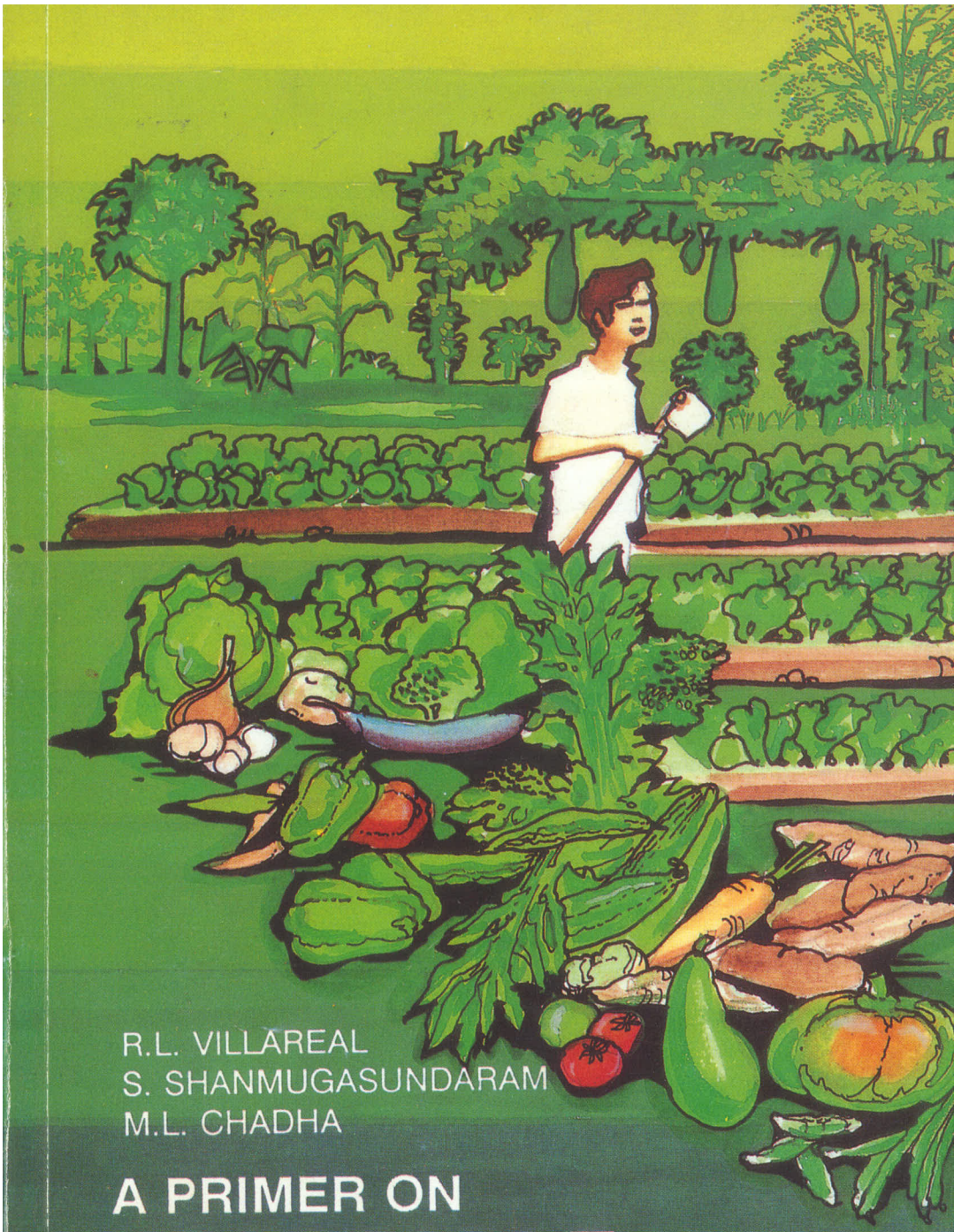

R.L. VILLAREAL
S. SHANMUGASUNDARAM
M.L. CHADHA

A PRIMER ON VEGETABLE GARDENING

About the Authors

Dr. Ruben L. Villareal, *a multi-awarded scientist and professor of horticulture at the University of the Philippines Los Baños, has more than thirty years of experience in vegetable research. His studies have been conducted not only in the Philippines where he was born and educated but also in the United States and Taiwan where he worked as a plant breeder at the Asian Vegetable Research and Development Center (AVRDC) from 1972 to 1981. Dr. Villareal is credited with the publication of three books (as author and co-author) and more than one hundred fifty papers in prestigious scientific journals and technical publications. He has formally presented his works in at least fifty conferences/symposia in the Philippines and in other countries worldwide. He obtained his B.S. and M.S. degrees from the University of the Philippines in 1960 and 1964, respectively, and his Ph.D. in horticulture from The Rutgers - The State University in 1966. He was formerly dean of the College of Agriculture and presently chancellor of the University of the Philippines Los Baños.*

Dr. Subramanian Shanmugasundaram, *currently plant breeder, Soybean Breeding/CIP and director, International Cooperation Program, Asian Vegetable Research and Development Center, Taiwan was instrumental in the release of vegetable Soybean variety*

(continued on back flap)

A PRIMER ON VEGETABLE GARDENING

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Madan Mohan Lal Chadha

ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER
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CONTENTS

Foreword

The spectre of grinding poverty, haunted today by the continuing population growth and the widespread degradation of farm lands, exerts heavy pressure on the world's food supply. Millions of people in the developing countries face the threat of daily hunger. Malnutrition due to lack of essential vitamins and minerals is acute among children.

Shortage in the supply of vegetables - the main source of some essential vitamins and minerals - is one of the main causes of this tragedy. If only the poor can be equipped with efficient methods of vegetable production, this needless suffering can be reduced. Vegetables which are highly nutritious foods will become readily available and affordable to the people. At the same time, poverty will be eased, with vegetable production's potential to generate income for small producers and additional employment for landless workers.

This "Primer on Vegetable Gardening" was conceived in recognition of the potential role of vegetable gardening as an efficient source of nutrition and cash income for poor families in the developing world. It is fully illustrated and contains simple and precise information on vegetable gardening for use by garden teachers and millions of school children, as well as women and family members, worldwide. It covers a wide range of topic - from the importance, and postharvest handling - to give the readers a complete understanding of modern vegetable production.

This primer is a product of collaborative efforts among the College of Agriculture, University of the Philippines Los Baños, the Asian Vegetable Research and Development Center (AVRDC), and the AVRDC/USAID Agriculture Research Project in Bangladesh. Special thanks go to the Japan Shipbuilding Industry Foundation for providing a grant to AVRDC under which this primer is published.

It is our hope that this primer contributes to the alleviation of global hunger and malnutrition.

S.C.S. TSOU
Acting Director General
AVRDC

CHAPTER I -- THE VEGETABLES

What is a vegetable

Importance of vegetables

- improve nutrition
- good source of fiber
- possess some medicinal values
- generate rural employment
- boost exports

Utilization

Classification

- botanical classification
- temperature requirements
- principal parts used

Parts of selected vegetables

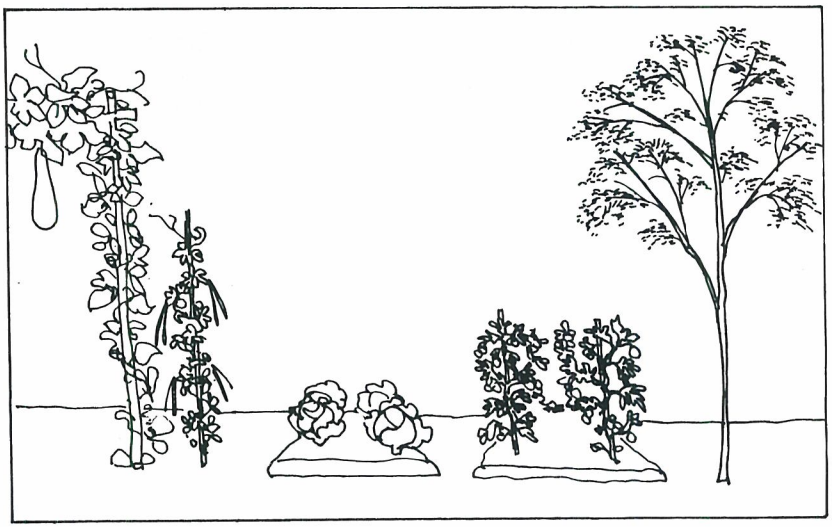
- carrot
- kangkong
- onion
- pechay
- squash
- tomato
- yardlong bean

Life cycles of selected vegetables

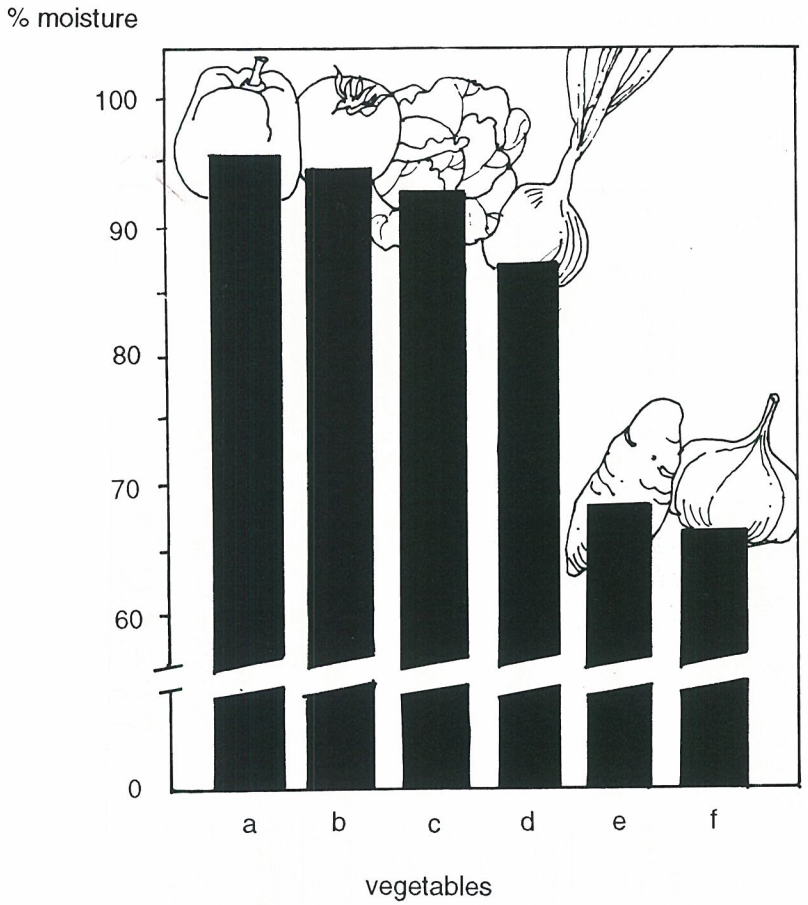
- carrot
- kangkong
- onion
- pechay
- squash
- tomato
- yardlong bean

What is a vegetable

- an edible, usually a succulent plant
- eaten with staples as main course or as supplementary food
- can be eaten either in cooked or raw form



- maybe herbaceous, viny, shrubby or tree in growth habit



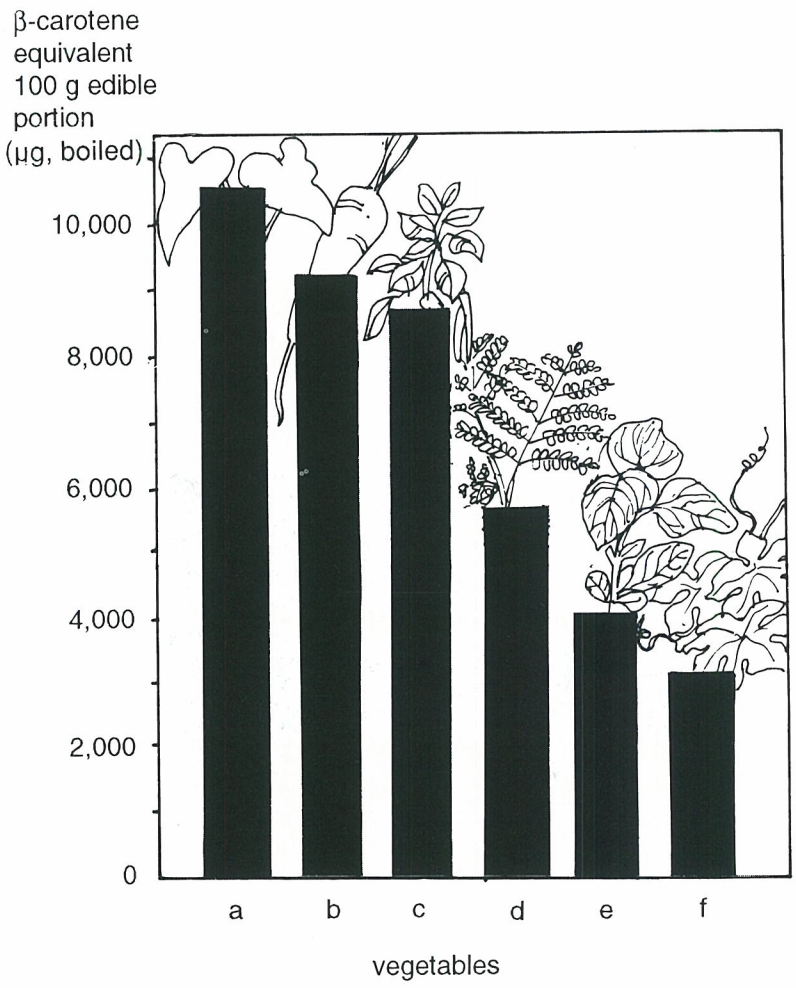
a - sweet pepper
b - tomato
c - cabbage
d - onion
e - sweet potato
f - garlic

Most vegetables are high in water which make them bulky.

Importance of vegetables

■ Improve nutrition

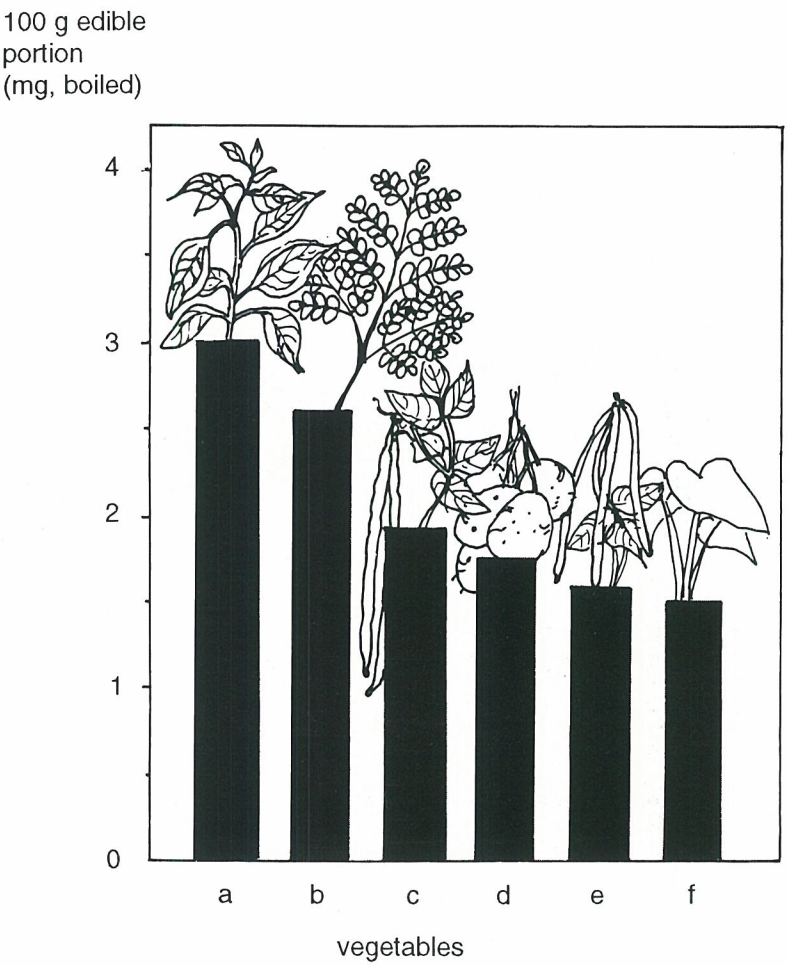
- good source of vitamin A



a - taro (leaves)
b - carrot (roots)
c - hot pepper (leaves)
d - malunggay (leaves)
e - Malabar spinach (young leaves)
f - bitter gourd (tops and young leaves)

Lack of vitamin A causes poor growth and night blindness.

- good source of vitamin B (thiamine, riboflavin and niacin)

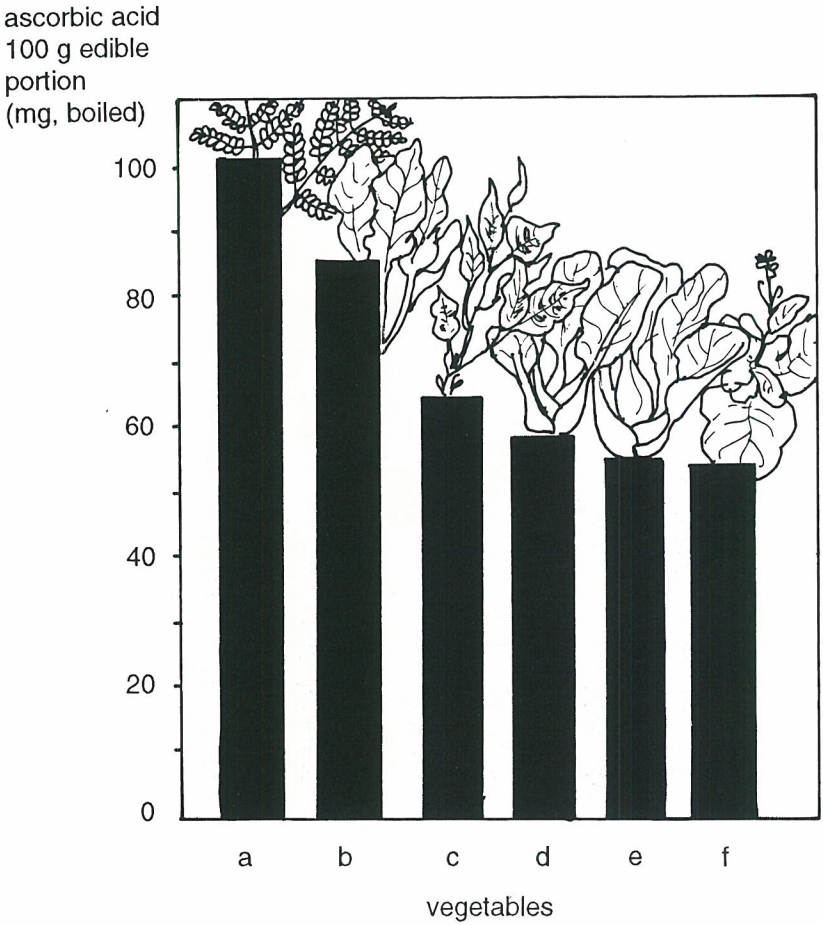


a - pepper leaves
b - malunggay
c - yardlong beans
d - potato
e - cowpea
f - taro

▲ for the utilization of carbohydrates and protein

▲ prevents anemia

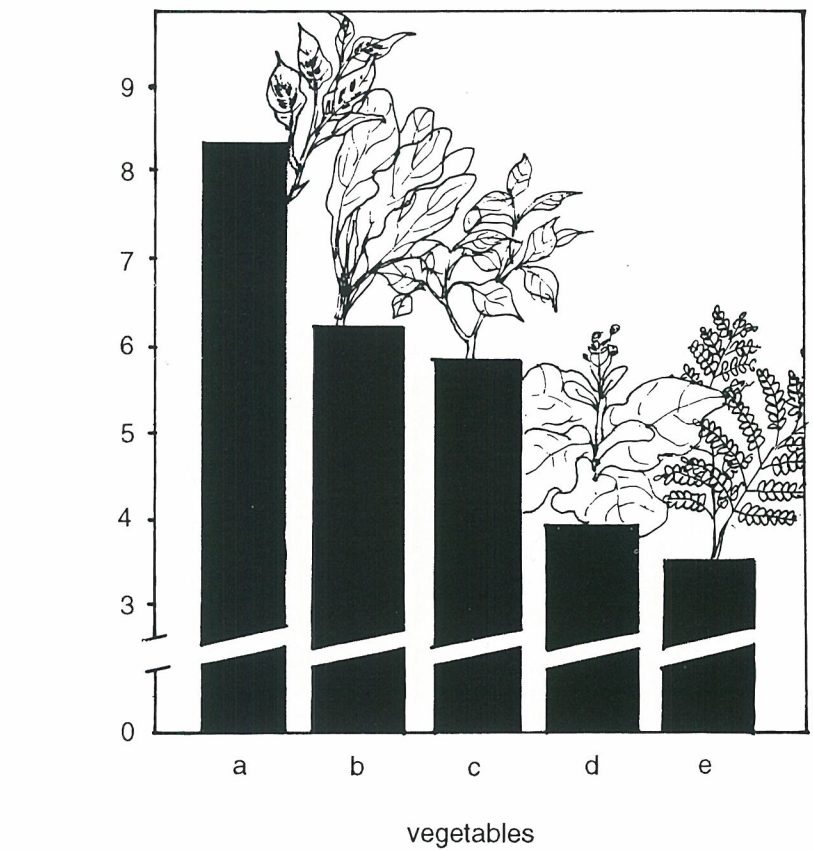
- good source of vitamin C



a - malunggay (leaves)
b - Malabar spinach
c - amaranth
d - mustard (leaves and petioles)
e - pechay (leaves and petioles)
f - kale (leaves and petioles)

- ▲ prevents scurvy
- ▲ increases resistance to cough and colds
- ▲ improves availability of iron

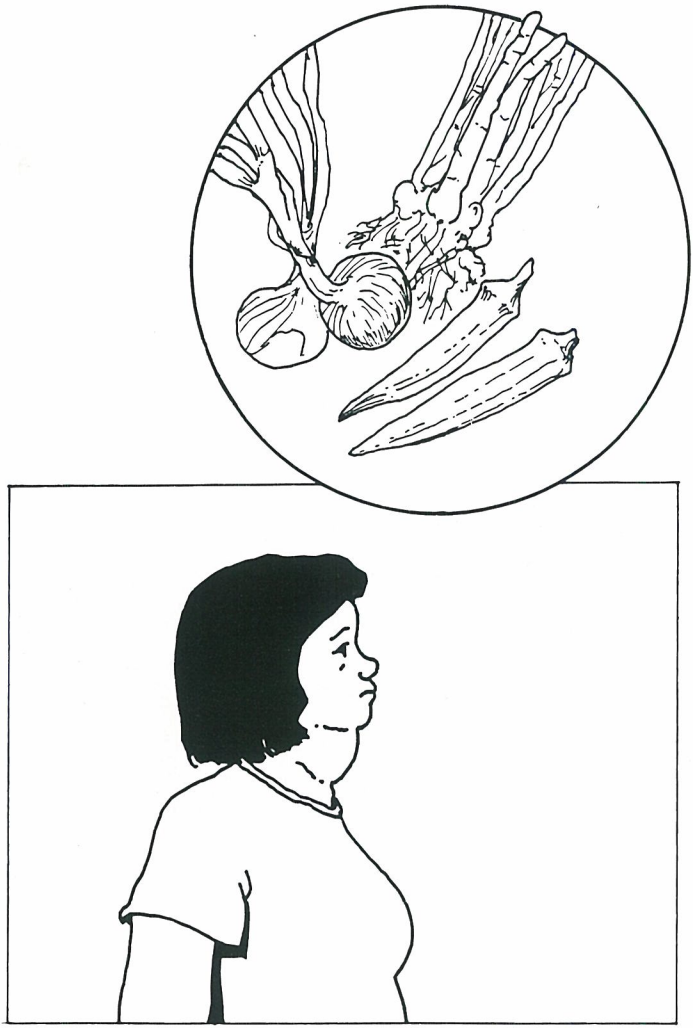
- good source of iron



a - amaranth
b - malabar spinach
c - hot pepper (leaves)
d - kale
e - malunggay

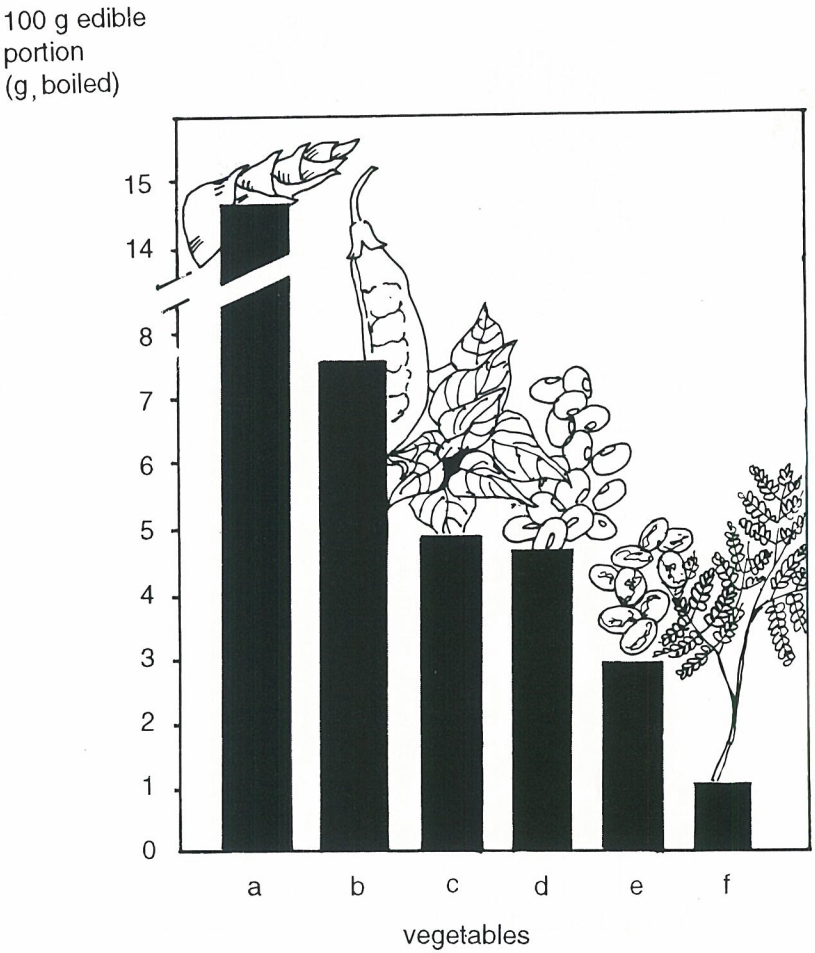
- prevents nutritional anemia

- good source of iodine



- ▲ onion, okra and asparagus are good sources of iodine
- ▲ prevents goiter

■ Good source of fiber



a - bamboo (dried shoots)
b - pigeon pea (dried seeds)
c - sweet potato (young purple leaves)
d - mungbean (yellow seeds)
e - red kidney beans
f - malunggay (leaves)

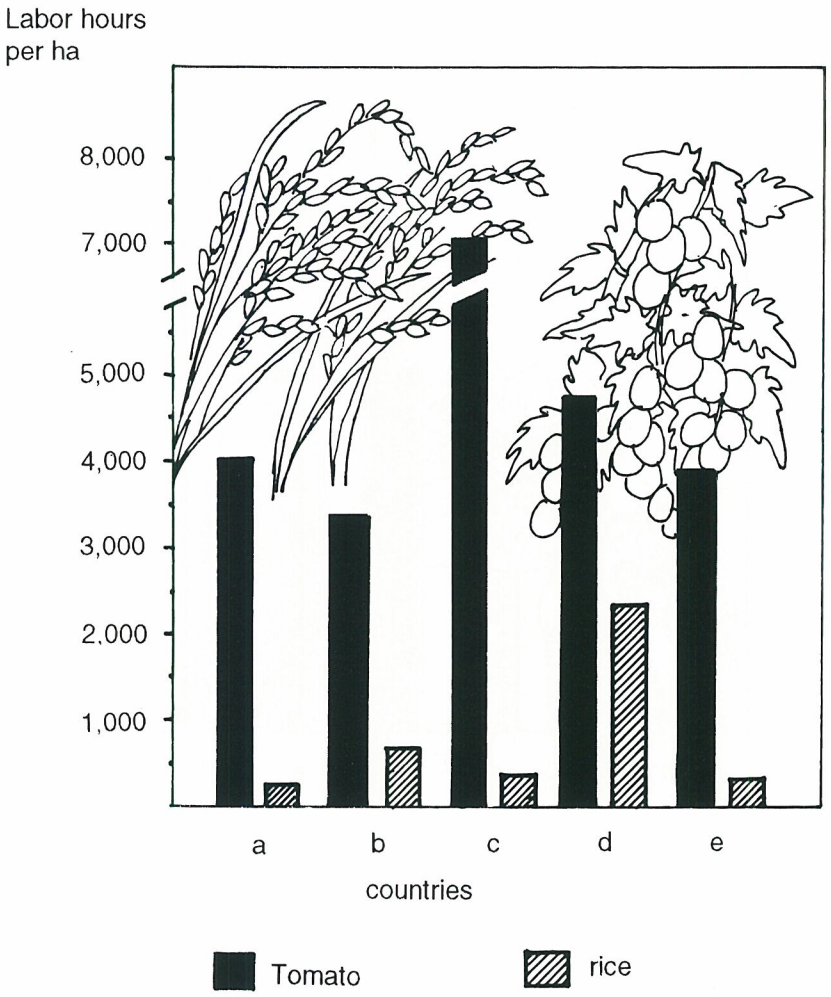
▲ Prevents constipation, gall stones and cancer of the colon.

■ Vegetables have some medicinal values

- lower high blood pressure
  Example: garlic

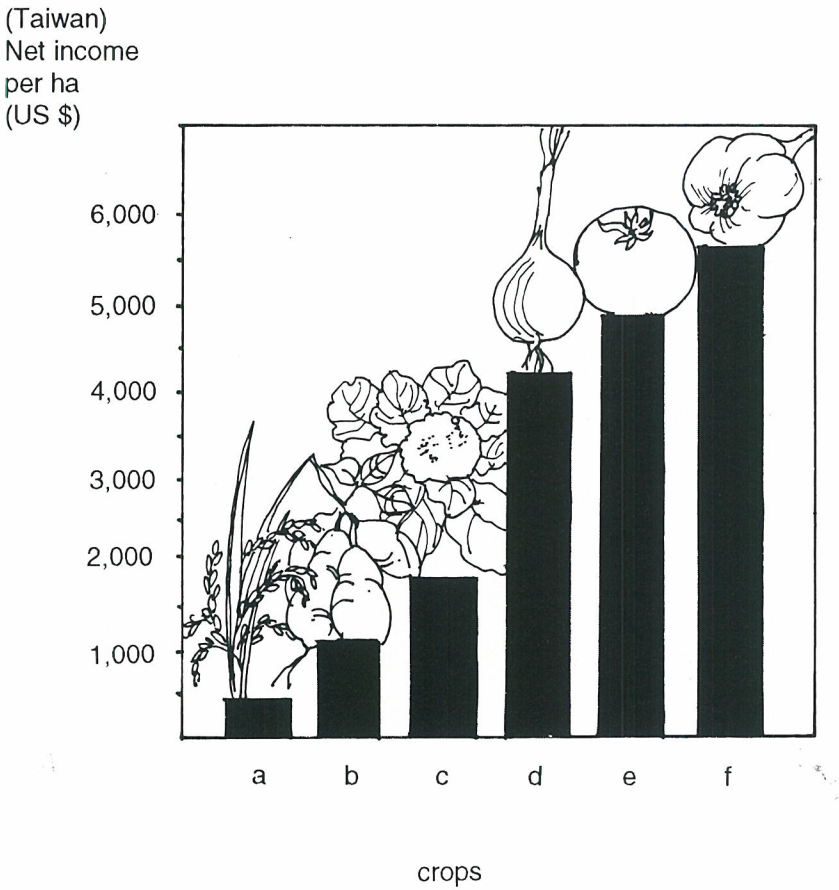
- prevent anemia
  Example: malunggay
- prevent night blindness
  Example: squash, carrot
- prevent rheumatism
  Example: garlic

■ Generate rural employment

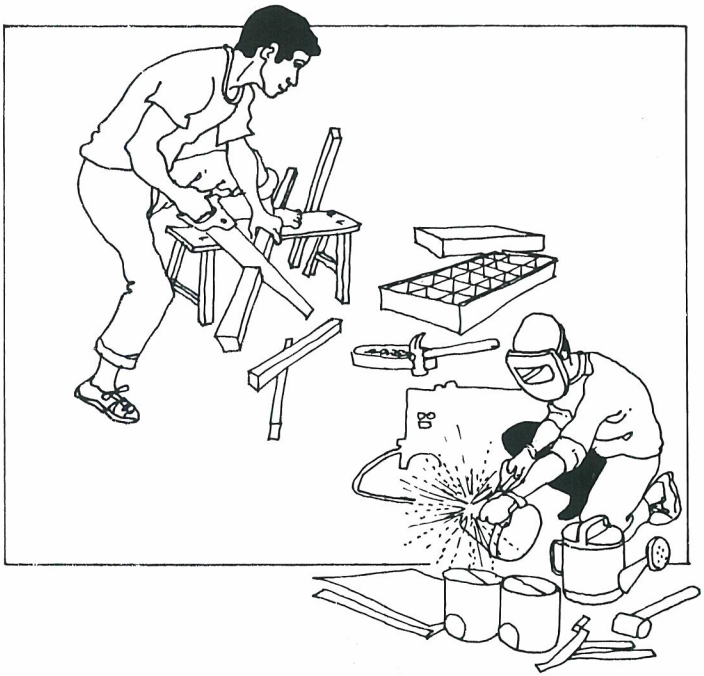


Production of tomatoes require more labor per hectare than rice.

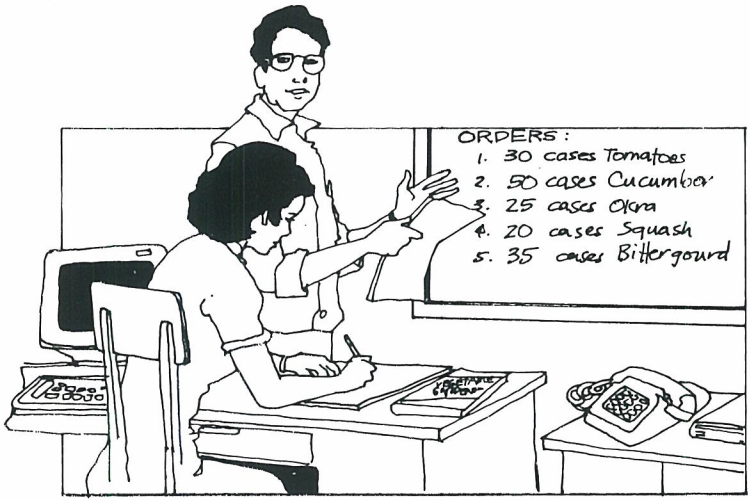
- Increase average income of farmers



- Stimulate urban employment



- provide business opportunities such as the manufacture of inputs and tools

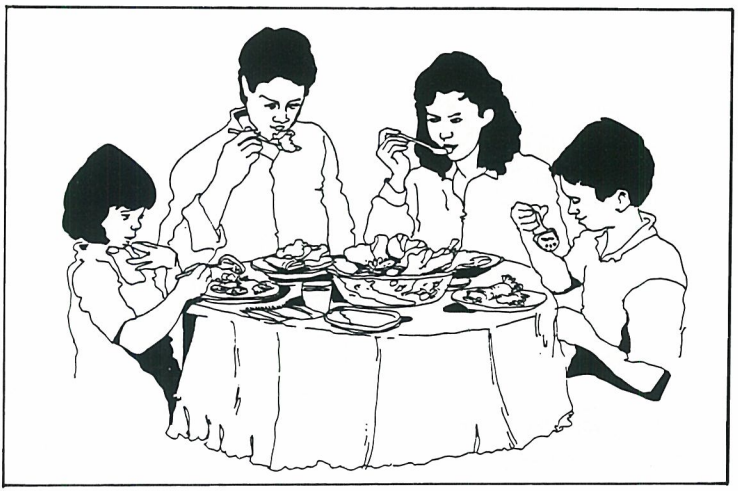


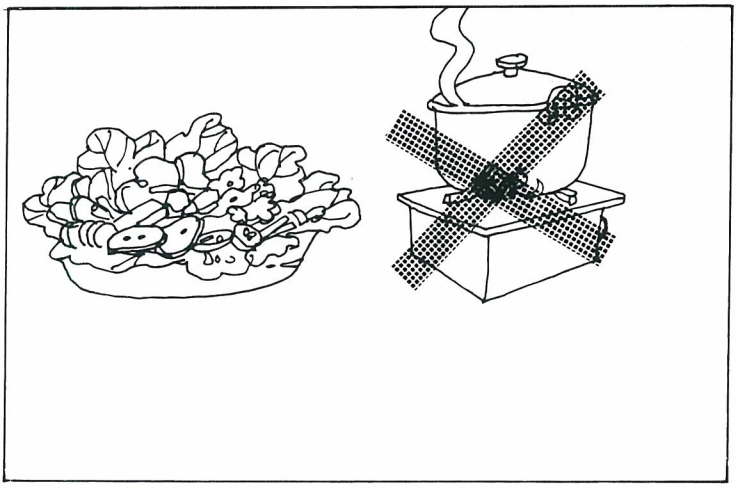
- handle business operations

- Expand exports

- source of foreign exchange

- Save energy

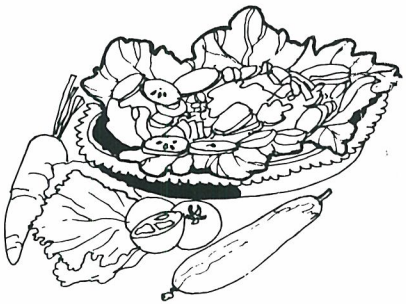




- Vegetables maybe eaten raw or partially cooked thus saving on fuel wood and/or gas for cooking.

Utilization

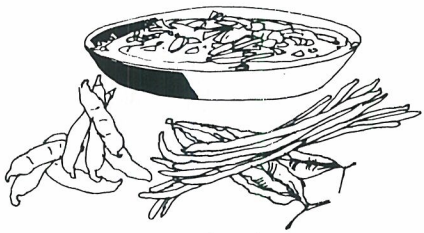
- Vegetables maybe prepared in various ways:



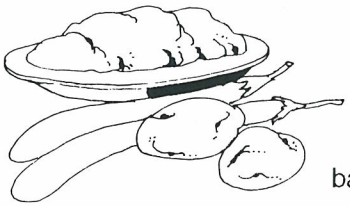
salads

side dish or mixed in a stew dish
or soup with meat or fish

boiled



sauteed



baked

- Vegetables maybe used as garnishings to decorate meat or fish

Classification of vegetables

There are many methods of classifying vegetables but the most common ones are:

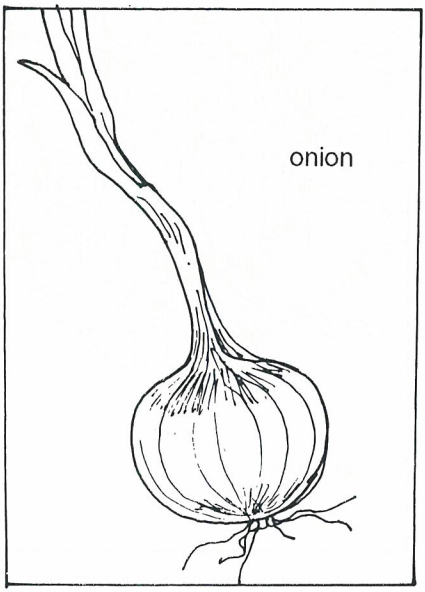
- botanical classification
  - Alliaceae or Allium Family
  - Brassicaceae (Cruciferae) or Mustard Family
  - Cucurbitaceae or Gourd Family
  - Solanaceae or Nightshade Family
  - Leguminaceae

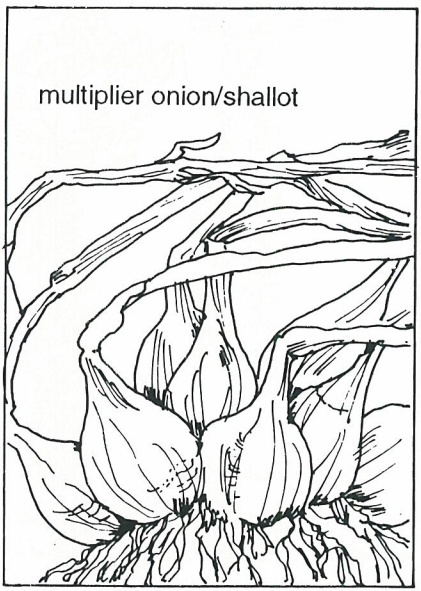
- temperature requirements
  - cool season
  - warm season

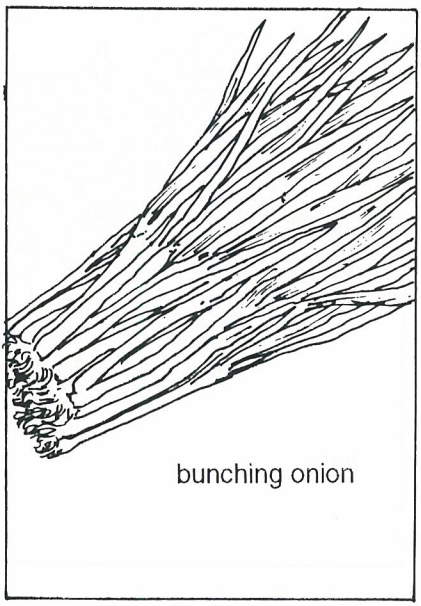
- parts used
  - leaves
  - fruits
  - roots/bulbs
  - flowers/curds
  - seeds

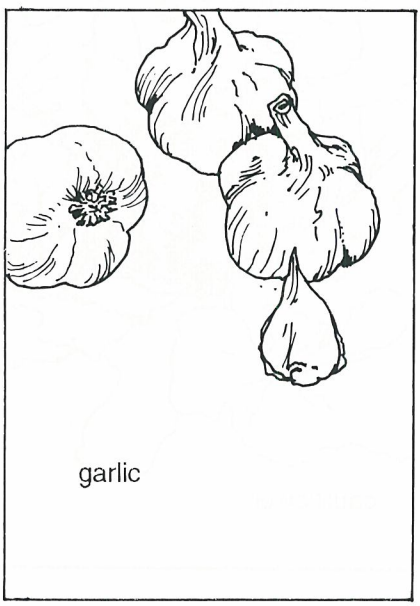
■ Botanical classification

- Alliaceae or Allium family

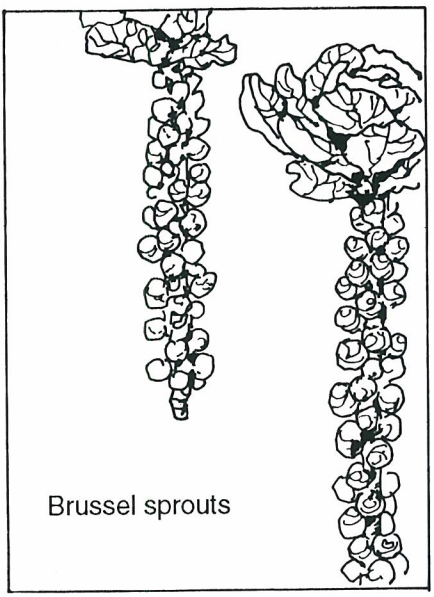


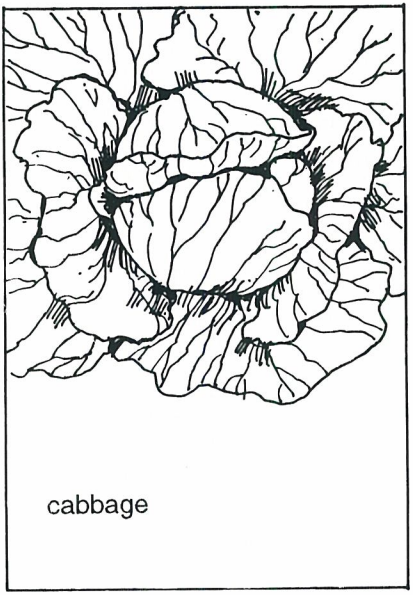




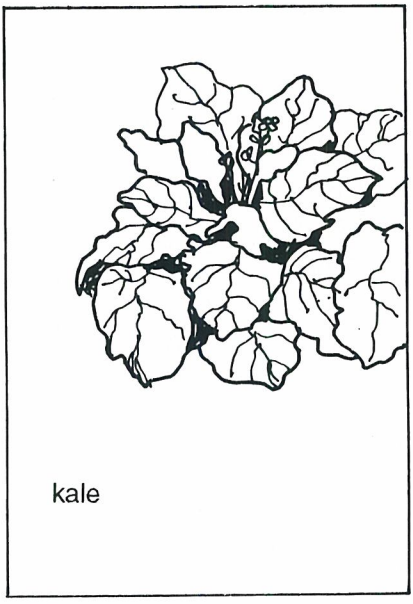


- Brassicaceae (Cruciferae) or mustard family


Brussel sprouts

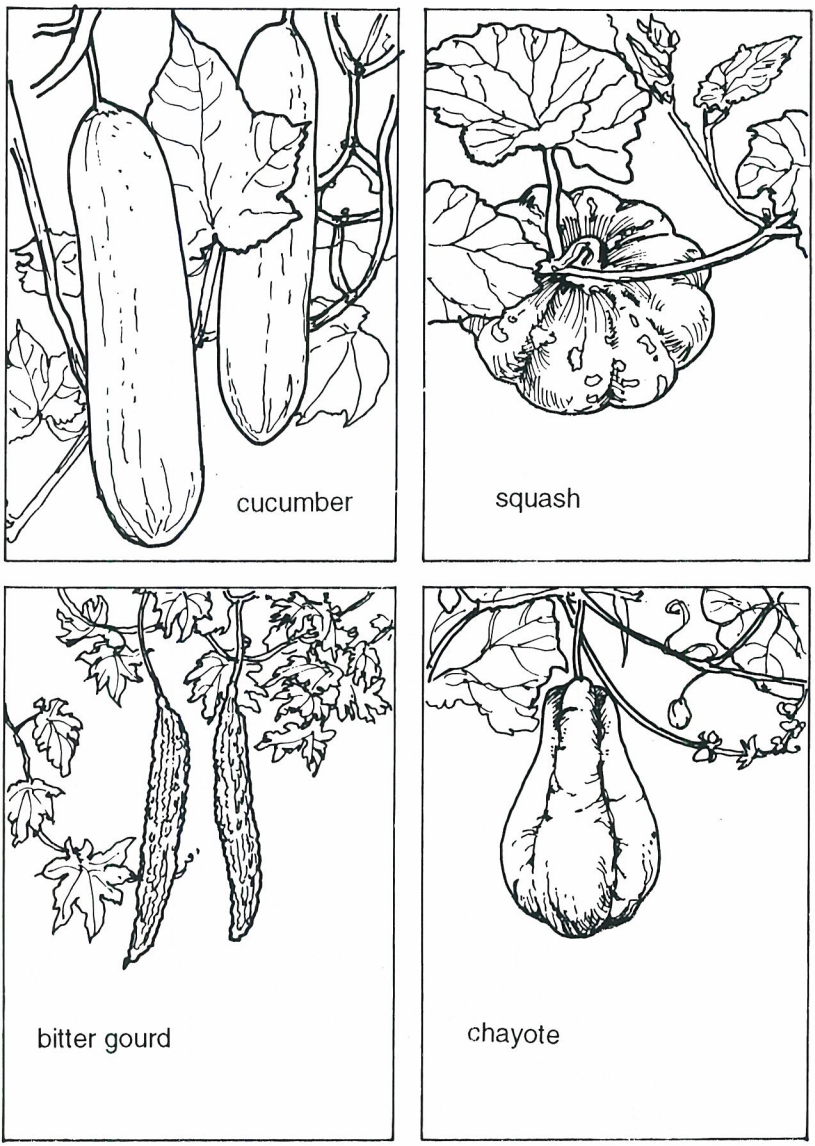

cabbage


cauliflower


kale

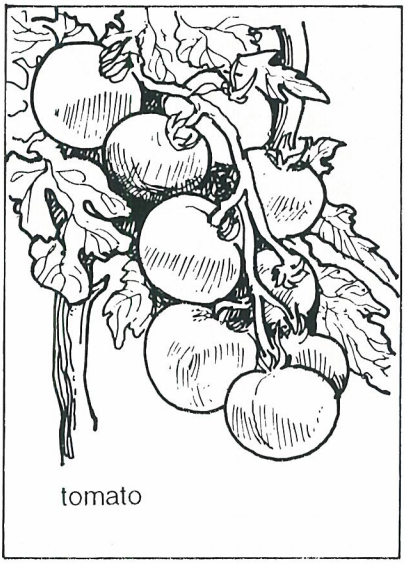
▲ Other crops belonging to this family are kohlrabi, mustard, rutabaga, turnip, pechay, Chinese cabbage, radish and watercress.

- Cucurbitaceae or gourd family

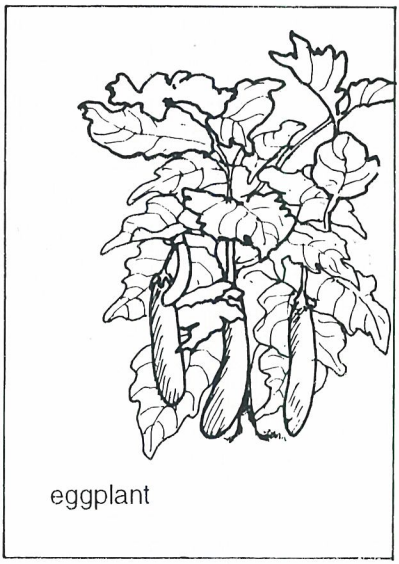


▲ Other crops belonging to this family are muskmelon, pumpkin, watermelon, bottle gourd, sponge gourd, wax gourd and snake gourd.

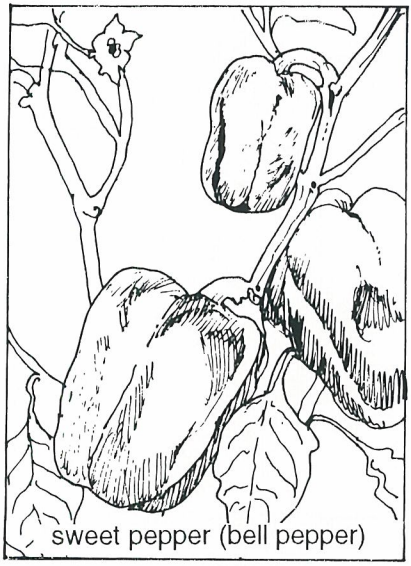
- Solanaceae or nightshade family



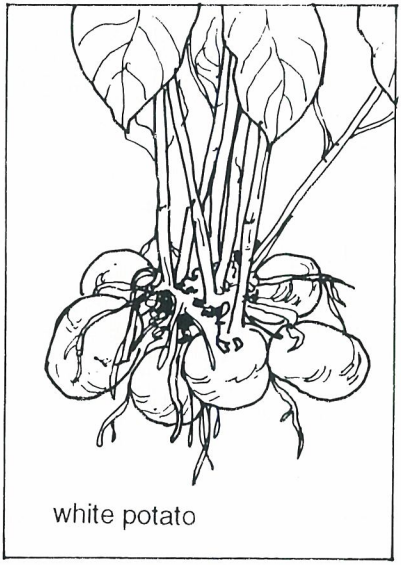
tomato



eggplant



sweet pepper (bell pepper)

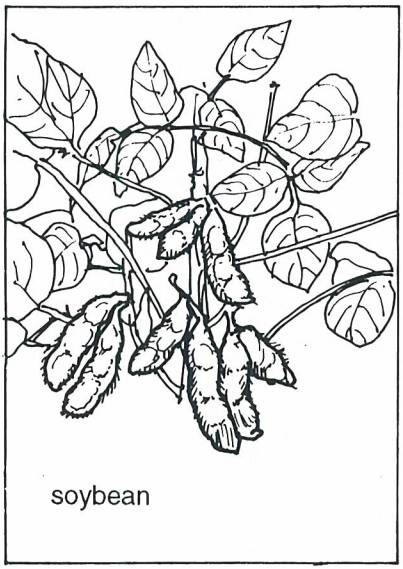


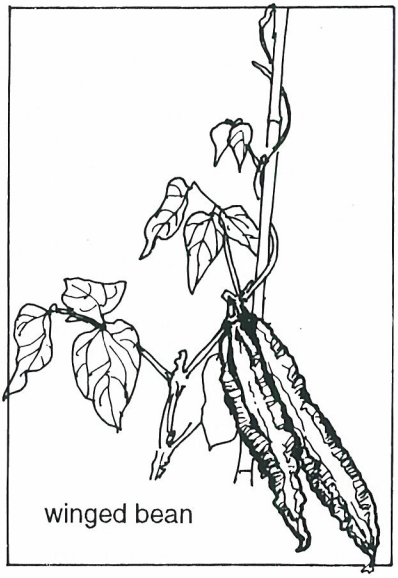
white potato

- Leguminaceae


yardlong bean


lima bean

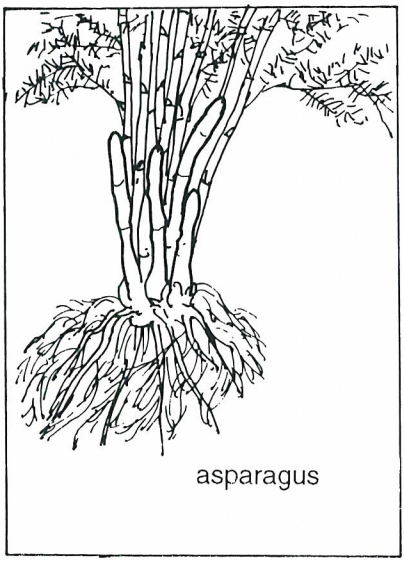

soybean

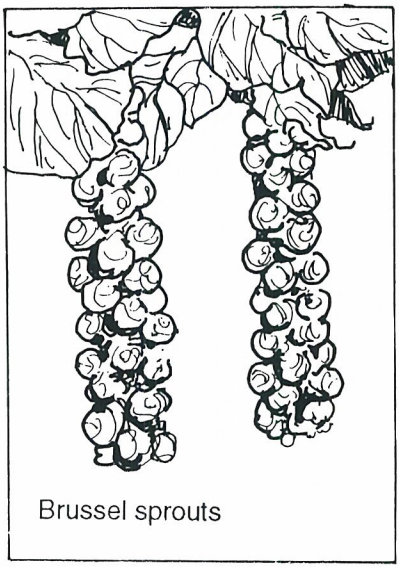

winged bean

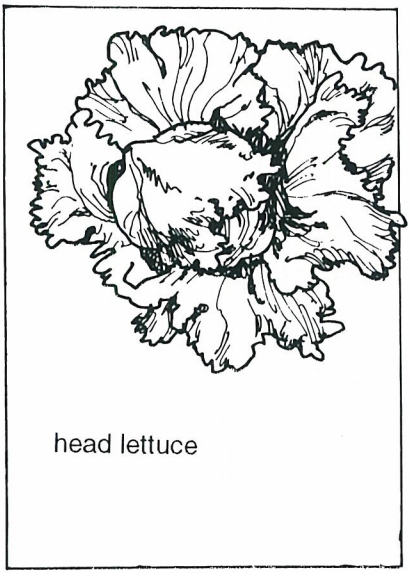
▲ Other crops belonging to this family are cowpea, hyacinth bean, kidney bean, chickpea, yambean, snapbean, pigeon pea and sweet pea.

■ Classification based on temperature requirements

- Cool season vegetables


asparagus

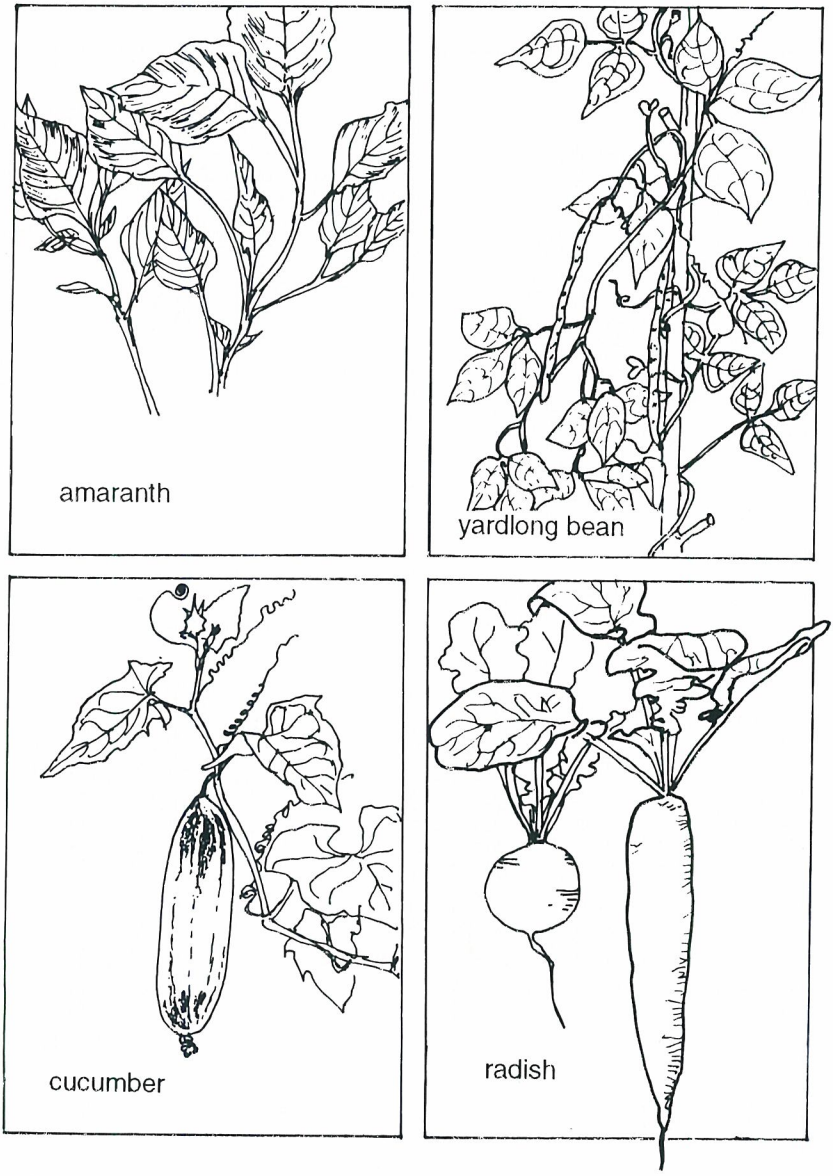

Brussel sprouts


head lettuce


kohlrabi

- ▲ Other crops include beet, cabbage, carrot, celery, chive,endive, leek, parsley, rhubarb, spinach, turnip, broccoli and water cress.
- ▲ Generally grown during cool season of the year.
- ▲ Grown at highlands throughout the year.

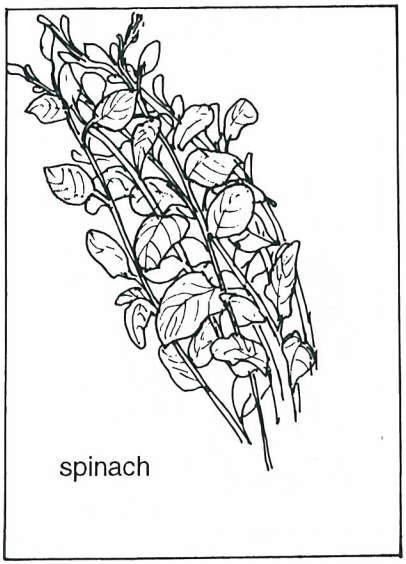
- Warm season vegetables

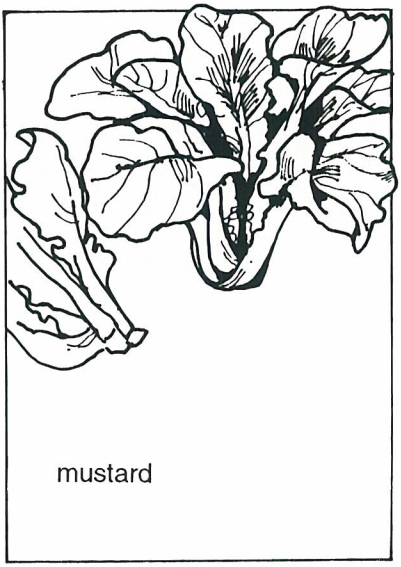


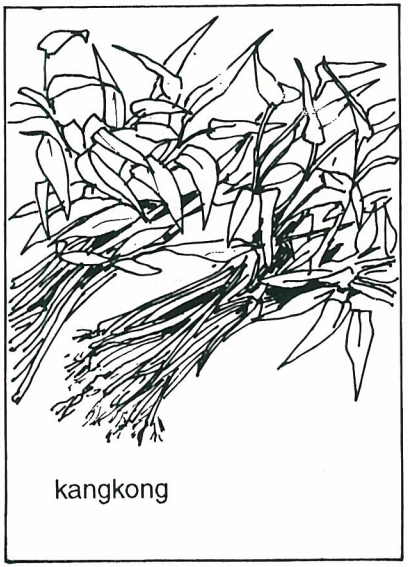
▲ Most of the lowland vegetables belong to this classification.

■ Classification based on principal parts used

- Leaves (petioles & young tops)

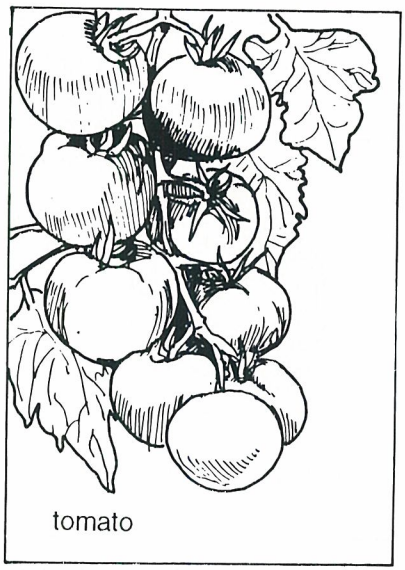




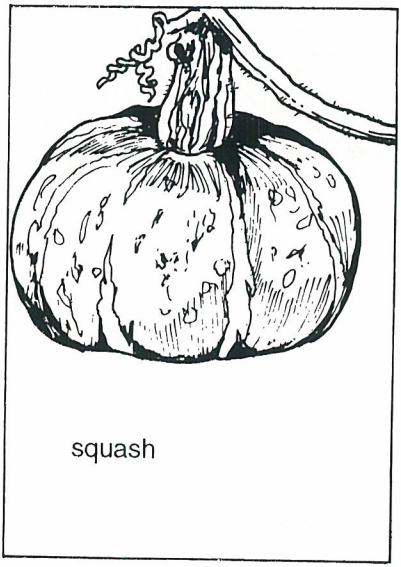


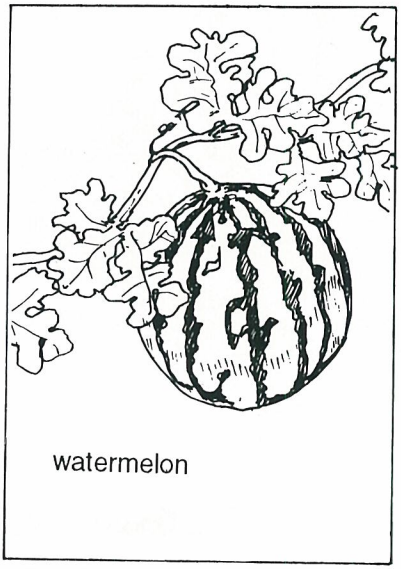
▲ Most crops include indigenous crops with edible leaves throughout the tropics (cassava, ipil-ipil, malunggay, amaranth, celery, sweet potato).

- Fruits

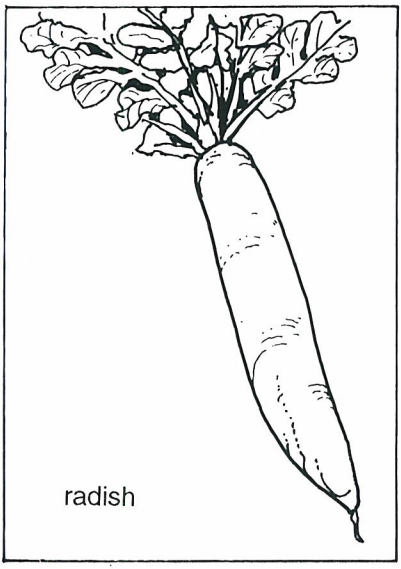

tomato

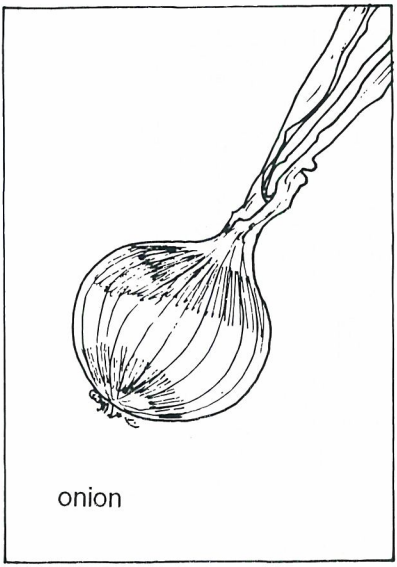

eggplant

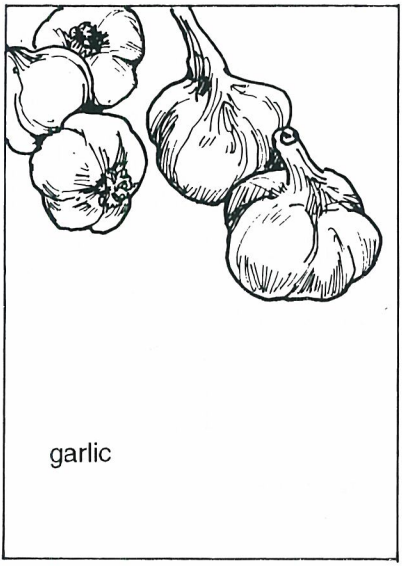

squash

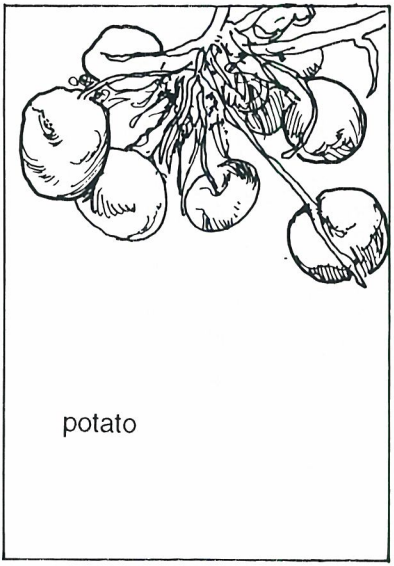

watermelon

- Roots/bulbs/tubers

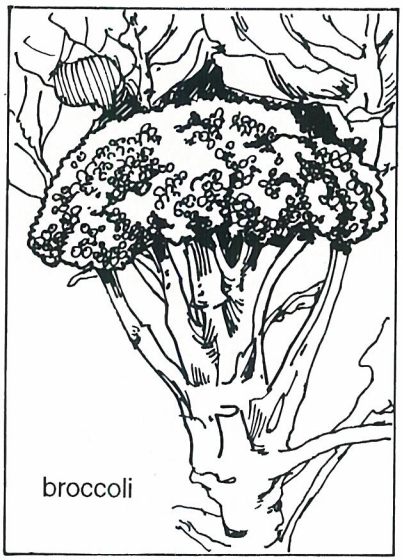

radish

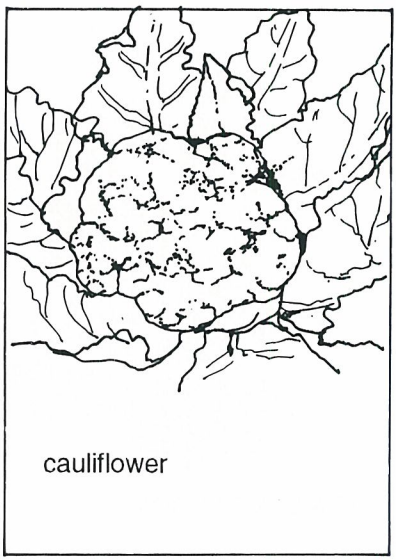

onion

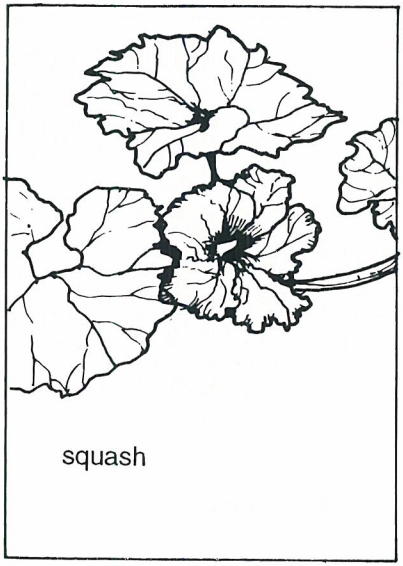

garlic


potato

- Flowers/curd


broccoli

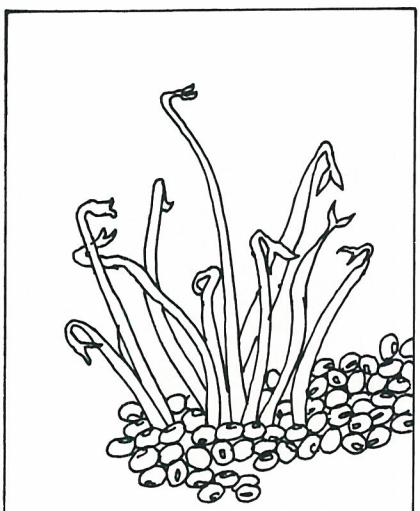

cauliflower


squash

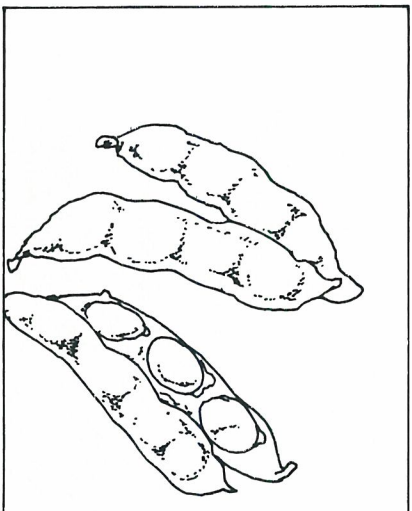

mustard

Other crops include malunggay, katuray, kale and banana.

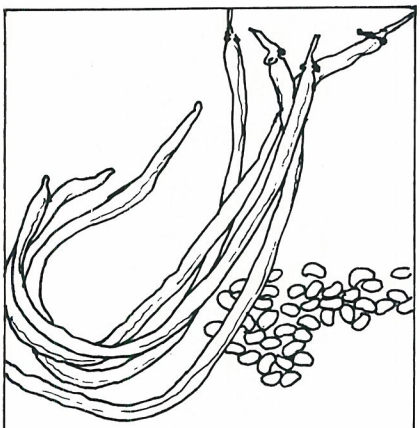
- Seeds



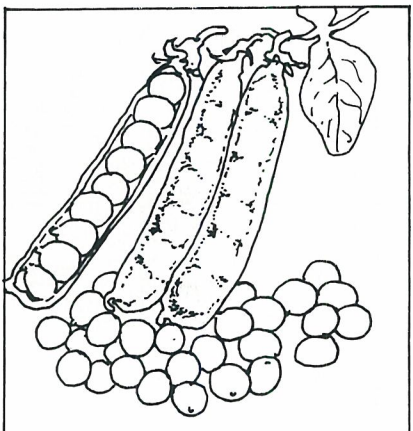
mungbean sprouts



vegetable soybean



yardlong bean

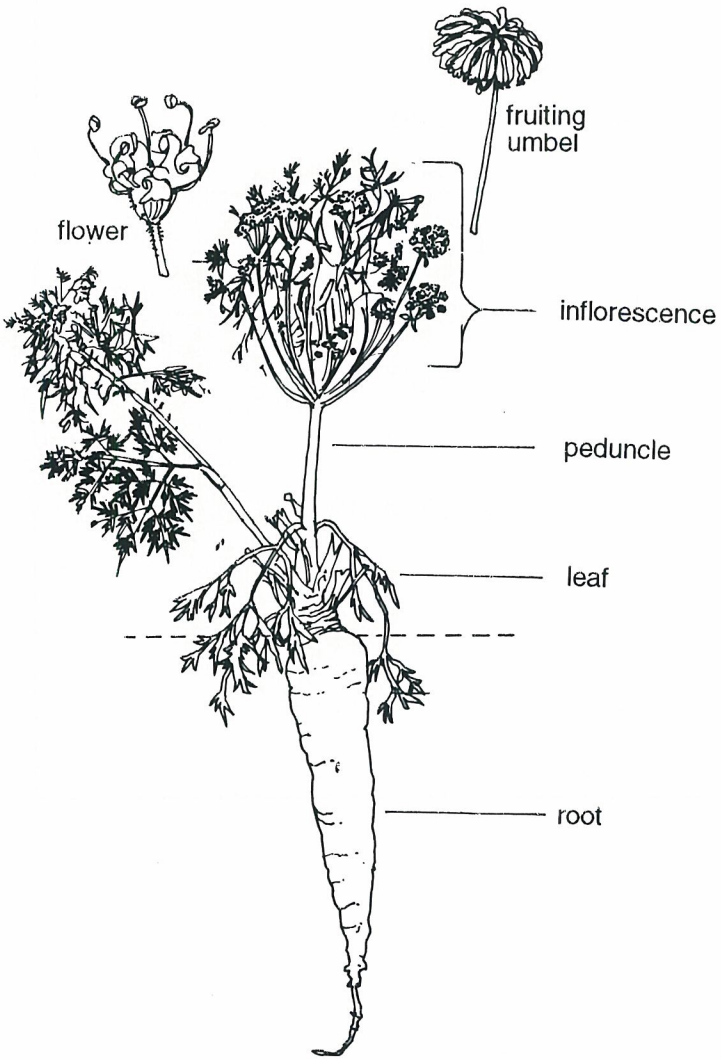


garden peas

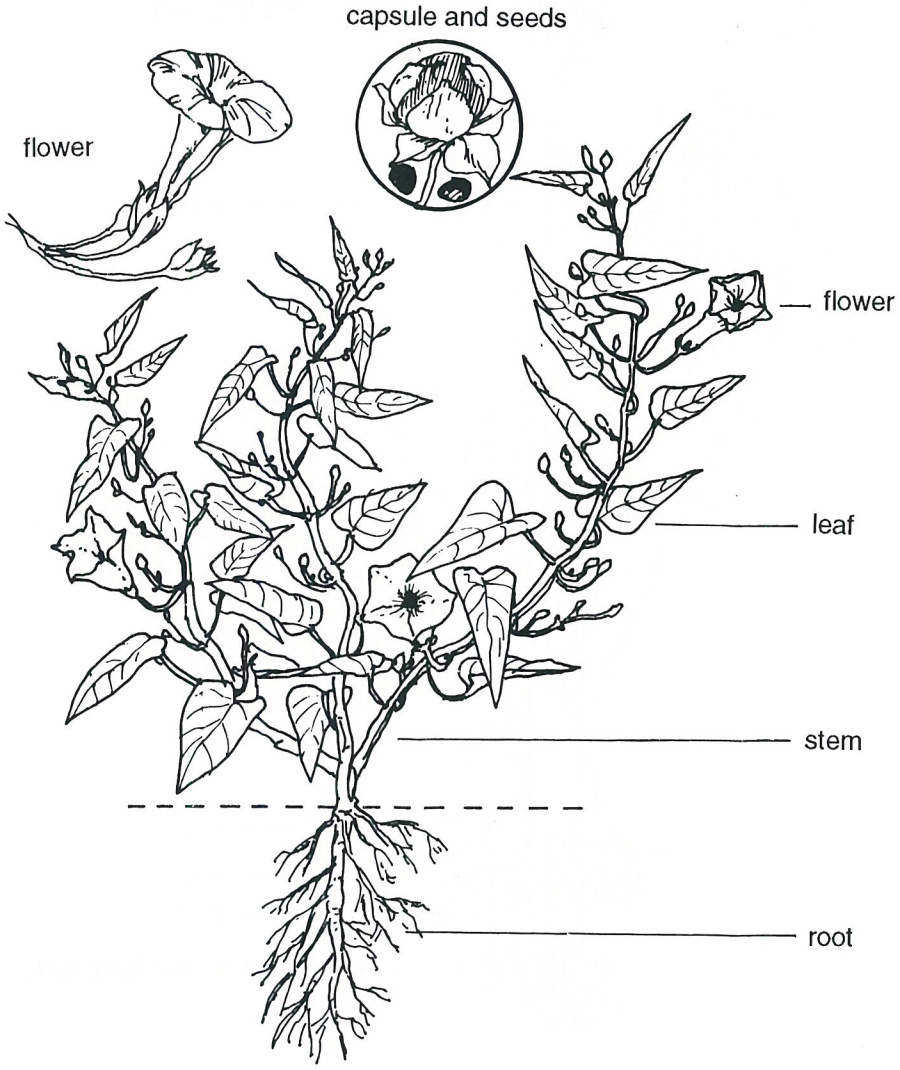
Parts of Selected Vegetables

- carrot
- kangkong
- onion
- pechay
- squash
- tomato
- yardlong bean

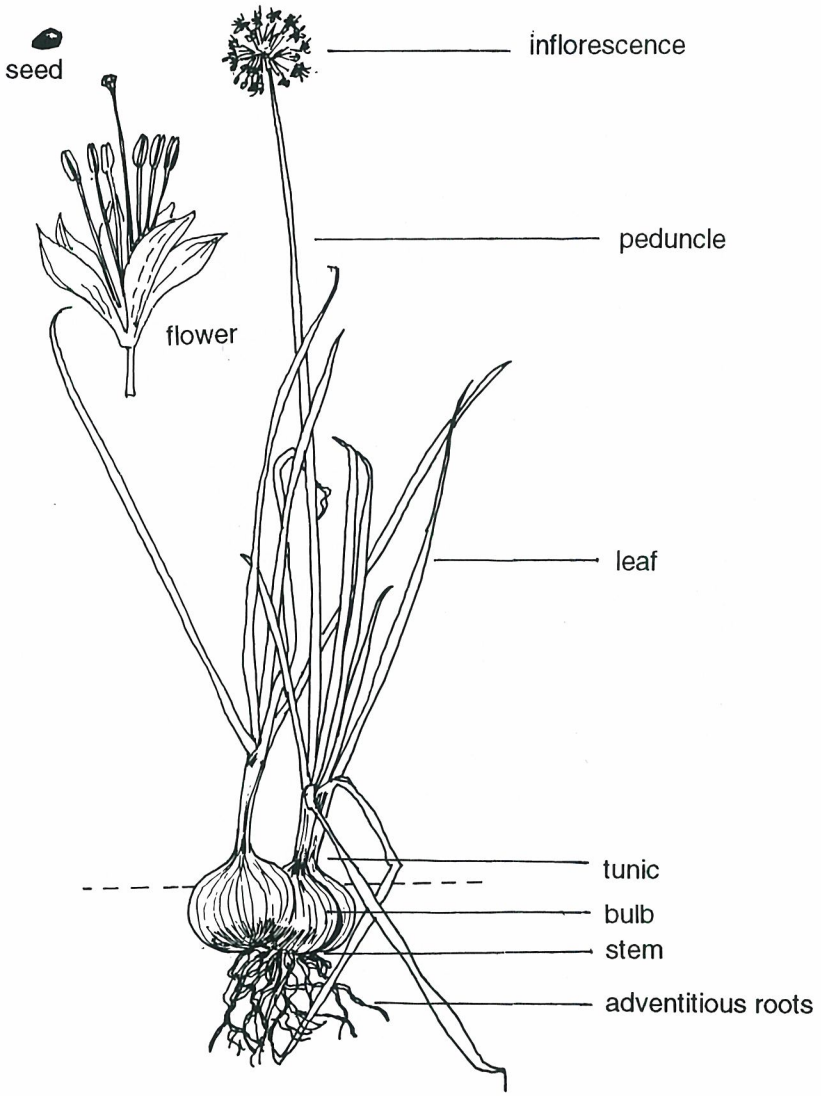
Carrot



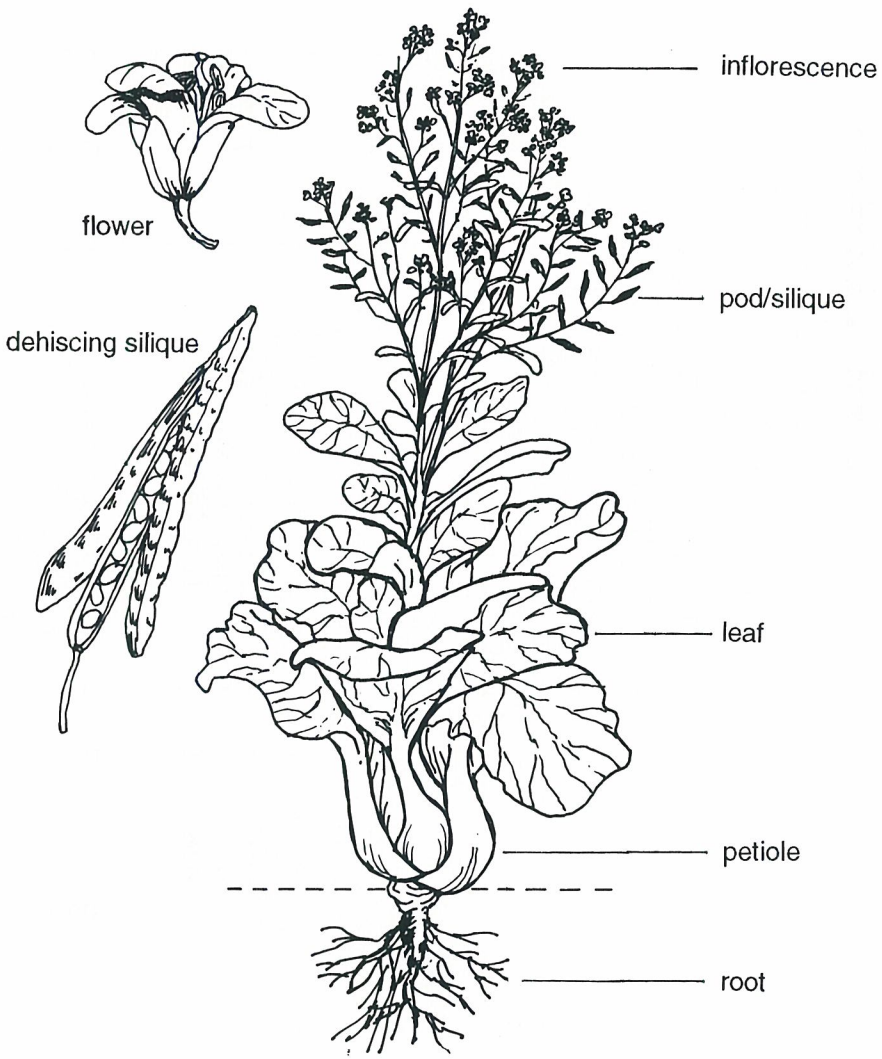
Kangkong



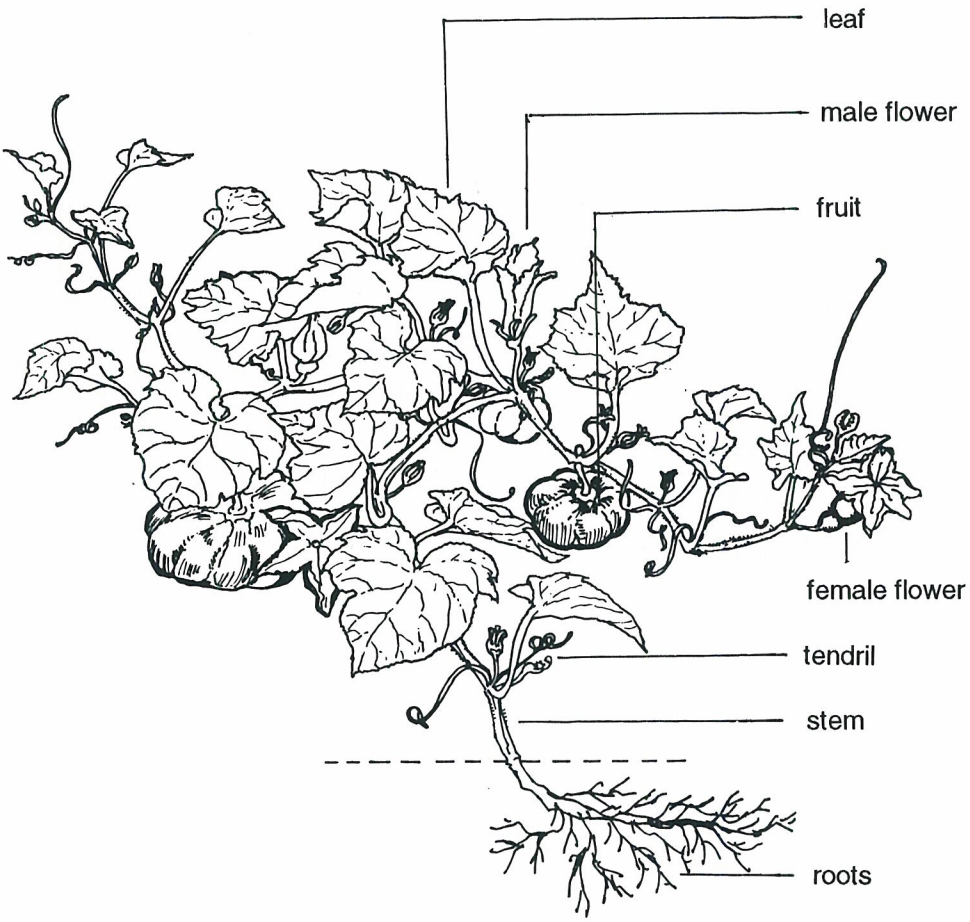
Onion


seed
inflorescence
peduncle
flower
leaf
tunic
bulb
stem
adventitious roots

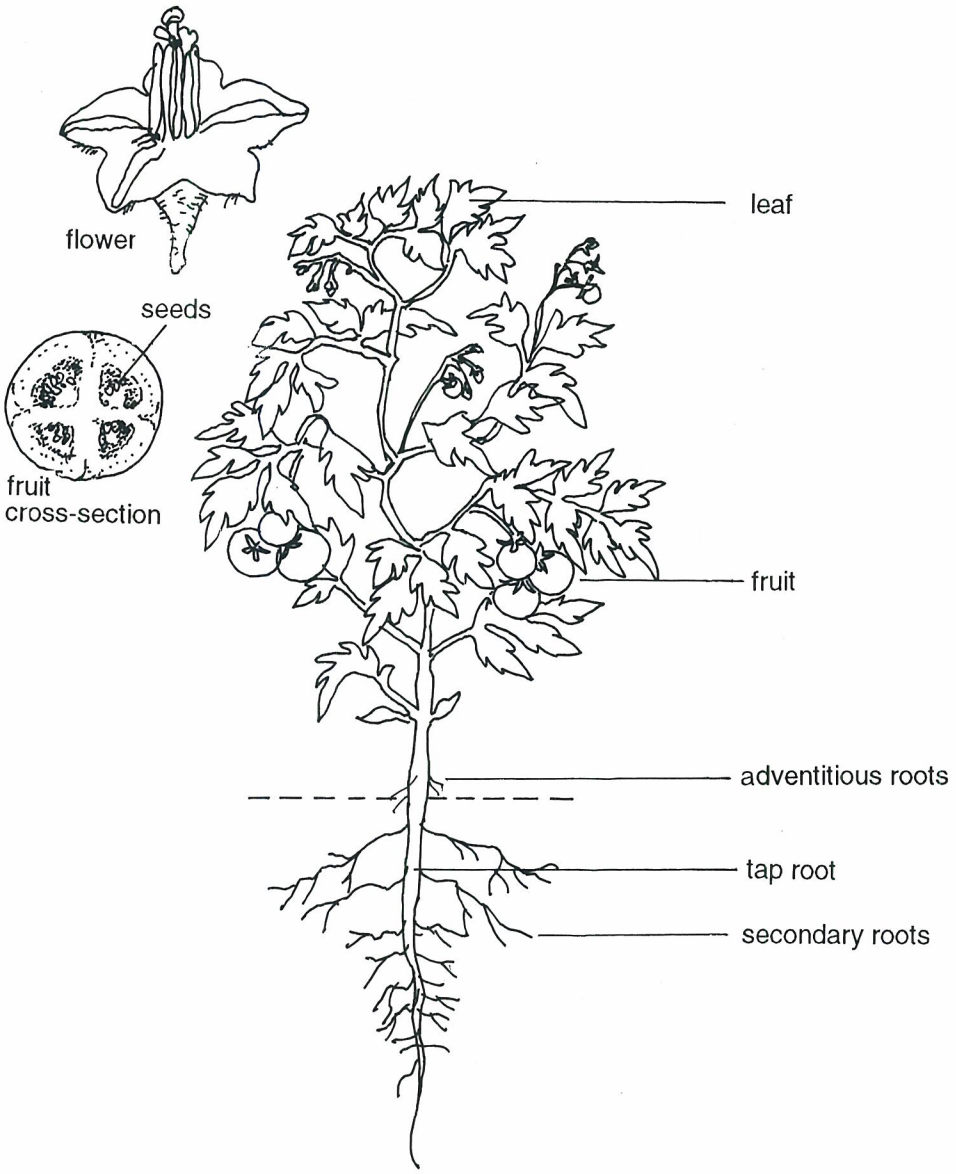
Pechay


inflorescence
flower
pod/silique
dehiscing silique
leaf
petiole
root

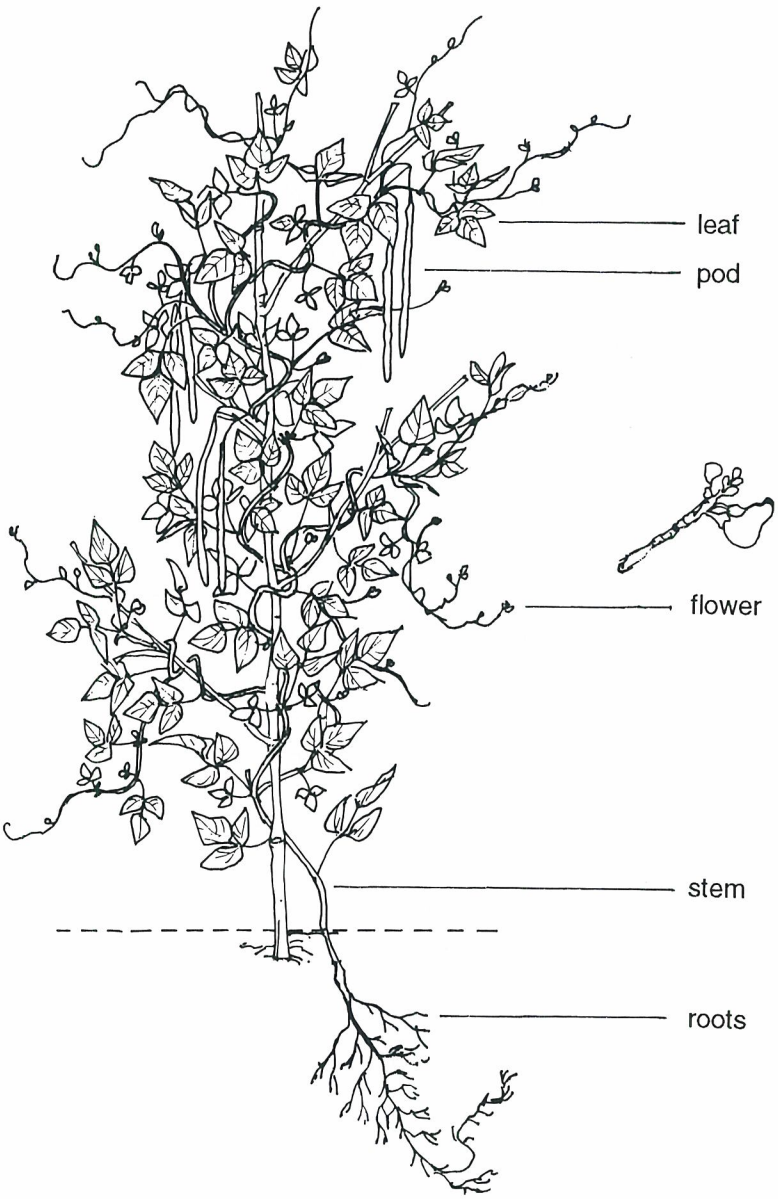
Squash



Tomato


flower
seeds
fruit
cross-section
leaf
fruit
adventitious roots
tap root
secondary roots

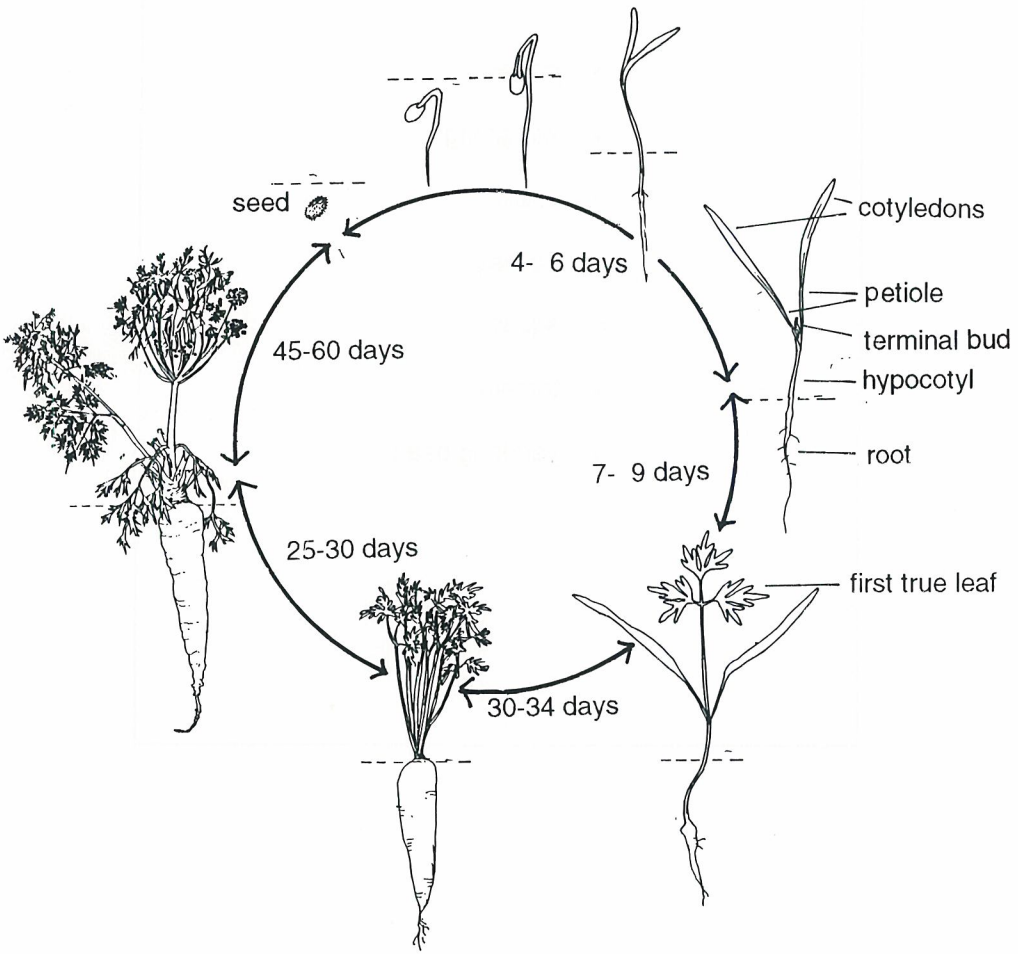
Yardlong bean



Life cycles of selected vegetables

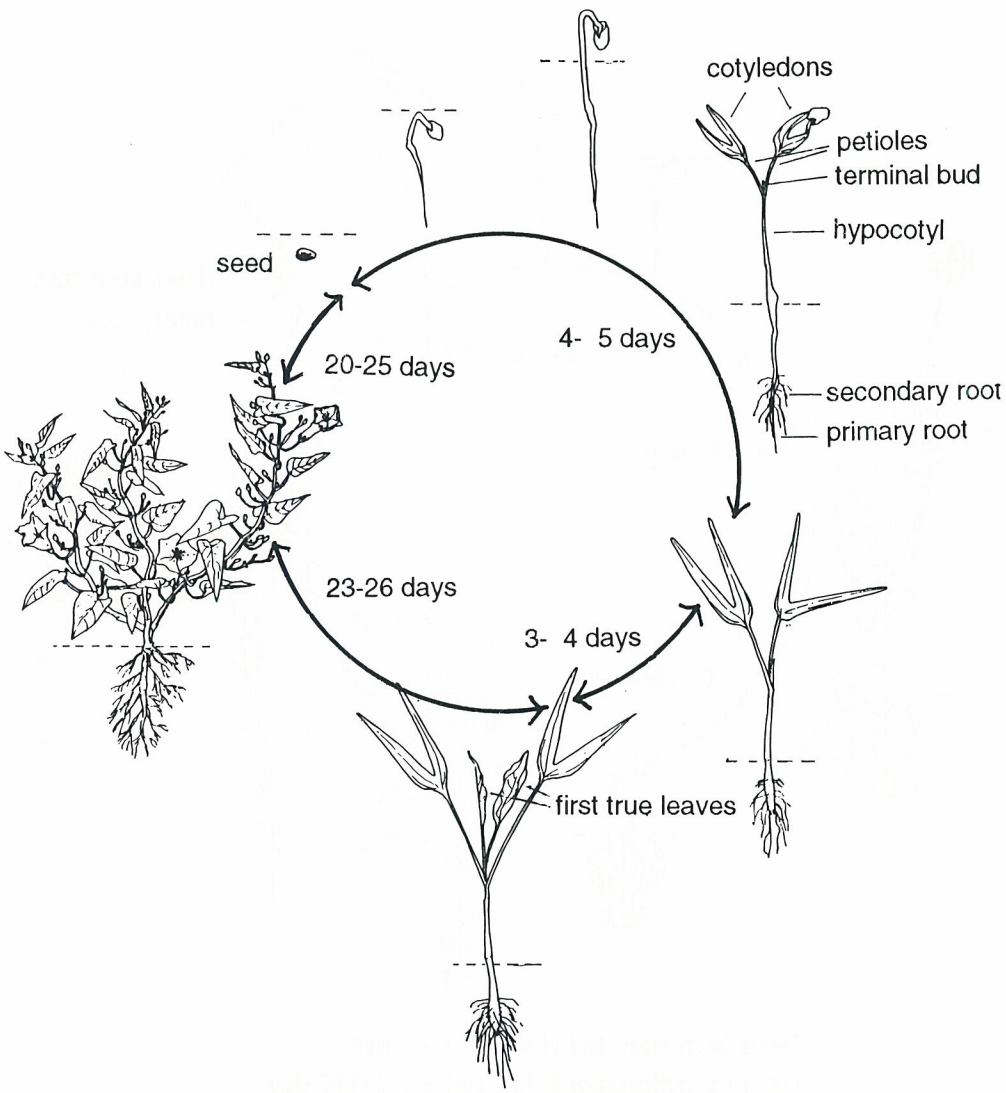
- carrot
- kangkong
- onion
- pechay
- squash
- tomato
- yardlong bean

Life cycle of carrot



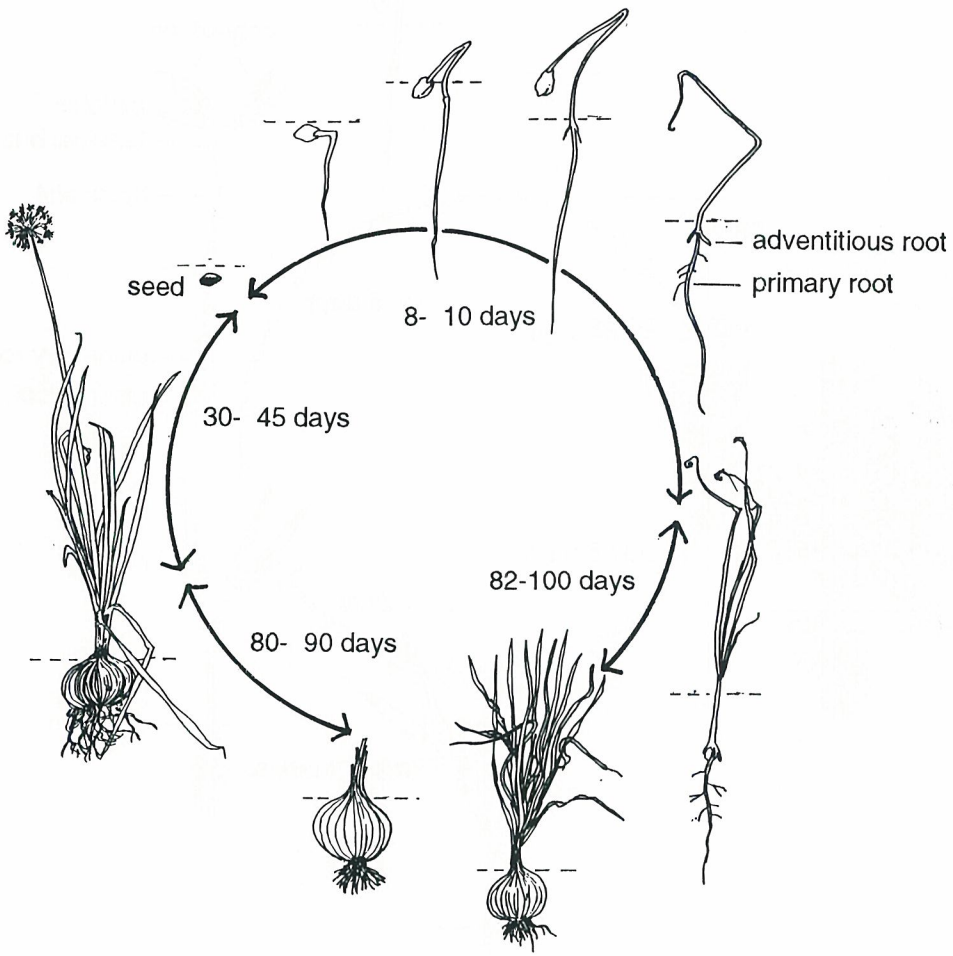
Days from seed to seed = 130-160 days

Life cycle of kangkong



Days from seed to seed = 50-60 days

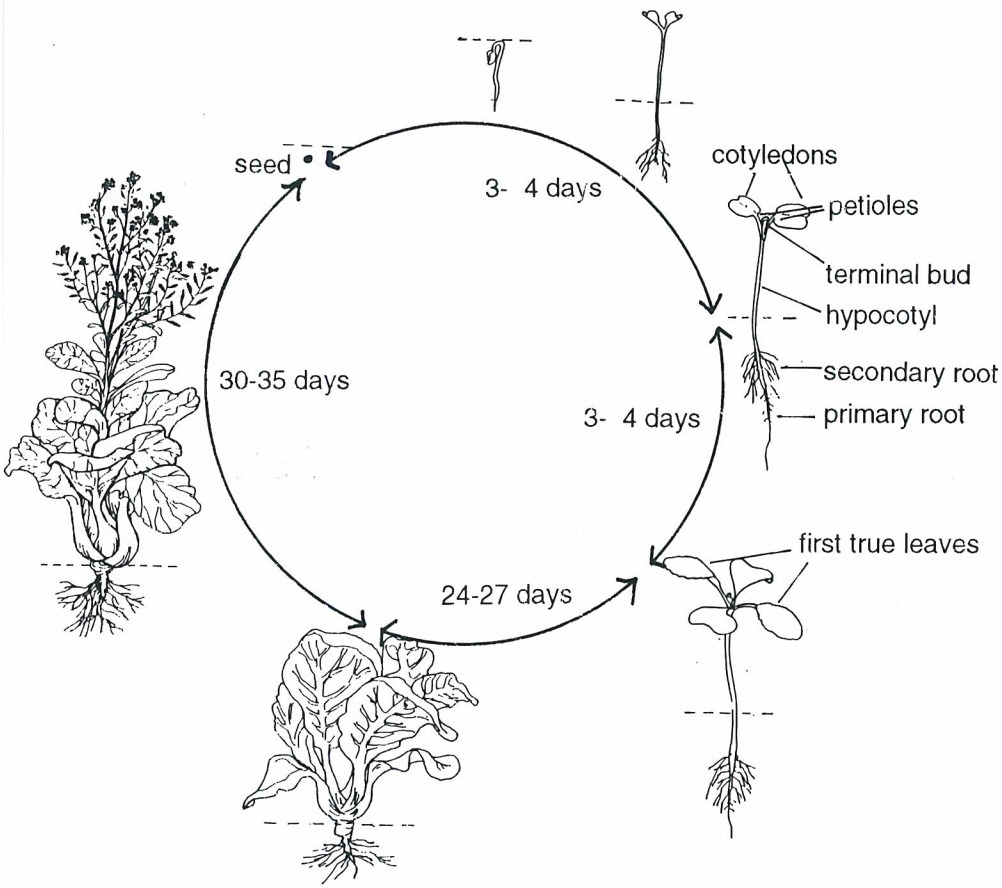
Life cycle of onion



Days from seed to bulb = 90-110 days
Days from stored bulb to seed = 110-135 days

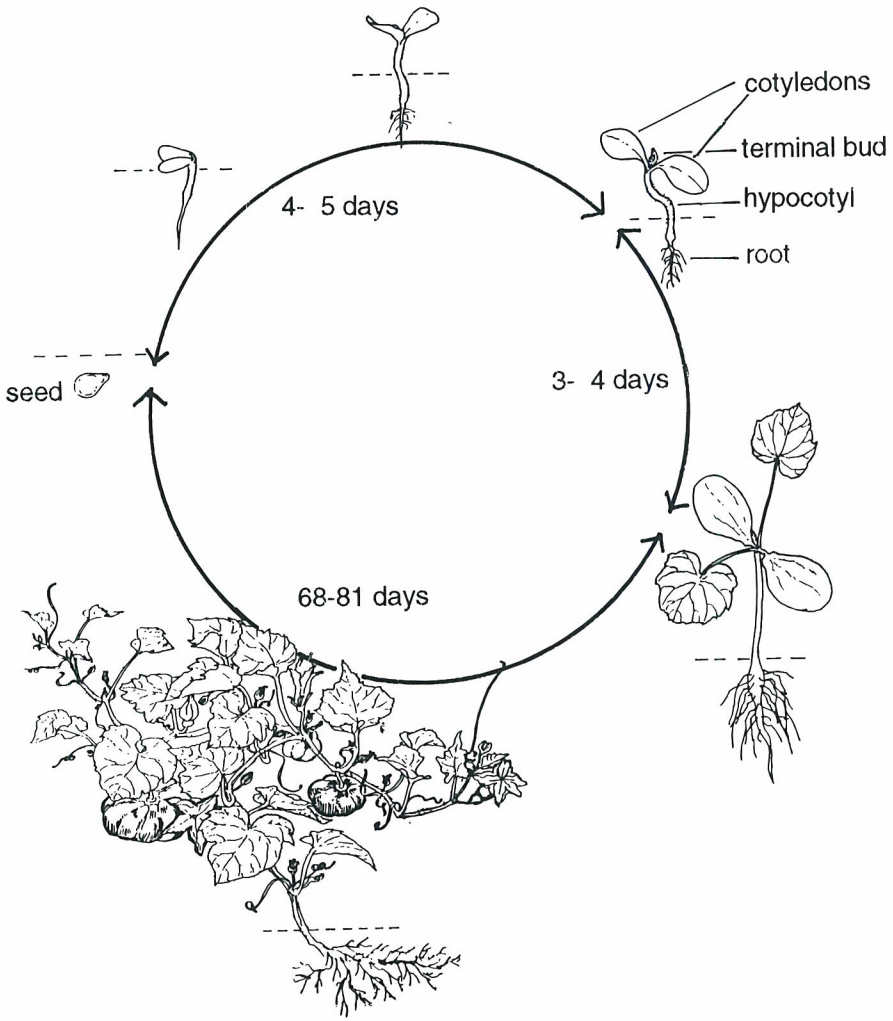
Newly harvested bulbs are kept in cold storage for about 3 months before planting for seed production.

Life cycle of pechay



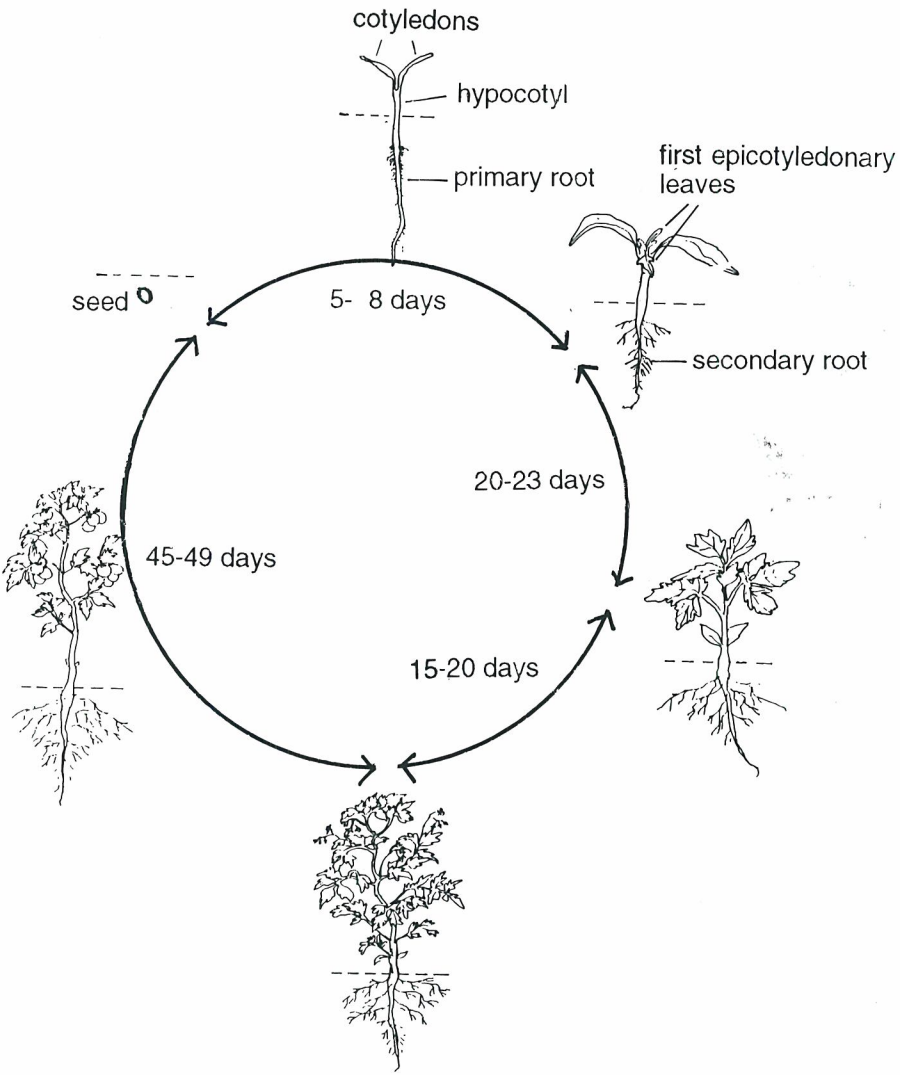
Days from seed to seed = 60-70 days

Life cycle of squash



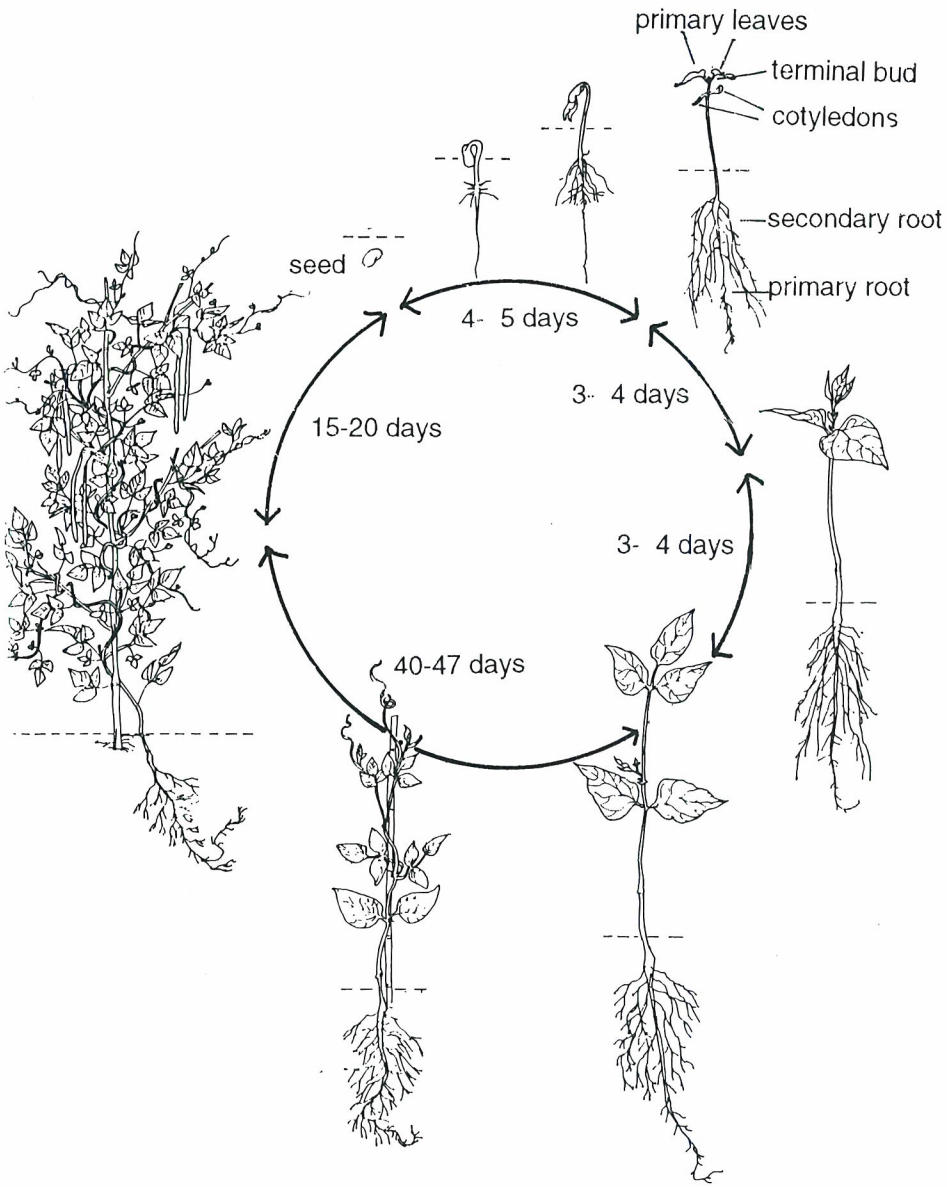
Days from seed to seed = 75-90 days.

Life cycle of tomato



Days from seed to seed = 85-100 days

Life cycle of yardlong bean



Days from seed to seed = 65-80 days

CHAPTER II. VEGETABLE GARDENING

What is a vegetable garden

Importance

Types

- home garden
- school garden
- community garden
- growing in containers

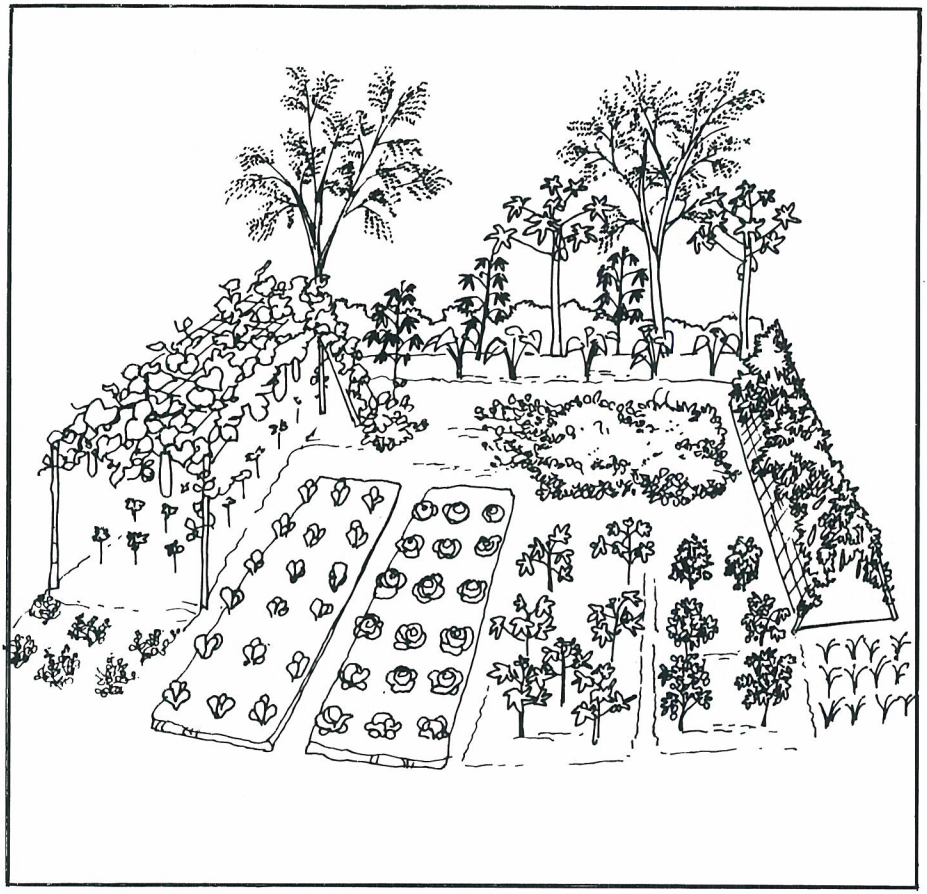
Planning a garden

- site selection
- size of garden
- selection of vegetables
- planting plan
  - ▲ relay cropping
  - ▲ intercropping

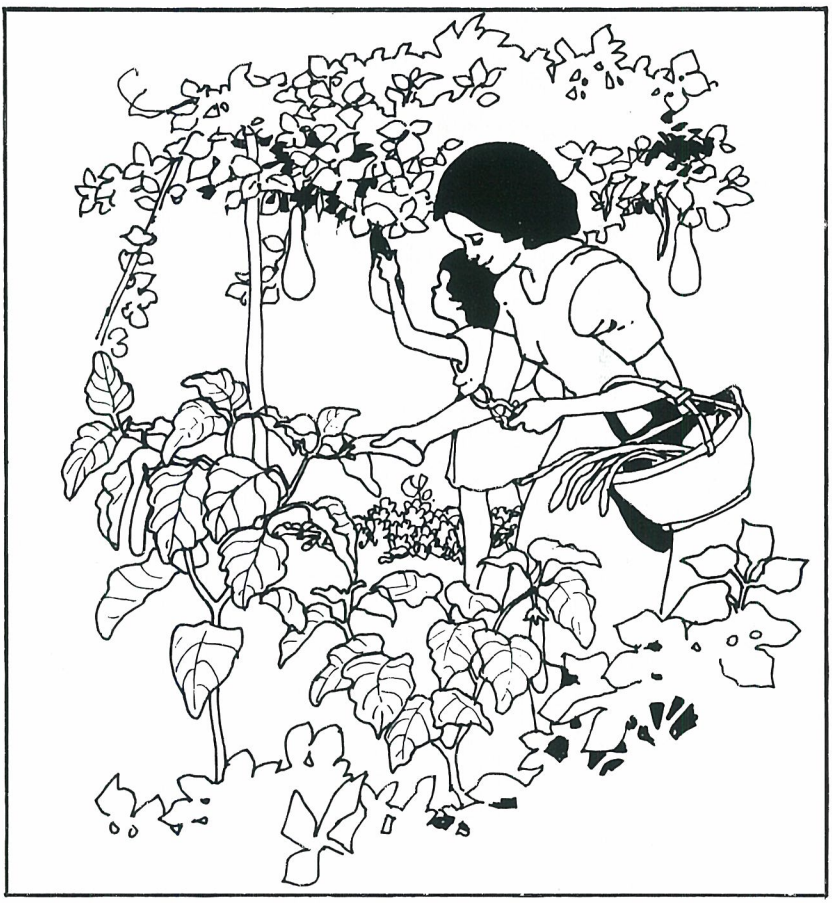
Fencing

Tools used in vegetable gardening

What is a vegetable garden



- A vegetable garden is an intensive type of growing vegetables to minimize buying from the market and to provide continuous supply of fresh and nutritious vegetables for the family.



- Marketing and postharvest problems are eliminated since a gardener chooses the crop he wants most and harvests them as they are ready for the table.

Importance of vegetable gardening

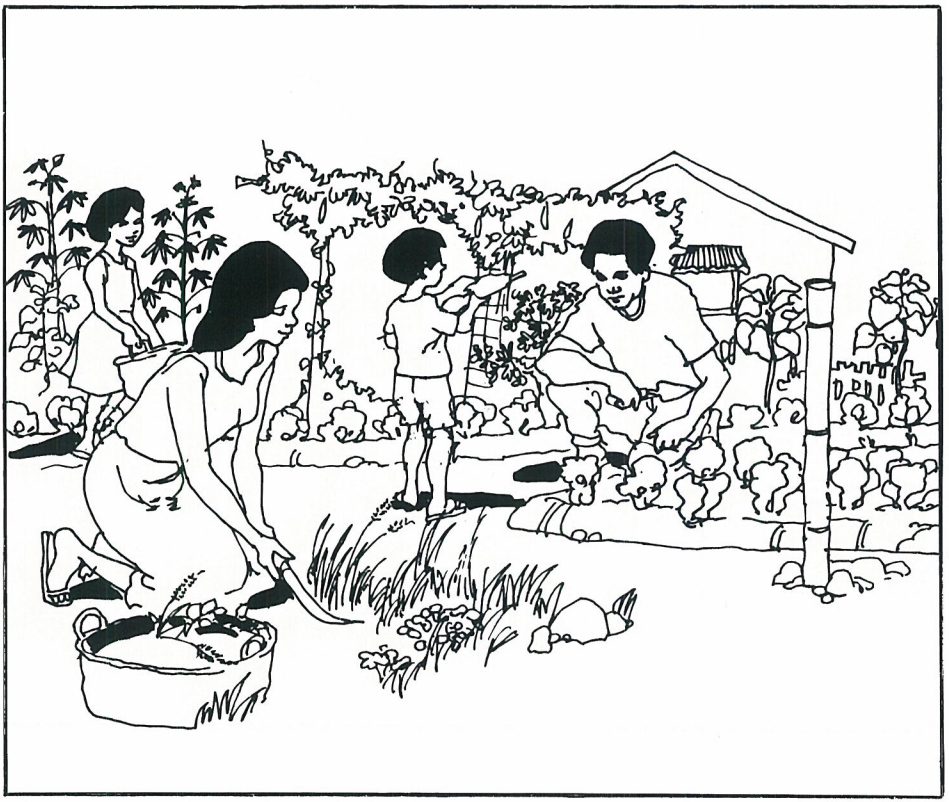
- contributes to family nutrition

- reduces cash outlay for food

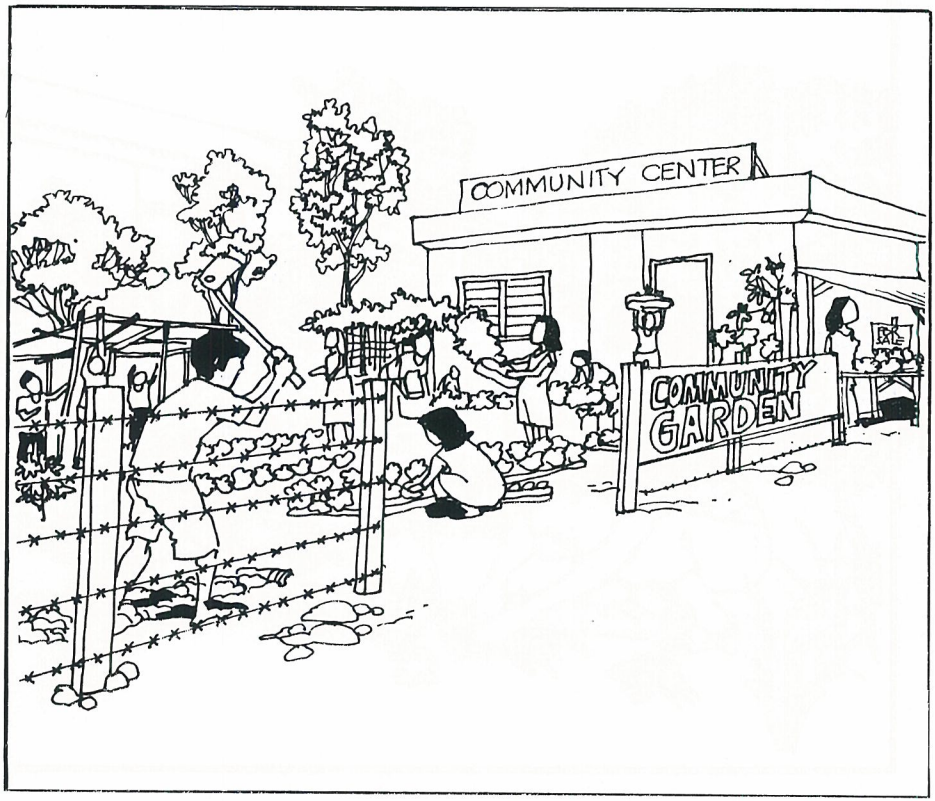
- eliminates the need to procure financing loans to be able to produce vegetables

- provides additional income

- provides good exercise and leisure time
- gives opportunity for the family to work together and strengthen ties

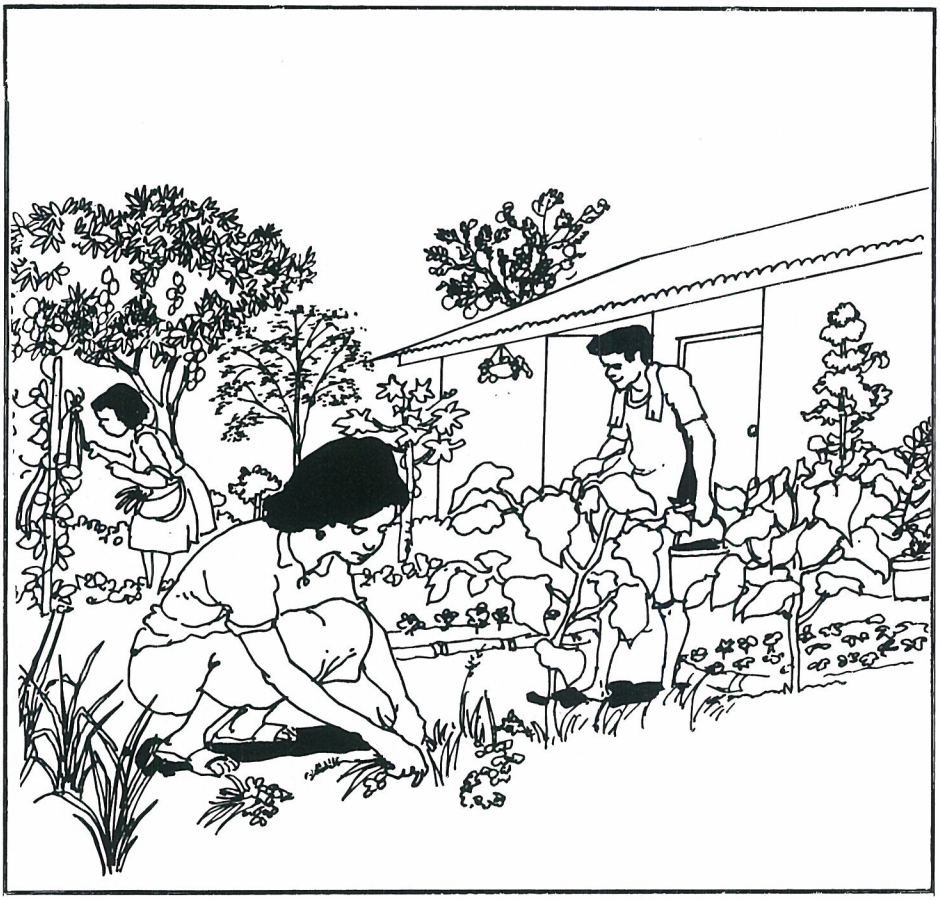


- encourages cooperation among neighbors



Types of Vegetable Gardens

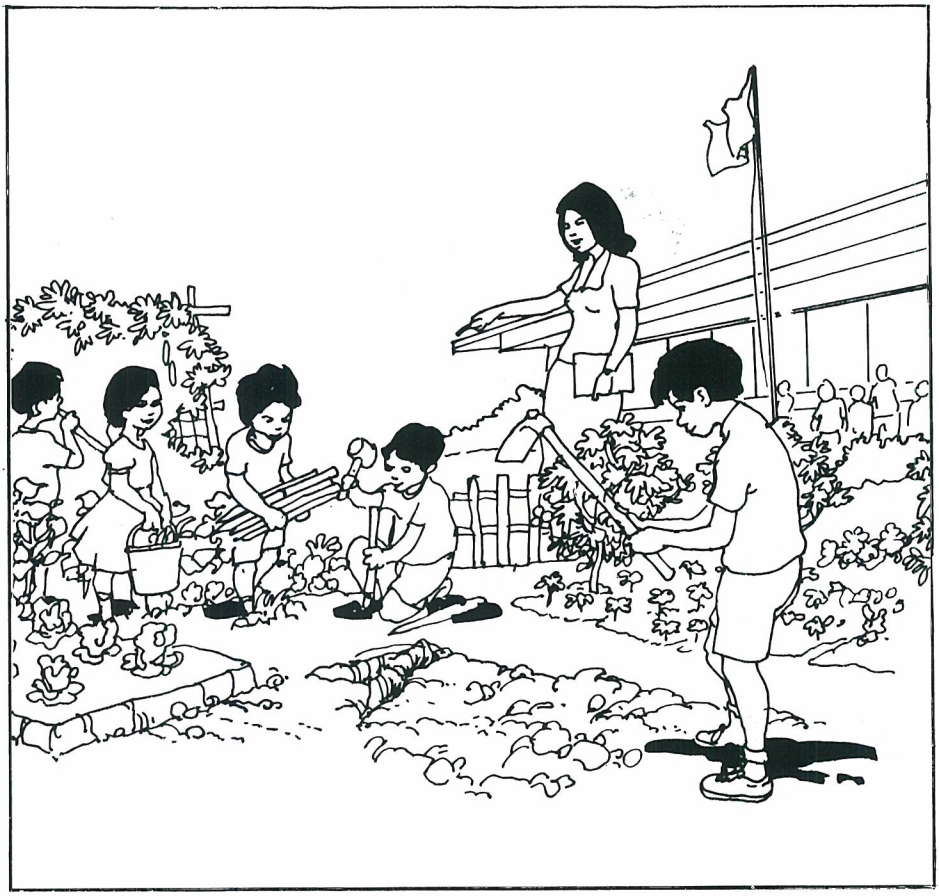
- **Home garden**



▲ Raising of different kinds of vegetables to provide a supplementary source of essential nutrients for the family.

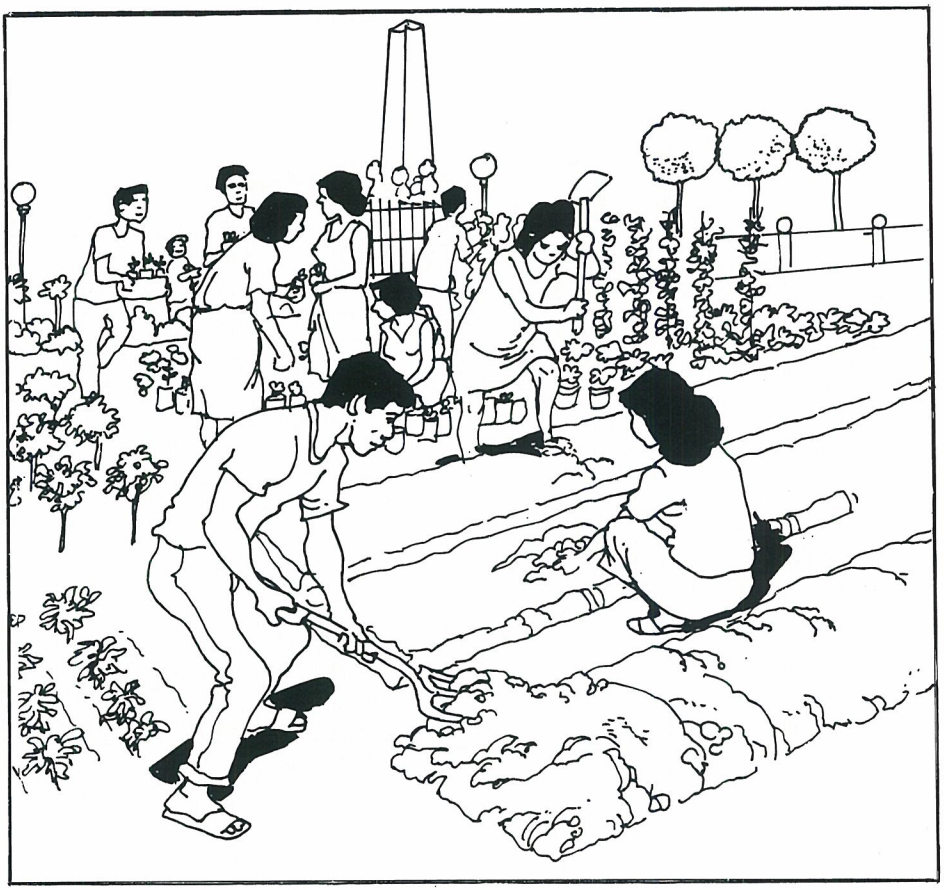
▲ Vegetables may be grown in combination with fruit trees, ornamentals, and other crops.

- **School garden**



▲ Growing of different kinds of vegetables in plots assigned to pupils in elementary schools and students of agricultural high schools instill the dignity of productive labor.

- **Community garden**



- Maybe idle government lots temporarily cultivated byinterested landless citizens
- Maybe part of a park assigned to a neighborhood where families can collectively grow vegetables
- Community gardening encourages cooperative undertakings among participants

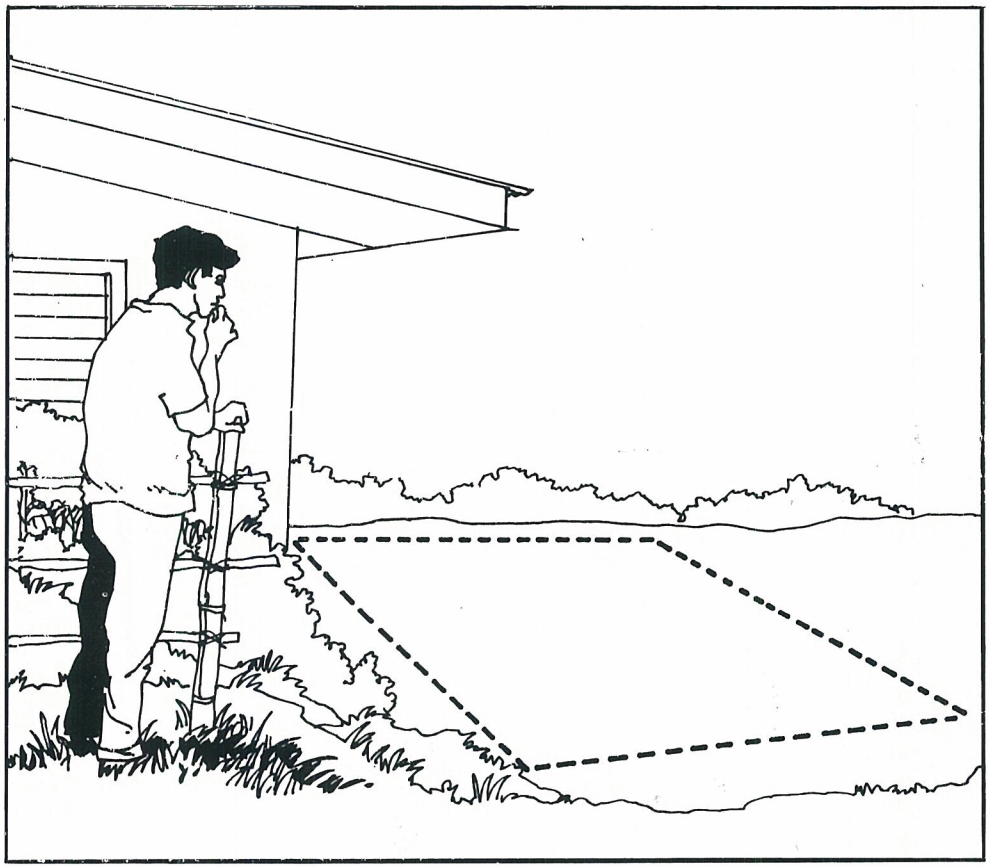
- **Growing in containers**

▲ In urban communities where most houses have limited space, vegetables are grown in containers such as pots, cans, and boxes.

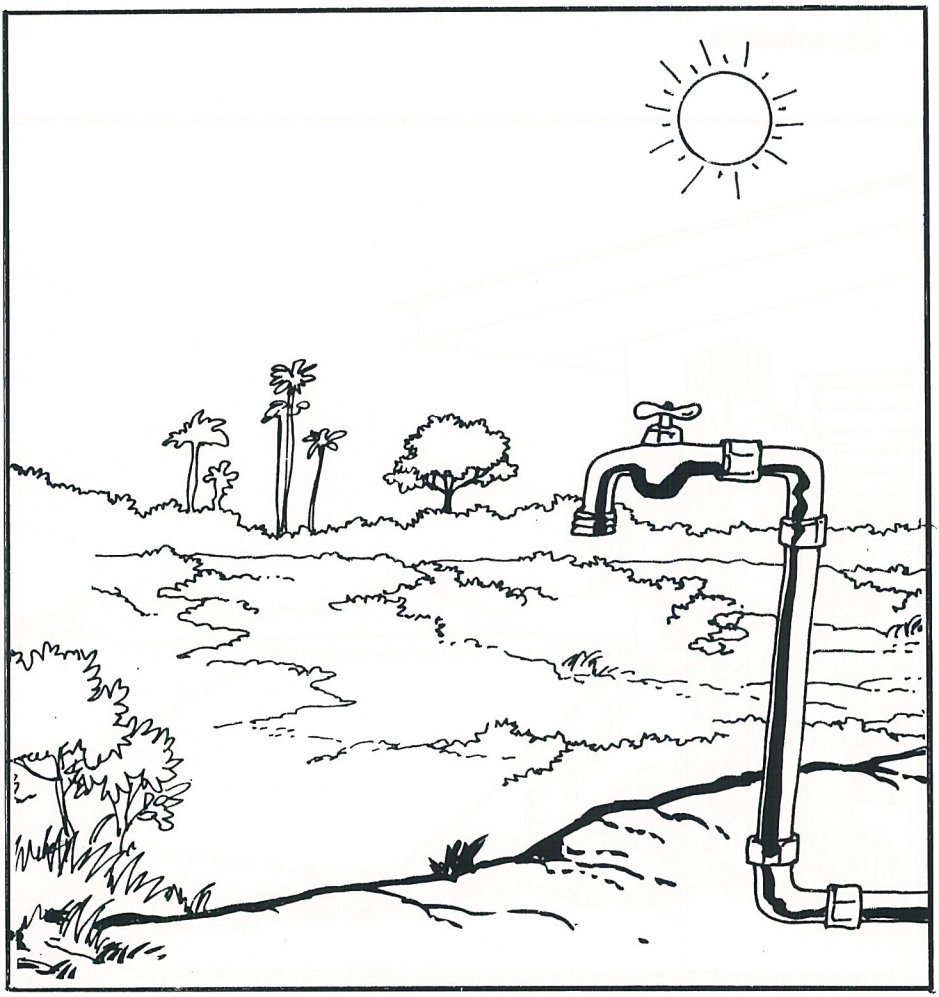
Planning a garden

- Site selection
- Size of garden
  - ▲ home garden
  - ▲ school garden
  - ▲ community garden
- Selection of vegetables
- Planting plan

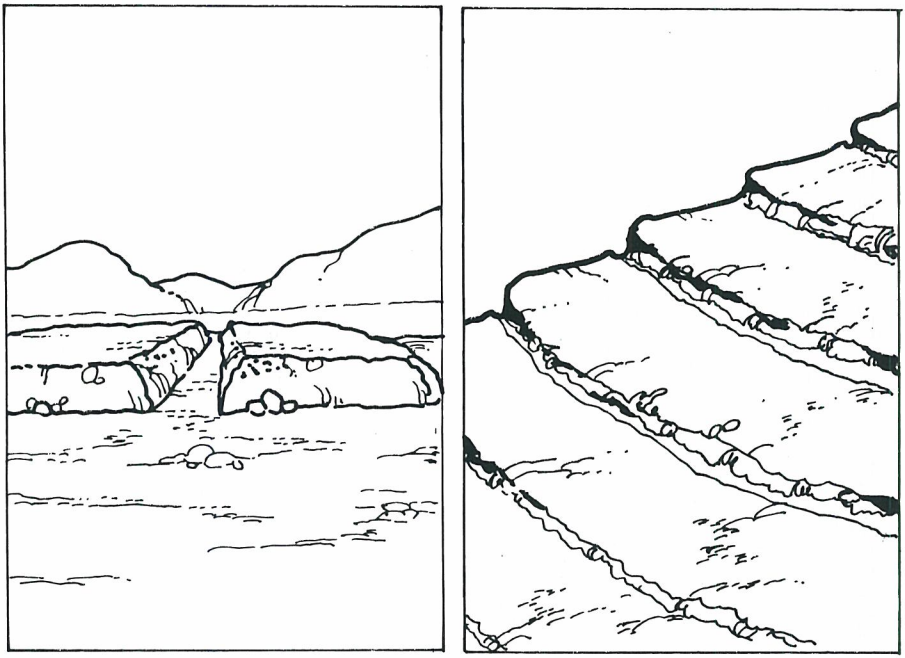
- **Site selection**



- For convenience, the garden should be near the house, school building, or community center.
- It can be in the back, front or side of the house depending upon space availability.

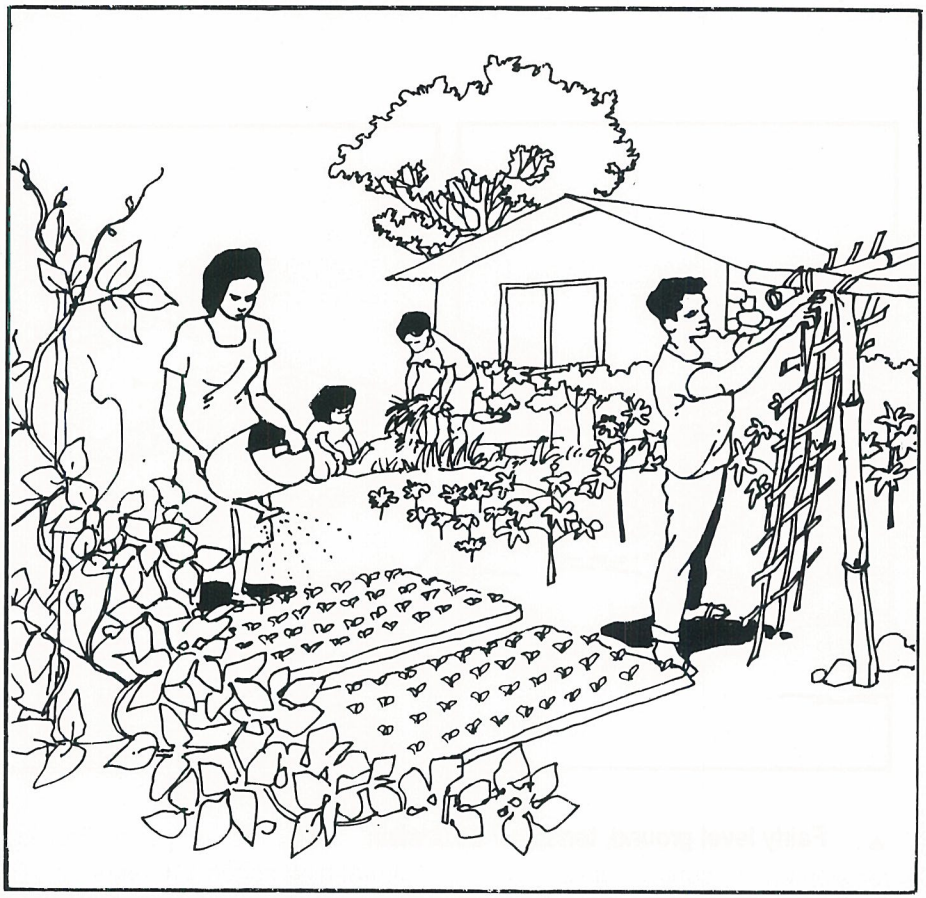


- Site should be near a water source.
- Choose an open area that will allow the plants to receive sunshine at least for 1/2 day.



- Fairly level ground, terrace if otherwise.
- Well-drained soil, raise beds during the rainy season for better drainage.

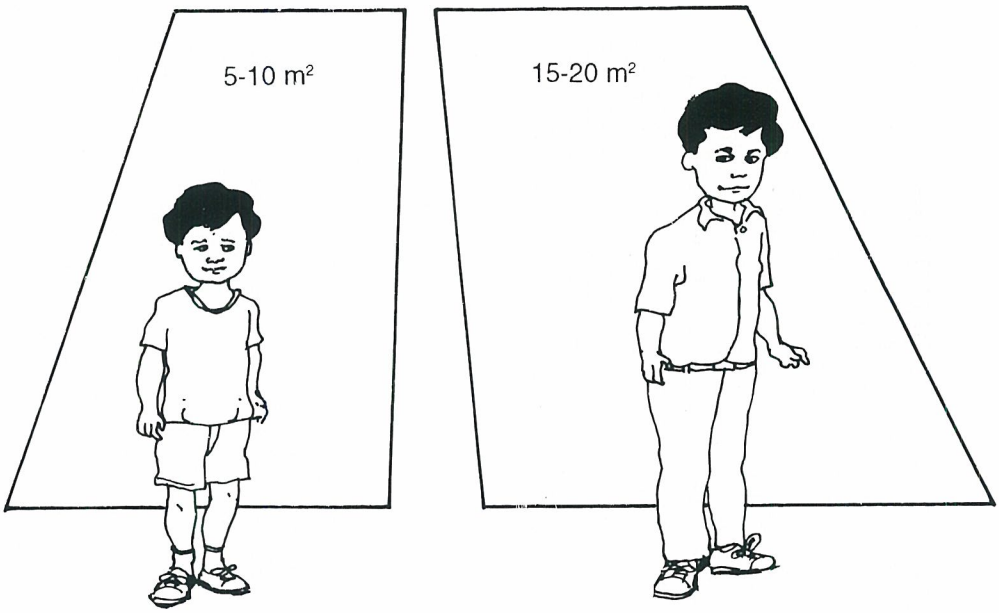
- **Size of Garden**



For home garden, size depends on:

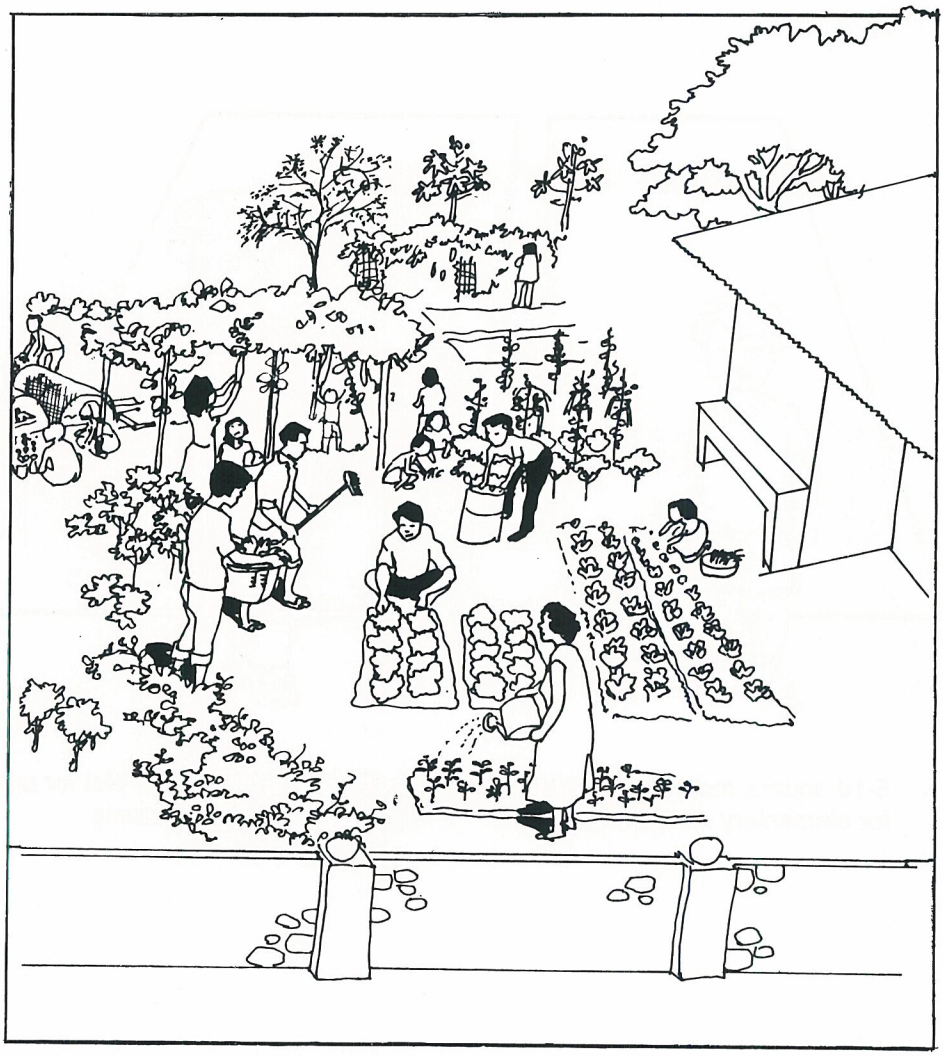
- ▲ size of family; big family will have more labor for gardening
- ▲ available land
- ▲ time availability

For School Garden



- 5-10 square meters per plot for elementary school pupils
- 15-20 square meters per plot for agricultural high school students

For Community Garden:



▲ size depends largely on available land for a neighborhood

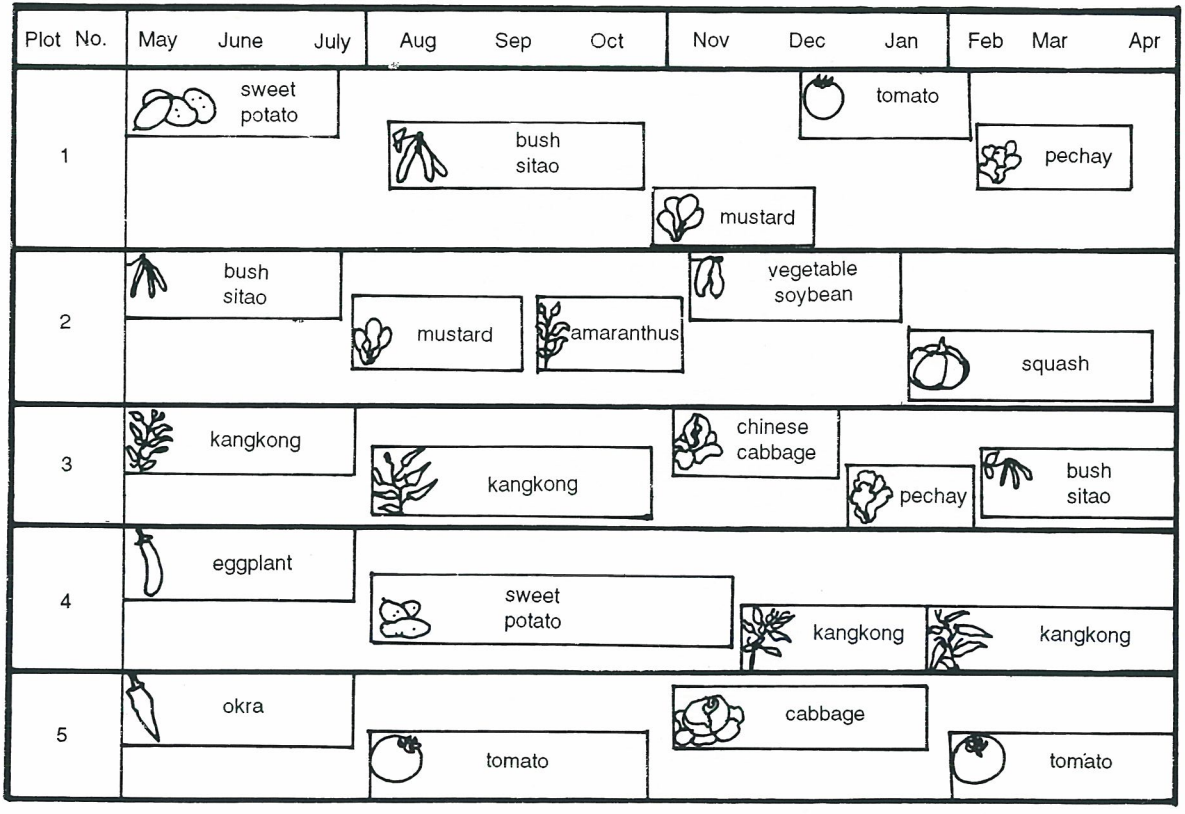
- **Selection of vegetables**

▲ Select vegetables that are preferred and likely to be eaten

▲ Select a variety of vegetables with nutritional diversity

- Easy to manage
- Productive and preferably tolerant to common pests and diseases

• Planting plan

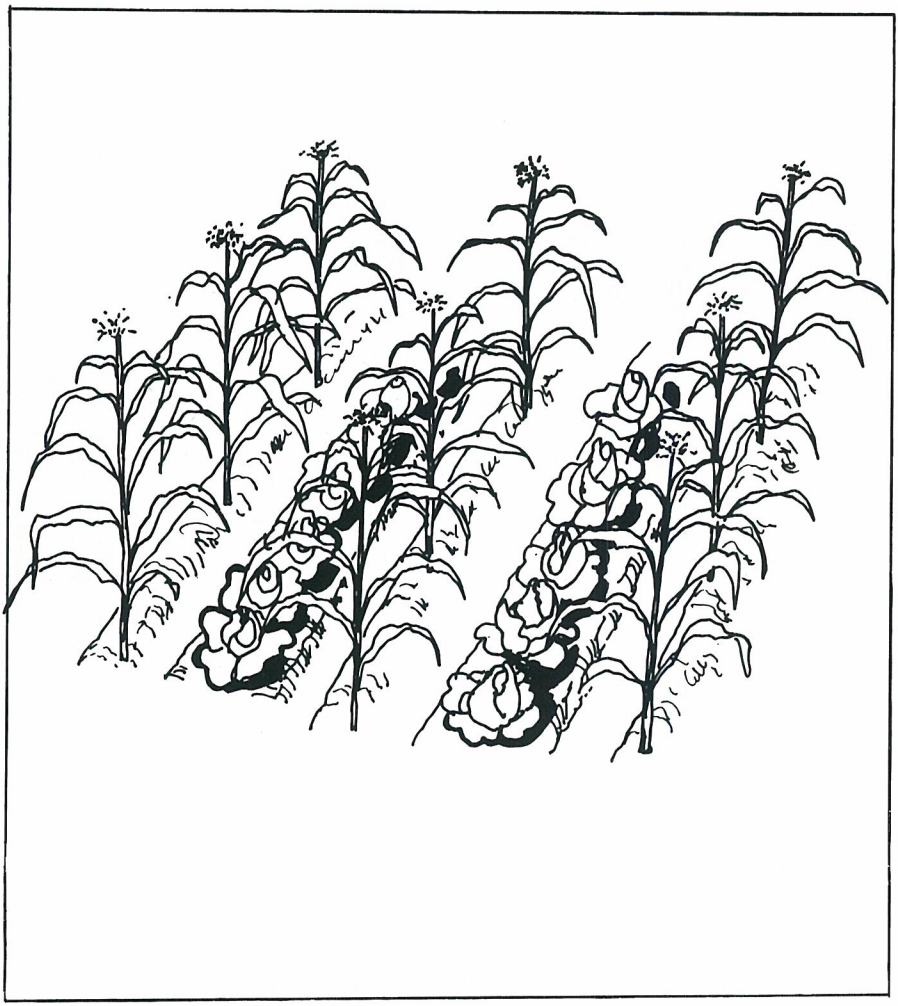


▲ Needed to maximize utilization of limited space

▲ Assures year-round production through crop rotation

▲ Relay cropping assures continuous year-round supply of vegetables

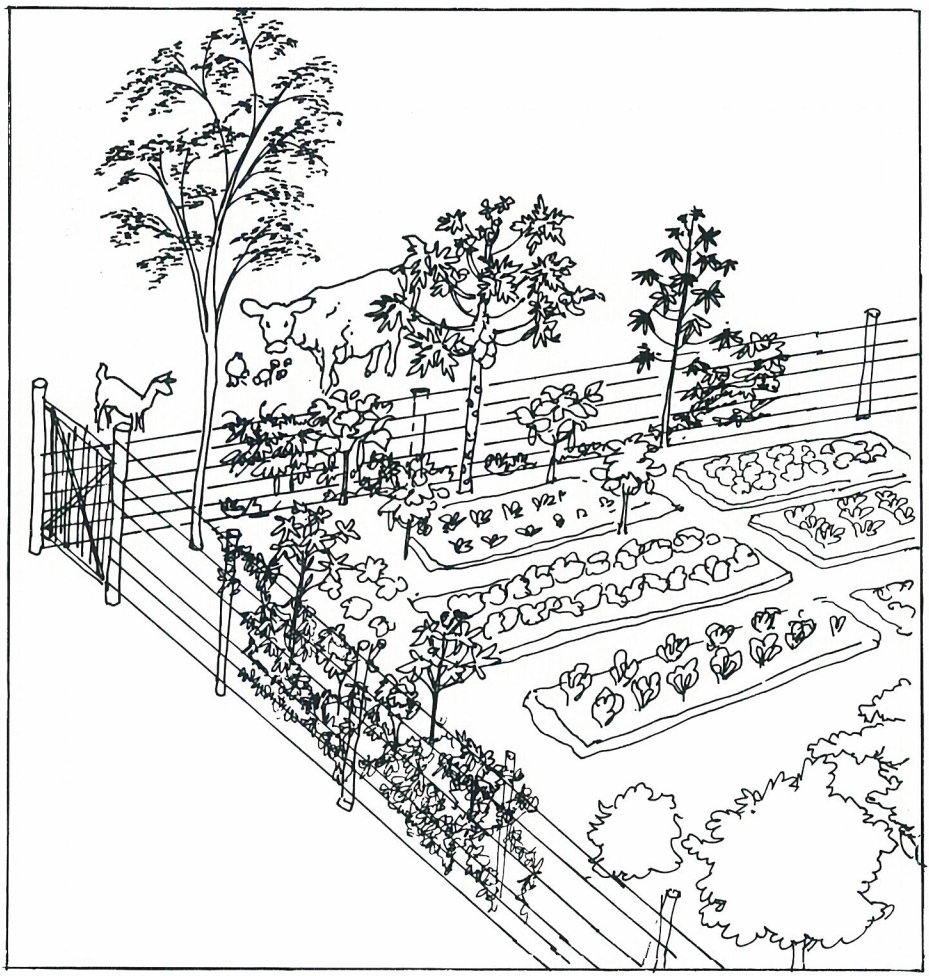
Example: tomato with sweet corn



▲ Year-round production can also be assured through intercropping of vegetables with different maturity duration.

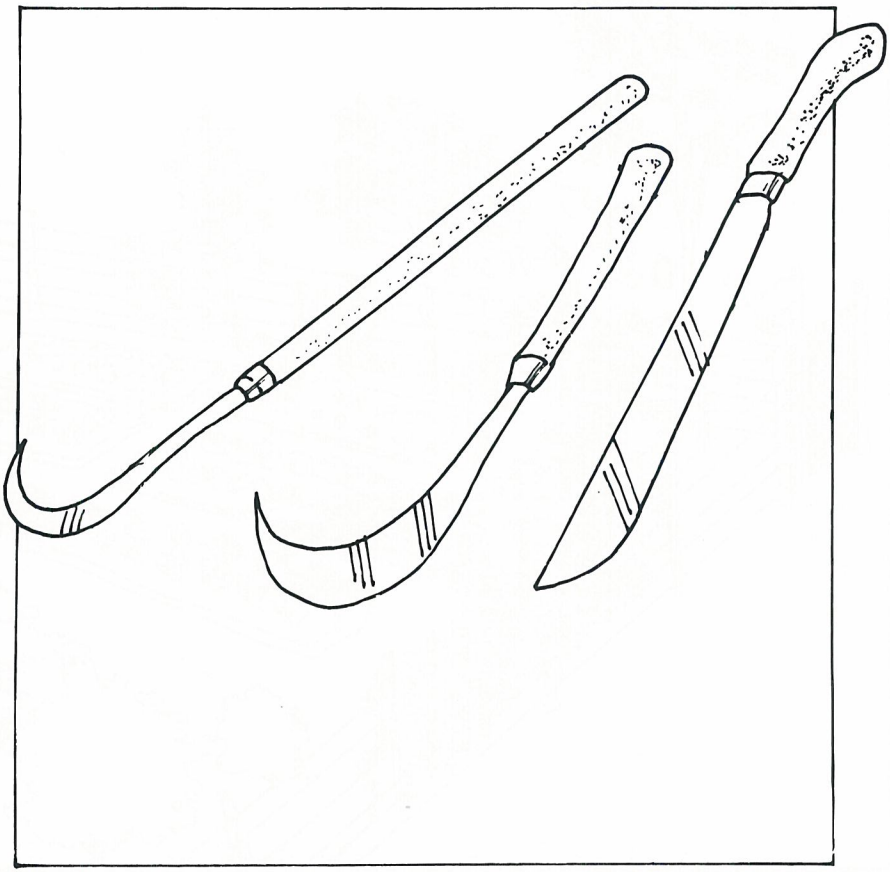
Example: cabbage and sweet corn

Fencing

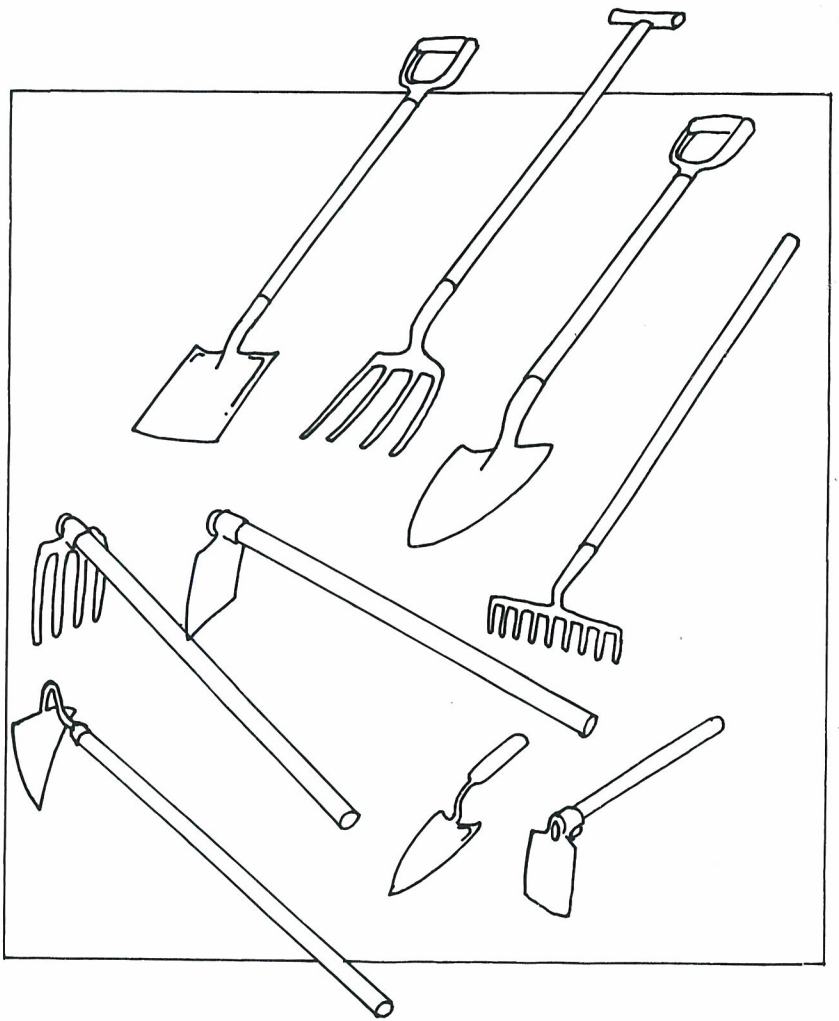


- protects garden from stray animals
- serves as trellis for climbing vegetables

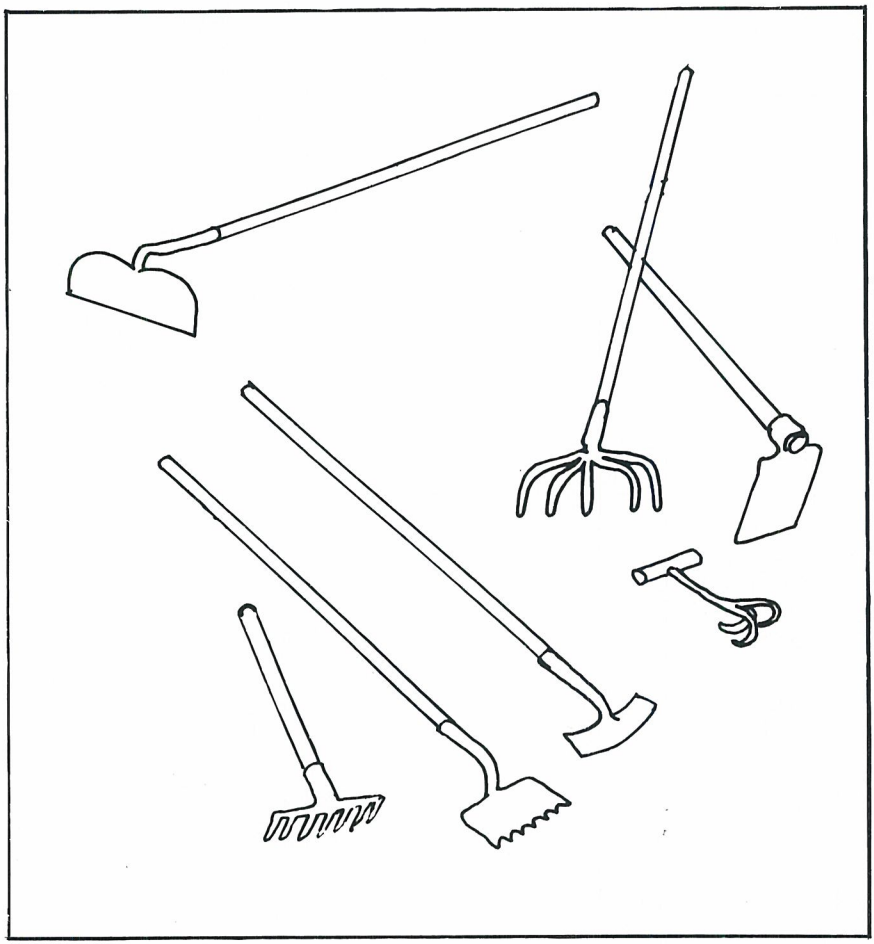
Tools used in gardening



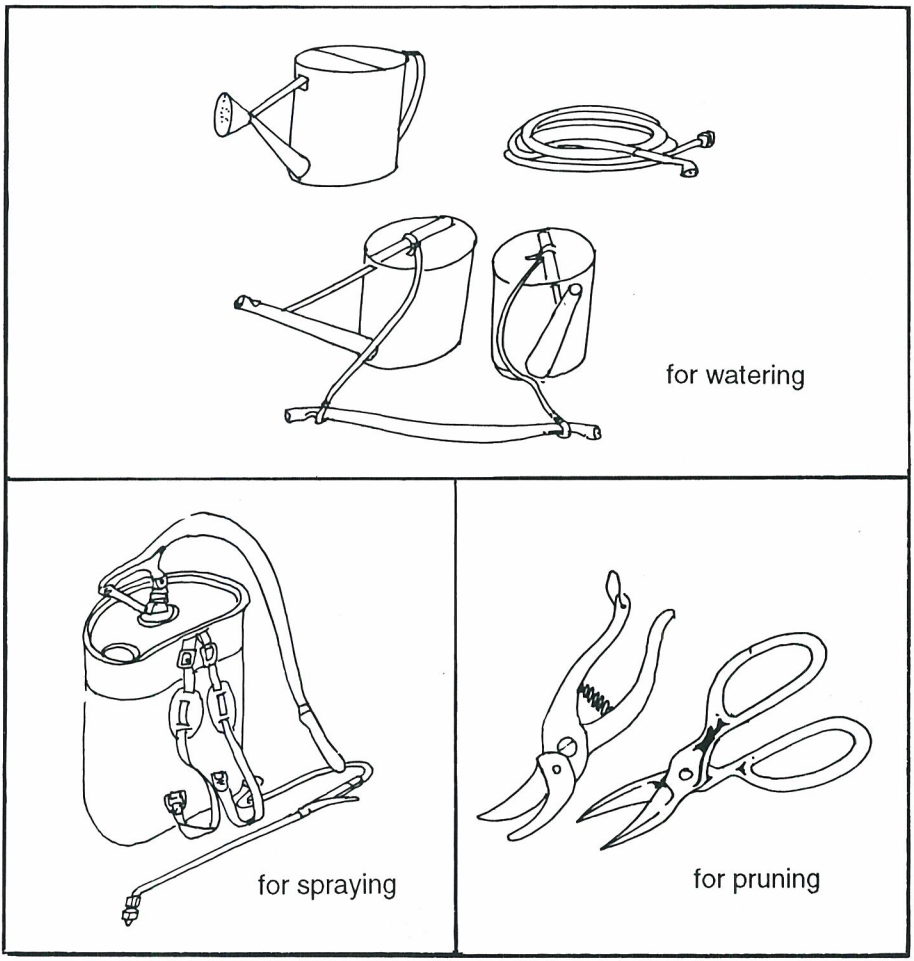
- knives for clearing the land



- for digging, levelling, and ridging



- for weeding and cultivation


for watering
for spraying
for pruning

CHAPTER III. REQUIREMENTS FOR SUCCESSFUL VEGETABLE GARDENING

Varieties

Seeds

Crop Management

Soil and Fertilizer Management

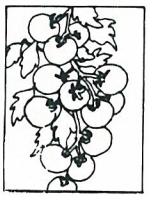
Water Management

Pest Management

- weeds
- diseases
- insects

The appearance, yield, quality, and other characteristics of a vegetable (PHENOTYPE) result from the contribution of its genetic constitution (GENOTYPE), its immediate environment (ENVIRONMENT), and the combined effects (INTERACTION) of these two factors.

PHENOTYPE = GENOTYPE (G) + ENVIRONMENT (E) + INTERACTION



= AVRDC Variety (tropical tomato) + **22° - 25°C (night temperature)**

= RUTGERS (temperate tomato) + **22° - 25°C (night temperature)**

= AVRDC Variety (tropical tomato) +

6 bags 14-14-14
2 bags 45-0-0
3 bags 0-0-60

= AVRDC Variety (tropical tomato) +

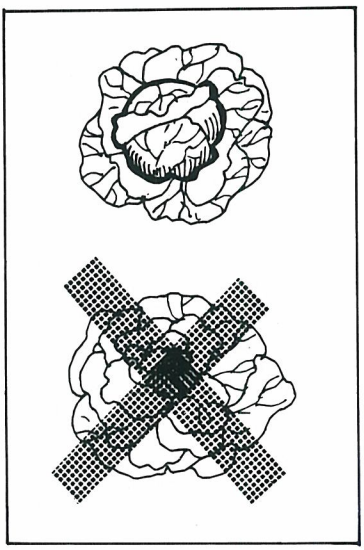
14 bags 14-14-14
4.5 bags 45-0-0
8 bags 0-0-60

Therefore, to be a successful vegetable gardener, one should have a good control of the:

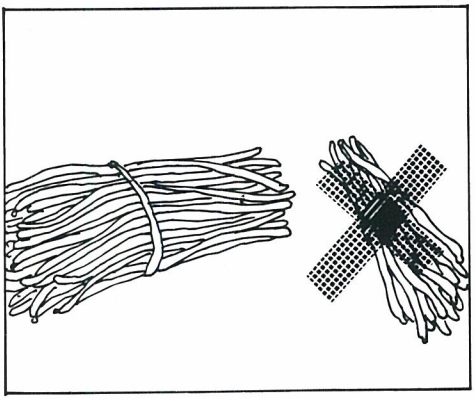
- genotype through the varieties he grows
- environmental factors such as appropriate management practices.

Varieties

- The correct choice of a variety assures the gardener of a crop which is:



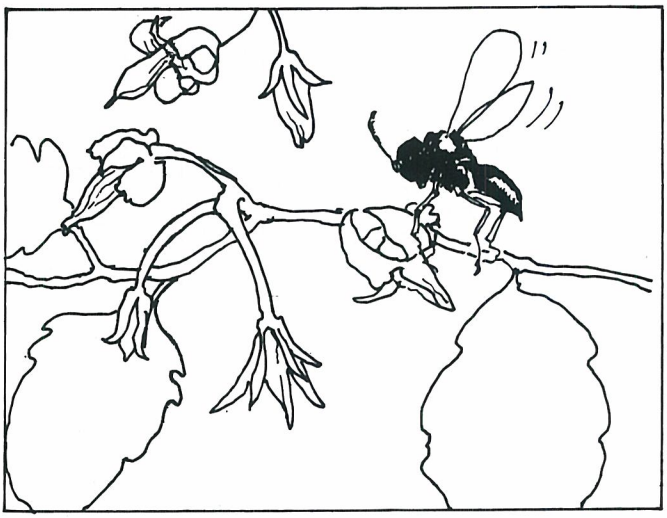
- reliable and adapted



- productive

- of desirable quality

- A variety maybe:



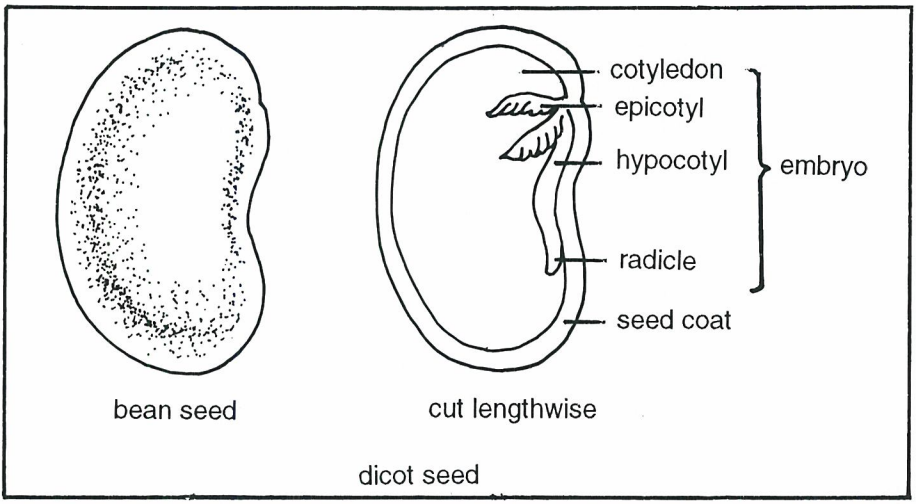
- open pollinated - seeds are produced by natural pollination through successive generations
  - ▲ save seeds from best plants

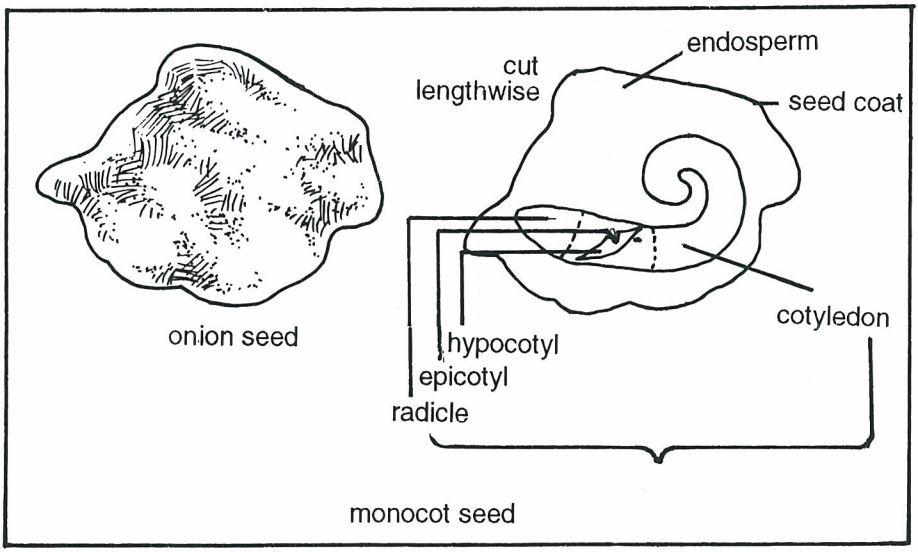
- hybrid - seeds are produced by controlled pollination of two distinct parents
  - ▲ buy fresh seeds when needed

Seeds

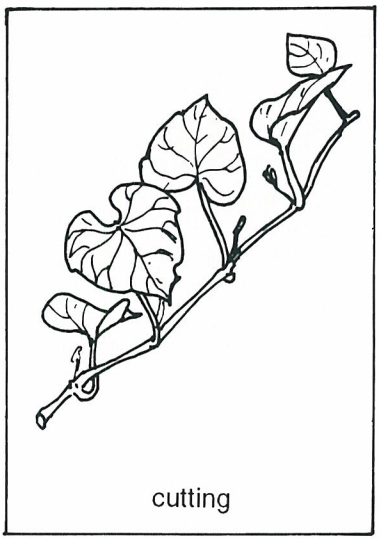
■ What is a true seed

- a mature ovule that contains a very small plant (embryo) and usually a food storage tissue within the seed coat.

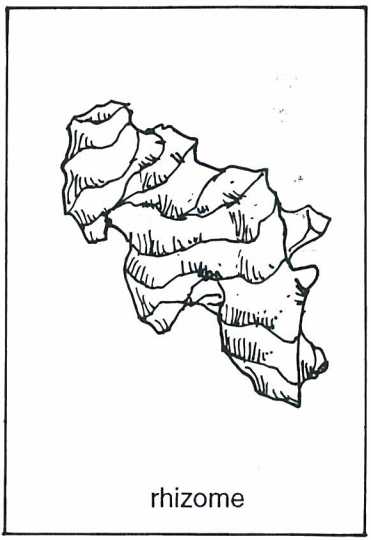




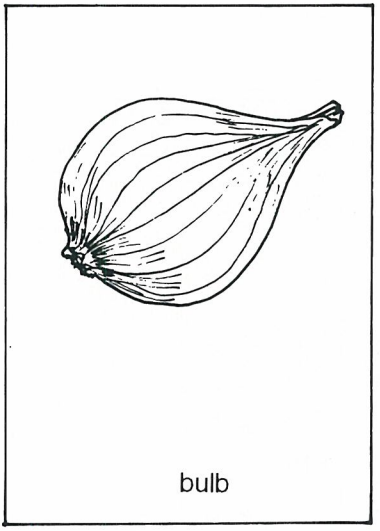
- The seed is also referred to as:



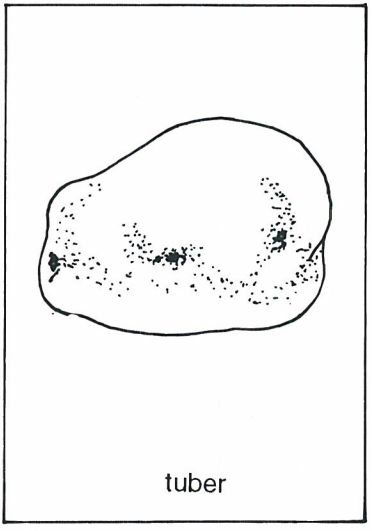
cutting



rhizome

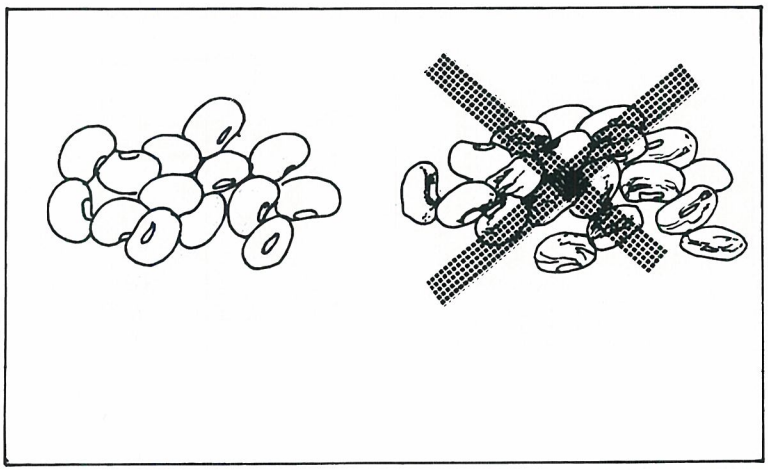


bulb

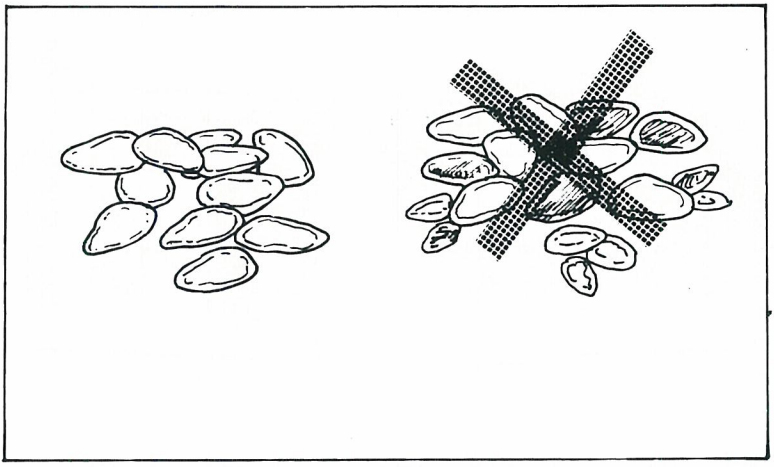


tuber

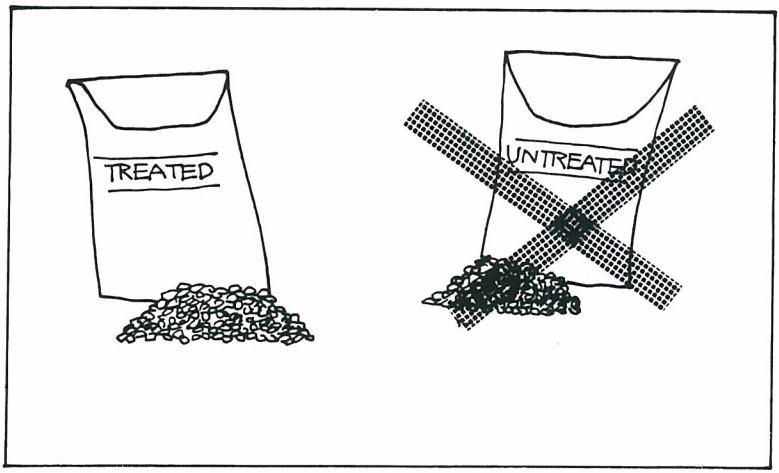
- Why select good seeds



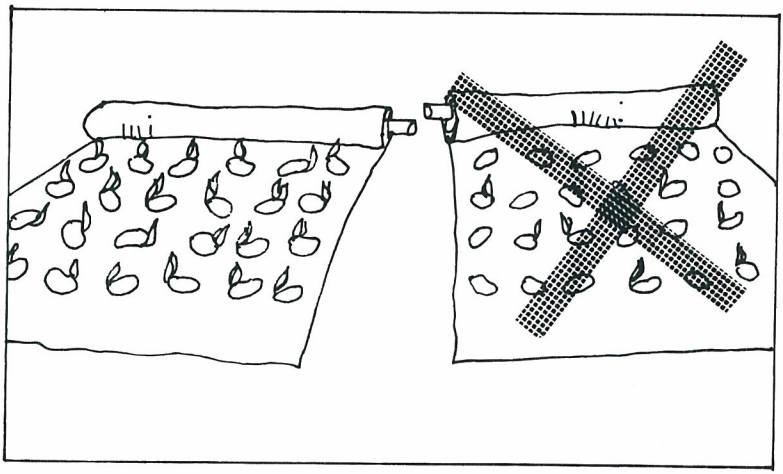
- damage-free



- free from mixtures of other varieties



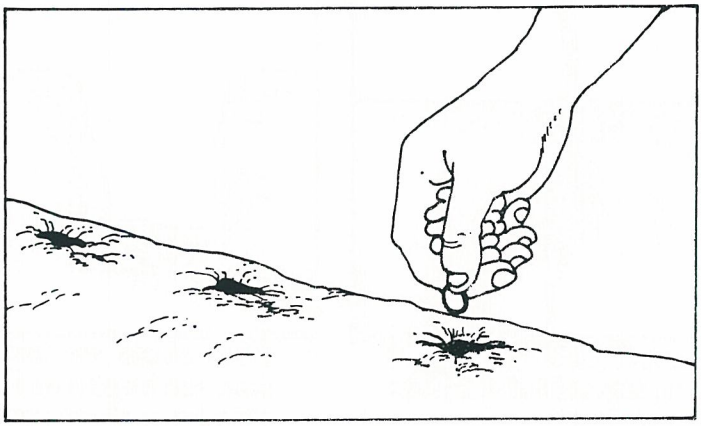
- free from seed-borne diseases



- with good vigor and germination capacity

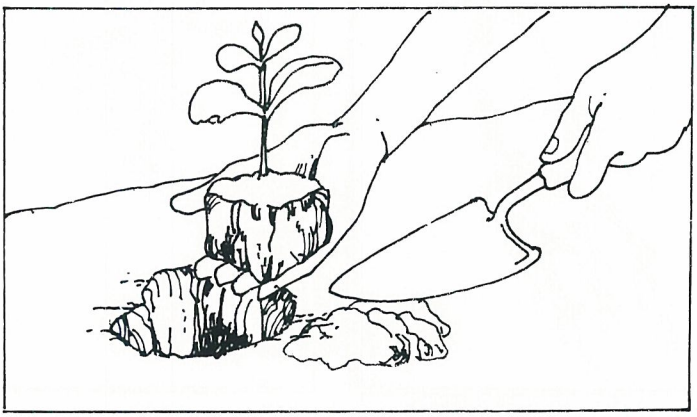
Crop Management

- There are two methods of planting vegetables:



- direct seeding

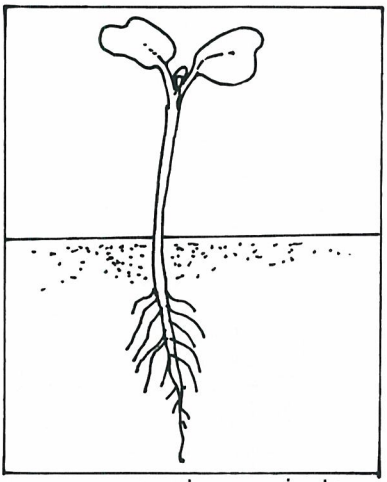
  Examples: okra, melons, beans, carrots



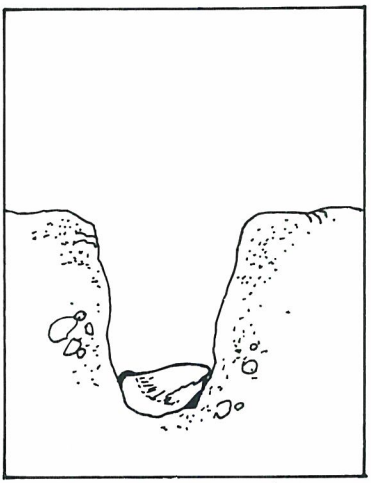
- asexually propagated materials are transplanted

  Examples: bunching onions, sweet potato, potato

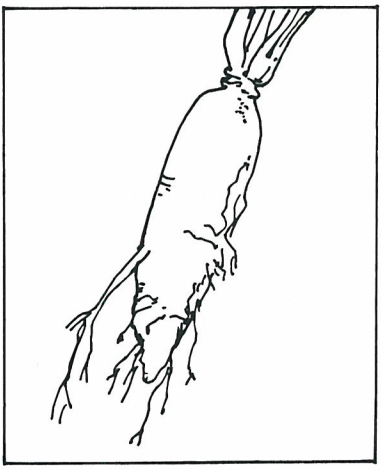
Why direct seed



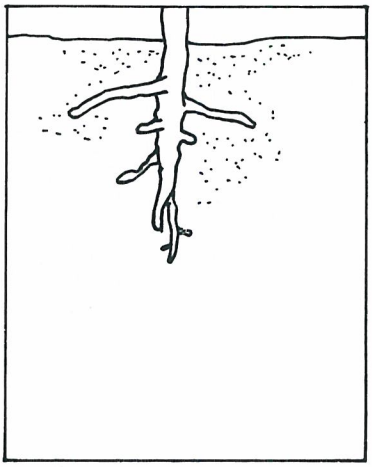
- some seeds germinate rapidly and their seedlings grow fast



- some seeds are large, thus, can be planted in a wide range of soil conditions



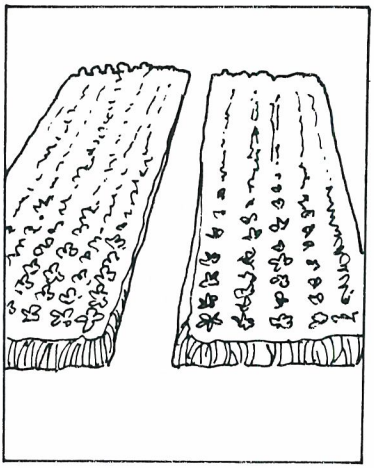
- some vegetables like carrot and radish have only one long tap root system which, if damaged, will deform the root



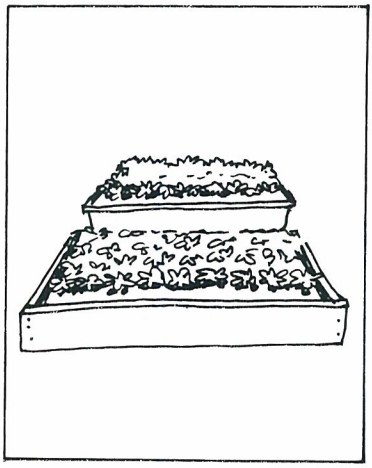
- some have slow root regeneration capacity

Raising Seedlings

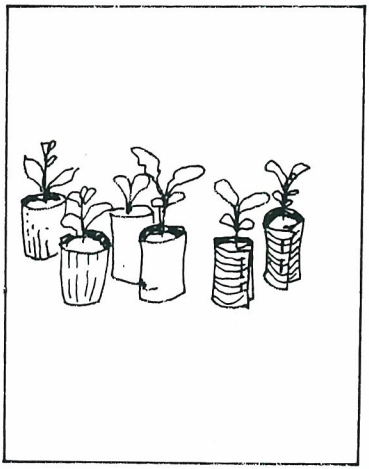
Methods of raising seedlings:



- seedbed method



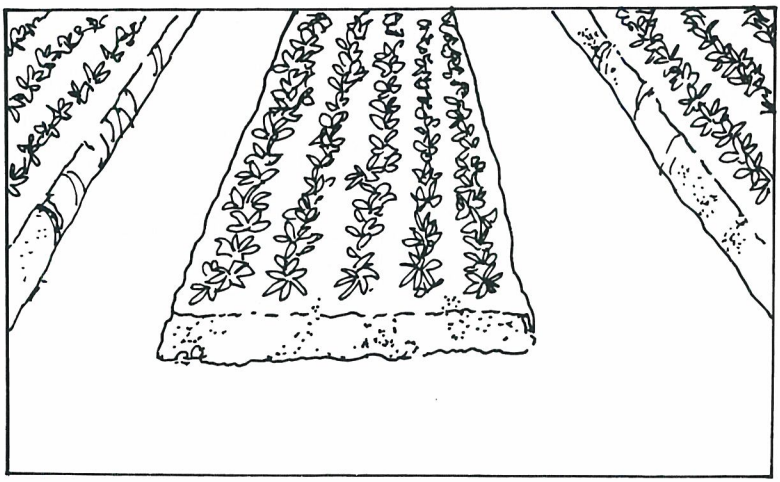
- seedbox or tray method



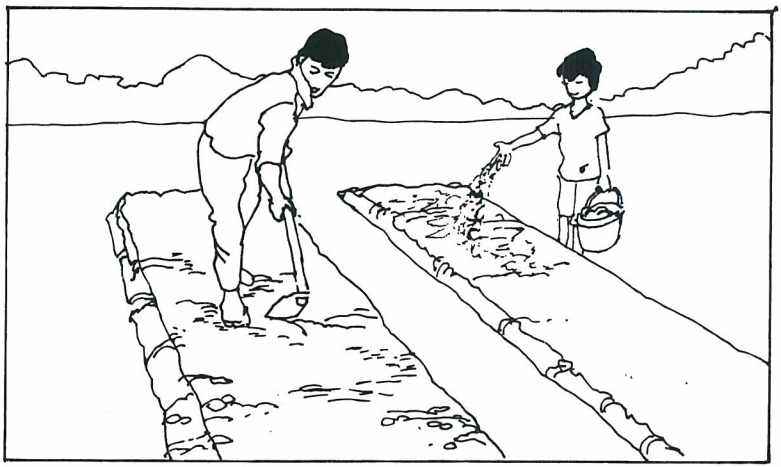
- seedling container method

Seedbed method

- Seedlings are raised in beds when large quantities of seedlings are needed as in community gardens.

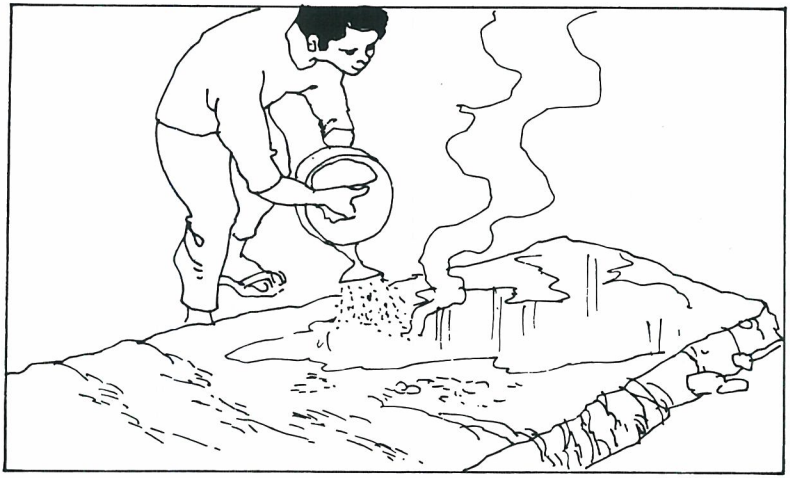


Step 1. Prepare the bed and improve the soil condition

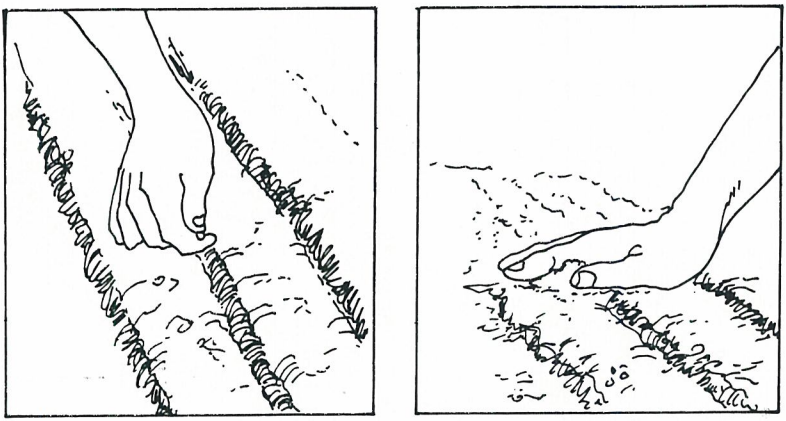


Step 2. Sterilize the beds

- by burning straw on soil surface



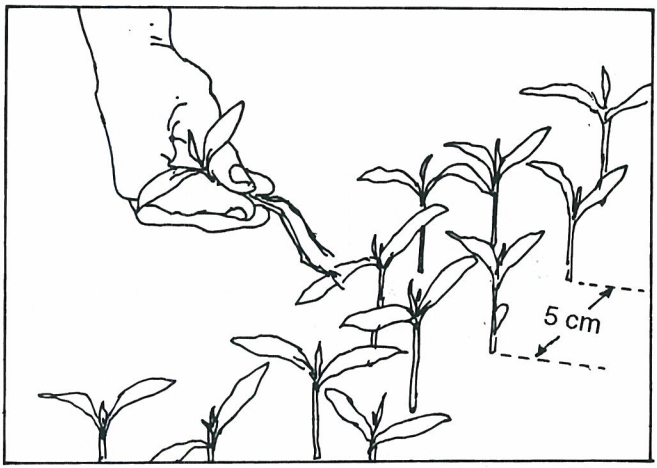
- by pouring boiling water on beds



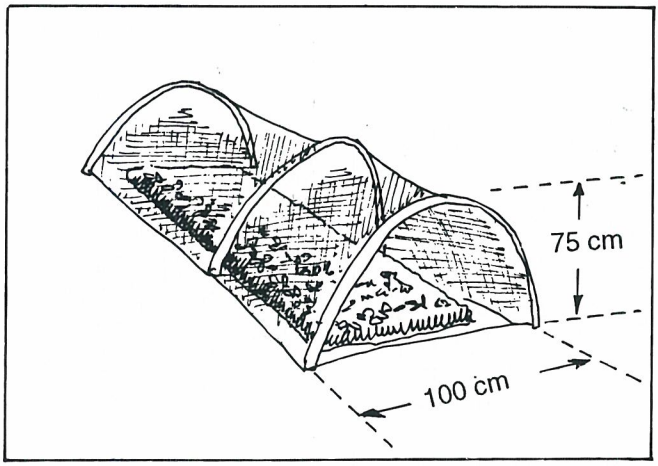
Step 3. Sow and cover the seeds

Step 4. Cover with straw

Step 5. Water the bed using a fine sprinkler

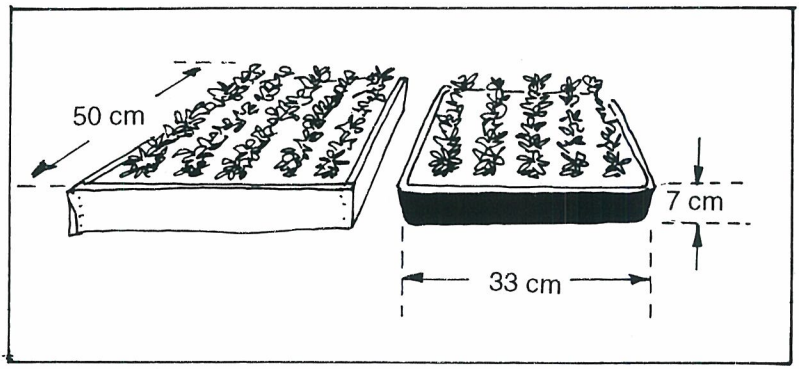


Step 6. Allow seedlings to grow 5 cm apart, thin out excess seedlings when first true leaves have appeared

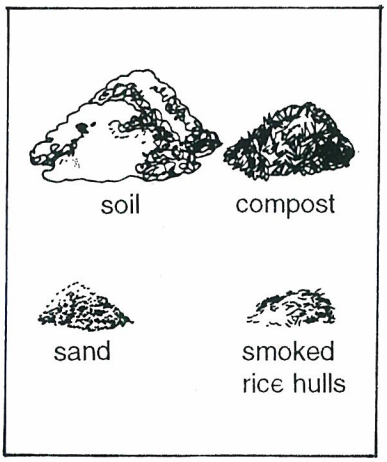


Step 7. Use simple structure to protect seedlings against rain and sun

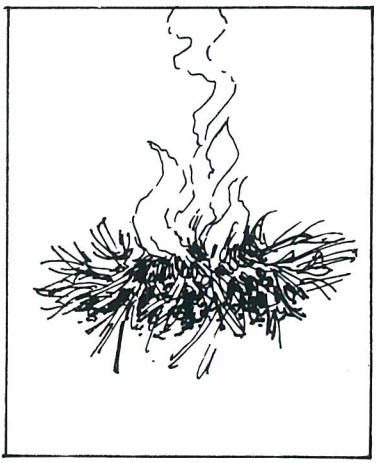
Seedbox or tray method



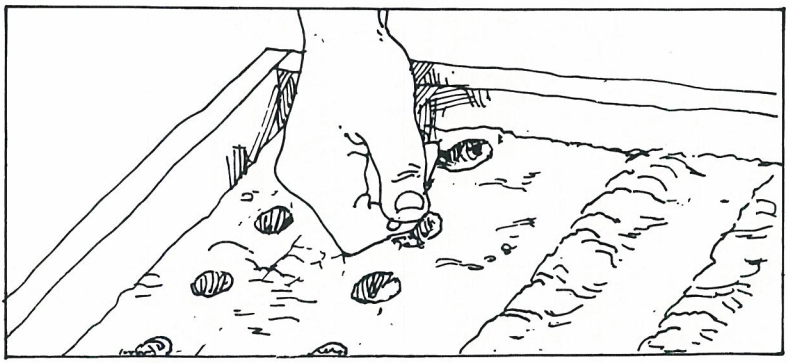
- Seedlings are raised in specially made wooden boxes or plastic trays



- Growing medium

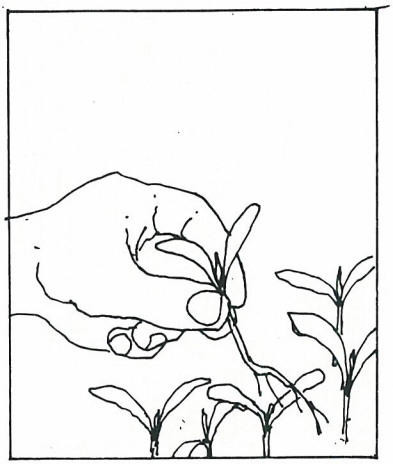


- Sterilize growing medium as in the seedbed method



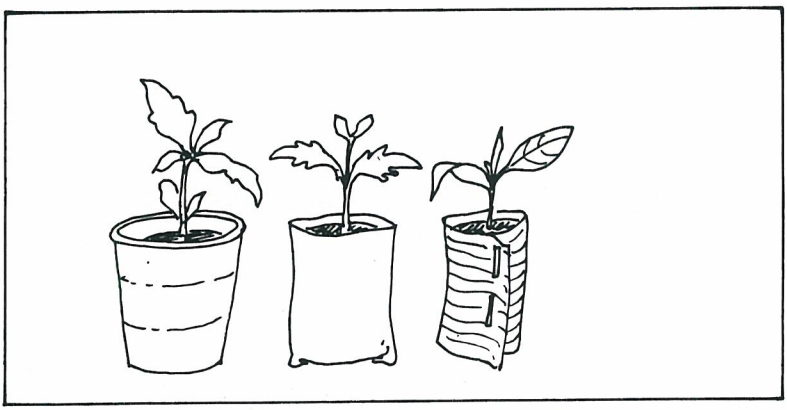
- Sow and cover seeds

- Water using fine sprinkler or watering can

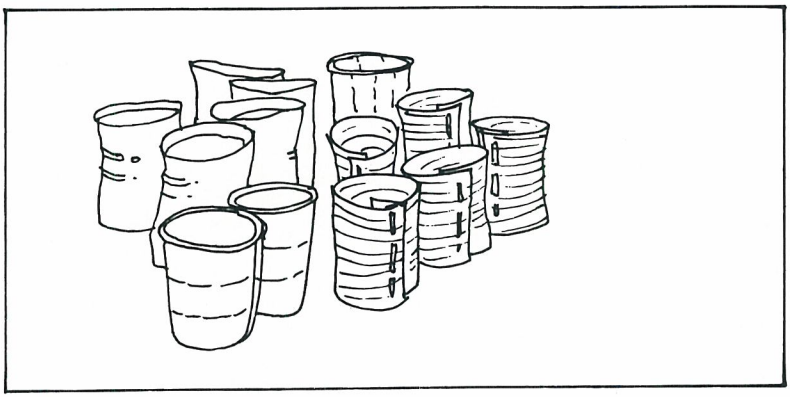


- Thin or prick out excess seedlings when first true leaves have appeared.

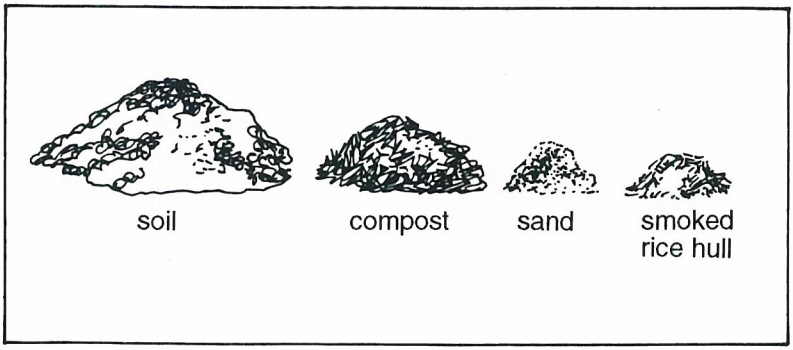
Seedling Container Method



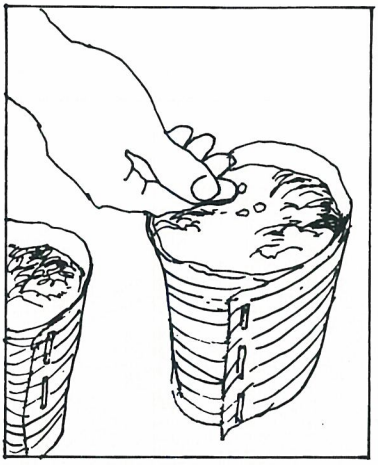
- Raising seedlings in separate pots or containers gives 100% survival in the field since root injury is minimized.



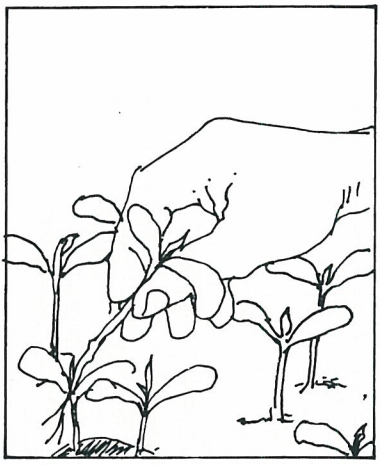
- Seedling containers:
  - ▲ biodegradable materials (rolled banana leaves, other locally available materials, paper pots)
  - ▲ small plastic bags may also be used.



- Same medium as in the Seedbox Method

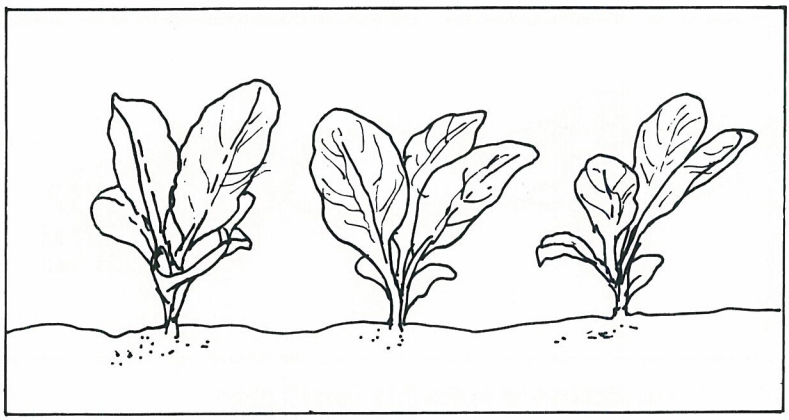


- Sow and cover the seeds

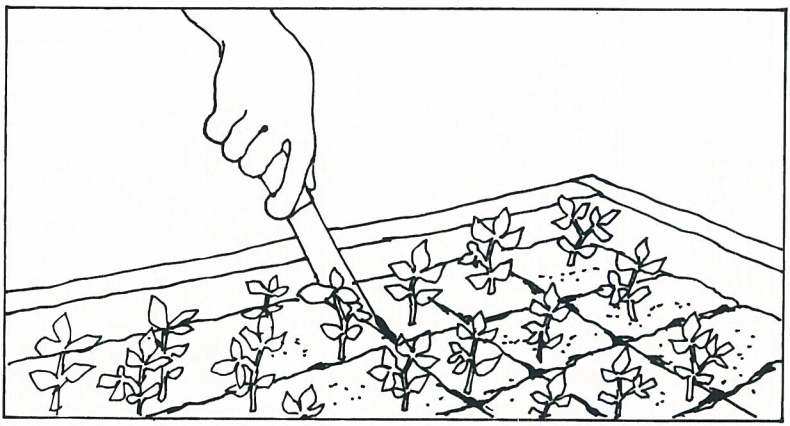


- Thin or prick out excess seedlings when first true leaves have appeared

Transplanting

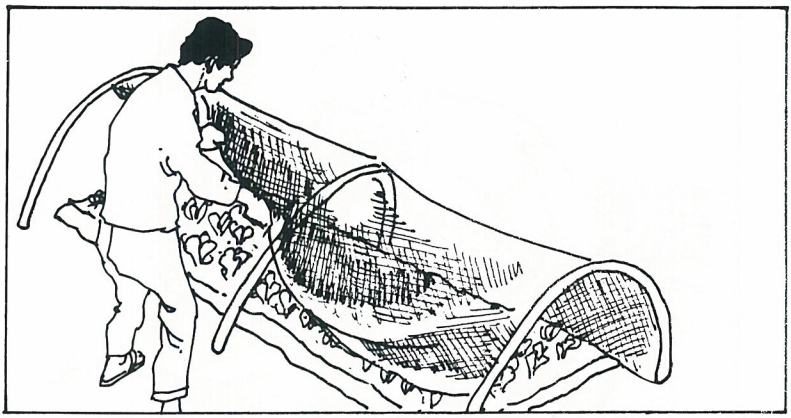


- 3-5 week-old seedlings are ready for transplanting

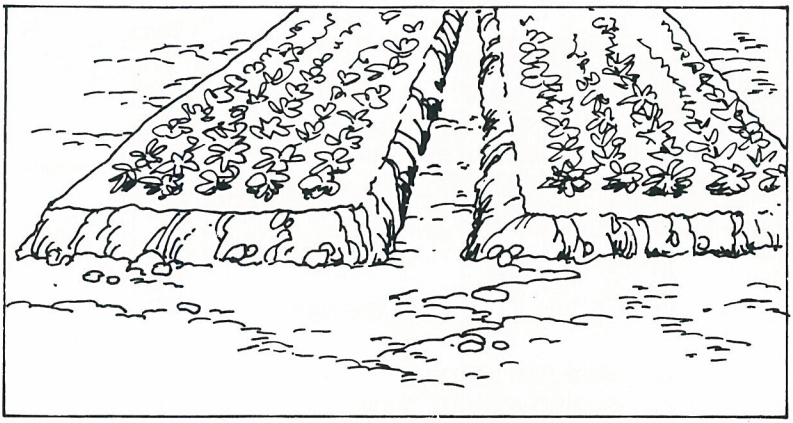


- Seedlings in boxes are blocked into 5 cm x 5 cm to confine roots 7-10 days before transplanting.

Hardening



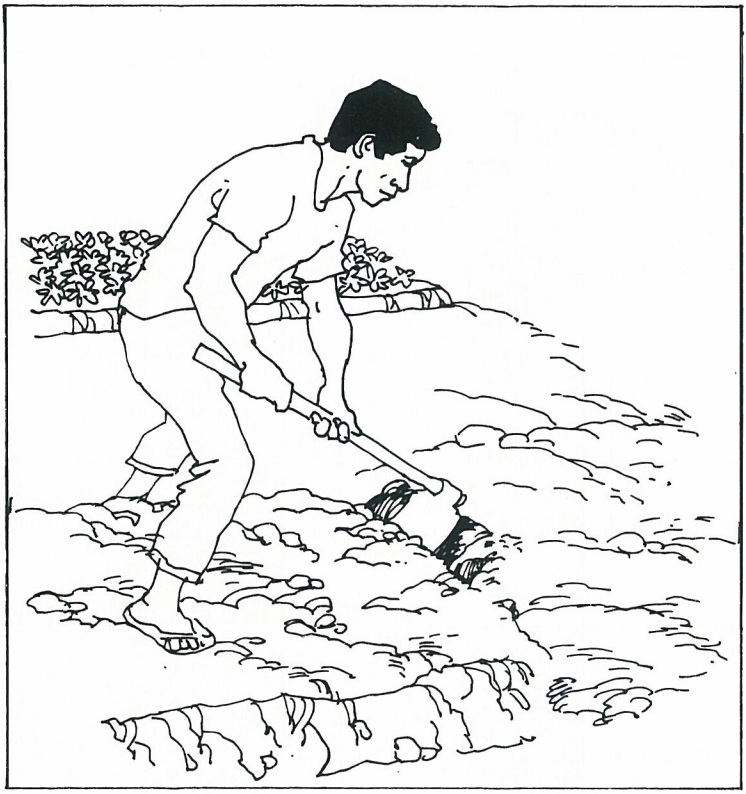
- If grown under partial shade, exposing seedlings to strong sunlight 1-2 weeks before transplanting hardens the seedlings.



- Withdraw water to slow plant growth resulting in thicker, less succulent, and harder plant tissues.

- Hardened seedlings are sturdy and requires no cover after transplanting.

Land Preparation

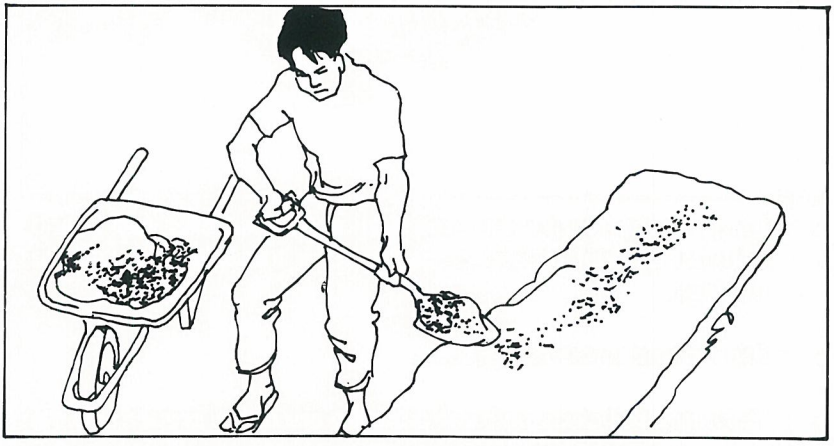


Why prepare land thoroughly

- to create favorable condition for:
  - ▲ seed germination
  - ▲ seedling establishment
  - ▲ management of the crops
- to eliminate most of the weeds and soilborne pathogenic microorganisms
- to improve water holding capacity, drainage and aeration of the soil

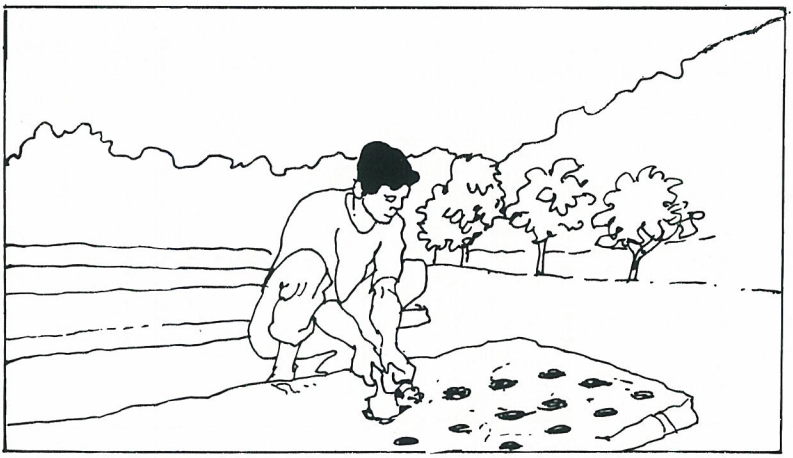
- Large seeds require less preparation than smaller seeds and minimal amount of land preparation for transplants and large cuttings.
- Dig dip and turnover the soil
- Pulverize soil clods until soil particles are of the proper size

- To improve soil texture, incorporate well-decomposed and sieved compost or farm manure at 2 kg/m^2



- If soil is too heavy, incorporate sand until desired soil texture is reached.

- Soil incorporate part or all of the recommended fertilizers before planting.

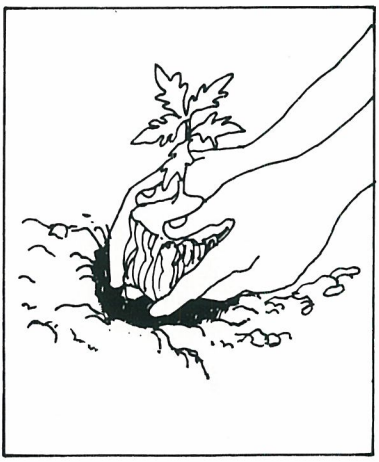


- Dig holes in rows following recommended spacing.

When to transplant

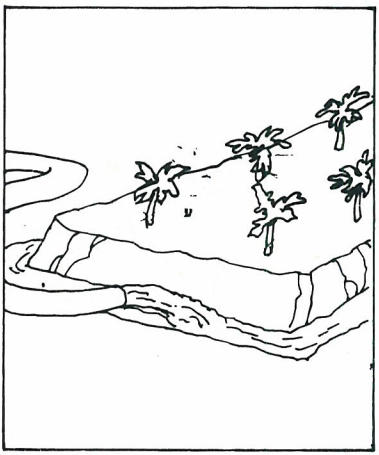
- Transplant in the afternoon during sunny days

How to transplant



- Carefully place transplant in the hole then fill the hole with soil.

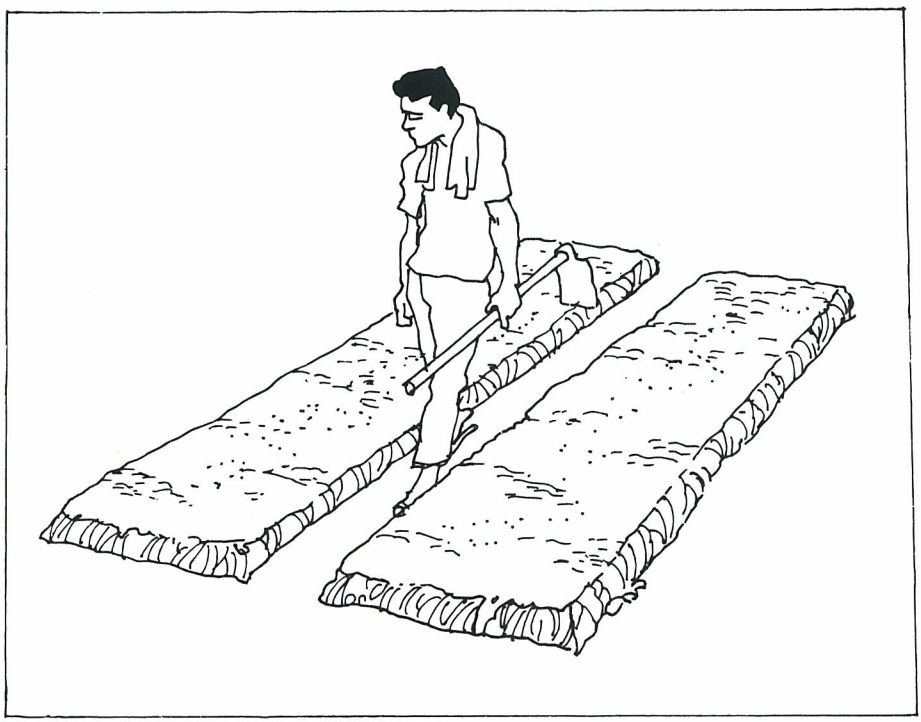
- Gently press downward to assure contact of roots with the soil.



- Irrigate newly transplanted seedlings.

Cultural Practices

- Bedding

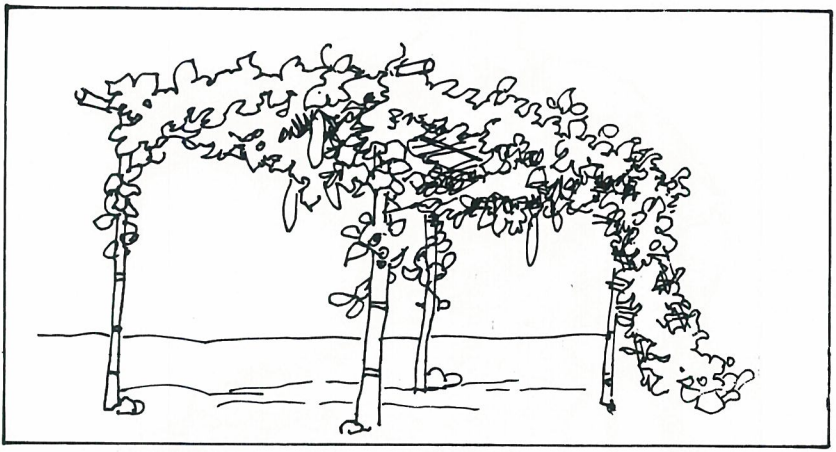


▲ Provides drainage during the rainy season

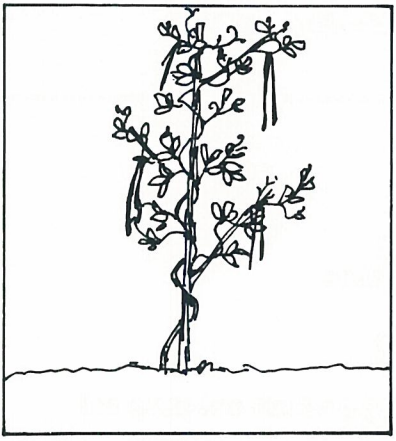
▲ Space between beds serves as furrow irrigation during the rainy season and walkway for gardeners.

- Trellising/Staking

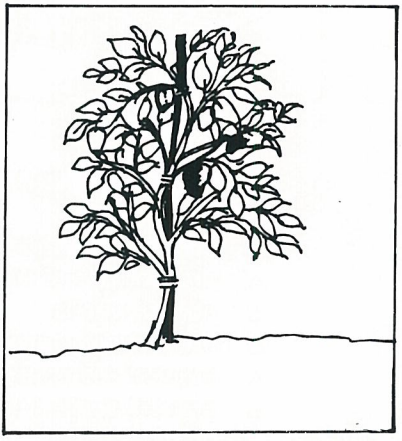
▲ All viny vegetables are generally trellised.



▲ For climbing plants



▲ For twining plants



▲ For plants without ability to climb or twine

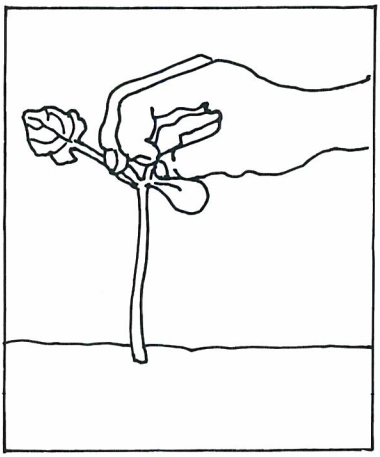
▲ Facilitates irrigation, pest control, and harvesting.

▲ Helps produce better products by preventing contact between products and damp soil

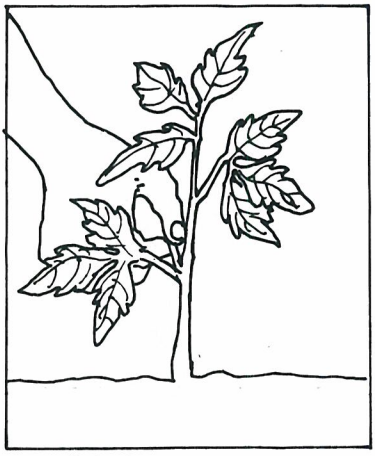
Mulching

- Mulching is practiced to:
  - control soil temperature
  - prevent loss of soil moisture
  - control weeds
  - prevent soil compaction
  - prevent soil erosion
  - prevent contact between products and damp soil

Pruning



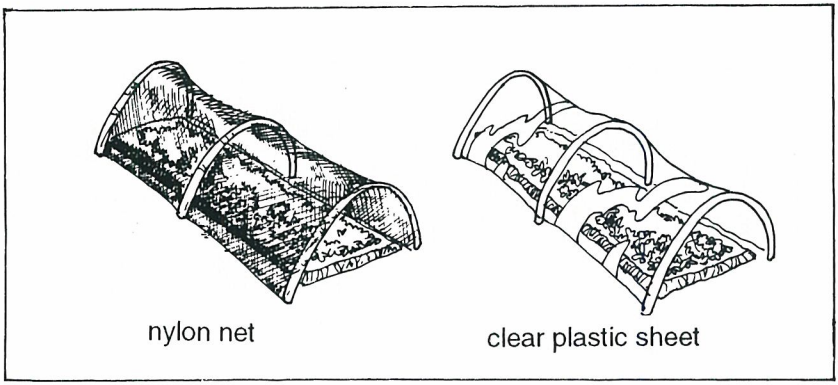
- In luffa, pruning of the tip of seedling stimulates earlybranching and fruiting on lower nodes.

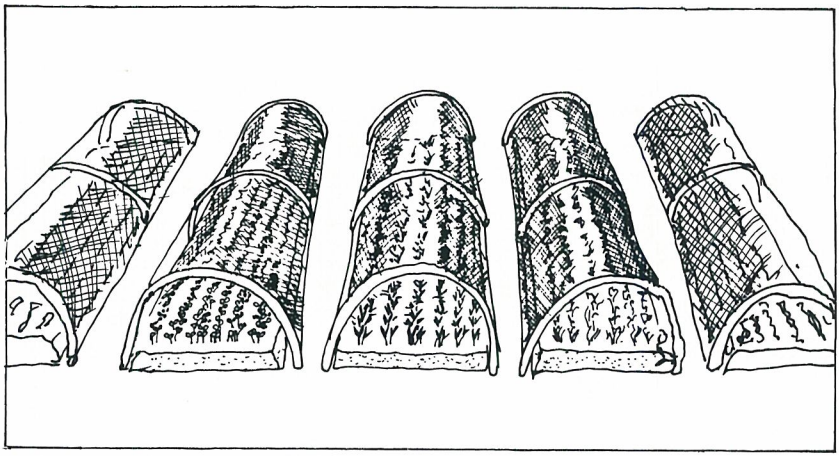


- In indeterminate tomatoes single stem pruning produces larger fruits.

- Ratooning okra and eggplant produces an earlier crop than when started from seedlings.

Protected cultivation

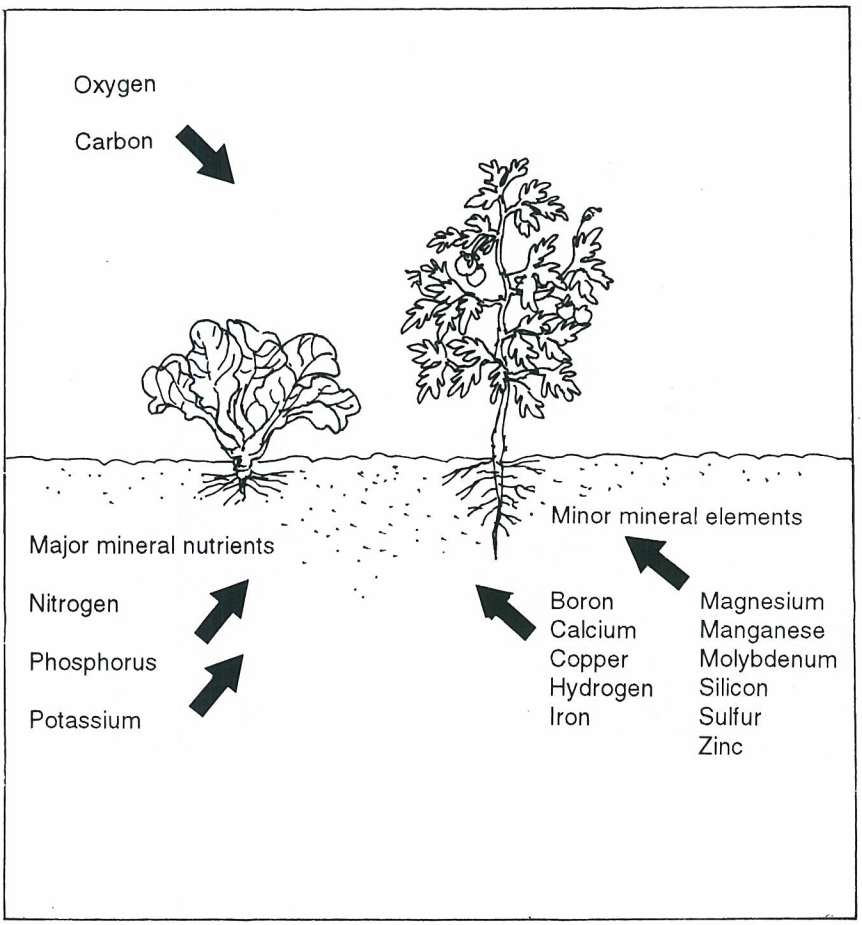




- Low tunnels covered with clear plastic sheets or nylon nets are simple structures now commonly used in vegetable gardens.
- Plastic sheets protect the crop against excessive rains.
- Nylon nets decrease wind speed, break the force of raindrops, and prevent mechanical damage to the leaves.
- Short maturing vegetables have been successfully grown under this structure.

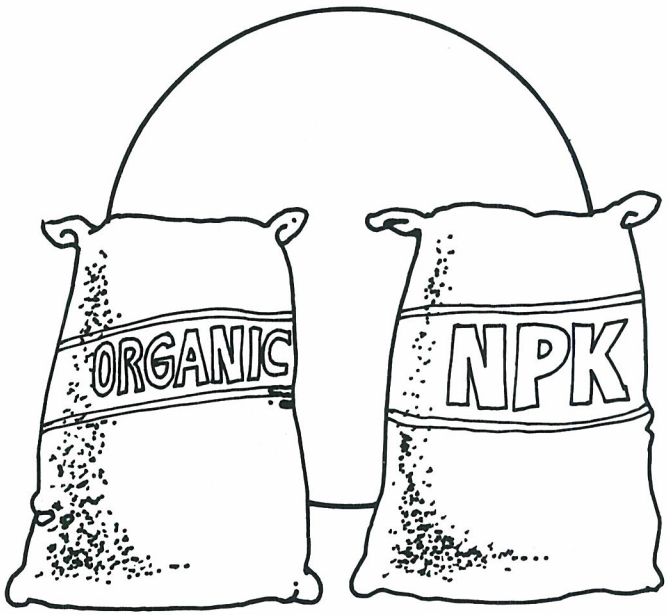
  Examples: pechay, mustard, kangkong, bunching onions, spinach

Soil and Fertilizer Management



- vegetables need nutrients
- vegetables need carbon and oxygen from the air, hydrogen from water, and mineral nutrients from the soil
- vegetables require major nutrients (nitrogen, phosphorus, and protein) in large amounts
- vegetables require minor nutrients in small amounts

Why use fertilizer

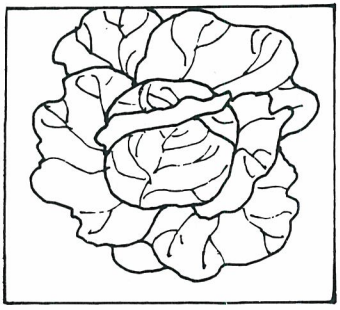


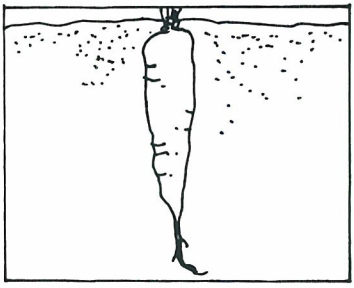
- Fertilizers contain nutrients which are food for plants

What type of fertilizers to use

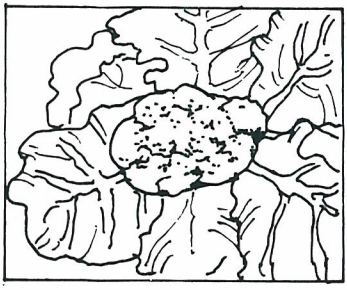
Fertilizers are either organic or inorganic

- Nitrogen is needed for healthy growth of leaves and flowers





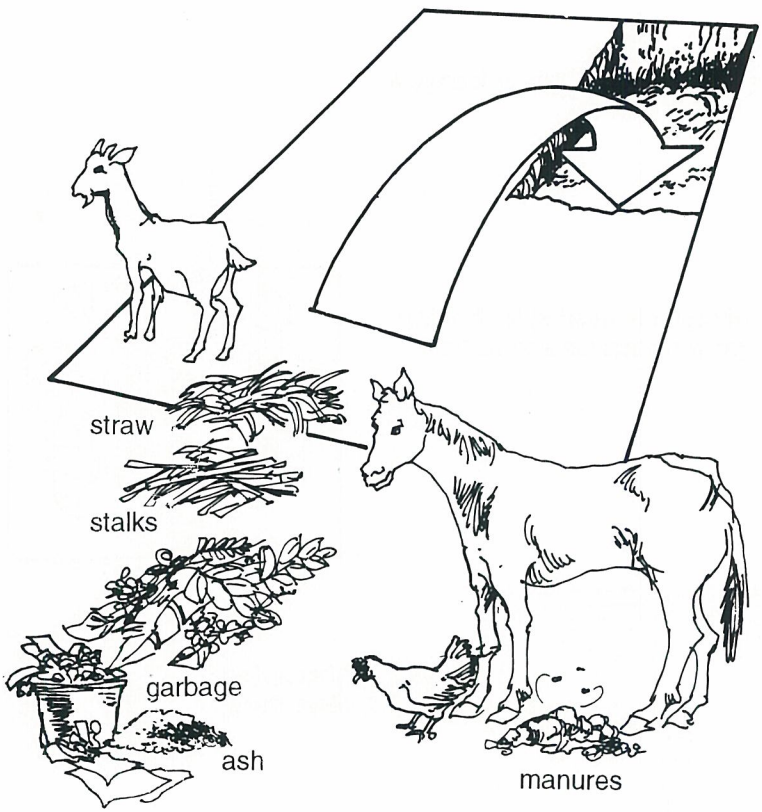
- Phosphorus is for good root and stem development



- Potassium is for better leaves, stems, and flowers

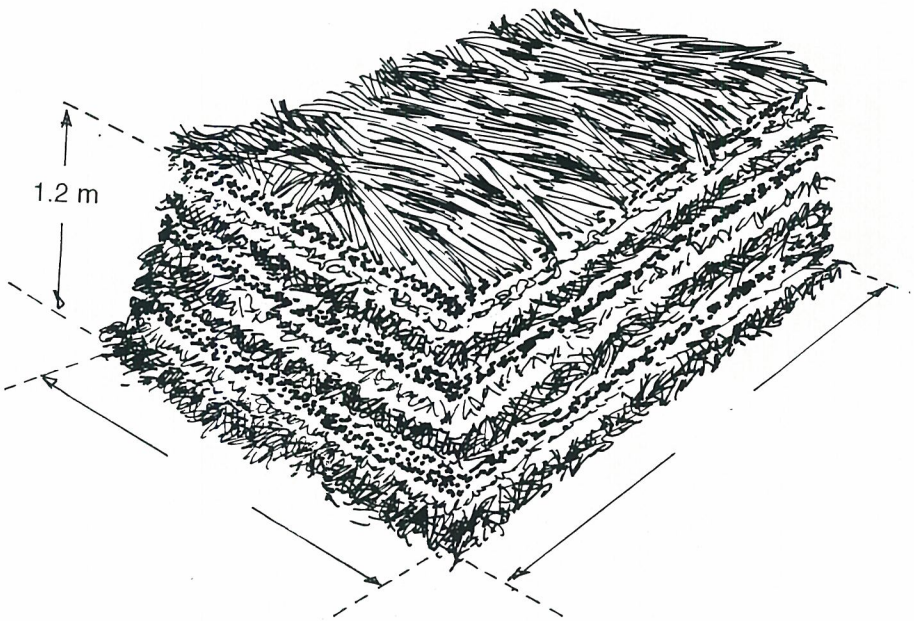
- Other nutrients for better growth and development

Organic fertilizers



- nutrients are in small concentration
- reaction is slow and therefore it takes time before results are observed
- improves soil texture and biological property

- What is compost

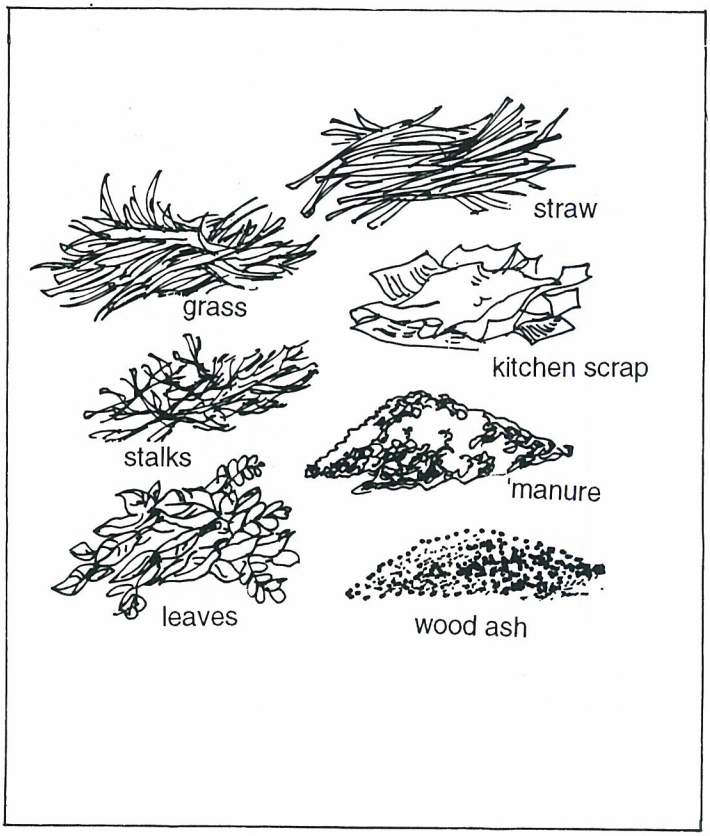


- ▲ a mixture of all kinds of organic wastes such as straw, leaves, ash, manure and kitchen scraps
- ▲ highly beneficial to soil and plant growth

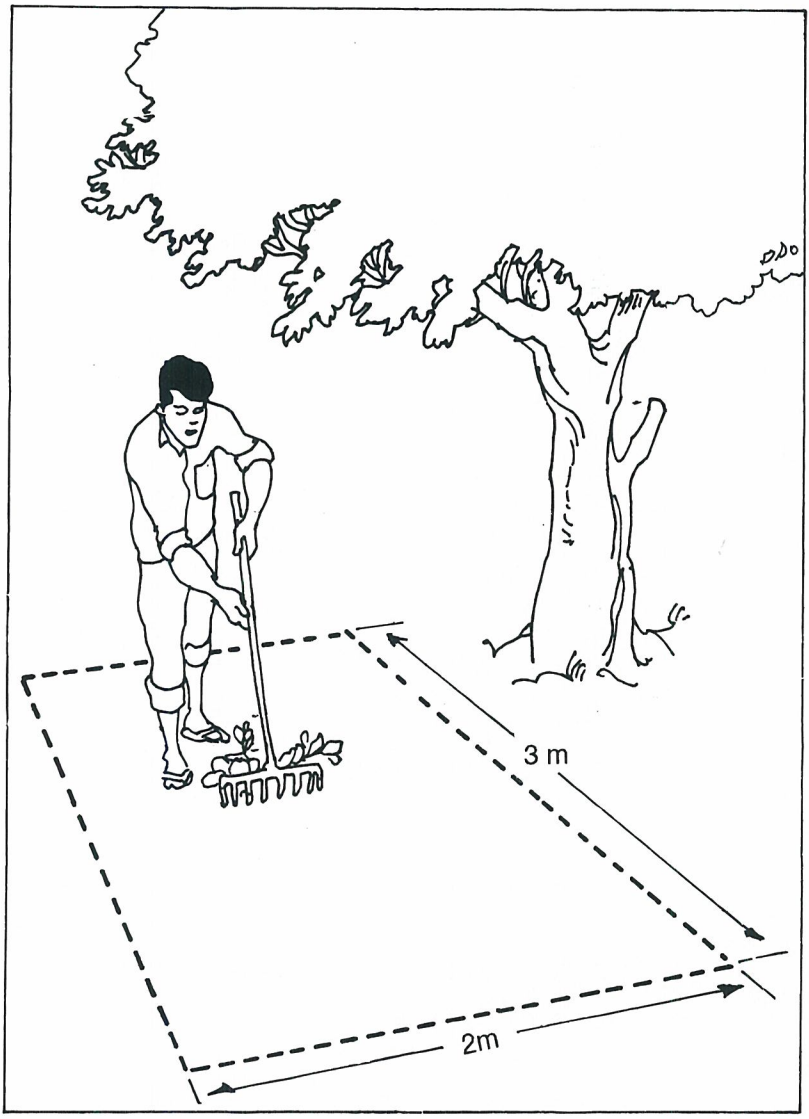
- How to make compost

▲ compost pile is best done during the rainy season when materials are fresh and moist

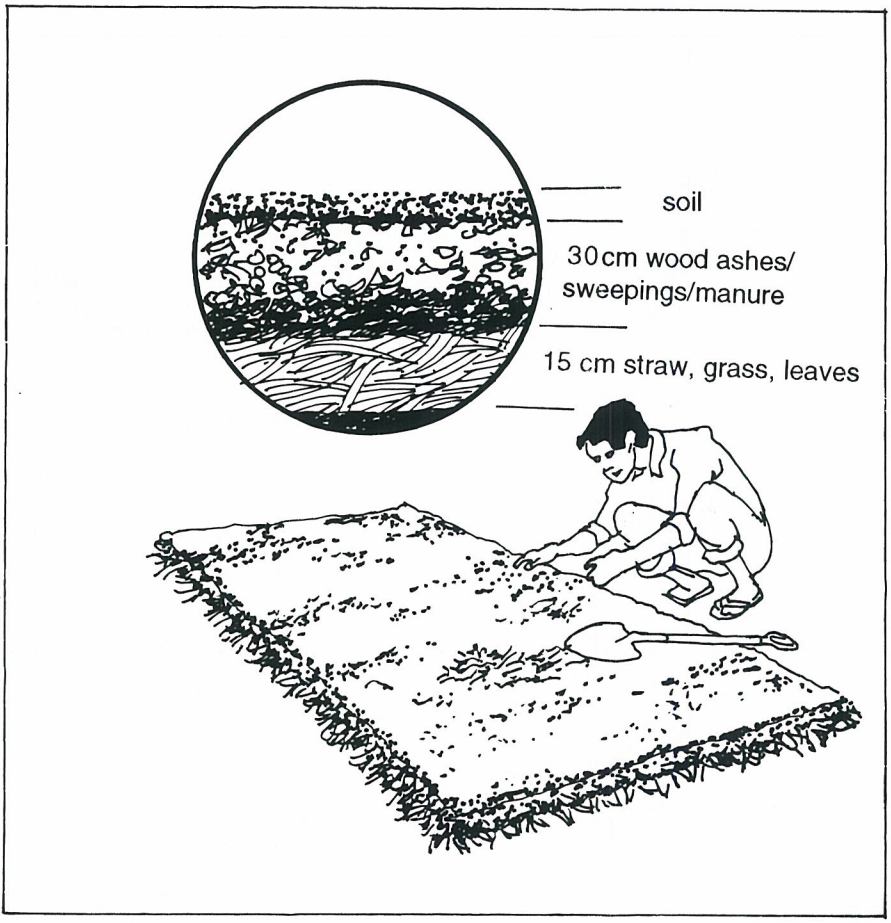
Step 1. Collect all waste materials



Step 2. Choose a shady level area measuring 3 meters long and 2 meters wide



Step 3. Pile by layers the different compost materials.

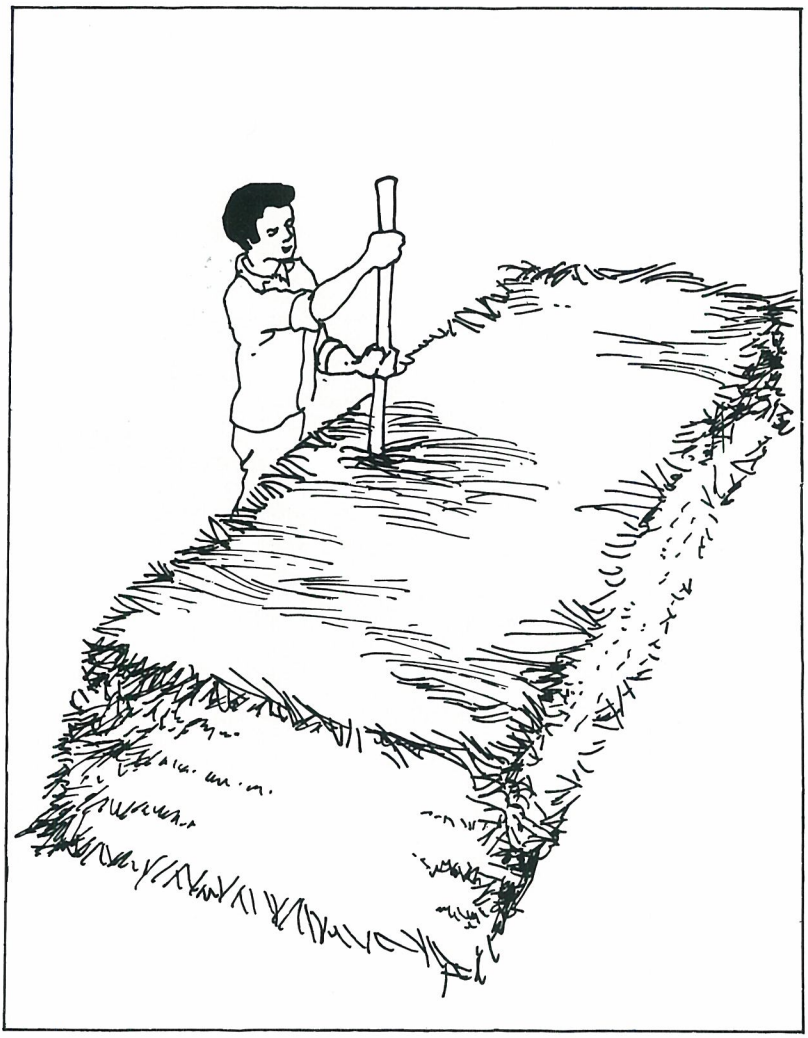


- Care should be taken not to pack the layers down to avoid slowing of decomposition.

Step 4. Water the pile evenly and avoid overwatering.
Repeat Step 3 to make the pile higher.

- Cover the pile with a layer of grass 10-15 cm high to keep the pile from drying up.

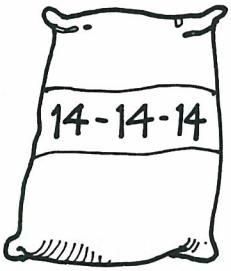
Step 5. Test if the pile is hot inside by inserting a stick all the way into the pile.



Step 6. Turn the pile upside down when it has cooled down.

- Cover with grass to keep the moisture in.
- Check the pile regularly and after one month turn over the pile again.
- After one month, the compost will be ready for use.

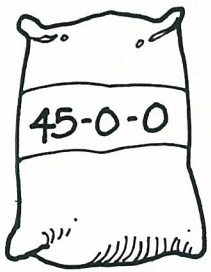
Inorganic fertilizers



14% nitrogen (N)

14% phosphorus (P_2O_5)

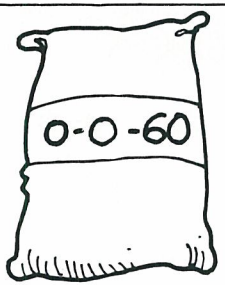
14% potassium (K_2O)



45% N

0% P_2O_5

0% K_2O



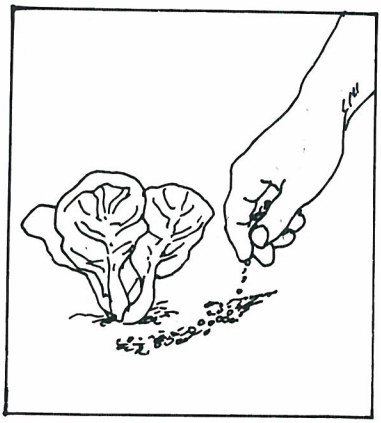
0% N

0% P_2O_5

60% K_2O

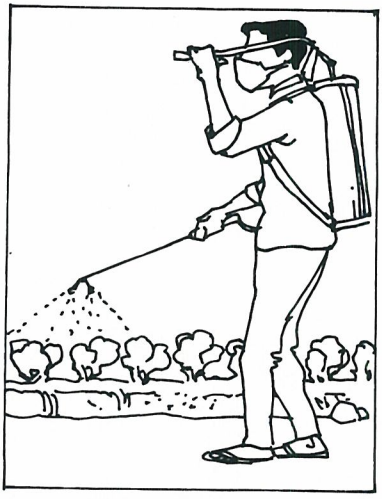
- commercially manufactured mineral nutrients.
- numbers on the bag refer to the percentage by weight of mineral nutrients
- available in different combination of mineral nutrients

How to apply fertilizer



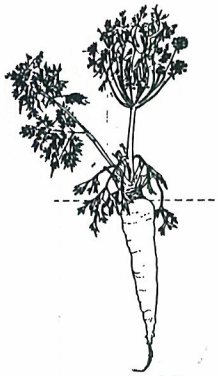
- localized

- broadcast/soil incorporation

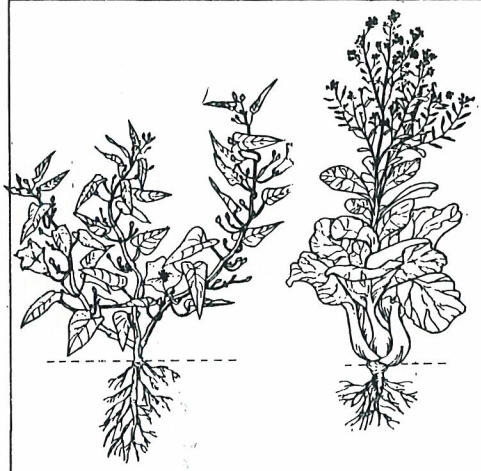


- foliar application

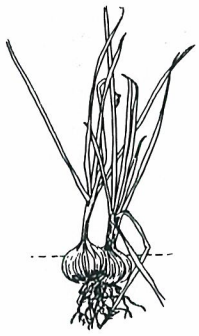
Frequency and time of application



- carrot
  - ▲ soil incorporate compost/manure before planting
  - ▲ apply P, K, and 1/2 N in band at planting
  - ▲ sidedress the remaining N at the initiation of rooting

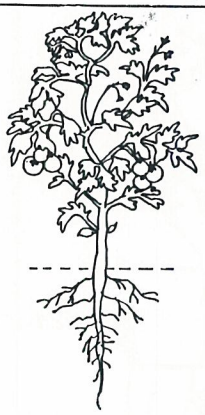


- kangkong and pechay
  - ▲ soil incorporate compost/manure before planting
  - ▲ apply P, K, and 1/2 N in band at planting
  - ▲ sidedress the remaining N 10 days after germination



- onion
  - ▲ soil incorporate compost/manure 1 week before seeding
  - ▲ apply P, K, and 1/2 N in band at planting
  - ▲ sidedress the remaining N at the initiation of bulbing

- squash
  - ▲ soil incorporate compost/manure before planting
  - ▲ apply commercial fertilizer at planting
  - ▲ sidedress when plants have at least 1 m vine
  - ▲ repeat sidedressing when first fruit is about the size of a chicken egg



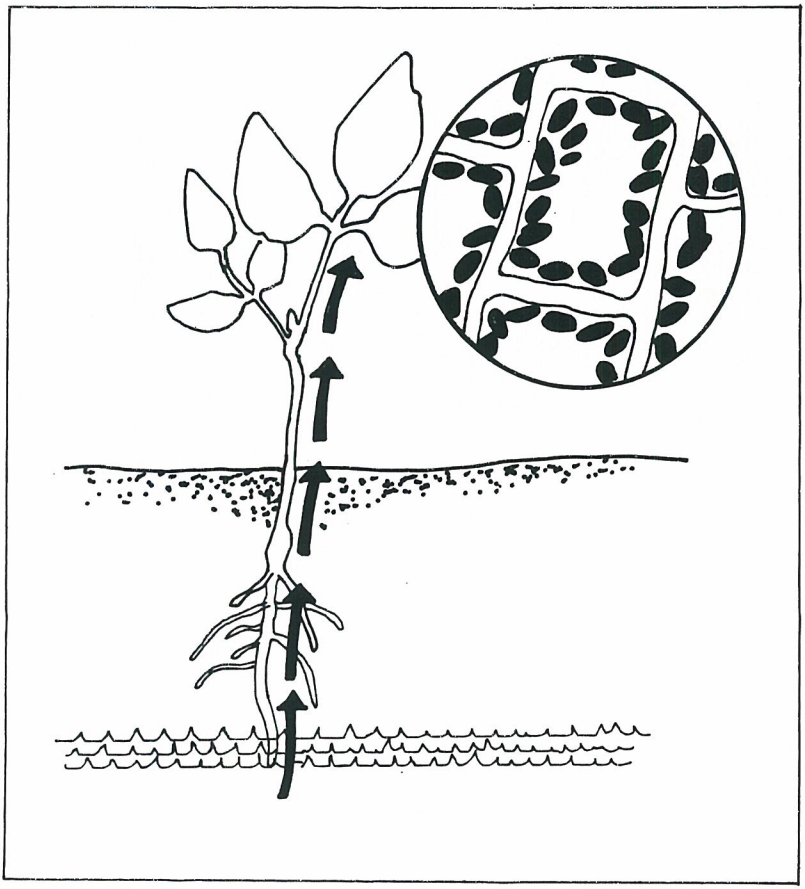
- tomato
  - ▲ soil incorporate compost/manure at planting time
  - ▲ apply P, 1/2 K, and 1/2 N in band at planting
  - ▲ apply remaining N and K 1 month after transplanting

- yardlong bean
  - ▲ soil incorporate compost/manure before seeding
  - ▲ during dry season apply all required fertilizer at seeding
  - ▲ during wet season apply 1/2 N and all P and K in band at seeding and sidedress the remaining half of N 3 weeks after seeding.

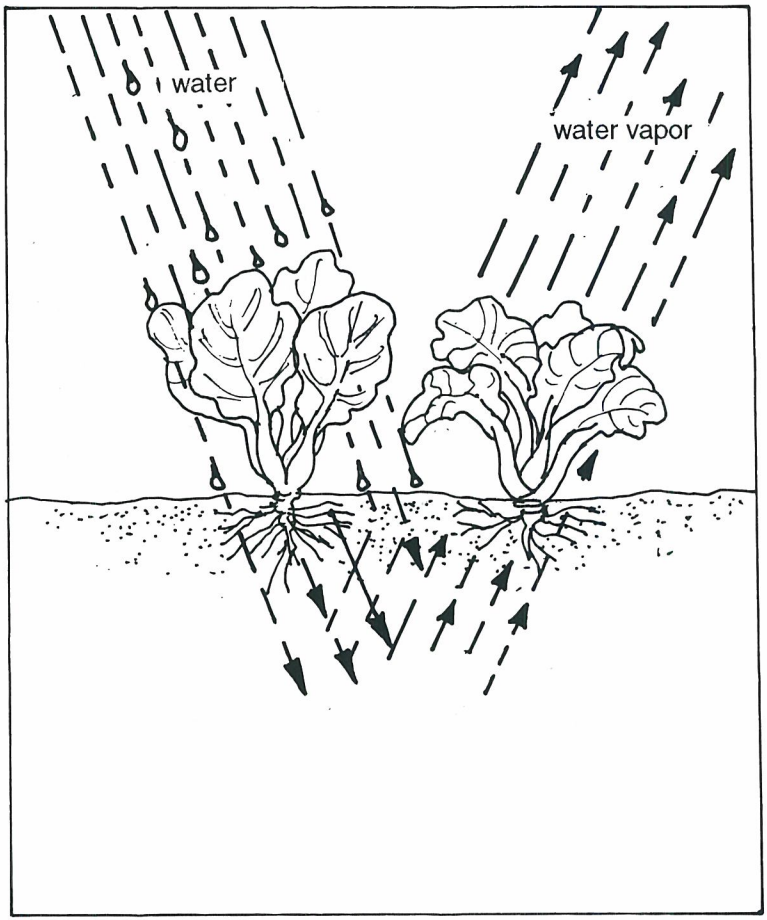
Water Management

■ Importance of water

- water is essential for photosynthesis



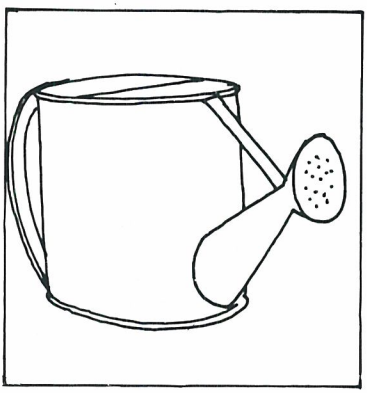
- raw material for food production
- carrier of food



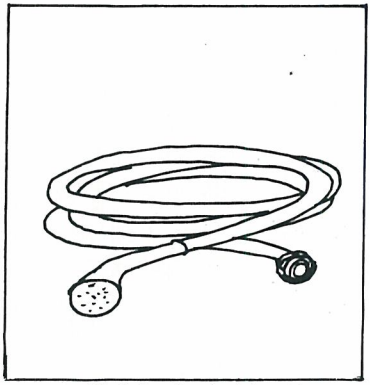
- watering cools the vegetable
- it keeps them tender, crisp, and fresh

■ Types of watering

- sprinkler

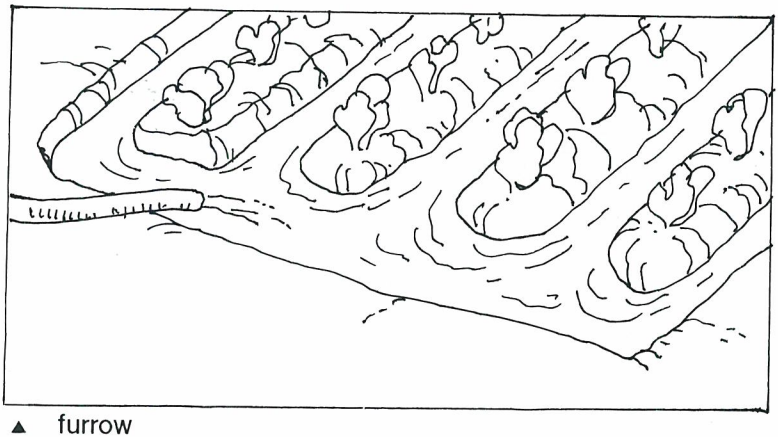


▲ spray



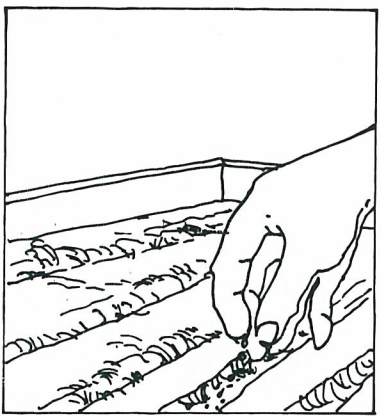
▲ artificial rain (rubber hose with sprinkler nozzle)

- surface

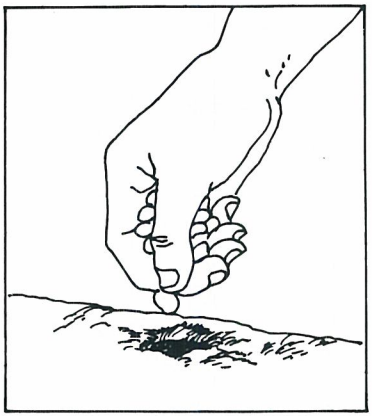


▲ furrow

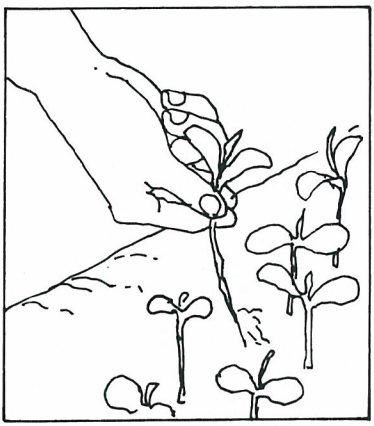
■ When to water



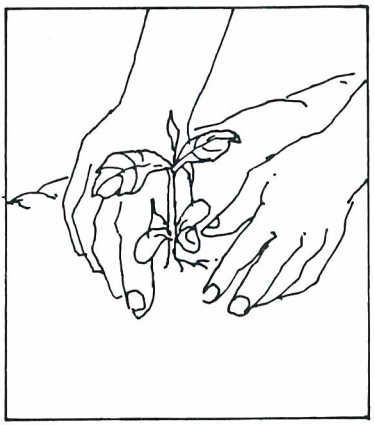
• after sowing seeds



• after seeding

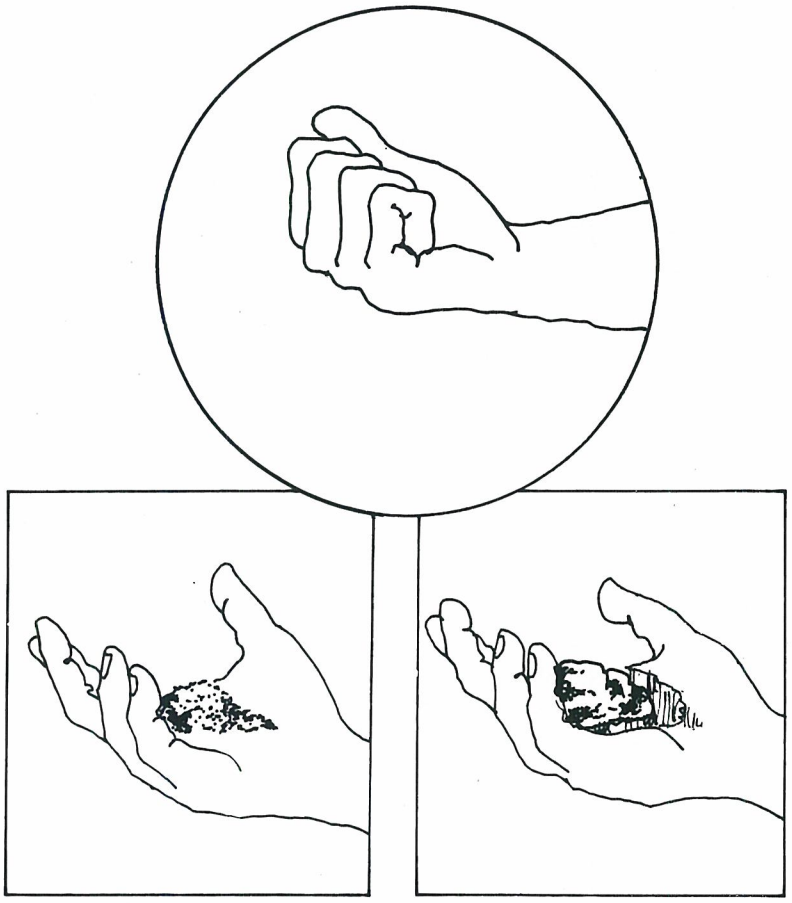


• after pricking



• after transplanting

- every time the soil is dry, there is the need to water
- to determine if soil is dry, get a handful of soil from your garden, squeeze it fairly hard, then open your hand:



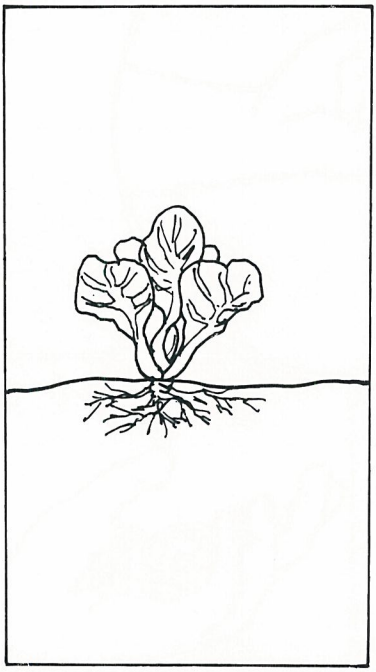
▲ need to water if soil crumbles

▲ no need to water if soil forms a ball with wet outline

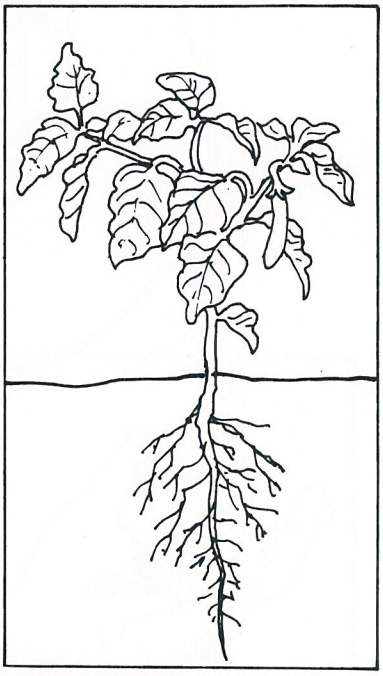
■ Amount and frequency of watering

Depends on:

- Root type

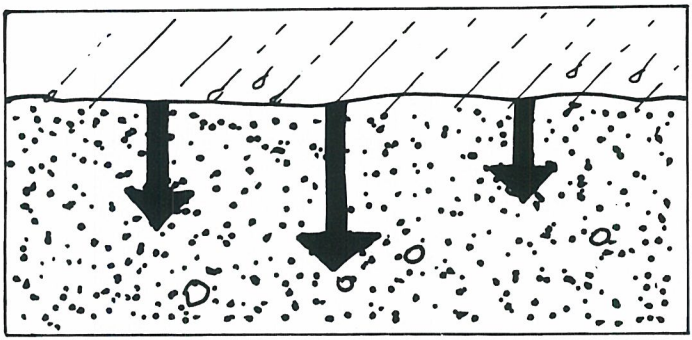


▲ more often for shallow-rooted crops like pechay, cabbage, mustard, and kangkong

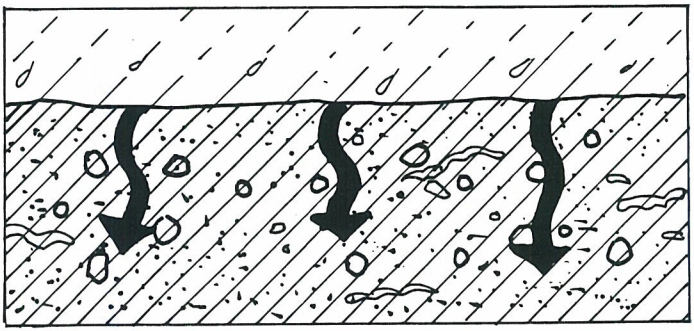


▲ less frequent for deep-rooted crops like okra, tomato, egg-plant, and pepper

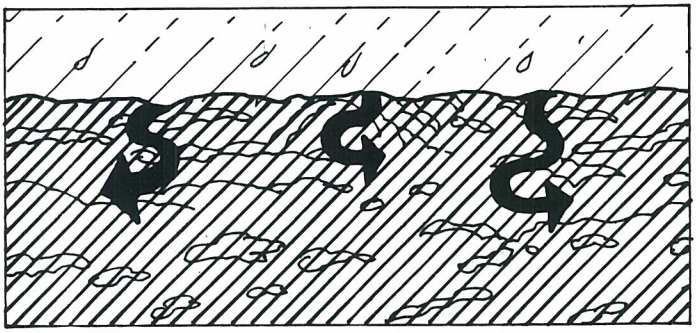
- Soil type



▲ more often in sandy soil since it does not hold much water (poor water holding capacity)

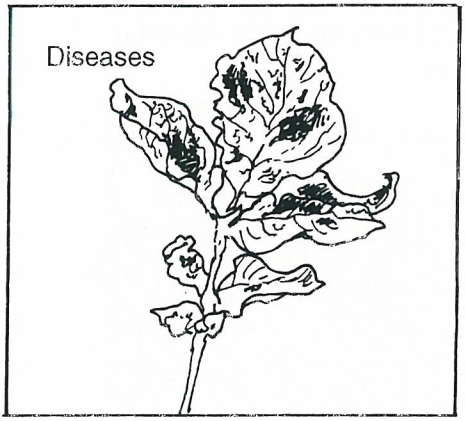


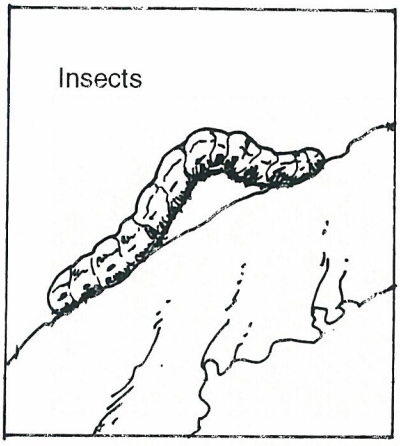
▲ moderate



▲ less frequent in clayey soil because of its good water holding capacity

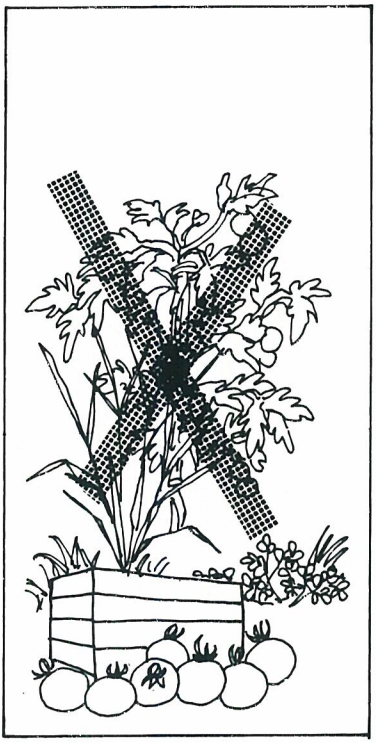
Pest Management

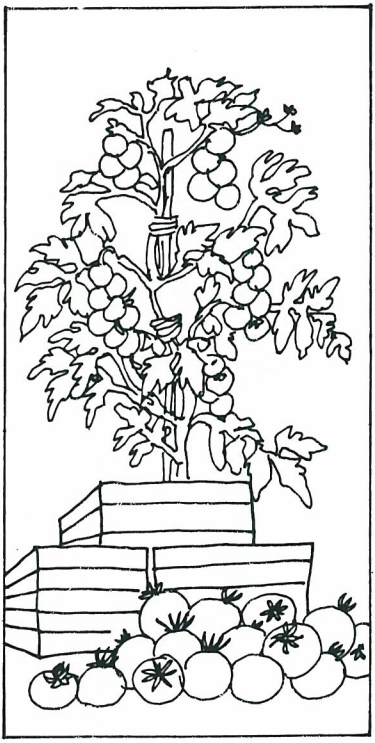




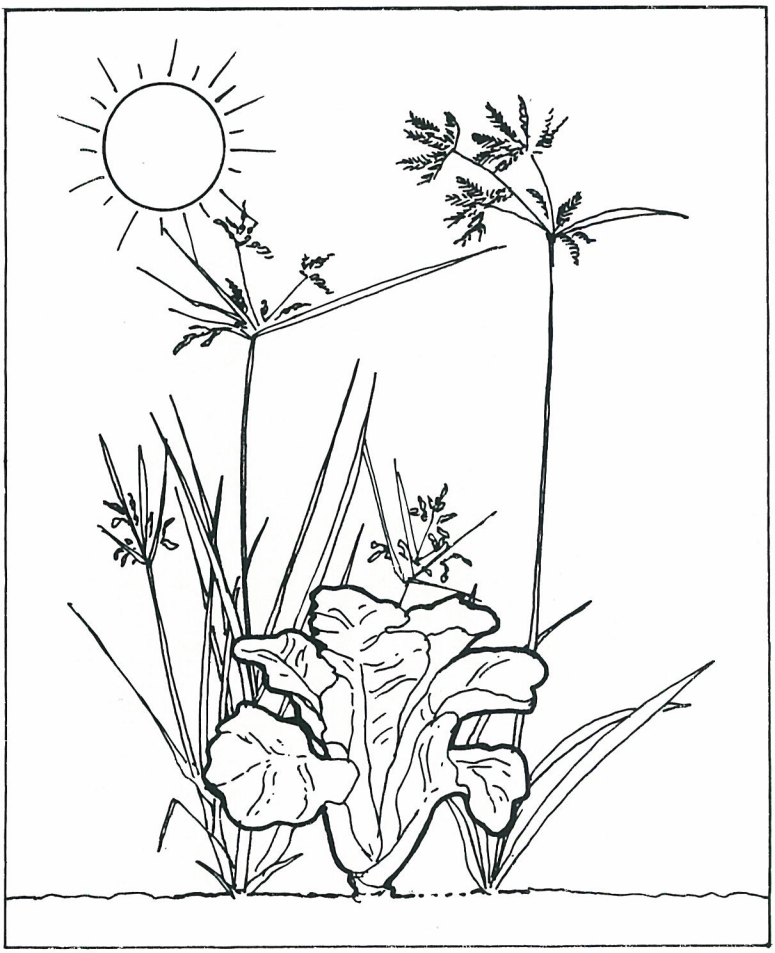
Weeds

- Importance

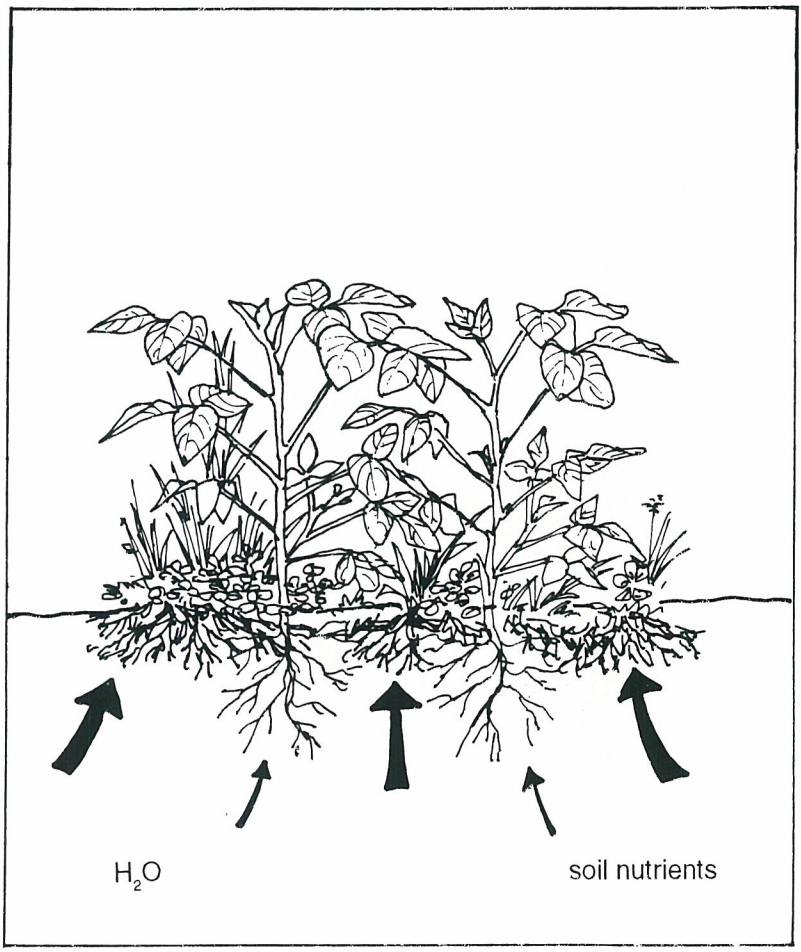




- lower yields of vegetables



- compete with vegetables for light and carbon dioxide

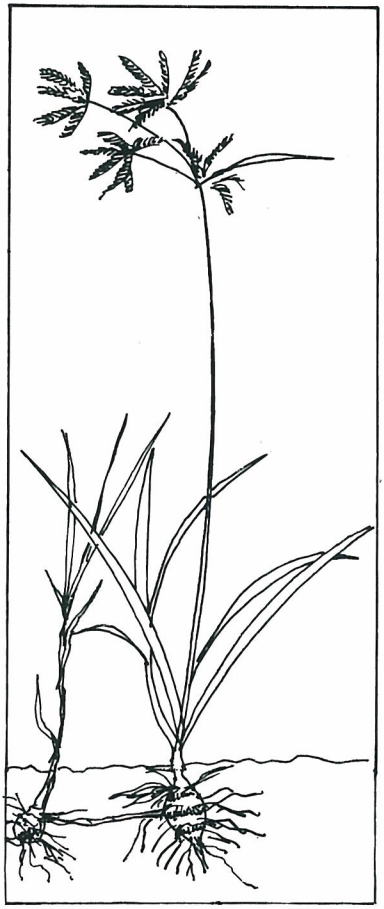


- compete with vegetables for water and soil nutrients

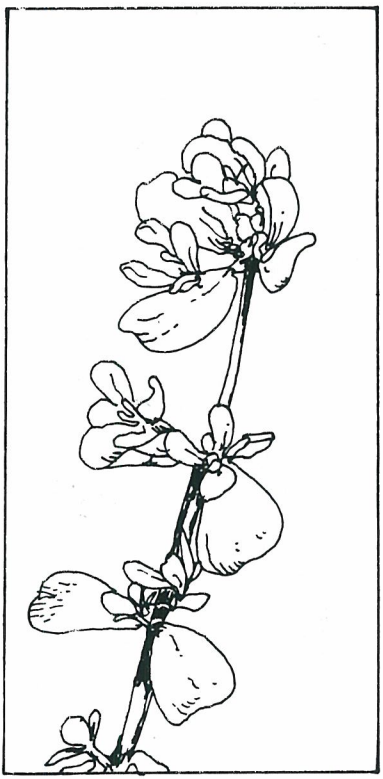
- act as an alternate host of pests and diseases

■ Common Weeds

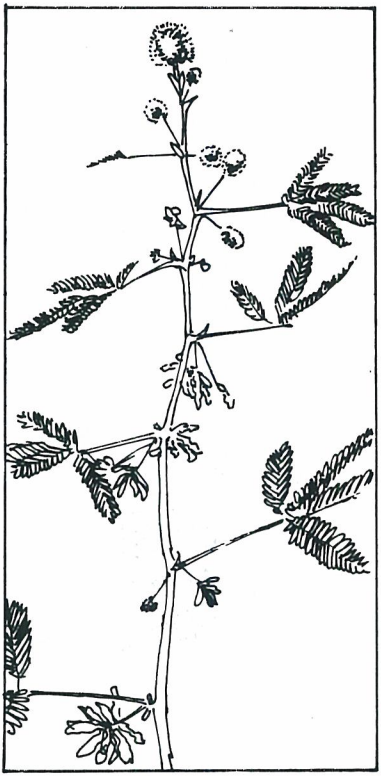
● Spring amaranth
(*Amaranthus espinosus*)



● Purple nutsedge
(*Cyperus rotondus*)



• Common purslane
(*Portulaca oleracea*)



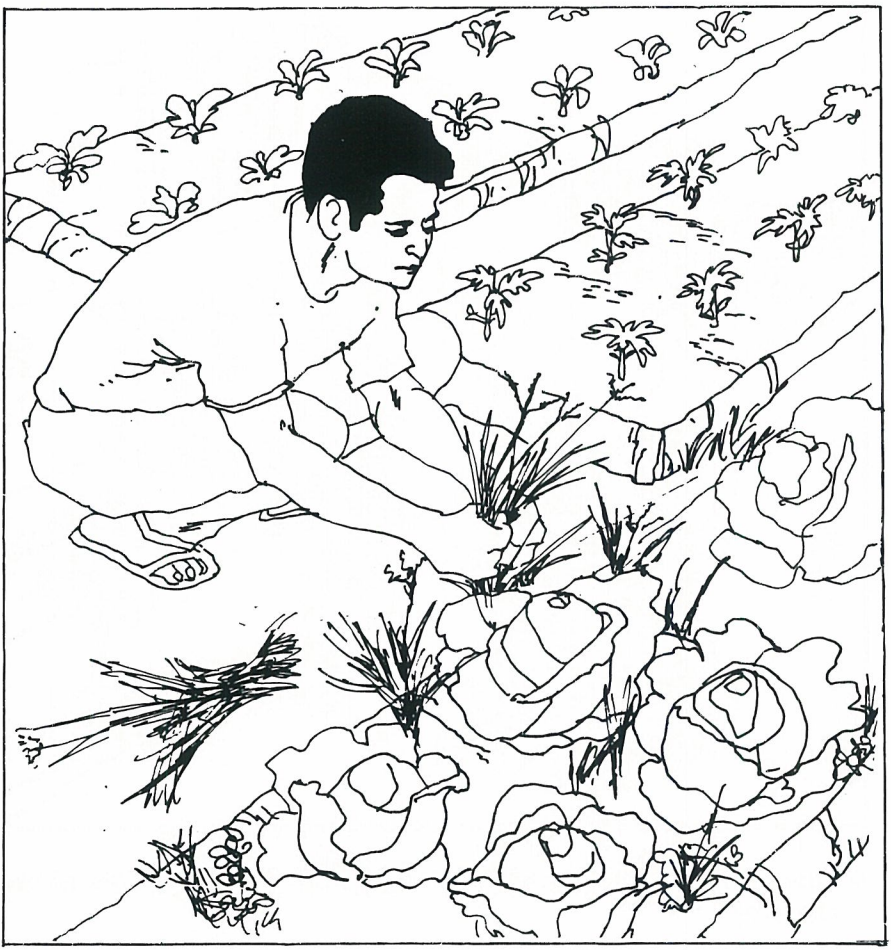
• Touch-me-not
(*Mimosa pudica*)

- When to weed

- Remove weeds at critical period of crop competition (25-30% of life duration)

■ Methods of control

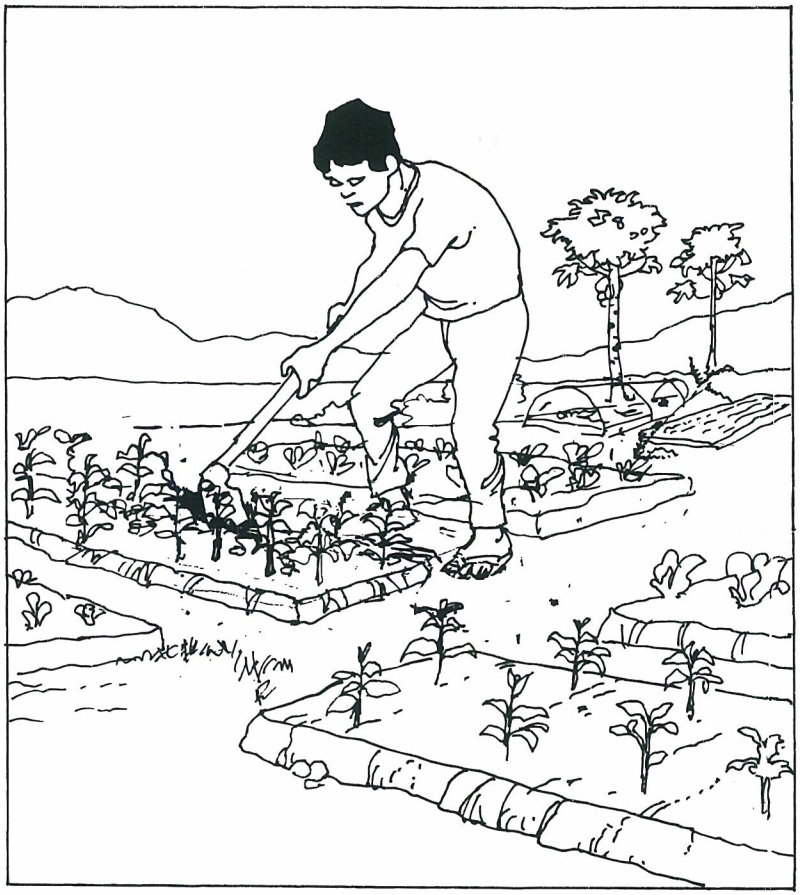
● Hand pulling



▲ most effective for small areas

▲ repeated weeding is necessary

- Hoeing and cultivation of beds



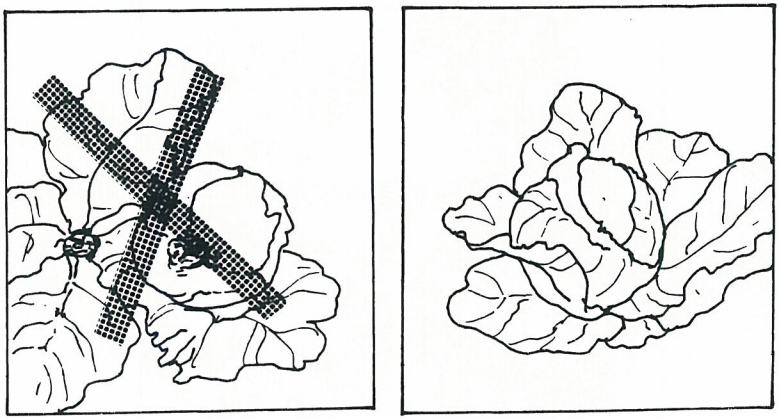
- Mulch on beds

Mulching with

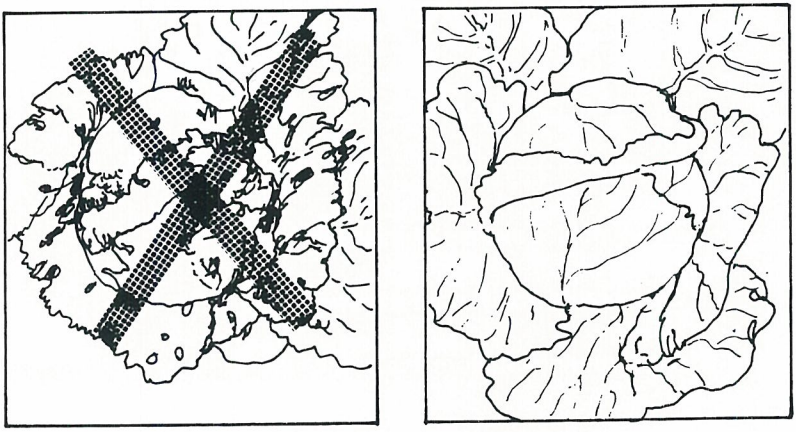
- ▲ rice straw
- ▲ sugarcane baggasse
- ▲ banana leaves
- ▲ coconut leaves

Mulch is placed 2-3 inches thick on top of the soil around the base of the plant.

Diseases

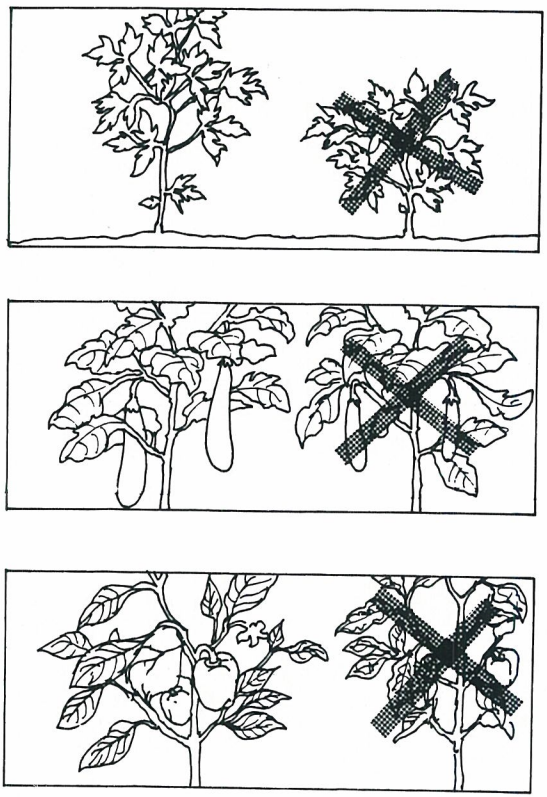


- Lower yields of vegetables



- Reduce quality of vegetables

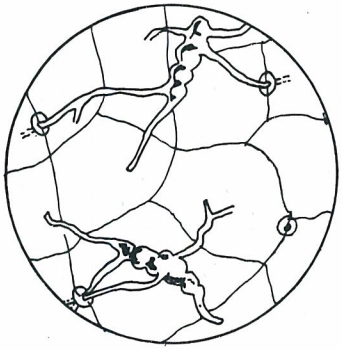
■ Non-parasitic diseases are due to:



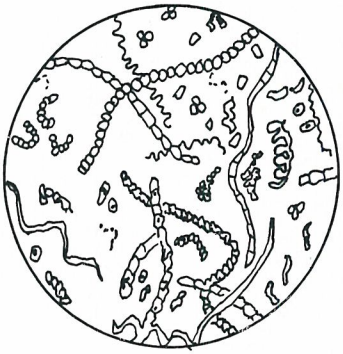
- either lack or excess of minerals
- unfavorable soil-water relations
- environmental factors like air pollution, low or high temperature

▲ injury from non-parasitic diseases serves as entry of parasitic diseases

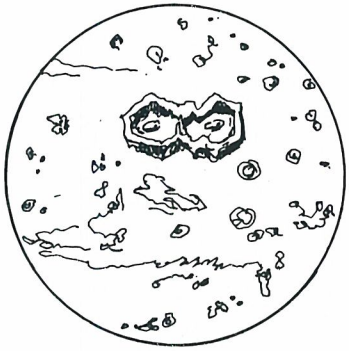
- Parasitic diseases maybe caused by:



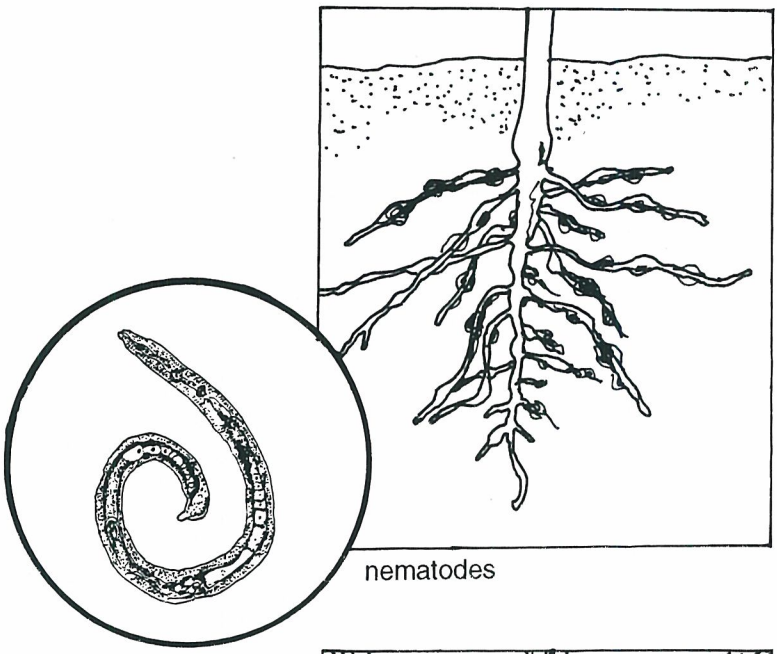
fungi



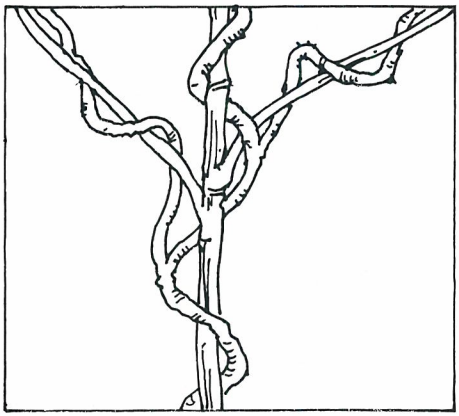
bacteria



virus

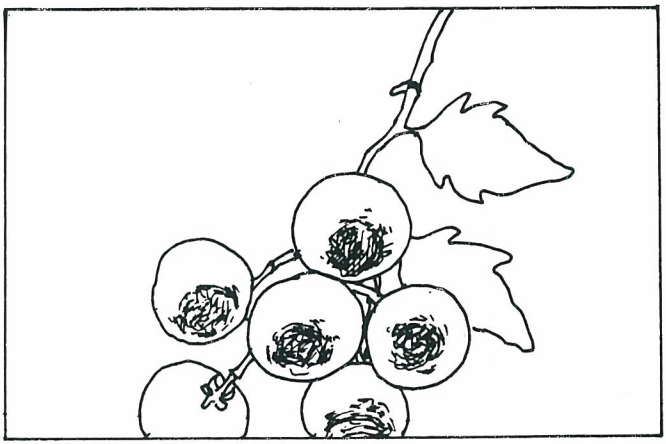


nematodes

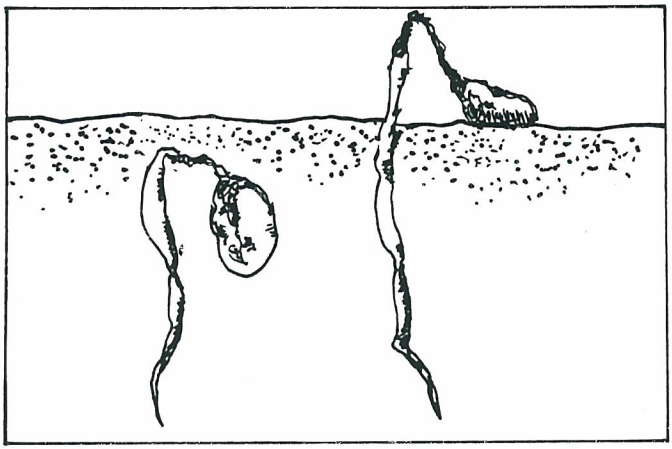


flowering parasitic plants

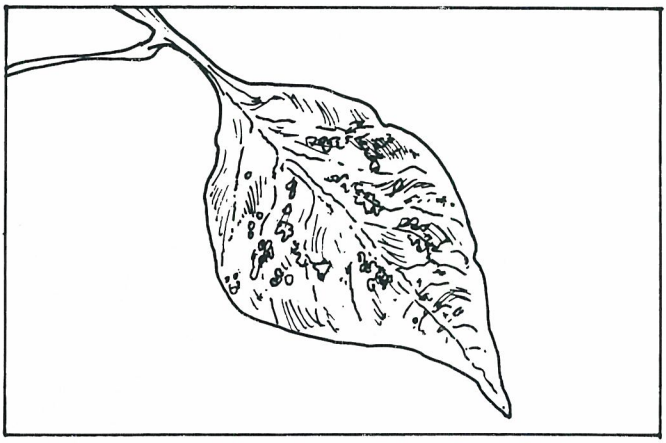
■ Common diseases



- blossom - end rot of tomato



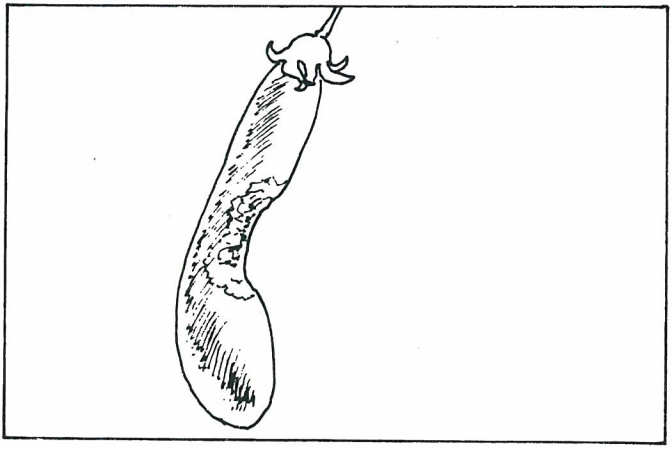
- pre-emergence damping-off: rotting of seeds after sprouting but before stem reaches soil
- Post emergence: rapid rotting at the base of the emerged seedling causing it to fall



- bacterial spot of pepper

- downy mildew of cucurbits

- cucumber mosaic virus in tomato

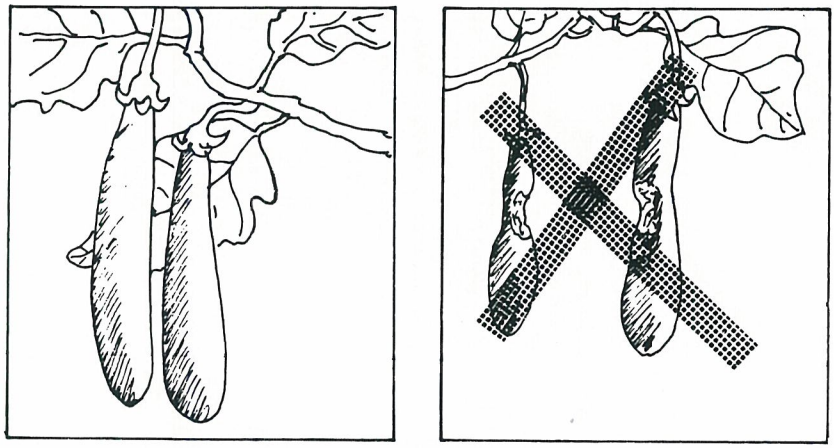


- fruit rot in eggplant

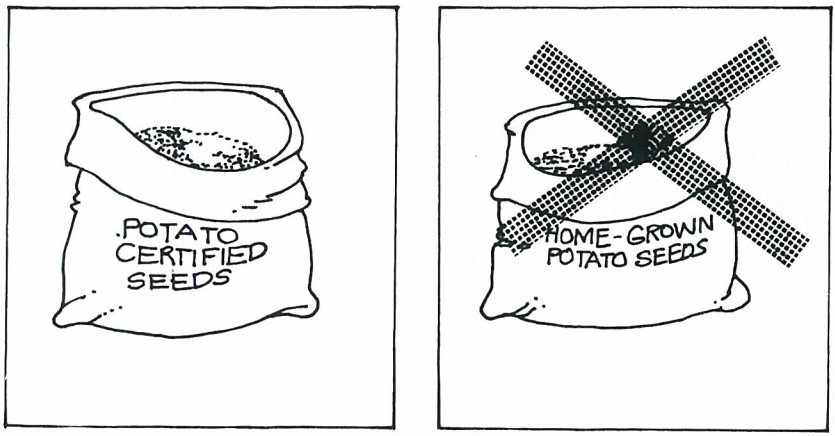
- orange galls of winged bean

- late blight of white potato

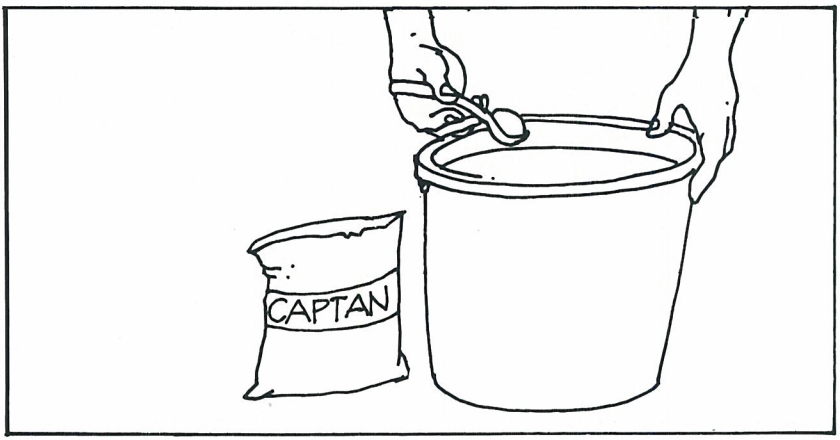
- Methods of Control



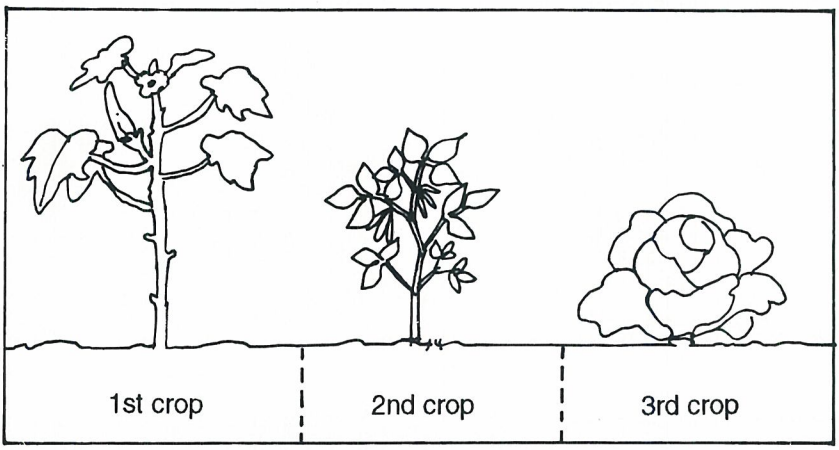
- use of resistant varieties



- use of disease-free seed stocks

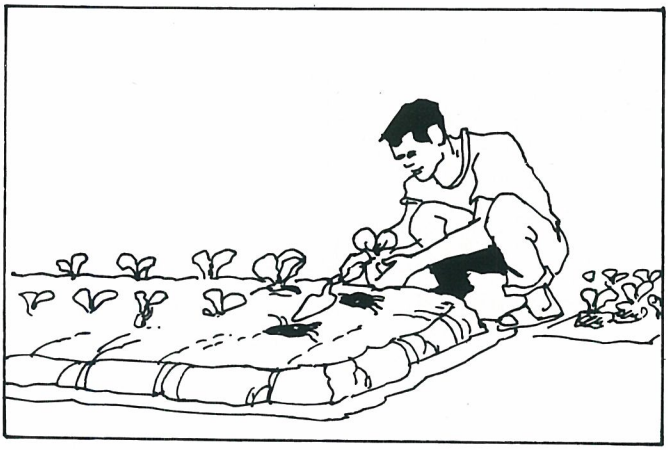


- seed treatment

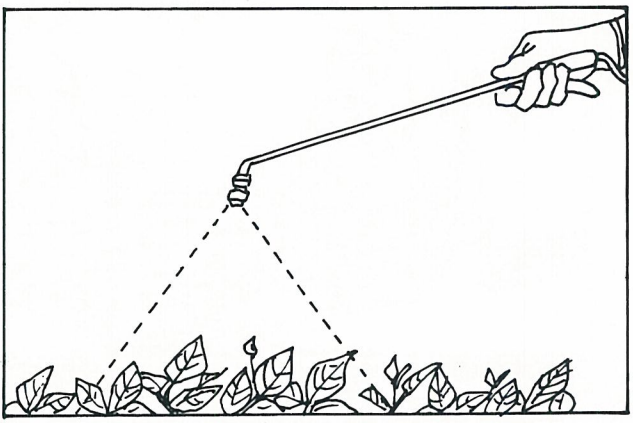


- crop rotation

- soil sterilization



- planting in well-prepared, fertile fields

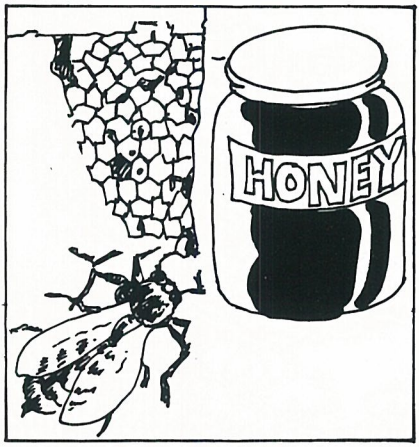


- weed and insect control

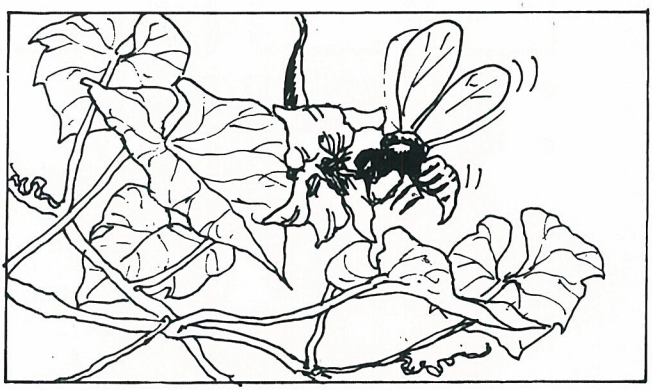
- practice cleanliness in the field

Insects

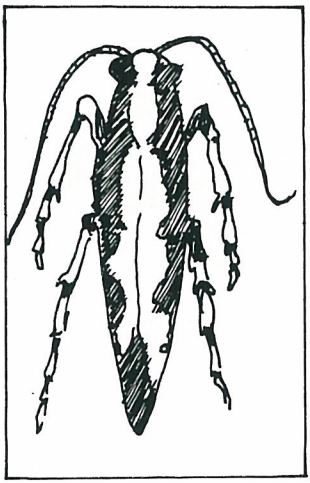
- Importance

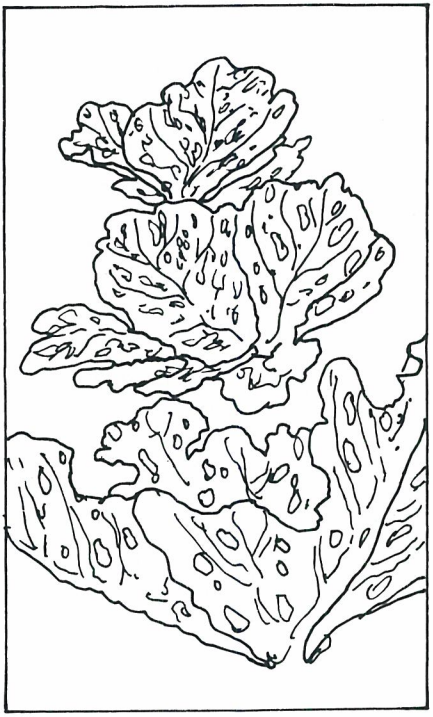


- produce beneficial materials like honeybees and silk



- butterflies and bees help in pollination

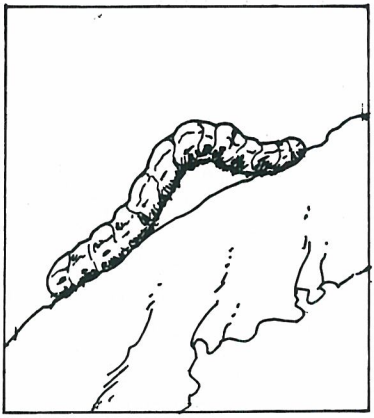




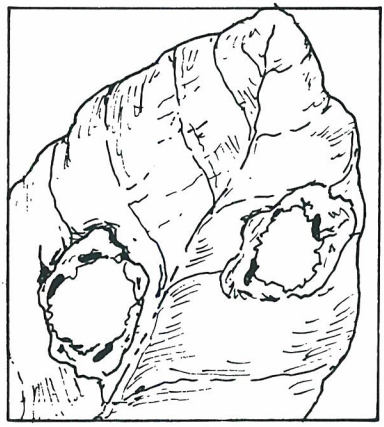
- lower yields and quality of vegetables
- transmit diseases to man and crops

- Common insect pests

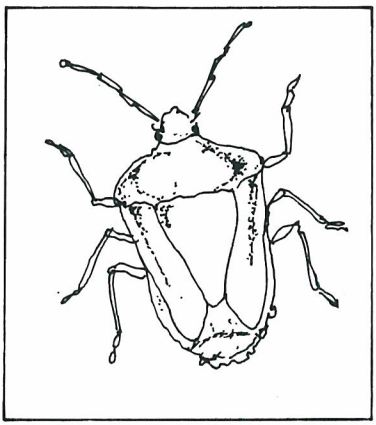
- beetles (Coleoptera)



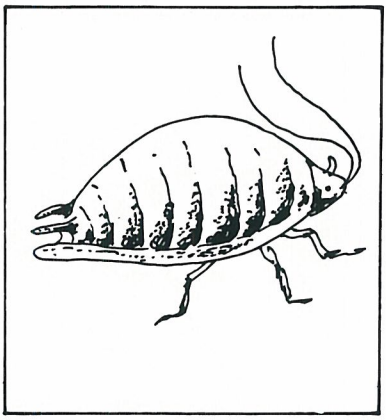
- butterflies and moth (Lepidoptera)



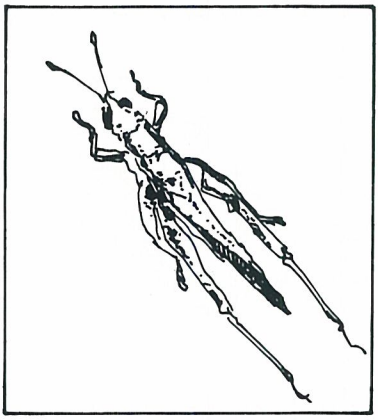
- flies (Diptera) - beanfly, leaf miner



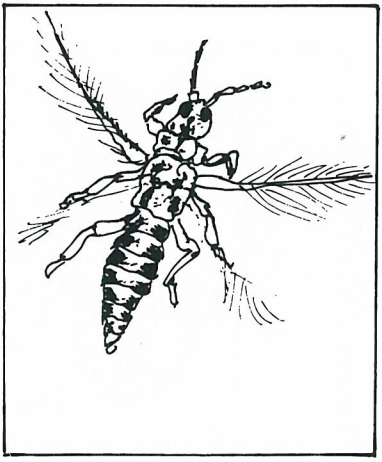
- true bugs (Nemiptera) green soldier bug



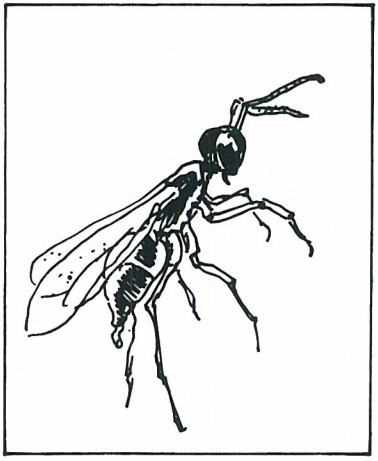
- aphids, hopper, and mealy bugs (Homoptera)



- grasshopper and crickets (Orthoptera)

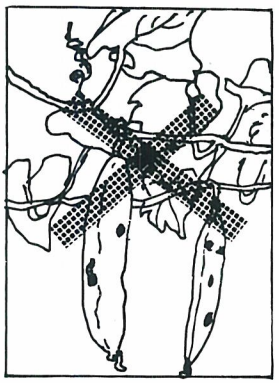


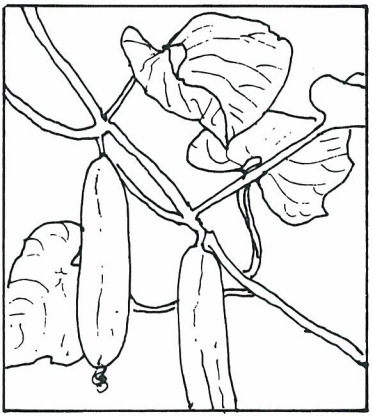
- thrips (Thysanoptera)



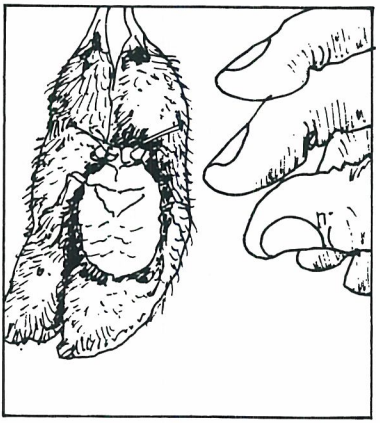
- ants, bees, and wasps (Hymenoptera)

■ Methods of Control



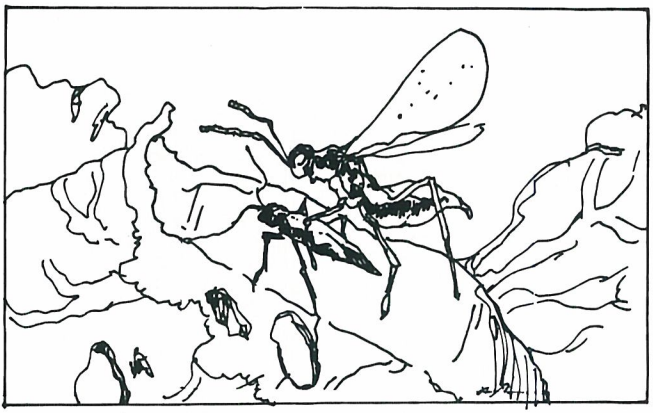


- use of resistant varieties

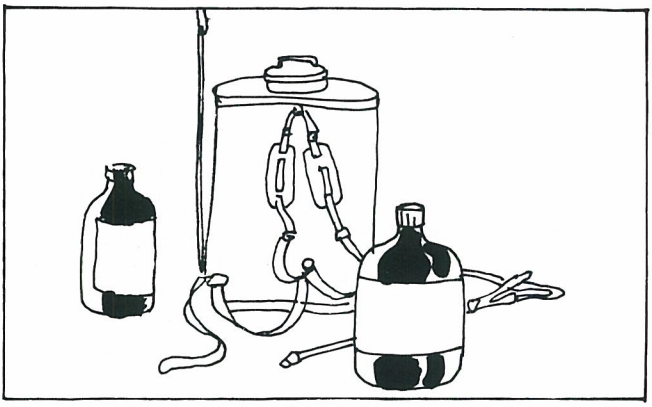


- hand picking

- use of botanical insecticides

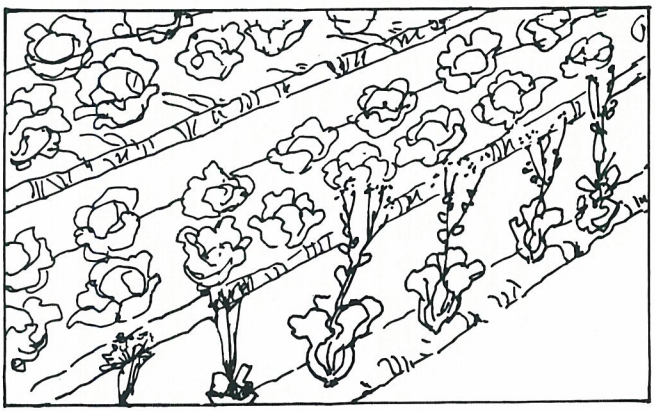


- use of parasites

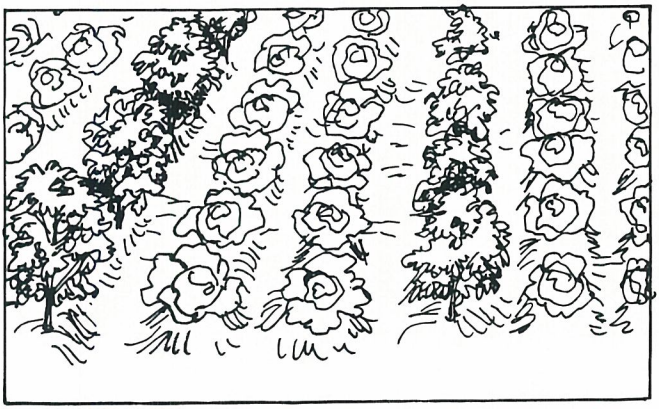


- use of microbial insecticides like bacteria, fungi and virus

- use of intercrop that repels some insect pests



▲ cabbage with mustard



▲ cabbage with tomato

CHAPTER IV. HARVESTING AND POSTHARVEST MANAGEMENT

When to harvest

What happens after harvest

How to harvest

Handling

Storage

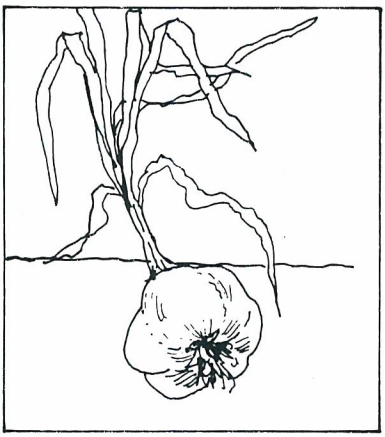
Processing

When to harvest

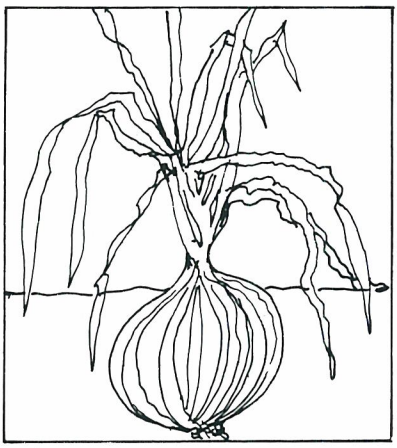
- Harvest your vegetables when the following have been achieved:
  - good quality
  - desired size
  - long term storability

■ Use indicators of maturity:

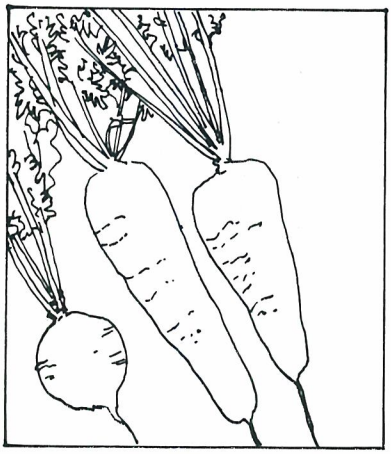
- **Root, bulb and tuber crops**



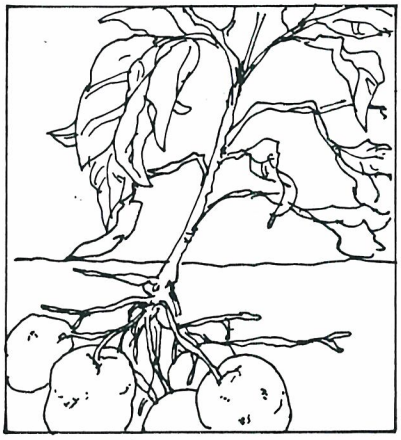
garlic - when tops begin to dry and topple down



onion - when tops begin to dry and topple down



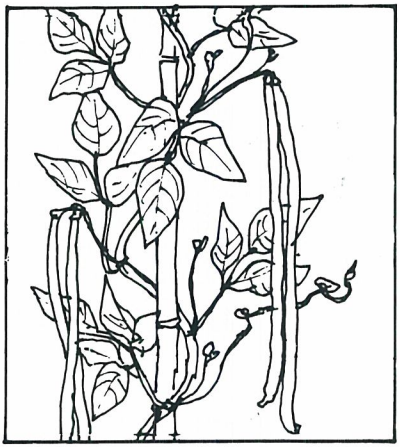
carrot - when desired size is attained



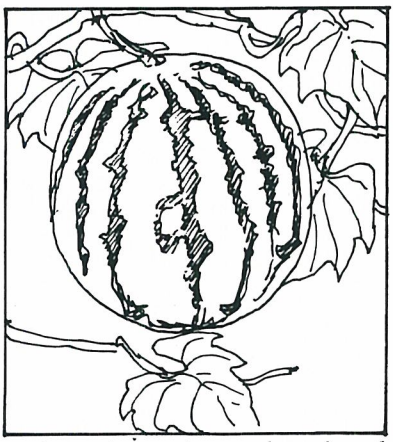
potato - when tops begin to dry and topple down

- **Fruit vegetables**

tomato - when green mature, pink or red ripe



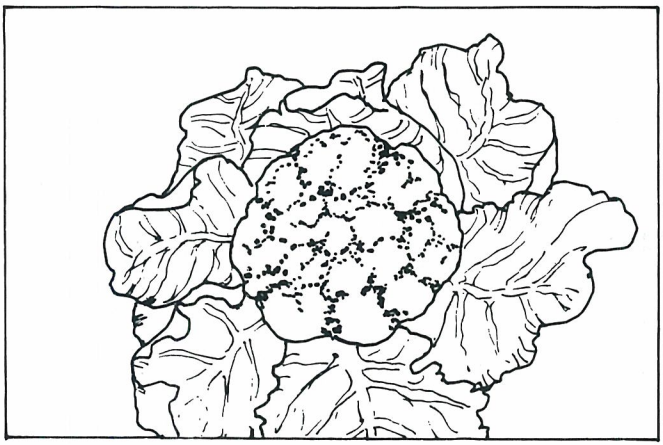
yardlong bean - well-filled pods that snap readily



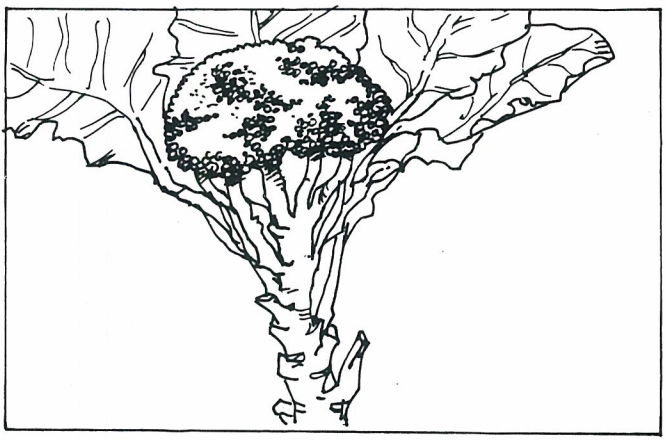
watermelon - change in color of lower surface from white to creamy yellow; produces dull sound when tapped with the back of the hand

sweet pepper - when it reaches marketable size

- **Flower vegetables**



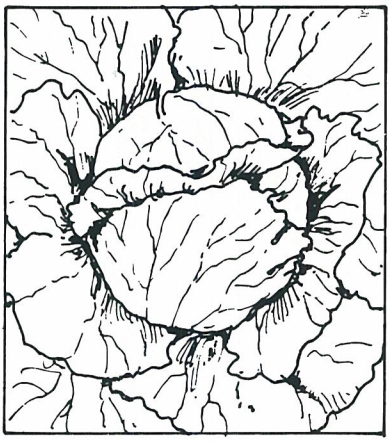
cauliflower - compact curd



broccoli - compact bud cluster

- **Leafy vegetables**

pechay - when desirable size is attained

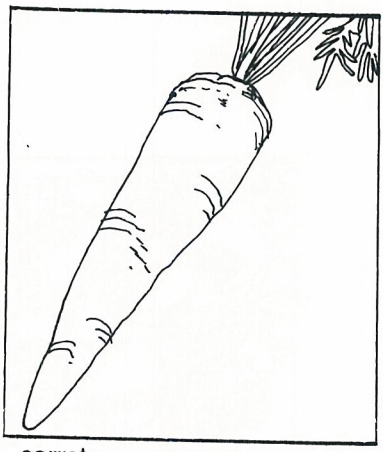


cabbage - compact head

kangkong - when desirable size is attained

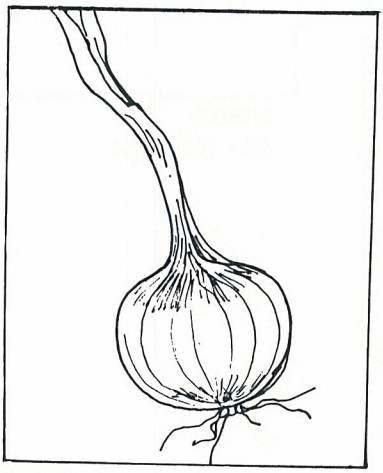
sweet potato - upper vine tips with unopened leaf buds

- Use of known maturity days



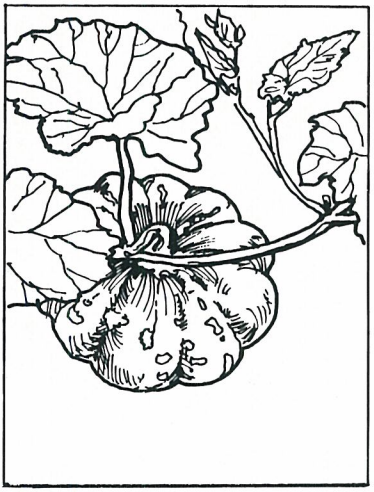
carrots
60 - 70 days

kangkong
30 - 35 days



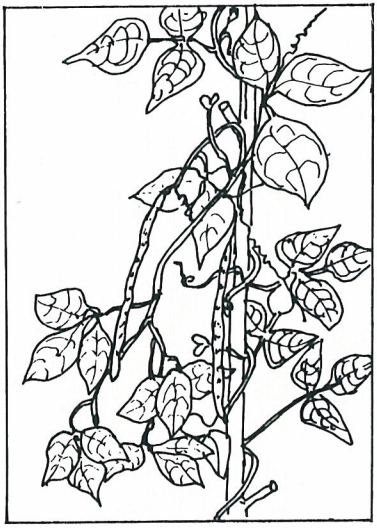
onion
90 - 110 days

pechay
30 - 35 days



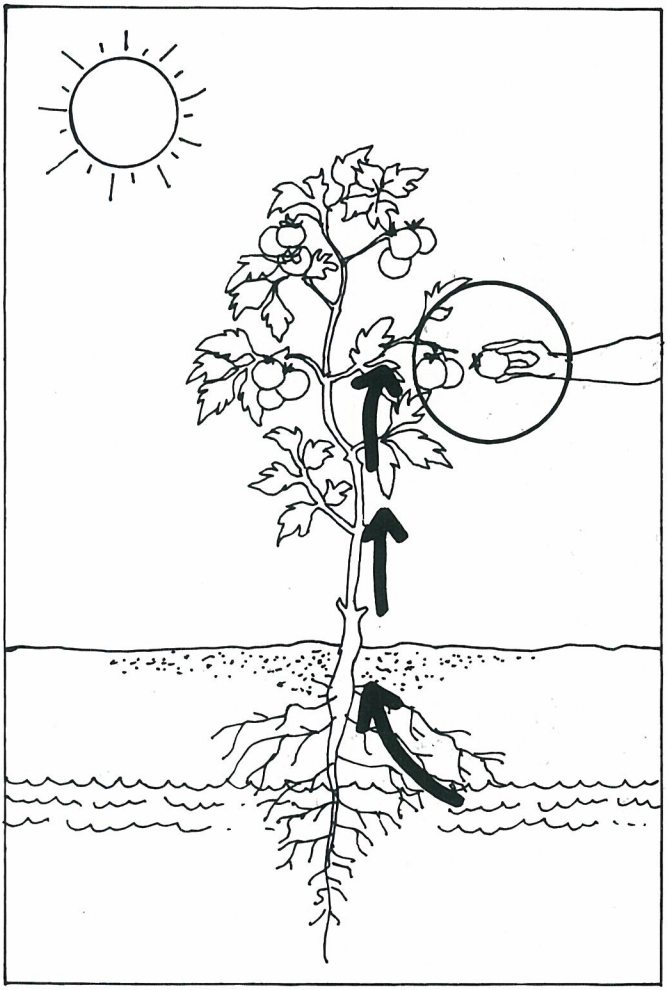
squash
75 - 90 days

tomato
85 - 100 days



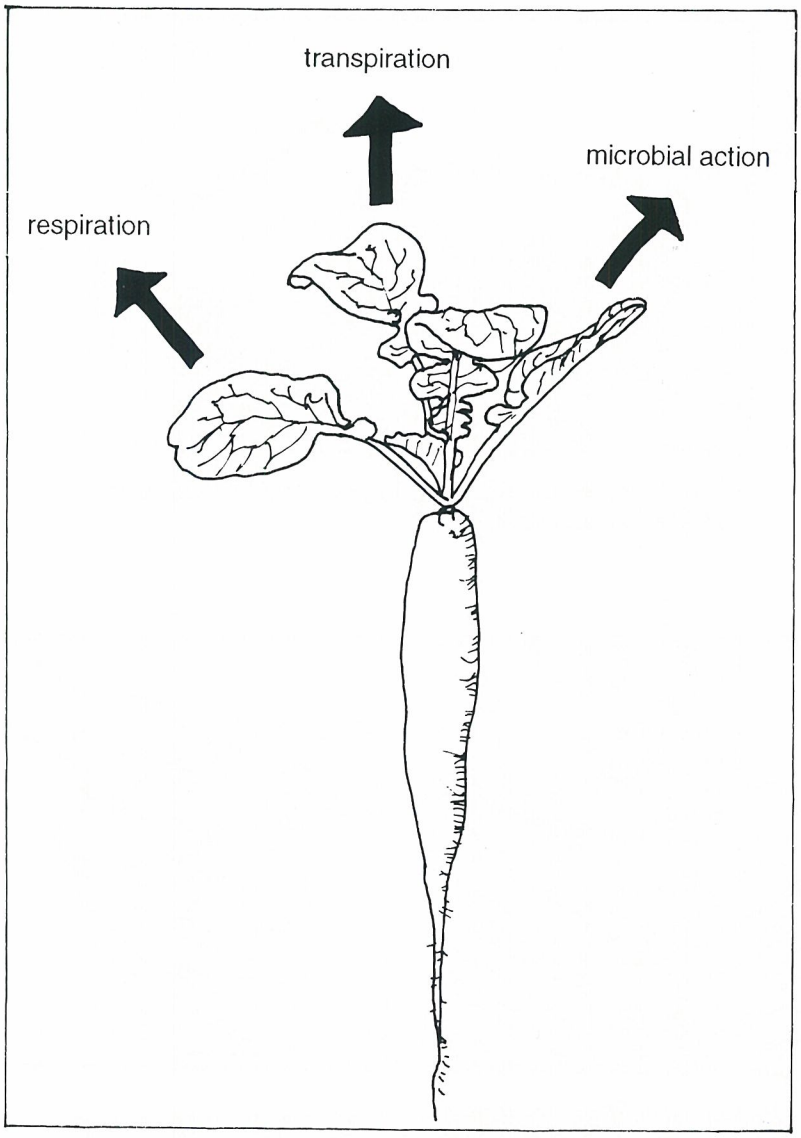
yardlong bean
50 - 60 days

What happens after harvest



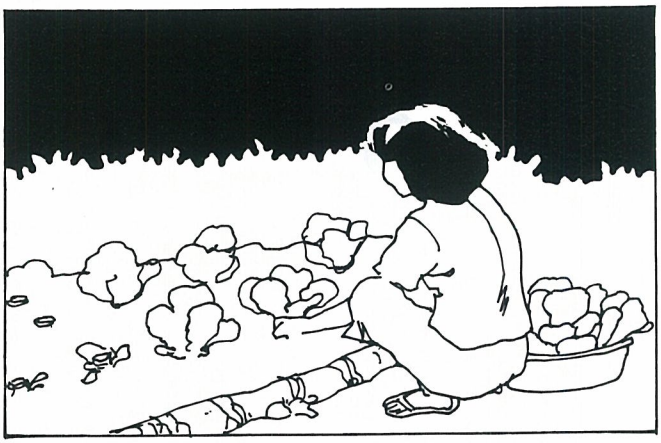
- Food production in the vegetable plant stops.

- Freshness of vegetables is prolonged when exposed to cool temperature and high humidity.

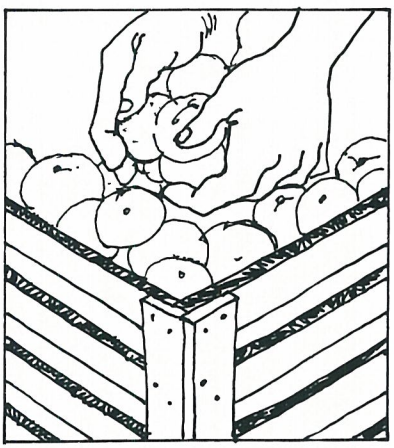


- Food and water reserves in vegetables are lost through respiration, transpiration and microbial action.

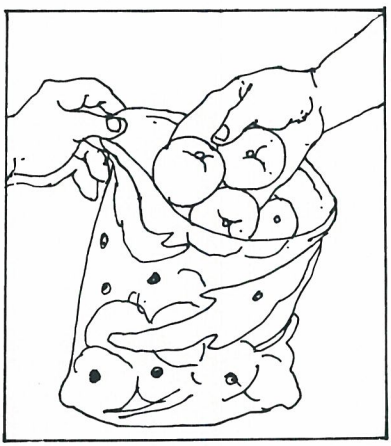
- Controlling the factors that affect respiration, transpiration, and microbial action prolong freshness of vegetables



▲ harvesting in the early morning or at night slows down respiration and transpiration

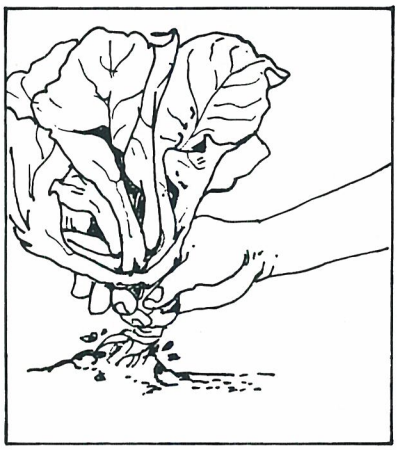


▲ careful handling minimizes injury to the product which serves as entry for microbes

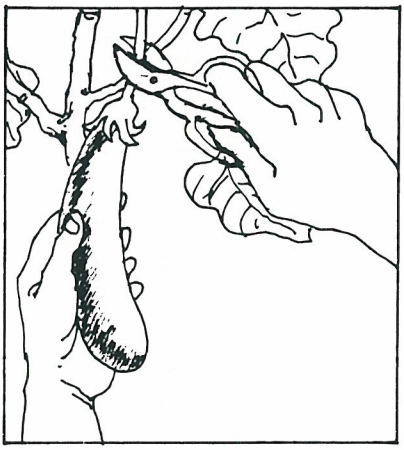


▲ perforated plastic bags reduce transpiration

How to Harvest

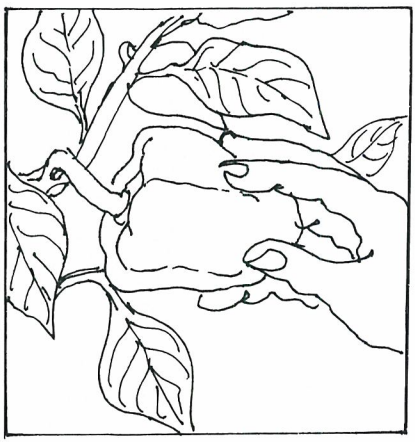


- pulling (mustard, pechay, celery, carrot, radish) is convenient if soil is sandy



- cutting (cabbage, broccoli, cauliflower, eggplant)

- digging (sweet potato, taro, white potato, onion, radish)



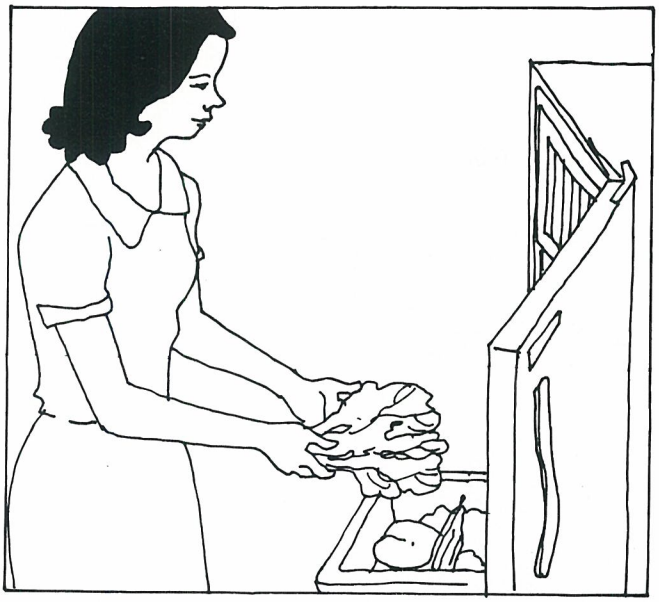
- picking (tomato, peas, pepper, beans, cucumber, okra)

Handling

- Washing
  - wash vegetables to remove dirt which may harbor pathogen
  - change water frequently if no running water is available to ensure clean vegetable
  - dry root vegetables immediately after washing to prevent unwanted sprouting
  - for fruit vegetables, wiping is better than washing

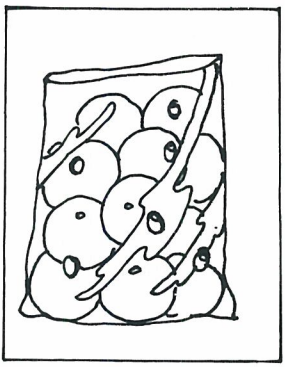
Storage

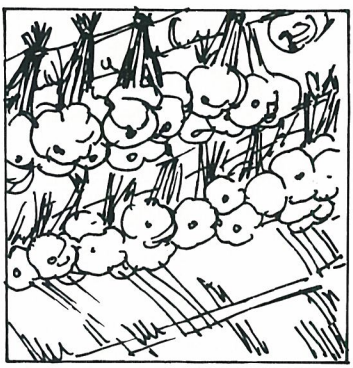
- refrigeration



- store clean vegetables in the chiller

- non-refrigeration





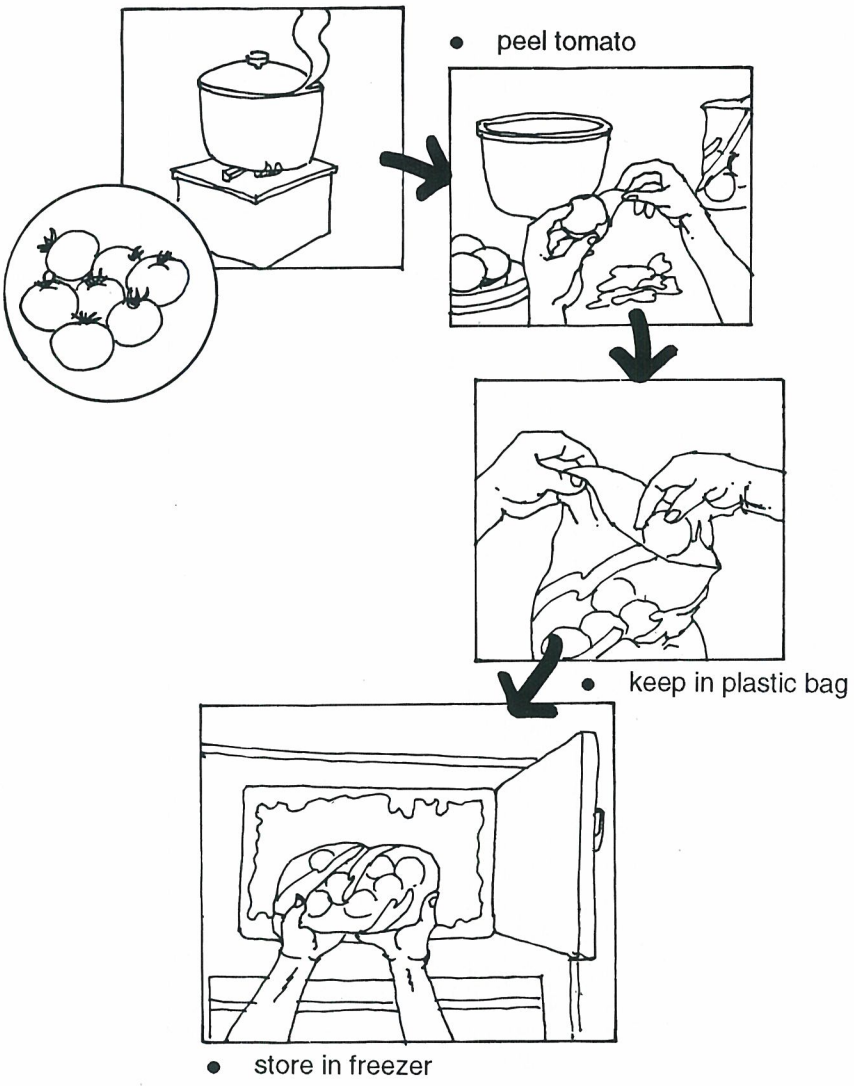
- if refrigerator is not available, store vegetables in plain or thick plastic bags with perforations for gas entrance and exit

- hang dry onions and garlic

- Trimming

- trim off damaged, diseased, and discolored parts at harvest time
- trim parts that can cause injury

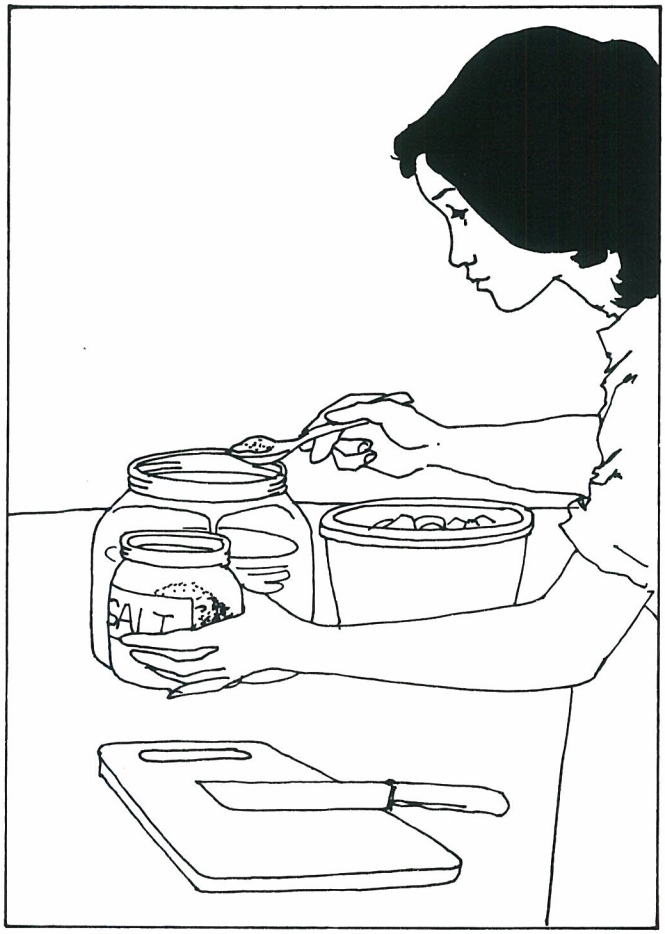
- tomato fruits are stored in the freezer



Processing

- fermenting and pickling preservations are normally done when there is excess harvest
  - alternatively, place product in 10% concentration of salt solution

    Examples: cucumber, cauliflower, onion, garlic , pepper, and Chinese cabbage



- alternatively, starters which are rich in lactic acid bacteria such as brine from previously fermented batches may be used

- fermentation is completed in 6-8 weeks

- if sweet pickle is desired, the salt stock is drained, rinsed, and transferred into brine made of sugar-saturated 4% vinegar

CHAPTER V. PRODUCTION OF PLANTING MATERIALS

How to obtain planting materials

Types of planting materials

- seed
- cutting
- rhizome/corm
- bulb/tuber

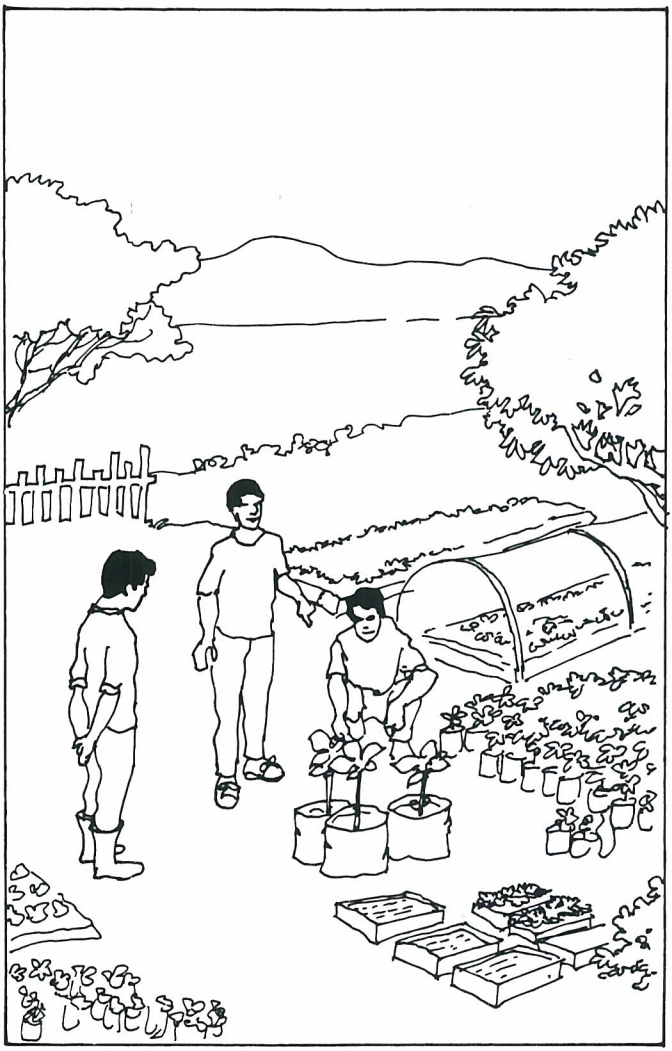
Suggested guide to produce planting materials

- seeds
- asexually propagated planting materials

Storage of planting materials

- seeds
- storage by hanging (bulbs/cloves)
- field storage (cuttings/rhizomes/corms)
- diffused light storage
- storage in the dark

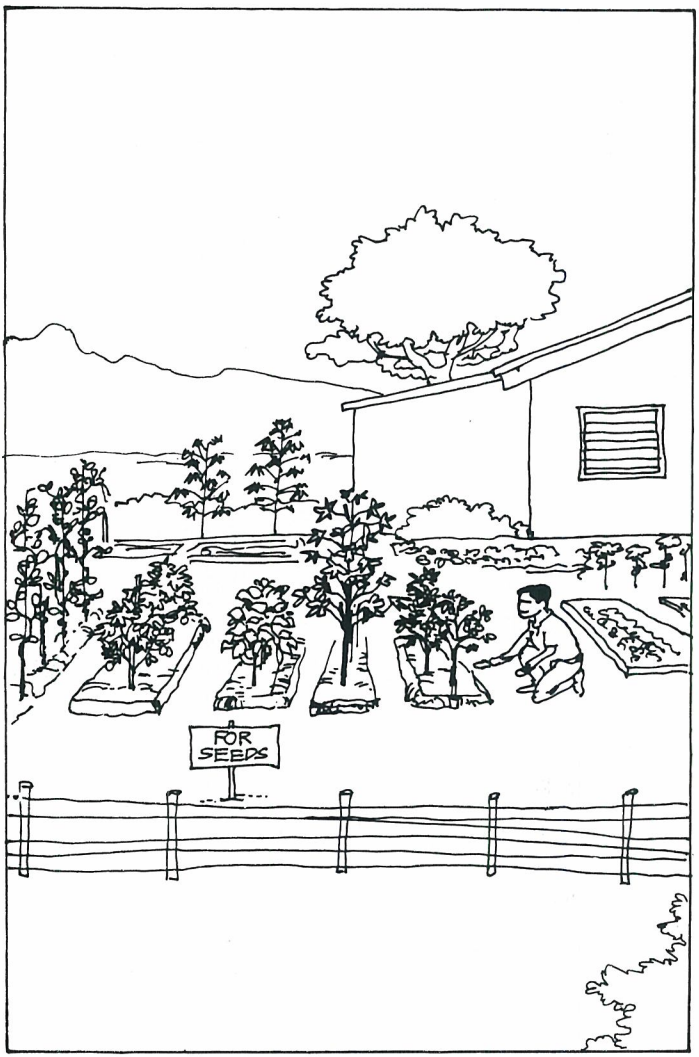
How to obtain planting materials



- Buy from local nurseries
  - ▲ high quality planting materials
  - ▲ adapted varieties
  - ▲ healthy planting materials
  - ▲ more uniform as in F_1 hybrids

- Get from neighbors/friends

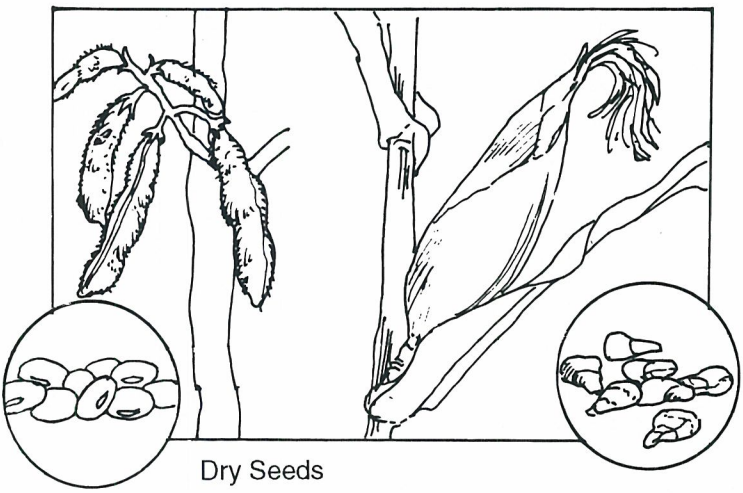
- Produce your own seeds



- ▲ ready access to seeds
- ▲ good quality seeds
- ▲ can produce own seeds from open-pollinated varieties

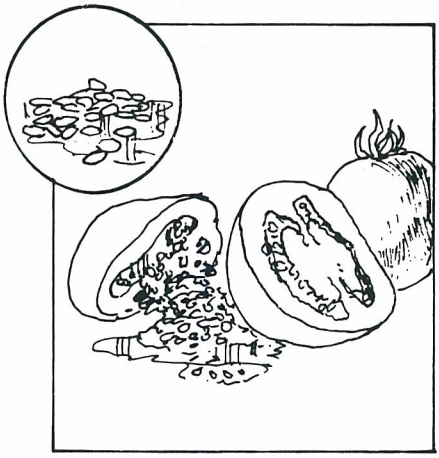
Types of planting materials

- **Seeds**



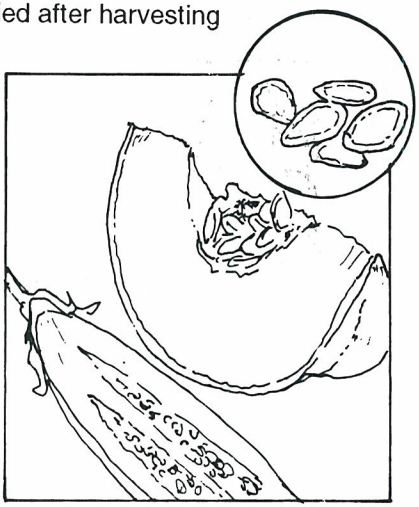
Dry Seeds

- fruits are left to dry on the plant
- seeds are further dried after harvesting



Wet seeds with muscilagenous coating

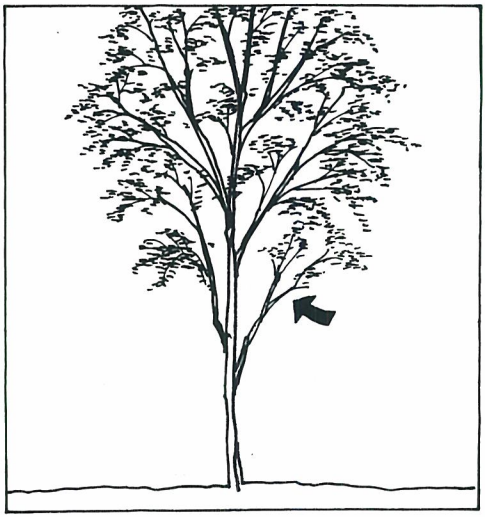
- crushed fruits are fermented for 2-3 days
- seeds are washed and then dried



Wet seeds without muscilagenous coating

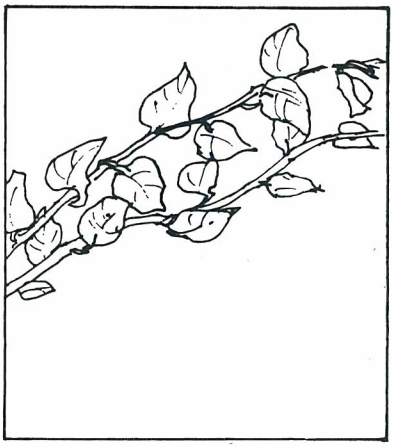
- seeds are extracted directly without fermentation
- seeds are washed and dried

Cuttings



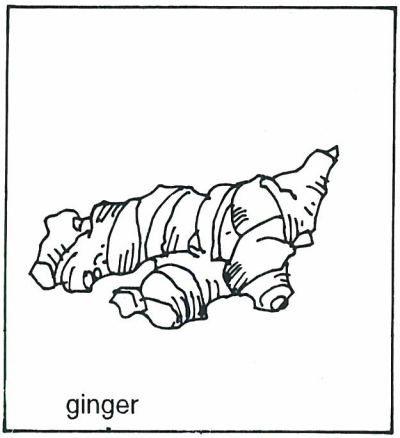
- 50-100 cm stem

- upper 20-30 cm terminals



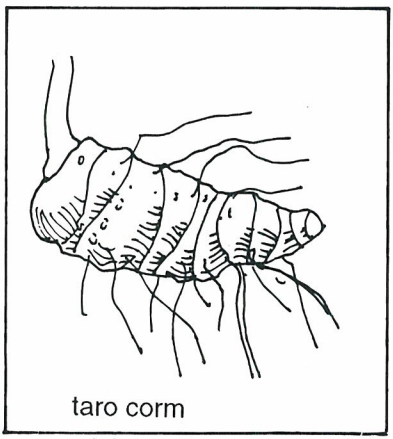
- survives better when older leaves are trimmed

■ Rhizomes/Corms



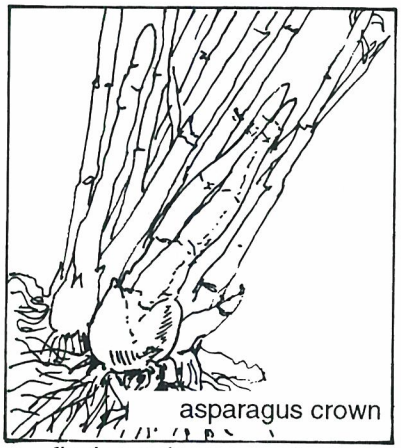
ginger

- horizontally underground stem with nodes and internodes



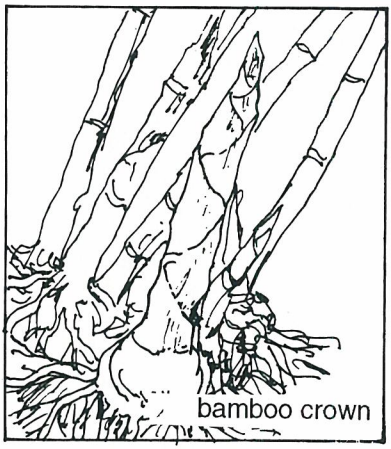
taro corm

- upright, thickened, solid stem
- with nodes and internodes
- few rudimentary leaves



asparagus crown

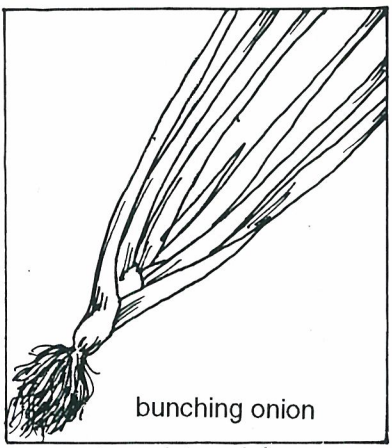
- fleshy underground rhizome
- edible vegetable is called spear



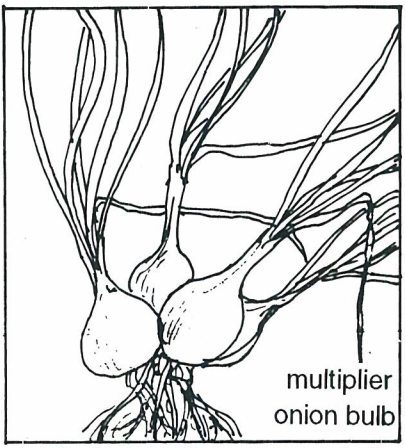
bamboo crown

- fleshy underground rhizome
- newly emerged shoots are the edible parts

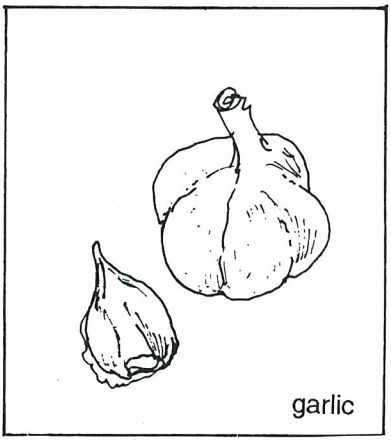
■ Bulbs/Tubers



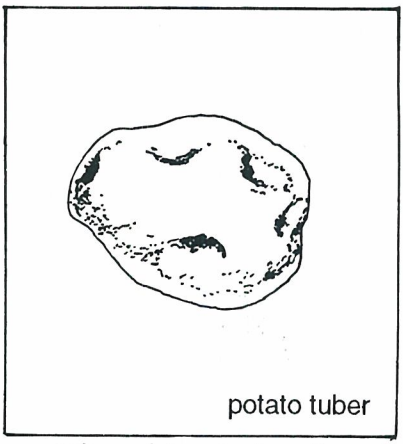
- thickened basal leaves enclosing a short plate-like stem



- similar structure as onion bulb
- several individual units which serve as planting materials



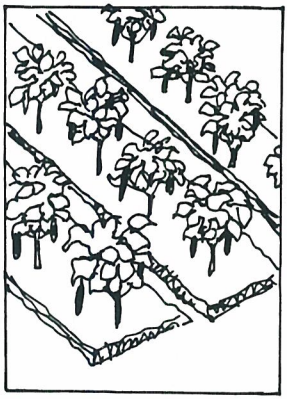
- compound bulb consisting of segments
- formed in axils of inner leaves of bulb

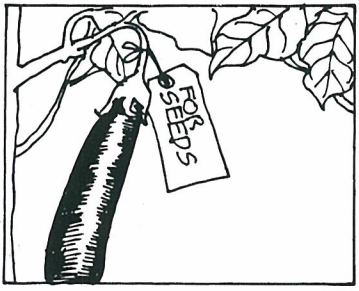


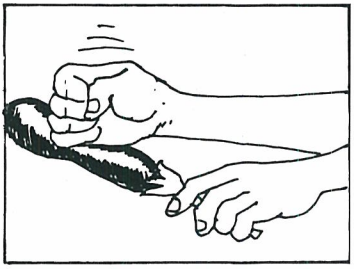
- enlarged terminal portion of underground stem
- consists of eyes

Suggested guide to produce planting materials

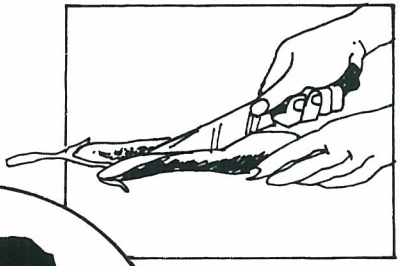
■ Seeds



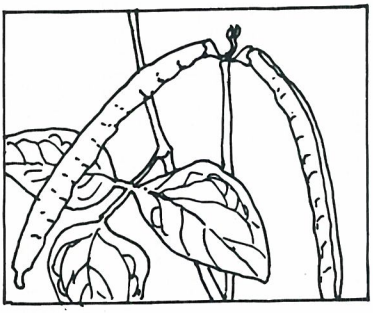




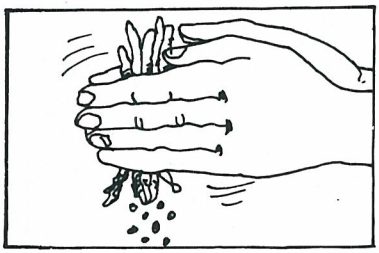
- select best plants from garden plots in terms of
  - ▲ growth habit
  - ▲ yield
  - ▲ appearance of edible part
  - ▲ disease-free
- tag the selected plant
- allow one or two fruits to mature fully
- harvest selected fruits separately
- extract seeds and dry properly



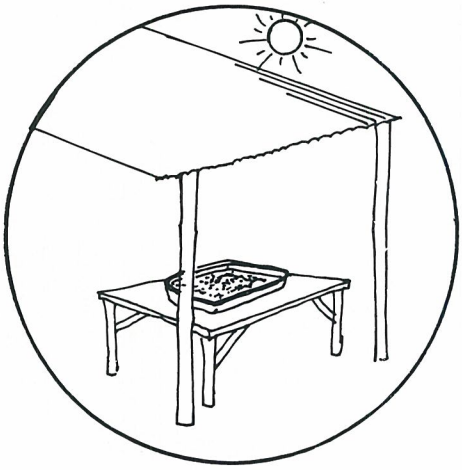
- Dry seeds



- **pods of beans or siliques of pechay are allowed to dry and harvested before pods start to shatter**
- seeds lose moisture due to wind and sun

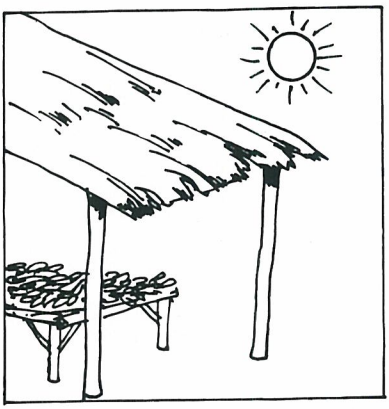


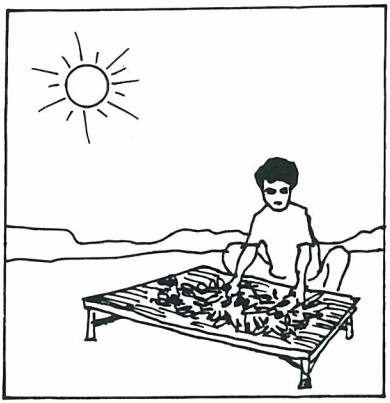
- seeds are manually threshed from dried pods/siliques by rubbing and splitting with hands or by beating with a stick
- the trash is then removed by any convenient means
- diseased, wrinkled seeds and dirt are removed by hand



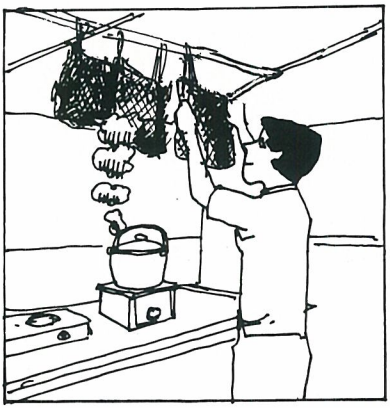
- during rainy season mature pods/siliques are harvested and air dried immediately:

▲ under the shade,





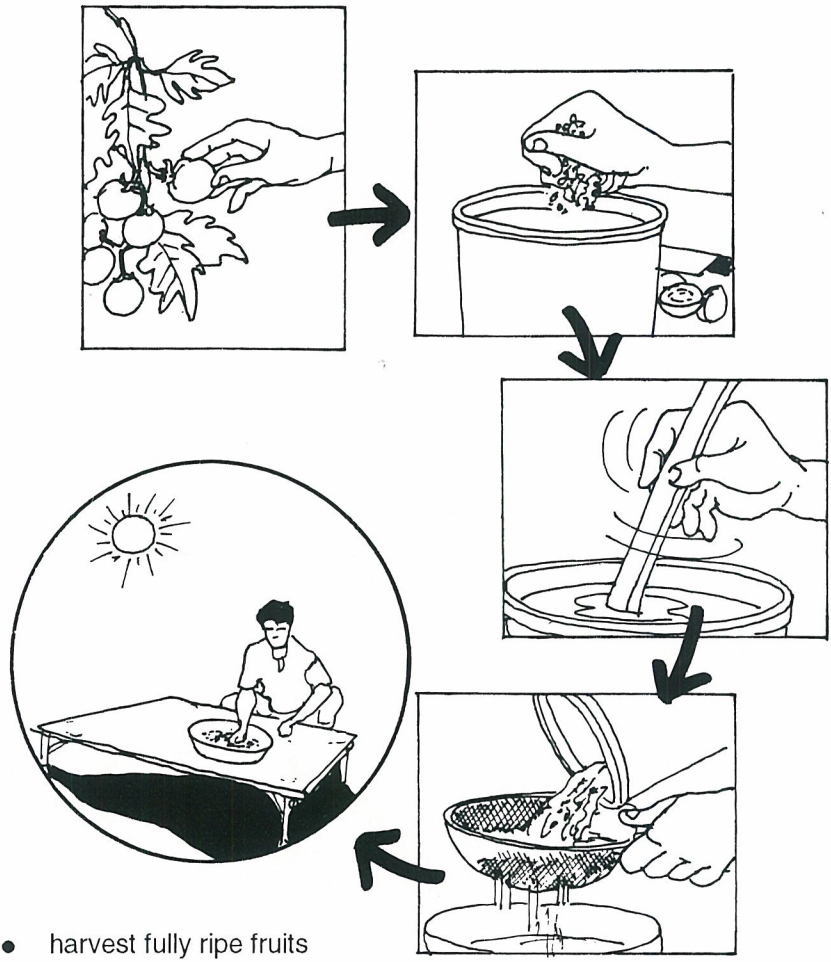
▲ under the sun, or



▲ by hanging wet pods/siliques placed in net bags above the stove

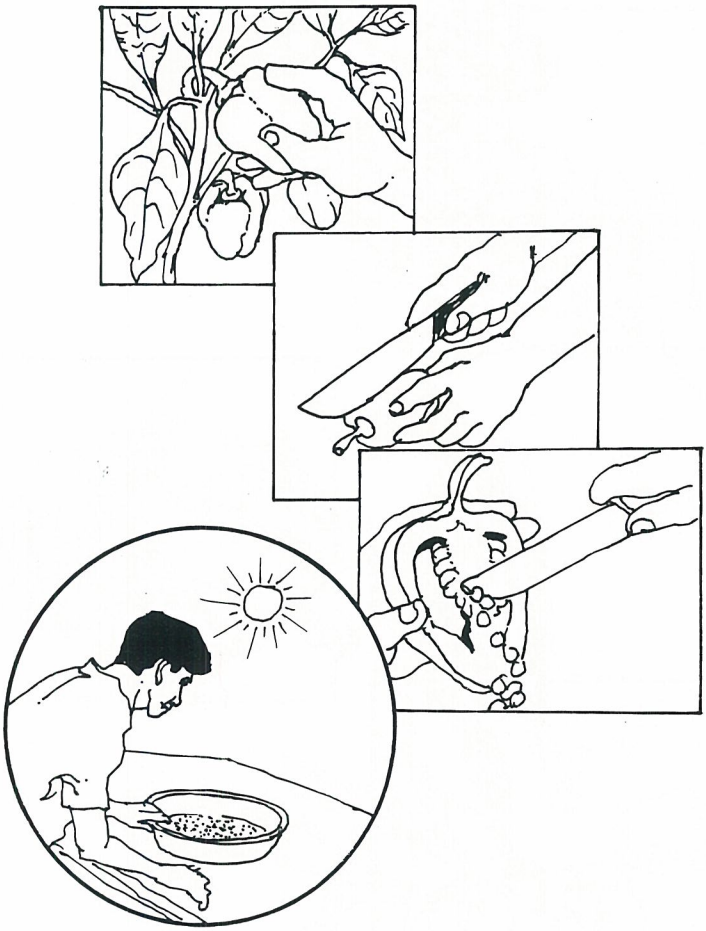
- in splitting wet mature pods to get the seeds, exercise great care to minimize bruising of seeds

Wet seeds with mucilagenous layer



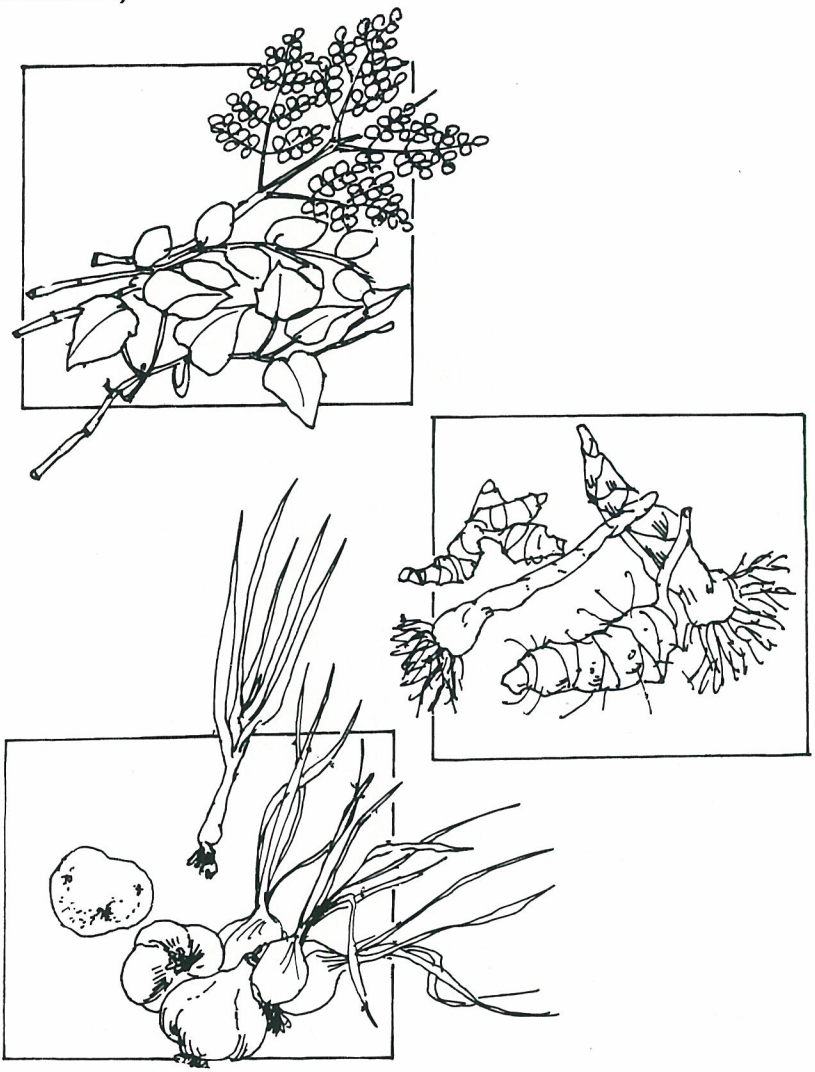
- harvest fully ripe fruits
- slice fruits and squeeze seeds and pulp in plastic container, alternately crush fruits in plastic container
- ferment seeds and pulp for 1-3 days
- stir mixture 3-4 times daily to encourage uniform fermentation
- after 1-3 days pass fermented mixture in a fine sieve and rinse with running water
- thoroughly drain water and spread out seeds under the sun to dry
- after drying store seeds properly

Wet seeds without mucilagenous layer



- harvest fully ripe fruits
- split fruits lengthwise
- remove seeds manually by any tool such as knife or a piece of stick; alternately remove seeds by rubbing off in water
- dry seeds under the sun
- after drying, store seeds properly

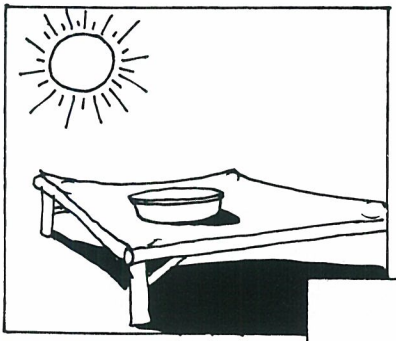
Asexually propagated planting materials (cuttings, rhizomes/corms, and bulbs/tubers)



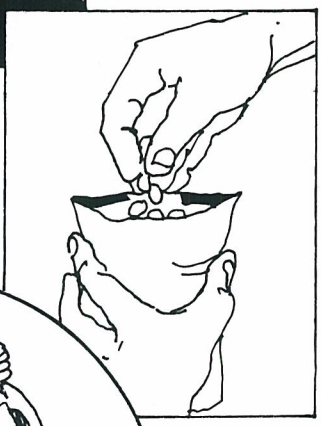
- select best plants from garden plots based on:
  - ▲ growth habit
  - ▲ yield
  - ▲ disease-free
- tag selected plants
- obtain planting materials when needed

Storage of planting materials

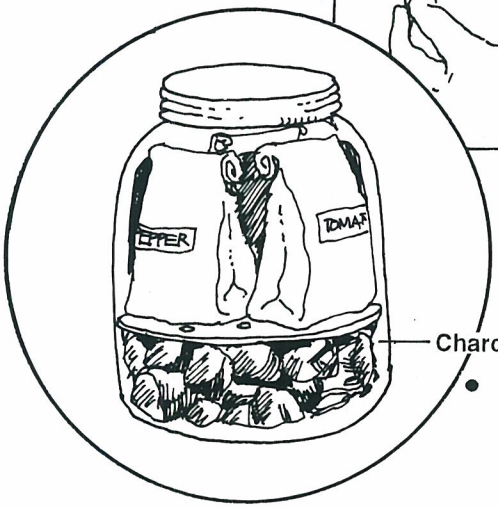
Seeds



- dry seeds thoroughly under the sun



- place seeds in paper envelope



Charcoal

- place seed envelope in homemade dessicator

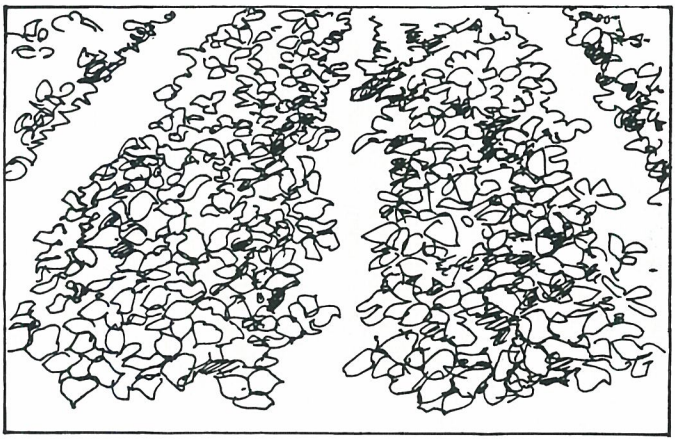
- keep in refrigerator or under ordinary room condition

- control moisture and temperature to prolong vigor and germination of seeds

■ Storage by hanging (bulbs/cloves)

- harvest bulbs/cloves and gradually dry under the sun
- bundle bulbs/cloves
- hang bundles under the shade
- occasionally inspect materials for insect infestation

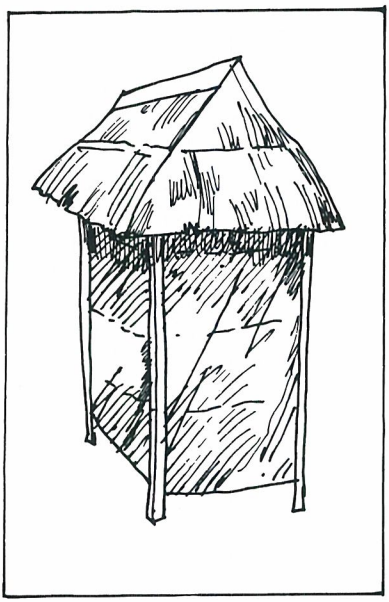
■ Field storage (cuttings/rhizomes/corms)



- Leave plants in the field until needed
- Alternately renew planting of such materials

■ Diffused light storage

- used if potato seed tubers will be stored for 6-8 months before planting



■ Storage in the dark

- used if potato seed tubers will be stored for 3-4 months before planting

GLOSSARY

Asparagus	*Asparagus officinalis* L.
Amaranth	*Amaranthus viridis* L. (A. *gracilis* Desf.)
Balsam peas	*Momordica charantia* L.
Bamboo	*Bambusa spinosa* Roxb.
Banana	*Musa sapientum* L.
Bitter gourd	*Momordica charantia* L.
Bottle gourd	*Lagenaria siceraria* (Md.) Standl. (L. *leucantha* (Duch Rusby)
Broccoli	*Brassica oleracea* L. var. *italica*
Brussel sprouts	*Brassica oleracea* L. var. *gemmifera* DC
Bunching onion	*Allium fistulosum* L.
Cabbage	*Brassica oleracea* L. var. *capitata*
Cauliflower	*Brassica oleracea* L. var. *botrytis*
Carrot	*Daucus carota* L.
Cassava	*Manihot esculenta* Crantz
Celery	*Apium graveolens* L. var. *dulce* Pers. (A. *dulce* Mill., A. *celleri* Gaertn.)
Chayote	*Sechium edule* (Jacq.) Sw.
Chickpea	*Cicer arietinum* L.
Chinese cabbage	*Brassica pekinensis* Rupr.
Chive	*Allium schoenoprasum* L.
Cowpea	*Vigna unguiculata* (L.) Walp. (V. *sinensis* Stickm.) Savi ex Hassk.
Cucumber	*Cucumis sativus* L.
Eggplant	*Solanum melongena* L.
Endive	*Cichorum endiva* L.
Garden pea	*Pisum sativum* L.
Garlic	*Allium sativum* L.
Ginger	*Zingiber officinale* Roscoe
Head lettuce	*Lactuca sativa* L.
Hot pepper	*Capsicum frutescens* L.
Hyacinth bean	*Dolichos lablab* L.
Ipil-ipil	*Leucina leucocephala* (Lam) De Wit
Kale	*Brassica oleracea* L. var. *acephala* DC.
Kangkong	*Ipomoea aquatica* Forsk. (I. *reptans* Poir.)
Katuray	*Sesbania grandiflora* (L.) Pers.
Kidney bean	*Phaseolus vulgaris* L.

Kohlrabi	*Brassica oleracea* L. var. *gongylodes*
Leek	*Allium porrum* L.
Lettuce	*Lactuca sativa* L.
Lima bean	*Phaseolus lunatus* L.
Malabar spinach	*Basella alba* L. and *Basella rubra* L.
Malunggay	*Moringa oleifera* Lam.
Melon, Muskemelon	*Cucumis melo* L. var. *reticulatus* Naud
Multiplier onion	*Allium cepa* L. var. *ascalonicum* (L.)
Mungbean	*Vigna radiata* (L.) R. Wilchzek var. radiata
Mustard	*Brassica juncea* L.
Onion	*Allium cepa* L.
Okra, ladies finger	*Hibiscus esculentus* L.
Parsely	*Petroselinum crispum* Nym. (*Apium petroselinum* L., A. *crispum* Mill., P. *sativum* Hoffm., P. *hortense* Hoffm.)
Pechay	*Brassica napus* L. var. *chinensis* (L.)
Pigeon pea	*Cajanus cajan* (L.)
Potato	*Solanum tuberosum* L.
Pumpkin	*Cucurbita maxima* Duch.
Radish	*Raphanus sativus* L.
Red kidney beans	*Phaseolus vulgaris* L.
Rhubarb	*Rheum rhaponticum* Mill.
Rice	*Oryza sativa* L.
Rutabaga	*Brassica rapobrassica* Mill.
Sitao	*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verde. Fruw.
Snake gourd	*Trichosanthes anguina* L.
Snap bean	*Phaseolus vulgaris* L.
Soybean	*Glycine max* (L.) Merr.
Sponge gourd	*Luffa cylindrica* Roem.
Spinach	*Spinacia oleracea* L.
Squash	*Cucurbita maxima* Duch.
Sugar beets	*Beta vulgaris* L.
Sugar pea	*Pisum sativum* L. var. *saccharatum*
Sweet corn	*Zea mays* L. subsp. mays
Sweet pea	*Pisum sativum* L. var. *saccharatum*
Sweet pepper	*Capsicum annuum* L.

Sweet potato	*Ipomoea batatas* L.
Taro	*Colocasia esculenta* L. Schott & Endl.
Tomato	*Lycopersicon esculentum* Mill. (L. *lycopersicum*(L.) Karst. ex Farw.)
Turnip	*Brassica rapa* L. var. *rapa* Thell
Vegetable soybean	*Glycine max* (L.) Merr. (*Phaseolus max* L.)
Watercress	*Nasturtium officinale* R. Br. (*Rorippa nasturtium-aquaticum* (L.) Hayek
Watermelon	*Citrullus lunatus* (Thumb.) Matsum and Nakai (*Citrullus vulgaris* Scrad.)
Wax gourd	*Benincasa hispida* (Thunb.) cogn.
White potato	*Solanum tuberosum* L.
Winged bean	*Psophocarpus tetragonolobus* (L.) DC.
Yardlong bean	*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verde. Fruw.
Yambean	*Pachyrrhizus erosus* (L.) Urb.

Sweet potato	*Ipomoea batatas* L.
Taro	*Colocasia esculenta* L. Schott & Endl.
Tomato	*Lycopersicon esculentum* Mill. (L. *lycopersicum*(L.) Karst. ex Farw.)
Turnip	*Brassica rapa* L. var. *rapa* Thell
Vegetable soybean	*Glycine max* (L.) Merr. (*Phaseolus max* L.)
Watercress	*Nasturtium officinale* R. Br. (*Rorippa nasturtium-aquaticum* (L.) Hayek
Watermelon	*Citrullus lunatus* (Thumb.) Matsum and Nakai (*Citrullus vulgaris* Scrad.)
Wax gourd	*Benincasa hispida* (Thunb.) cogn.
White potato	*Solanum tuberosum* L.
Winged bean	*Psophocarpus tetragonolobus* (L.) DC.
Yardlong bean	*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verde. Fruw.
Yambean	*Pachyrrhizus erosus* (L.) Urb.

(continued from front flap)

Kaohsiung No. 1 in 1987 which now covers 95% of the total vegetable soybean area. He was born in India and obtained his B.S. in Agriculture degree and M.S. (plant breeding and cytogenetics) from the University of Madras. He also earned his M.S. (horticulture) and M.S. (plant pathology) from the Universities of Hawaii and Wisconsin, respectively, and his doctorate degree in crop science in 1981 at the Kyushu University, Fukuoka, Japan. Dr. Shanmugasundaram has established international cooperative research program on the improvement of vegetables particularly in Asian, African, Central and South American countries. He worked as a research specialist in plant pathology at the University of Wisconsin before he joined AVRDC in 1972 as a research associate in soybean breeding.

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