Semester	Course	Hours	Credit	Sub. Code	Marks		
					Internal	External	Total
III	CC 10	6	4	18KP3B10	25	75	100

HORTICULTURE AND ECOLOGY

UNIT I: HORTICULTURE

History, Scope and Importance of horticulture, Division of horticulture, Climate, soil and nutritional needs, Water irrigation, Plant propagation method – Cutting, layering, grafting and budding. Stock – Scion relationship, micropropagation by induction of rooting. Role of growth hormone in horticultural crops.

UNIT II

Types of Garden, methods of designing outdoor garden – hedges, edges, fences, trees, climbers, rockeries, arches, terrace garden, Lawn making and maintenance, water garden – cultivation of water plants. Establishment of Herbal garden.

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PREPARED BY

UNIT-I & II

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HORTICULTURE:

INTRODUCTION:

- Horticulture is the science of growing flowers, fruits, vegetables and ornamental plants especially in gardens and orchards.
- It differs from agriculture and forestry in specializing the cultivation of garden crops.
- Garden crops includes fruits, vegetables, flowers, plantation crops, spices and aromatic plants.
- Horticulture is one of the branches in botany.
- The term 'horticulture ' is derived from two Latin words, hortus meaning garden and culture means cultivation.

HISTORY OF HORTICULTURE:

- The separation of horticulture from agriculture as a distinct activity is usually dated from the Middle Ages in Europe.
- Long after Mughal Emperors practised horticulture in the country, Rev William Carey, an English Baptist Missionary, founded the Agri-Horticultural Society in India in 1820 for the promotion and development of agriculture in the country.
- Before the formation of the society, good vegetables were scarcely possible to be procured.
- In 1820, Carey published an essay presenting reasons for the establishment of an Agricultural Society in India.

Carey's essay on supporting the formation of an agricultural and horticultural society in India states the following grounds Carey predicted for the society:

- ✔ Encouraging the better mode of cultivation for the improvement of the land.
- ✔ Evolving and using the best methods of crop rotation and land-cropping.
- ✔ Introduction of useful and new types of plants.
- ✔ Improvement in the implementation of husbandry practices.
- ✔ Improvement in animal husbandry.
- ✔ Inclusion of wastelands into a state of cultivation.

- ✔ Over the years, India has emerged as a major producer of horticultural crops and the share of horticulture in the economy has been increasing, there is still a lot of scope in harnessing the potential of this sector.
- ✔ The Indian Institute of Horticultural Research (IIHR) is an autonomous organization acting as a nodal agency for basic, strategic, anticipatory, and applied research on various aspects of horticulture such as fruits, vegetables, ornamental, medicinal and aromatic plants and mushrooms in India.

SCOPE OF HORTICULTURE:

- India has great variety of climate and edaphic conditions which can be exploited by growing horticultural crops.
- Climates are varying from tropical, subtropical and temperate regions. From this humid, semi-arid, arid and varying temperature trees are also grown.
- Likewise soils like loamy, alluvial, laterite, medium black, rocky shallow heavy black sandy etc are also available. From this, large crop areas can be grown with very high level of adaptability.
- To meet the requirements in terms of vitamins and minerals, minimum of 85 g of fruits and 200 g of vegetables per head per day with population of above 1000 million people, fruit and vegetables are to be grown on large scale.
- For providing raw material to small scale industries like silkworm, lack, honey, match, paper, canning, and dehydration etc. horticulture has wide scope.
- In India larger area of lands are waste land, problematic soil, desert land which can be utilized for hardy fruits and medicinal plants.
- The fast development of communication and transport system create wide scope for horticulture development particularly in transporting the perishable commodities and products.
- The cultural operations are unique to each and every group o horticultural plants. Based upon the method of cultivation, horticulture has been grouped into following divisions.

DIVISIONS OF HORTICUTURE:

1.POMOLOGY

- The term Pomology is derived from the Latin word ‘pomum’ meaning ‘fruits’ and the Greek term ‘logy’ meaning Science. Thus, pomology is the science of production of fruit crops. OR The science of growing fruit crops.

- (a) Tree fruits: Fruits are produced on tree e.g. Mango, Chiku, Citrus etc.
- (b) Small fruits: Fruits are produced on shrubs or vines e.g. Phalsa, Raspberry, Mulberry, Grapes, Gooseberry, Strawberry.

2. OLERICULTURE:

- The term Olericulture is originated from Latin word 'oleris' meaning pot herb and the English word culture meaning raising of plants.
- Thus, olericulture is the science of vegetable crops. OR The cultivation of vegetable crops. e.g. brinjal, tomato, potato, radish, carrot, chilli, bottle gourd.

3. FLORICULTURE:

- It is a science of cultivation of flowers and ornamental plants for commercial purposes or merely for getting pleasure and as a hobby.
- Due to increase in domestic need of flowers, the career scope in the field of floriculture is also increasing . Nowadays, demanding of flowers like roses, gerbera, carnation, gladiolus, Orchids, and lilies is increasing day by day.

4.GARDENING:

- It is a science of designing and laying out home gardens, public gardens, parks, road side plantation, avenues.
- Living elements, such as flora or fauna; or what is commonly called gardening, the art and craft of growing plants with a goal of creating a beauty within the landscape.
- Natural elements such as landforms, terrain shape and elevation, or bodies of water; and
- Abstract elements such as the weather and lighting conditions.

5. ARBORICULTURE:

- Cultivation and management of forest tree e.g. teak wood, neem, ficus, eucalyptus etc.
- Control of crop composition and production of species of more economic value.
- Control of stand density for Production of maximum volume.
- Afforestation of blank under stock areas.
- Production of Quality Timber.
- Control of Rotation period.

6. SPICES:

- Spices are plant products used in cookery to season or flavour the food.
- Cultivation of crops which products are used as adjunct in food for flavor, aroma and taste. e.g cardamom, clove, nutmeg, coriander, cumin etc.
- It is low volume , high value crop.

7. PLANTATION CROPS:

- Cultivation of tea, coffee, coconut, arecanut, rubber, oil palm etc.
- 1)Expansion in non-traditional areas
- 2)Export potential :Plantation crops earn foreign exchange. Eg. Coir based products ,Coir export and Coffee .
- 3)Employment generation:Cultivation of plantation crops provide year round gainful employment on the farm and factories. Eg. Coconut provides for 78 man days/ha/yr.

8. AROMATIC AND MEDICINAL PLANTS

- Cultivation of aromatic and medicinal plants like gugal, aonla, beheda, harde, lucorice, lemon grass etc.
- The magical compound of medicinal and aromatic plants keeps saving human until present, such as medicine, food, healing, and recreation.
- One of the huge benefits from medicinal and aromatic plants was to overcome many difficult illnesses, such as contagious disease, cancer, and AIDS/HIV.
- The National Cancer Institute (NCI) screens plants for the possibility of new drugs and active plant chemicals for cancer and AIDS/HIV in several ongoing collaborative programs.

IMPORTANCE OF HORTICULTURE:

- Fruits and vegetables play an important role in the balance diet of human being by providing vital protective nutrients.
- They not only adorn the table but also enrich health from the most nutritive menu and tone up the energy and vigour of man.
- Fruits and vegetables have a key role in neutralizing the acid produced during digestion of protein rich and fatty foods.
- They provide valuable roughages which promote digestion and helps in preventing constipation.

- From unit are of land more income is obtained by growing fruits and vegetables crops.
- From energy point of view the fruit crops give very high amount of calories per acre e.g. wheat 1034880 calories/acre and banana 15252800 calories/acre.
- Horticulture is mother of several industries like canning, essential oil, dehydration, refrigeration, wine, cashew nut, transport etc. which provide work for many people. Farmers and labours can keep themselves engaged busy throughout year.
- Growing of horticultural crops is an art as well as science which help in mental development of farmers.
- The fruits and vegetables are chief source of vitamins and minerals which help in proper health and resistant to disease.
- The flowers, ornamental plants and gardens play a very important role in refreshing the minds of people and reducing air pollution.
- The growing of horticultural crops also contributes to the aesthetic side of rural and home life of community.
- Generate employment opportunities.
- Wide source of medicine.
- Effective utilization of wasteland through hardy fruits and medicinal plants.

CLIMATE SOIL AND NUTRITIONAL NEEDS:

CLIMATE

- Climate is the long-term average of weather, typically averaged over a period of 30 years.
- Some of the meteorological variables that are commonly measured are temperature, humidity, atmospheric pressure, wind, and precipitation. In a broader sense, climate is the state of the components of the climate system, which includes the ocean and ice on Earth.
- More generally, the "climate" of a region is the general state of the climate system at that location at the current time.
- Climates can be classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation. The most commonly used classification scheme was the Köppen climate classification.

The Thornthwaite system,in use since 1948, incorporates evapotranspiration along with temperature and precipitation information and is used in studying biological diversity and how

climate change affects it. The Bergeron and Spatial Synoptic Classification systems focus on the origin of air masses that define the climate of a region.

- Paleoclimatology is the study of ancient climates. Since very few direct observations of climate are available before the 19th century, paleoclimates are inferred from proxy variables that include non-biotic evidence such as sediments found in lake beds and ice cores, and biotic evidence such as tree rings and coral.
- Climate models are mathematical models of past, present and future climates. Climate change may occur over long and short timescales from a variety of factors; recent warming is discussed in global warming. Global warming results in redistributions.
- For example, "a 3°C change in mean annual temperature corresponds to a shift in isotherms of approximately 300–400 km in latitude (in the temperate zone) or 500 m in elevation.
- Therefore, species are expected to move upwards in elevation or towards the poles in latitude in response to shifting climate zones".

SOIL:

- Unconsolidated material on the earth's surface that supports or is capable of supporting plants out-of-doors.
- Material in the top layer of the surface of the earth in which plants can grow (especially with reference to its quality or use); the land had never been plowed; good agricultural soil.
- The part of the earth's surface consisting of humus and disintegrated rock.The top layer of the Earth's crust that consists of sufficient minerals and organic material to be richly inhabited by organisms in general. Many factors in the composition of soil, such as its pH, will determine what sort of organisms will be most suited.
- Nutrients in the soil are essential to the proper growth of a land plant. This tutorial deals with the properties of soil and the factors (i.e. climate, parent material, local topography, vegetation, living organisms, and time) that brought soil to what it is today.

NUTRITIONAL NEEDS:

Plants must obtain the following mineral nutrients from their growing medium:

- The macronutrients: nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg), carbon (C), oxygen (O), hydrogen (H)
- The micronutrients (or trace minerals): iron (Fe), boron (B), chlorine (Cl), manganese (Mn), zinc (Zn), copper (Cu), molybdenum (Mo), nickel (Ni)

- These elements stay beneath soil as salts, so plants consume these elements as ions. The macronutrients are consumed in larger quantities; hydrogen, oxygen, nitrogen and carbon contribute to over 95% of a plant's entire biomass on a dry matter weight basis. Micronutrients are present in plant tissue in quantities measured in parts per million, ranging from 0.1 to 200 ppm, or less than 0.02% dry weight.
- Most soil conditions across the world can provide plants adapted to that climate and soil with sufficient nutrition for a complete life cycle, without the addition of nutrients as fertilizer.
- However, if the soil is cropped it is necessary to artificially modify soil fertility through the addition of fertilizer to promote vigorous growth and increase or sustain yield.
- This is done because, even with adequate water and light, nutrient deficiency can limit growth and crop yield.
- At least 17 elements are known to be essential nutrients for plants. In relatively large amounts, the soil supplies nitrogen, phosphorus, potassium, calcium, magnesium, and sulfur; these are often called the macronutrients.
- In relatively small amounts, the soil supplies iron, manganese, boron, molybdenum, copper, zinc, chlorine, and cobalt, the so-called micronutrients. Nutrients must be available not only in sufficient amounts but also in appropriate ratios.
- Plant nutrition is a difficult subject to understand completely, partially because of the variation between different plants and even between different species or individuals of a given clone.
- Elements present at low levels may cause deficiency symptoms, and toxicity is possible at levels that are too high. Furthermore, deficiency of one element may present as symptoms of toxicity from another element, and vice versa. An abundance of one nutrient may cause a deficiency of another nutrient. For example, K+ uptake can be influenced by the amount of NH+4 available.

WATER IRRIGATION:

IRRIGATION

- Water is an essential element for survival. About seventy per cent of the human body consists of water; plants contain almost 90 per cent of water. Still, we have to depend on some outside sources to fulfil the water requirements of our body.
- Similarly, the crops require water for their growth and development. The process of supplying water to the crops is known as irrigation.

Types of irrigation:

1.Surface Irrigation

2.Localized Irrigation

3.Sprinkler Irrigation

4.Drip Irrigation

5.Centre Pivot Irrigation

6.Sub Irrigation

7.Manual Irrigation

There are different types of irrigation practised for improving crop yield. These types of irrigation systems are practised based on the different types of soils, climates, crops and resources. The main types of irrigation followed by farmers include:

Surface Irrigation

In this system, no irrigation pump is involved. Here, water is distributed across the land by gravity.

Localized Irrigation

In this system, water is applied to each plant through a network of pipes under low pressure.

Sprinkler Irrigation

Water is distributed from a central location by overhead high-pressure sprinklers or from sprinklers from the moving platform.

Drip Irrigation

In this type, drops of water are delivered near the roots of the plants. This type of irrigation is rarely used as it requires more maintenance.

Centre Pivot Irrigation

In this, the water is distributed by a sprinkler system moving in a circular pattern.

Sub Irrigation

Water is distributed through a system of pumping stations gates, ditches and canals by raising the water table.

Manual Irrigation

This a labour intensive and time-consuming system of irrigation. Here, the water is distributed through watering cans by manual labour.

Methods of Irrigation.

Methods of Irrigation

Irrigation can be carried out by two different methods:

- ✔ Traditional Methods
- ✔ Modern Methods

❖ **Traditional Methods of Irrigation**

- In this method, irrigation is done manually. Here, a farmer pulls out water from wells or canals by himself or using cattle and carries to farming fields. This method can vary in different regions.
- The main advantage of this method is that it is cheap. But its efficiency is poor because of the uneven distribution of water. Also, the chances of water loss are very high.
- Some examples of the traditional system are pulley system, lever system, chain pump. Among these, the pump system is the most common and used widely.

The modern method compensates the disadvantages of traditional methods and thus helps in the proper way of water usage.

The modern method involves two systems:

- ✔ Sprinkler system
- ✔ Drip system

- **Sprinkler System**

A sprinkler system, as its name suggests, sprinkles water over the crop and helps in an even distribution of water. This method is much advisable in areas facing water scarcity.

Here a pump is connected to pipes which generate pressure and water is sprinkled through nozzles of pipes.

- **Drip System**

In Drip system, water supply is done drop by drop exactly at roots using a hose or pipe. This method can also be used in regions where water availability is less.

Importance of irrigation:

- ➤ Insufficient and uncertain rainfall adversely affects agriculture. Droughts and famines are caused due to low rainfall. Irrigation helps to increase productivity even in low rainfall.
- ➤ The productivity on irrigated land is higher as compared to the un-irrigated land.
- ➤ Multiple cropping is not possible in India because the rainy season is specific in most of the regions. However, the climate supports cultivation throughout the year. Irrigation facilities make it possible to grow more than one crop in most of the areas of the country.
- ➤ Irrigation has helped to bring most of the fallow land under cultivation.
- ➤ Irrigation has stabilized the output and yield levels.
- ➤ Irrigation increases the availability of water supply, which in turn increases the income of the farmers.

Plant propagation:

Plant propagation is the process of creating new plants from a variety of sources: seeds cutting and other plant parts. Plant propagation can also refer to the artificial or natural dispersal of plants.

Methods of propagation:

i. Sexually
ii. Asexually

Sexual Propagation starting plants from seeds Germination rate % that sprouts 75 of 100 = 75%. Rates are affected by temperature and moisture Rates vary depending on plant and quality (viability) of seed Seed viability is the seed's capability of growing or developing Seed viability is affected by temperature and moisture Plant seeds based on size of seeds Plant seeds no more than 1.5 times the diameter of the seed Larger seeds are planted deeper Smaller seeds are planted shallow Ex. Petunia seeds are TINY Water small seeds by bottom soaking to prevent burying them Seedlings small plants The first sets of leaves are called cotyledons Monocots produce one seed leaf Dicots produce two seed leaves True leaves are the second set of leaves Transplant seedlings when the first true leaves appear Before planting in the outdoor environment, reduce humidity and water and make environment more like outside to "harden off" plants. 1. Fast way to get many plants. 2. Easy to do. 3. Economical. 1. Some plants, especially hybrids, do not reproduce true to parents. 2. Some plants are difficult to propagate from seeds. Asexual Reproduction –starting plants by means other than seed Methods include:

Cuttings♣ Layering♣ Division♣ Separation♣ Grafting♣ Budding♣ Tissue culture♣ Stem

Cutting :

Start with sterile flats, soil, and tools Must include a node A node is a point along a plant stem where leaves or other stems are attached Internode is the area between two nodes Cutting is taking a 4-6 inch piece of the plant and forcing roots to grow Using hormones help speed up rooting Dipping the cutting in fungicides help prevent rotting Rooting media should be about 4 inches deep Herbaceous plants are soft-tissue plants Woody plants are plants that produce woody tissue Examples of plants that can be started by cuttings Herbaceous – geranium, impatiens, begonia and coleus Woody – holly, abelia, and rosemary Leaf Usually propagated from herbaceous plants Midrib vein must be cut in order to make roots form Examples African violet and philodendron Snake plant and jade plant Root Should be spaced three inches apart in rooting area A sand, vermiculite or perlite mixture is a good medium for root cuttings Examples: hosta and daylily The best time of day to take a stem, leaf, or root cutting is early morning because plants have more moisture.

Layering :

Tricking the plant stem into growing roots while still attached to the parent plant Examples Air layering Trench Layering Mound Layering.

Air layering

Making an incision at the node of a branch Dust with rooting hormone, place sphagnum moss in plastic and wrap around the incision forcing roots to grow on the stem of the plant Air layering Once roots form, remove below the new roots for a new plant Examples Decora

rubber plantv Weeping figv Some plants, like the spider plant, naturally layer.

Trench Layering –

new plants form at each nodev along the stem while still attached to the plant Is cutting a trench and laying a branch in thev trench Types of trench layering are simple, tip, andv serpentine Examples of plants for trench layeringv Grapesv Clematisv Simple Layering Tip Layering Serpentine Layering Mound layeringv Is mounding the soil on a branchv An example would be an azaleav Mound Layering

Grafting :

Joining separate plant parts together so thatv they form a union and grow together to make one plant. Tools needed are a knife, tape, and waxv Plants must be related to each other andv normally in the same genus or family Scion is the piece of plant at the top of thev graft Rootstock is the piece of the plant at the rootv or bottom of the graft Examples of plants that can be grafted:v Maples and fruit treesv Sweetgum (fruitless sweetgum)v Pecan

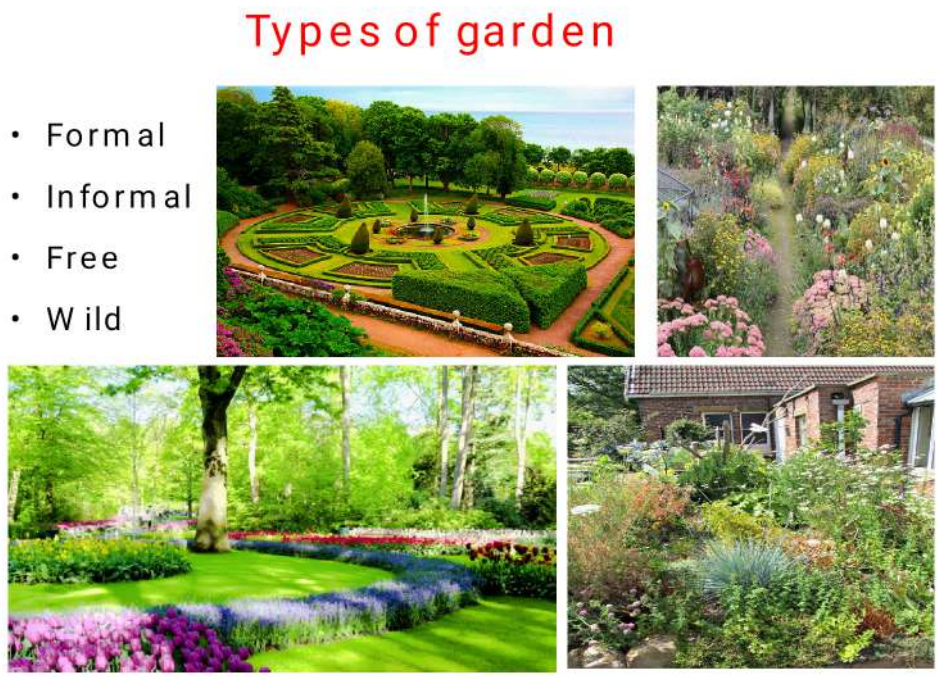
Budding:

A form of grafting when a bud is used.v Types:v T-budding,v Chip budding,v Patch Budding.v Successful T budding requires:v that the scion (top)material have fully-formed,v mature, dormant buds, that the rootstock be in a condition of activev growth such that the "bark is slipping". This means that the vascular cambium isv actively growing, and the bark can be peeled easily from the stock piece with little damage. An example would be a rose.

UNIT-2

Garden:

- A **garden** is a planned space, usually outdoors, set aside for the display, cultivation, or enjoyment of plants and other forms of nature. The garden can incorporate both natural and man-made materials. The most common form today is a residential garden, but the term garden has traditionally been a more general one.
- Garden design is the process of creating plans for the layout and planting of gardens and landscapes. Gardens may be designed by garden owners themselves, or by professionals. Professional garden designers tend to be trained in principles of design and horticulture, and have a knowledge and experience of using plants.



Features of a formal gardens:

- First plan is made on paper and then land is selected accordingly
- Land is leveled

- Symmetrical design
- Geometrical: Square, rectangular, circular beds and borders
- Roads and paths cut at right angle
- Balance is symmetrical as same feature replicated on both sides of central axis
- Hedges, edges and topiary are trimmed
- Trees can be selected as individual feature
- Mughal, Persian, Italian, French and American gardens

Features of informal gardens:

- Plan is forced to fit the land
- Main aim is to capture natural scenery
- Land is not leveled
- Asymmetrical design
- Non-geometrical beds and borders
- Untrimmed hedges, edges and topiary
- Individual plants are not selected as feature
- Japanese, Chinese, English gardens

Free and Wild style of gardening:

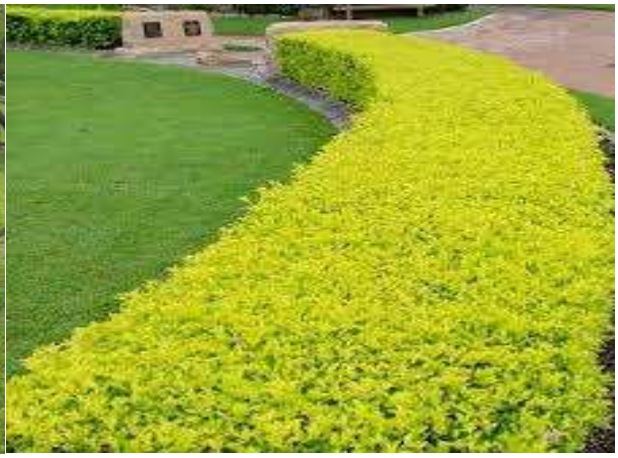
- In Free style gardening best of both formal and informal styles are selected to secure the most picturesque effect whereas in Wild style gardening no rules are followed but aim is to make the garden beautiful and natural.
- This style combines the good points of both formal and informal style of gardening. Rose garden of Ludhiana is an example of this style of gardening.

Methods of outdoor garden:

Hedge

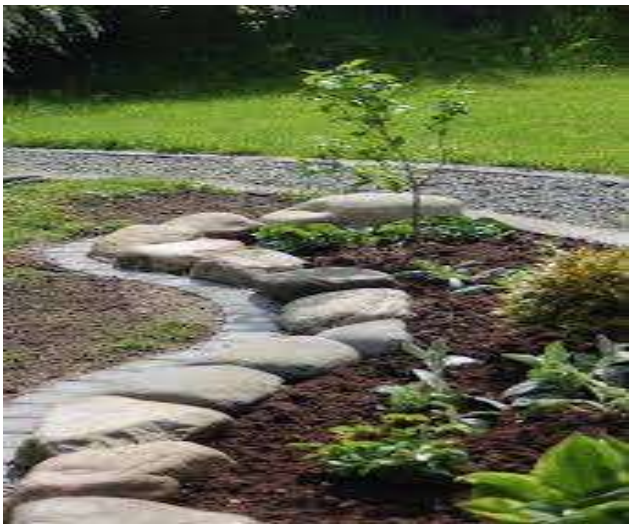
- A hedge or hedgerow is a line of closely spaced shrubs and sometimes trees, planted and trained to form a barrier or to mark the boundary of an area, such as between neighboring properties. Hedges used to separate a road from adjoining fields or one field from another, and of sufficient age to incorporate larger trees, are known as

hedgerows. Often they serve as windbreaks to improve conditions for the adjacent crops, as in blockage country. When clipped and maintained, hedges are also a simple form of topiary.

Edges

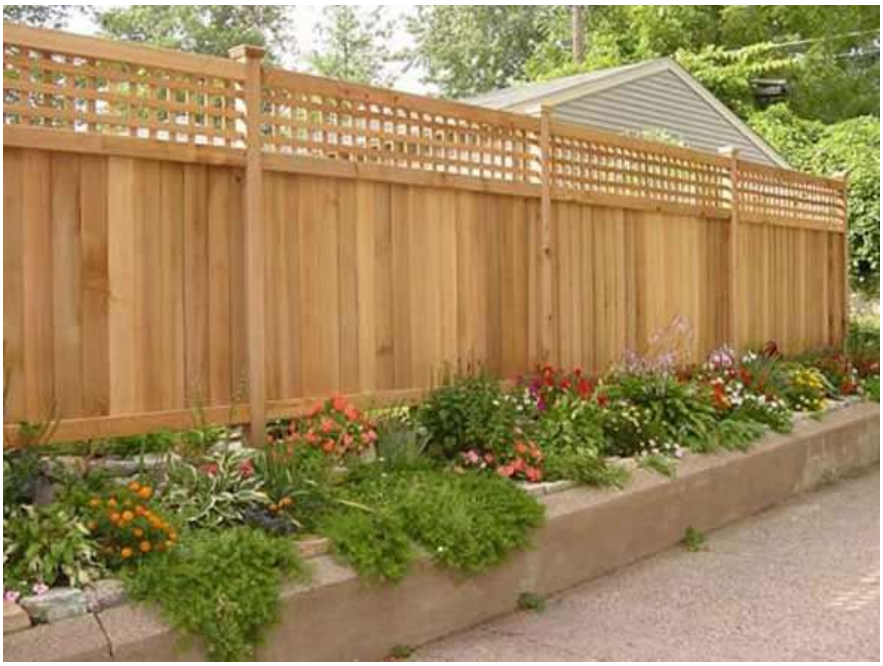
- Edging creates clean, crisp lines between beds and other areas. It is most visible between a lawn and the adjoining garden, but landscape edging can define a flower border, a shrub bed, a single tree, or the transition from a patio to the surrounding garden.



Fences

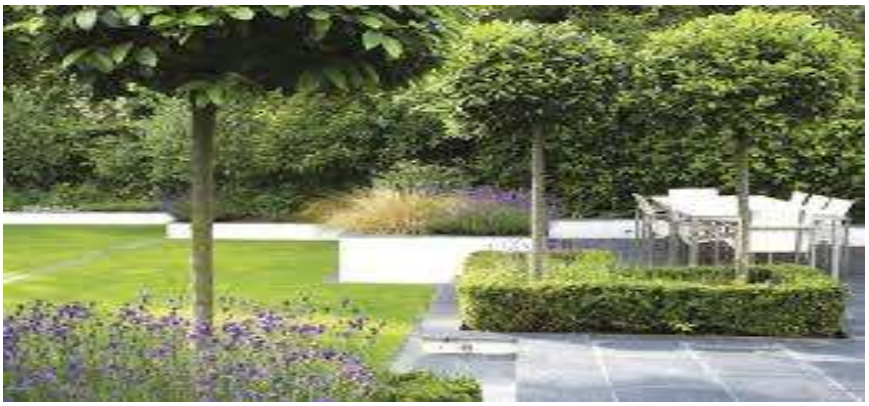
- Welded wire works best on relatively level ground. Welded wire products with smaller mesh along the lower edge (intended to keep horses from getting their hooves caught) also deter some animal pests. Stock panels are rigid fencing panels sold in

standard 16-foot lengths.



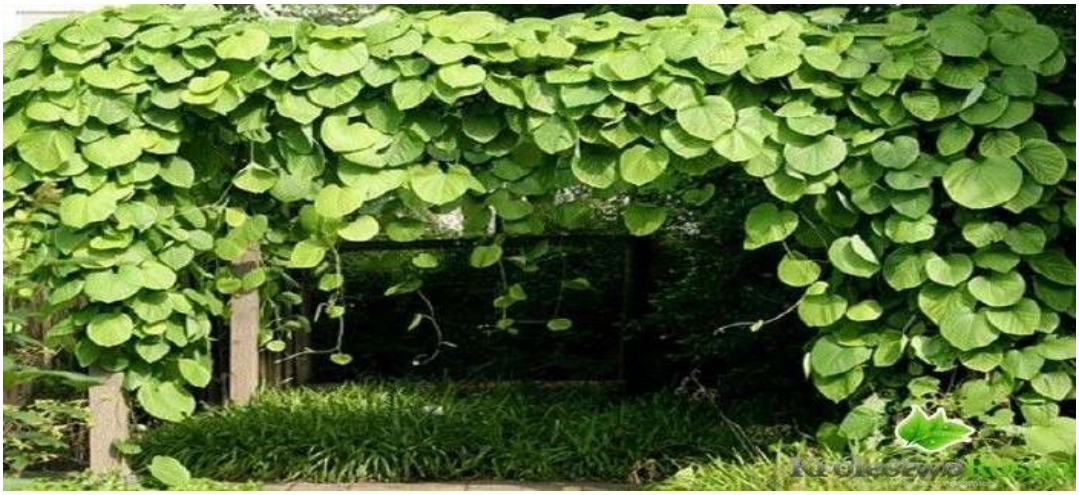
Trees

- Trees form the main framework of the garden. Some trees produce attractive and beautiful flowers including fragrant flowers, few trees are noted for their attractive foliage and few more trees are known for their peculiar shape or form which are used as specimen trees. Shady trees are planted in chosen spots of large public garden which provides place for picnic and relaxation. Such trees are also planted along the borders of roads as avenue for giving shade. In selecting ornamental trees, the pur¬pose should be decided first and then the place of its culture should be finalized. *E.g.Acacia auriculiformis*



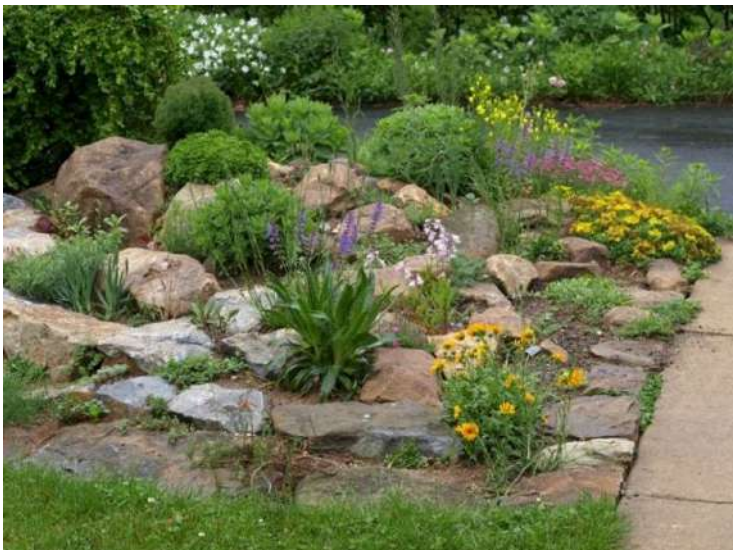
Climbers

- Botanically, plants which have the special structure to climb on supports are defined as climbers. Climbers are very important ornamental plants and are com¬monly used on walls, arches and pergolas but in cities their utility is increased for the purpose of screening the premises from adjacent houses and maintaining privacy. Bare walls can be most effectively decorated by growing colorful climbers.
- Climbers like *Allamanda, Antigonon, Aristolochia elegans, Solanum seaforthianum* can be used on arches, bowers and pergolas.



Rockeries

- A rock garden, also known as a rockery or an alpine garden, is a small field or plot of ground designed to feature and emphasize a variety of rocks, stones, and boulders.
- The standard layout for a rock garden consists of a pile of aesthetically arranged rocks in different sizes, with small gaps between in which plants are rooted. Typically, plants found in rock gardens are small and do not grow larger than 1 meter in height, though small trees and shrubs up to 6 meters may be used to create a shaded area for a woodland rock garden. If used, they are often grown in troughs or low to the ground to avoid obscuring the eponymous rocks. The plants found in rock gardens are usually species that flourish in well-drained, poorly irrigated soil.



Arches

- A garden arch, also known as an arbor, is a freestanding structure that serves as a passageway and can support climbing vines and plants. It typically features two side panels and a curved roof which may be open or closed. In contrast, a trellis is a flat lattice panel that can also be used to support climbing vines. Some trellises are mounted to a wall, while others are free-standing structures. While trellises usually feature a square bottom with a rounded top, you can find them in a variety of decorative shapes like a heart or triangle.

Trace garden

- In gardening, a **terrace** is an element where a raised flat paved or graveled section overlooks a prospect. A raised terrace keeps a house dry and provides a transition

between the hardscape and the soft cape.

Lawn making:

- A lawn is an area where grass is grown as a green carpet for a landscape and is the basic feature of any garden. It serves to enhance the beauty of the garden, be it larger or smaller. Proper lawn maintenance plays a crucial part in any landscape design. A beautiful well maintained lawn can make the entire landscape look good, whereas a lawn that is not maintained can completely ruin it's beauty. The lawn not only harmonizes with a decor of the drawing room, but also sets of a suitable background for a specimen tree or a shrub, as well as for colourful beds and borders. The position of the lawn largely depends upon the layout of the garden in relation to the house. In general lawn should be wide open with access to direct sunshine, especially in front of a rockery and a water pool.
- **Site and Soil**
- After choosing the site, the next important factor for consideration is the size and shape of the lawn. The preparation of site includes digging, leveling and enriching the soil with organic manures or by amending with fertile soil. If the soil is very heavy, coarse sand may be added by removing subsoil to a depth of 20 cm. The ideal soil pH should be 5.0 to 5.6. If it is very acidic 500 g/m2 lime should be added and to clayey loam or alkaline soil gypsum of the same quantity may be added. Provision of drainage for excess rain water should be made if the ground is not sloppy.
- **Levelling**
- The site should be thoroughly levelled with spade, pebbles and weeds are hand picked. The soil is rolled with a roller. Weeds especially nut grass should not be allowed to grow and should be removed with roots for at least 2 to 3 times.

Methods of lawn making:

Seeding

- The most popular grass suitable for seeding is "Doob" grass (*Cynodon dactylon*).
- It has the fast spreading mat forming habit, radially forms roots at the nodes, the foliage is dark green, narrow with parallel vines.
- A lawn from seed is thought of only when grass roots are not available.
- About 30 kg of seed is required for planting one hectare.
- The soil should be reduced to fine tilth and given a light rolling.
- The site should be divided into suitable small squares or rectangles, the seeds are mixed with double the quan¬tity of finely sieved soil and should be rolled again and wa¬tered liberally with rose can.
- The seeds take four to five weeks for germination.
- Care should be taken not to flood the site.
- For the first few times, the grasses are cut with a scythe.
- Lawn mower may be used for easy maintenance and for its spreading.

Turfing

- The turfs are nothing but pieces of earth with compact grasses on them.
- These turfs should be cut uniformly in squares from a place where the grass is short, compact and free from weeds.
- These turfs should be placed on the prepared ground site, side by side and beaten down flat with a turf beater.
- The cavities in between should be filled with fine soil.
- The entire turfed area should be rolled and watered liberally.
- This is the most expensive way of lawn making.

Turf plastering

- The doob grass can be procured in large quantities free from weeds and chopped properly into small bits of 5-7 cm long.

- Two baskets of chopped grass pieces should be mixed well with one basket each of garden soil and fresh cow dung and a shovel full of wood ash with required quantity of water to form a thick pasty substance.
- This mixture is then spread uniformly on the surface of a previously wetted perfectly leveled ground to a thickness of at least 2.5cm and watering should be done with a rose can.
- The next day, ground should be rolled and the grass should be allowed to spread. The grass will shoot up in a fortnight.
- To start with, cut with a scythe and after three months, use the lawn mower.

Dibbling roots

- This is the cheapest but time consuming method. Small pieces of grass roots should be dibbled 10 – 15 cm apart in a leveled ground when it is wet after rain. The roots spread and grow underground in the course of six months making a fairly compact lawn by frequent mowing, rolling and watering.
- **After Care:** It includes rolling, mowing, watering and restora¬tion of patchy places, which should be done regularly.
- Fertilizing the lawn thrice a year is adequate to maintain rich greenness. Application of urea or ammonium sulphate at the rate of 1 kg / 50 sq. m during February - March, June - July and October - November is quite beneficial. At times well decomposed compost at 10 kg / 10 sq. m area will be sufficient as top dressing.
- Weeds should be removed as soon as they appear, otherwise they spread, seed multiply and overpower the grass. Fill the gaps with grass roots and fine soil. In the absence of rain, watering is done regularly at weekly intervals.
- A mower should not be employed until a firm green sword has been formed. The grass is first cut with sickle and the surface is then rolled. Heavy roller should be used frequently but not when the ground is either too wet or dry.
- Mowing should be done at brief intervals and never allow to produce seed stalks. Avoid cutting the grass too short as this can damage the grass, inhibit a deeper root system from setting up and give rise to weeds. Different grasses have different heights at which they can grow best, so make sure you enquire about this from the vendor or your landscaping company. The ideal height of most grasses is 3 to 4 inches. Removing more than one-third of the grass leaf in a single cutting is not recommended. Mow only on dry grass and not when the grass is wet. Make sure you mower's blade is a new and sharp before starting a fresh moving session. To ensure smoothness make sure you change the mower's oil once or twice during mowing season.

- Once in a year rake the lawn before rain and top dress with rich mixture of decomposed manure and soil. This will accelerate the grass with new vigorous growth.
- The best time to water the lawn would be during the early hours of morning. Watering during this time will allow the water to reach the roots without evaporating. Mid afternoons may lead to water getting evaporated soon and watering at night times can give rise to the possibilities of diseases. While watering, care should be taken to spread the water homogeneously across the lawn without over flooding or missing certain areas/spots. If the lawn is placed on heavy slopes make sure that the water does not run -off. Several applications of water would be necessary for such surfaces to ensure adequate penetration.

Astro Turf

- It is a synthetic lawn popularly used in developed countries in roof gardens as well as in play grounds. It dispenses the normal maintenance usually required for normal lawns. Constant sprinkling of water is one of the prime requi¬site to bind the synthetic fibre to provide a surface akin to a lawn carpet. A spacious lawn though beautiful will often be monotonous. So, to break the monotony, some beautiful tree or shrub is recommended as single specimen in the lawn.

Water garden:

- **Water gardens**, also known as **aquatic gardens**, are a type of water feature. They can be defined as any interior or exterior landscape or architectural element whose primary purpose is to house, display, or propagate a particular species or variety of aquatic plant. The primary focus is on plants, but they will sometimes also house ornamental fish, in which case the feature will be a fish pond.
- Water gardening is gardening that is concerned with growing plants adapted to pools and ponds. Although water gardens can be almost any size or depth, they are typically small and relatively shallow, generally less than twenty inches (50 cm) in depth. This is because most aquatic plants are depth sensitive and require a specific water depth in order to thrive. The particular species inhabiting each water garden will ultimately determine the actual surface area and depth required.

Cultivation of water plants:

- Growing plants in water, whether houseplants or an herb garden, is a great activity for the novice gardener, people with limited space or an aversion to messy dirt, and those who are plant watering-challenged. This method for growing plants is not only low

maintenance, but disease and pest resistant.

- Many plants grow easily in water and are an often used method of propagation as well, with some folks choosing to root houseplants in bottles or the like. An indoor water garden may often consist of clippings from existing houseplants in bottles covering every surface available, to a couple of growing plants in water perched on the kitchen windowsill. Growing plants in water allows for a greater flexibility in arrangement and can be accomplished in most any type of receptacle that will hold water. Growing houseplants in water may be a slower method than soil-based planting; however, the indoor water garden will remain lush for a lengthy period of time.

Good Plants for Water:

- Hanging or creeping plants from cuttings are often the easiest to root in a water environment, but rooted plants may be used as well. Wash all the soil completely off the roots of the “soon to be indoor water garden plant” and cut off any decayed or dead leaves or stems. Place the plant in the water/fertilizer solution. You may have to top off the solution on occasion due to dissipation. Replace the nutrients solution in the indoor water garden every four to six weeks in its entirety. As mentioned above, to retard algae growth, use a dark or opaque container. However, should algae become an issue, change the solution more frequently.

Herbal garden:

- Establish herbal garden of various types to popularize the usefulness of commonly available and frequently used Medicinal Plants among the various stakeholders and sensitize the public about our traditional knowledge. It is also a way of conserving Rare, Endangered and Threatened (RET) species of Medicinal Plants. Herbal Gardens of various kinds will be promoted under the scheme to create awareness about traditional usage of medicinal plants. This would include Herbal Gardens of National and State importance as well as at the level of Institutions, Schools, Universities, Colleges and Homes.

Type of Herbal Garden:

- 1. Home Herbal Gardens
- 2. School Herbal Gardens
- 3. Institutional/ Public Herbal Gardens
- 4. Herbal Gardens of State and National Importance

Functions of herbal Gardens:

- 1. Botanical gardens act as out-door laboratories.
- 2. Initiate studies on the tropical and temperate ecosystems and their biota, before they are lost to science and preserve such systems.
- 3. Serve as centres of gene pools or germ plasm bank of wild relatives of economically important plants.
- 4. Establish Nature centres and youth Museums to focus attention on destruction of tropical and temperate ecosystem, environmental degradation.
- 5. Maintain less attractive and abandoned ornamental plants.
- 6. Train city arborists in the plantation of trees in urban areas.
- 7. Collaborate university and others to conduct research in environmental biology etc.
- 8. Organise educational programmes to create environmental awareness among children students and train teachers in environmental education.
- 9. Centres of conservation of endangered and rare species.
- 10. Botanical gardens provide living plant materials for research.
- 11. They serve as pollution indicator centres by growing pollution – susceptible plants.

- 12. Most of the economic plants were originally introduced and distributed to the other parts of the world through botanic gardens.
- 13. Inspire poets, litrators etc. by providing aesthetical pleasure.
- 14. Serene site for relaxation. The gardens provide a suitable environment for relaxation and relieve the body and the mind of the stress and strain.
- 15. Garden therapy for eye-sight, mental-stress etc.
- 16. People of advance—age find a great solace in lovely gardens.
- 17. Gardens also arrange flowers shows, put on displays seasonal plants, flowers and plants of unusual interest.
- 18. The landscape gardens are becoming quite popular and land a great charm to the adjoining building like libraries, museums, sportground etc.
- 19. Conserve the flora and fauna in natural habitat.