicate mineral
  - Water holding capacity: high
  - Aeration & drainage: good
  - Low bulk density
  - Source of K, Mg & Ca
  - Quantity used: 25-50% of volume of media

- **Other components:**
  - Bark, peat, calcined clay, rockwool
  - Composted products such as compost, manure, composted municipal refuse, composted sewage sludge.

**Factors to consider in selecting media components**

- **Economic**
  - Cost
  - Availability
  - Easy to produce

- **Chemical properties**
  - pH, CEC, C:N ratio

- **Physical properties**
  - Aeration, water holding capacity, weight

**Objective:**
A media mix that can produce good quality plants in the shortest time at the least cost.
Topic 4: Potting and repotting

Important Content

Planting a container plant

1) Keep the plant’s root ball intact.
2) Cover drain hole with a disc or stone.
3) Position root ball ½ inch below rim.
4) Fill inside with potting soil mix.
5) Tamp container gently to settle soil.
6) Smooth soil surface, then water.
When a plant outgrows its container, the roots will fill all available space and become potbound. Potbound plants have to be repotted into another container.

Purpose of repotting
- To supply new & fresh medium
- To increase space for roots to grow
- To get a good balance between container size and foliage
- To replace broken pots/containers

Repotting should be carried out when the following symptoms appear:
- Roots grow out of the drainage hole
- The root ball is made up of mostly tangled roots with very little medium
- Slow growth, even after fertilizing
- Foliage looks top-heavy in proportion to container
- Water runs quickly through the medium with little retention
Topic 5: Pruning and training

**Important Content**
- Remove unwanted parts of plants (stems/branches, shoots, roots, flower, fruit)
- Promote growth of plant; improve yield, feature and functions of plants through pruning and training a plant.

**Objective of pruning and training**
- Control tree size
- For tree health
  - prune branches affected by pest and diseases
  - prune branches that grow too closely together or overlapping branches
  - improve aeration
- Improve tree appearance and shape
  - prune dry/withering flowers
  - prune dead branches
  - produce special shape – topiary
- Encourage shoot, flower and fruit production (simulative pruning)

**Parts of Tree**
• Lead branch (central leader)
  - main branch, dominant
  - cannot be pruned – lost original shape of tree; except for certain fruit trees to encourage fruiting and ease maintenance
    - ‘double leader tree’ – two ‘leaders’
    - prune weak branches
      (when tree is young) – maintain one

• Scaffold branches (side branches)
  - branches except for the leader
  - shape the structure/canopy of the tree
  - number of branches & size of leaves
  - prune excessive branches

• Canopy
  - canopy of a tree

• Suckers (sulur)
  - shoots growing from underground (base of stem)
  - have to be pruned

• Water sprouts (sulur air)
  - shoots appearing along tree stem
  - have to be pruned

• Crotch
  - place of meet/connection of branch with tree stem or with bigger branches
    - ‘wide crotch union’ – strong
    - ‘narrow crotch union’ - weak
Pruning Method

1. **Heading back**: Prune only part of the branch (example: prune till the eye bud). Several methods:

   - **Pinching**
     
     - prune terminal shoot (1-2 inches) to encourage branching
     (example: chrysanthemum)

   - **Shearing**
     
     - Cut multiple shoots at once (example: hedges)

   - **Pollarding**
     
     - the whole top part of tree is pruned –only main branches are maintained
     
     - to control tree size or to produce new shoot (canopy)
2. **Thinning**: Prune all branches till the base (example: prune side branches till the main branch)

![Image of pruning](image)

**Effects of Pruning on Growth**

*Heading back*
- encourage growth of multiple new shoots
- tree becomes more compact
- Original shape of tree may change
- Tree is short, small canopy

*Thinning*
- tree becomes more ‘open’ – improves aeration
- main shape of tree is maintain
- can reduce tree size

**Pruning Equipment**

- *hand pruners (secateurs)*
  - for small branches
- *pruning loppers, pole pruner*
  - for more mature branch
  - diameter ~ 4 cm
- *Hedge shears*
  - for smaller/younger branches
  - (hedges)
- *Pruning saw*
  - medium size branches (3-6 cm)
• **Power pruner**
  - prune big & tall branches

• **Axe**
  - for trees with huge branches and roots

**Method of Pruning**

**Heading back**

- Location & direction of pruning influences:
  - growing direction of new shoot (shape)
  - the size of the cut on the tree
- Observe growing direction of eye shoots
- Choose eye shoots that is facing out
- Prune above eye shoots
- Slant downwards, opposite to eye shoots

**Thinning**

- Huge Branch Pruning (jump-cutting technique)
- 3 stages – to avoid split of skin
  i. Prune from lower part of the branch – to ¼ size of branch
  ii. Prune from above of the branch until branch break
  iii. Prune on the part where the branch is connected with the stem
**FRUIT TREE SHAPES**

Shapes of your fruit trees should be chosen according to their suitability for the available garden space. The more decorative shapes are again dependent on space, but are also a matter of personal preference with regard to how they fit in with the design of the garden as a whole. Obviously, the larger decorative shapes will produce more fruit.

**SQUARE TREE** This is the most practical "tree" shape for most domestic gardens. It is not too large, making it relatively easy to pick the fruit as well as to carry out pruning.

**STANDARD** This is the largest of the fruit tree shapes and is not often grown these days. Standards are very large, open trees that need ladders to access them.

**SEMI-STANDARD** This is similar to a standard except it is smaller. They still need ladders to reach the fruit and for pruning. They have the advantage of looking like a "tree".

**SPINDLE BUSH** A small, bush-like fruit tree that has its branches spaced for maximum light. Most can be reached from the ground, although taller ones need steps.

**DWARF PYRAMID** The smallest of the tree shapes and eminently suitable for a small garden. Fruit can be reached and pruning done from the ground.

**CORDON** This takes up very little space and can be surprisingly productive. A row of different varieties can easily be accommodated in a small garden.

**DOUBLE CORDON** This is similar to a cordon, but is upright and has two main stems. Double cordons are obviously more productive than single ones.

**POLE** This is rather like a single cordon except that it can be much taller. Poles are very useful for small gardens and some can be grown in containers.

**MULTIPLE CORDON** This is very similar to the double cordon except that it has four or five upright stems. These can look very decorative, especially once they have aged.

**ESPALIER** This is one of the most productive of the more decorative shapes. If used against the end of a house, it can produce enough tiers to reach the eaves.

**STEP OVER** A delightful way of growing apples and pears, making good edging for paths or for dividing areas. In essence, it is a one-tiered espalier.
Topic 6: Weed, pests and diseases control

Important Content

Weed
- Annuals
- Perennials

Pests
- Vertebrate: rats, birds
- Invertebrate: Insect, snail

Diseases
- Bacteria
- Fungal
- Virus

Factors of problems

Invasion: Introduce, no natural enemy
Persistence: alternative host, dormant (fungal spores or weed seeds)
Suitable environment condition: temperature, humidity, aeration
Recessive variety

Ways to control

- Prevention control
  - most essential aspect
  - quarantine procedures
  - early detection of new invaders
  - certified planting materials (virus free plantlet)
  - ensure healthy plant growth (fulfill the plant requirement: proper light intensity, fertilizer and water management, pruning)

- Cultural control
- establishment of competitive and desired vegetation (cover crops) to control weeds
- prevents or slows down invasion
  - establish plant with repelling smells to protect the main crops (onions)
  - planting plant which luring pests as sacrificial plants, ease to concentrating and remove pest

- Chemical control
  - Herbicides (kill higher plant or weed), fungicide (kill fungal), antibiotic (kill bacteria), no chemical to control virus – eliminate and burn the infected plant
  - classified depending on their mode of action (contact, systemic), relative time of application and chemical composition
  - Application method: foliar spray, dip or soaking (for tubers, corms and rhizomes), dust (seeds), injection, bates (control rats and snail), fumigation (eliminate most life form including nematodes, weed seeds and fungal spores)

- Mechanical control
  - kill or suppress through physical disruption
    - pulling, digging, disking, plowing and mowing to control weed
    - collecting mature insect and larva by hand, set up insect and mouse trap
    - prune away infected plant parts

- Biological control
  - use of living agents to suppress vigor and spread of weed, pest and disease
    - agents can be insects, bacteria, fungi, virus or animals
    - reduce infestation to a 'tolerable level'
UNIT 7
HARVESTING AND POSTHARVEST HANDLING

Introduction

Post-harvest – stages where commodities being harvested from the field until being used
Harvest → Treatment → Handling → Storage → Distribution → Marketing (to the consumer)

Handling – harvesting operation, grading, transportation, storage and ripening

Post-harvest losses – quantity/weight lost, quality/nutrient lost, economical losses due to low market price

Objective

1. To know the post-harvest processes of horticultural produce
2. To discuss the factors affecting post-harvest losses
3. To discuss the post-harvest technologies in reducing post-harvest losses
**Topic 1: Post-harvest losses**

**Important Content**

Post-harvest losses

- Depletion of post-harvest commodities
- Quantity changes
  - Water lost
- Quality changes
  - Softening
  - Starch turned into sugar
  - Sugar turned into acid/CO₂/H₂O
  - Reduce sweetness
  - Reduce vitamin C
- Lowering or reduce the usage of commodities

Estimated post-harvest losses in
- Developed country → 5-25%
- Developing country → 20-50% (Malaysia: 10-50%)

To reduce losses, producer and processor need to:
- Understand the biological and environmental factors that affected the depletion of commodities
- Implement post-harvest technologies to slow down senescence and maintain quality

**Topic 2: Biological factors**

**Important Content**

Biological factors that lowering the quality of horticultural commodities:

1. Respiration
2. Production of ethylene gas
3. Composition changes
4. Growth and development
5. Transpiration
6. Physiological damage
7. Physical and pathological damage
**Topic 3: Post-harvest technologies**

**Important Content**

1. Handling temperature and storage temperature
   - Cooling and pre-cooling techniques
   - Cold room or cold storage
2. Humidity and water/weight lost
   - Air relative humidity controller
   - Packaging
3. Storing atmosphere
   - Modified/controlled atmosphere
   - Controlled fruit senescent gas (ethylene)
4. Transportation
   - Cooling
   - Transportation damage
5. Storing facilities
   - Controlling respiration and ethylene production
   - Materials and methods of packaging
   - Waxing
6. Insect and pathogen control
   - Radiation
   - Fumigation
   - Fungicide treatment
   - Heat treatment

**Topic 4: Post-harvest processes**

**Important Content**

**Harvesting**

- Quality cannot be improved after harvest, only maintained
- Harvest fruits, vegetables and cut flowers at the proper stage and size and at peak quality
- Factors contributed to good quality harvest:
  - Maturity indices
  - Method of harvesting
  - Time
  - Equipments
  - Container
  - Handling at farm
Packaging station/house

- To prepare produce for market
- From a simple hut to a high-tech complex equipped with modern machinery
- Basic necessity – water, electric power, storage facility
- Location near production area

Selection

- Select only produce which meet the minimum quality – fresh, free from damage and defects
- Activities:
  - Remove from packaging
  - Remove produce with bruises, defective, immature, overripen and very dirty
  - Trimming stalk

Cleaning and washing

- Remove dirt or any foreign matter
- Second wash with chlorinated water to control microbes
- Pre-cooling action

Treatment

- To control pathogen and diseases such as anthracnose, end-rot, fungal and microbial infection
- Dipping in permissible chemicals for 5 – 10 minutes
- Eg. Water heat treatment: soak in benomyl solution for 5 minutes at 52°C to control anthracnose in mango and papaya
- Quarantine treatment using vapour heat treatment (VHT) – temperature 46.5 °C and RH 50% for 20 minutes – for export to USA, Japan, Australia and New Zealand

Drying

- Ambient air dry or mechanical dryer

Grading

- Classify the produce according to quality and size
- Important criteria:
  - Variety
  - Uniform size
  - Uniform index (maturity)
  - Physical/visual defect
  - Damage – injury and infection
Packaging

- Packaging should be designed to prevent physical damage to produce and be easy to handle
- Identify contents
- Attractive – help to sell

Labeling

- FAMA’s market regulation; packaging, labeling and grading
- Product traceability

Storage

- Pre-cooling
  - To remove field heat of a freshly harvested crop quickly – extend shelf-life
  - Common pre-cooling methods:
    1. Room cooling: produce is placed in an insulated room equipped with refrigeration units
    2. Force-air cooling: fans are used in conjunction with a cooling room to pull cool air through packages of produce
    3. Hydro-cooling: Dumping produce into cold water, or running cold water over produce, is an effective way to remove heat and can serve as a means of cleaning at the same time

Distribution

- Good distribution system to ensure quality products – truck equipped with cooling system

Traceability

- Ability for fresh/processed food products to be traced back to their raw materials, the producer, previous handlers in the supply chain
- Can trace forward to guarantee the location of products in the post harvest chain so that food safety and quality standards can be sustained
- SALM, GAP, EUROGAP
- Four types of traceability:
  1. Production system – GAP: good agriculture practice
  2. Process system – GMP: good management practice
  3. Pest and disease
  4. Genetic – seeds or GMO?
- How to trace? Use barcode or radio frequency ID