Lecture 6

Classification of crops

There are more than 600 cultivated plant species in the world, of which about 200 species play important role in the world market. However, about only 15 field crops species represent the most important economic crops. Handling the huge number of crops is troublesome, unless they are classified. There is definitely demand of classification of crop species in an appropriate way to assure communication and retrieval of specific and scientific information as well as to facilitate their conservation and improvement. Generally, classification of those crop species is important for these reasons:

- To get acquainted with crops;
- To understand the requirement of soil & water different crops.
- To know adaptability of crops.
- To know the growing habit of crops.
- To understand climatic requirement of different crops.
- To know the economic produce of the crop plant & its use.
- To know the growing season of the crop
- Overall to know the actual condition required to the cultivation of plant.

In general, field crop is an organism grown and/or harvested for obtaining yield. Agronomically, crop is a plant cultivated for economic purpose. Classification is done to generalize similar crop plants as a class for better understanding of them.

Classification types used in field crops

1. Based on ontogeny (Life cycle)
2. Based on economic use (Agronomic)
3. Based on Botany (Scientific)
4. Based on seasons
5. Based on climate
6. Based on special purpose
7. Based on life span
8. Based on root depth
9. Based on CO₂ fixation
10. Mode of pollination
11. Based on leaf morphology
12. Based on cultural requirements
13. Based on origin

1. Based on Ontogeny (Life cycle)
   - Annual crops
     Crop plants that complete life cycle within a season or year. They produce seed and die within the season. Example, wheat, rice, maize, mustard etc.
   - Biennial crops
     Plants that have life span of two consecutive seasons or years. First years/season, these plants have purely vegetative growth usually confined to rosette of leaves. The tap root in some crop is fleshy and stores food. During the second year / season, they produce flower stocks from the crown and after producing seeds the plants die. Example, sugar beet, beet root, etc.
• **Perennial crops**
They live for three or more years. They may be seed bearing or non-seed bearing. Ex. Napier fodder grass, coconut, etc.

2. **Based economic use (Agronomic)**

**Cereals:** Cereals are the cultivated grasses grown for their edible grains. Larger grains used as staple food like rice, wheat, maize, barley, and oats and so on. Cereal grain contains 60 to 70% of starch and is excellent energy rich foods for humans. Some important cereals are:

1. Rice: *Oryza sativa*
2. Wheat: *Triticum aestivum*
3. Maize: *Zea mays*

**Millet:** Millets are small and coarse grained cereals, staple food in drier regions. They are also annual grasses of the group cereals. These are also staple food for people of poor countries. Millets are classified into two, as major millets and minor millets.

**Major millets**
1. Sorghum (*Jowar*): *Sorghum bicolor*
2. Pearl millet (*Bajra*): *Pennisetum glaucum*
3. Finger millet (*Ragi*): *Eleusine coracona*

**Minor millets**
1. Foxtail millet: *Setaria italica*
2. Little millet: *Panicum miliare*
3. Common millet: *Panicum miliaceum*
4. Barnyard millet: *Echinhloa colona var frumentaceae*
5. Kodo millet: *Paspalum scrobiculatum*

**Pulses:** Seeds of plants belong to leguminaceae family used as food grain and rich in protein. Pulses are preferred as a source of vegetable protein and also economically important in cropping system. The wastes or stalk is called the ‘haulm’ or ‘stover’. Haulm is used as green manure and has high value cattle feed. Green whole pods are sometimes used as vegetables, e.g. cowpea, French bean, lablab. Seed coat of pulses are nutritious cattle feed. Some of the examples of pulse crops are as follows.

1. Red gram: *Cajanus cajan*
2. Black gram: *Vigna mungo*
3. Green gram: *Vigna radiata*
4. Cowpea: *Vigna unguiculata*
5. Bengalgram: *Cicer arietinum*
6. Horsegram: *Macrotyloma uniflorum*
7. Lentil: *Lens esculentus*
8. Soybean: *Glycine max*
9. Pea: *Pisum sativum*
10. Grass pea - *Lathyrus sativus*

**Oil seeds:** Oilseed crops are rich in fatty acid and cultivated for the production of vegetable oil. The vegetable oil produced from the oilseeds are used for edible, industrial or medicinal purposes.

1. Groundnut or peanut: *Arachis hypogaeae*
2. Sesame or gingelly: *Sesamum indicum*
3. Sunflower: *Helianthus annuus*
4. Castor: *Ricinus communis*
5. Linseed or flax: *Linum usitatissimum*
6. Niger: *Guizotia abyssinica*
7. Safflower: *Carthamus tinctorius*
8. Indian Mustard: *Brassica juncea*

**Sugar crops:** These are the crops cultivated to obtain sugar and the crops are actually raw material for sugar industry.
1. Sugarcane: *Saccharum officinarum*
2. Sugar beet: *Beta vulgaris*

**Fibre crops:** Plants are grown for obtaining fibre and basically these crops are also the raw material for industry. Different kinds of fibre are, i) seed fibre, cotton; ii) Stem/bast fibre, Jute, mesta; iii) leaf fibre, Agave sp.

1. Cotton: *Gossypium hirsutum*
2. Jute: *Corchorus olitorius/C. capsularis*
3. Mesta: *Hibiscus cannabinus*

**Forage:** Forage refers to vegetative matter, fresh or preserved, utilized as feed for animals.

1. Grasses: Bajra (*Pennisetum glaucum*), napier (*Pennisetum purpureum*), guinea grass (*Megathyrsus maximus*), para grass (*Brachiaria mutica*)
2. Legumes: Lucerne (*Medicago sativa*), Barseem (*Trifolium alexandrium*)

**Spices and condiments:** Crop plants or their products used for flavour, taste and add colour to the fresh or preserved food.

1. Ginger: *Zingiber officinale*
2. Garlic: *Allium sativum*
3. Fenugreek: *Trigonella foenum-graecum*
4. Cumin: *Cuminum cyminum*
5. Turmeric: *Curcuma longa*
6. Coriander: *Coriandrum sativum*
7. Anise: *Pimpinella anisum*

**Medicinal plants:** Medicinal plants are the crops used for preparation of medicines. These are either used as fresh product or processes and value added in industry. Example of medicinal plants are:

1. Tobacco: *Nicotina tabacum*
2. Peppermint: *Mentha piperita*
3. Aswagandha: *Withania somnifera*
4. Aloe: *Aloe vera*

**Beverages:** Products of crops used for preparation of mild, agreeable and simulating drinking.

1. Tea: *Camellia sinensis*
2. Coffee: *Coffea arabica*
3. Cocoa: *Theobroma cacao*

3. **Based on scientific or botanical classification**

Botanical classification indicates the family and scientific names of plants which consist of genus and species and are universally accepted. Carolus Linnaeus, a Swedish botanist, was responsible for the binomial system of classification with genus and species. Botanical classification is based upon similarity of morphological characters, namely, plant parts and floral structure. Scientific classification is considered as the most important way of classification because it determines the extent of similarity. Field crops belong to the spermatophyte which produces seed under the division of plant kingdom. Within this division, the most of the common crops belong to the subdivision of angiosperm. Angiosperm is characterized by producing seeds with seed-coats and the angiosperm is divided into two classes, namely, monocotyledons and dicotyledons. All the grasses, which include the cereals and sugarcane, are monocotyledons. The rest plants (except the grasses, which include monocotyledons) are classified as dicotyledons. Each of these two classes is still further divided into orders, families, genus and species. According to the botanical classification, the families of the most important field crops can be listed as shown below.

- **Monocotyledons**
  - **Poaceae /Gramineae:** Wheat, barley, rice, maize, oat, sugar cane, sorghum, rye grass, sudan grass and different millets.
  - **Liliaceae:** Onion and garlic.
- **Dicotyledons**
Leguminosae: Green gram, black gram, red gram, field bean, Bengal gram, lentil, fenugreek, barseem, lucerne, soybean, groundnut, grass pea, French bean, red clover and white clover.
Malvaceae: Cotton.
Linaceae: Flax.
Solanceae: Potato, tobacco.
Pedaliaceae: Sesame.
Composite: Sunflower, safflower.

4. Based on seasons
Crops are grouped under the seasons in which their major growing duration falls.
Kharif crops: Crops which are grown between June-July to September-October and which require a shorter day length for flowering. Example of kharif crops are rice, castor, millets and so on.
Rabi crops: Crops sown during October–November and harvested during February-March, which need cold dry weather conditions for their growth and longer day length for reproduction. Common example of rabi crops are wheat, rapeseed and mustard, barley, oats, potato, chick pea and lentil.
Summer crops: The summer crops are sownduring February–March and harvested in May–June. The warm dry weather is congenial for the vegetative growth of summer crops and longer day length for flowering. In Indian language it is also termed as zaid crop. Example of summer crops are sesame, black gram, green gram, cowpea.

5. Based on climatic condition
Tropical crop: Coconut, sugarcane
Sub-tropical crop: Rice, cotton
Temperate crop: Wheat, barley
Polar crop: All pines, pasture grasses

6. Based on Special purpose
Sometimes the crop plants are grown for special purposes or these provide advantages to the farmer in relation to his farming practices including the contingency situations.
Catch or emergency crop: These crops are used to substitute main crops that have failed due to unfavourable conditions. Catch crops are usually fast growing in nature and matured within a short span of time (such as green gram, rye, millet, clover).
Cash crop: These are the crop grown to generate cash rather than for subsistence. Cash crops are usually related to location. Example of cash crop is chilli for Andhra Pradesh, jute and potato in West Bengal, cotton in Maharashtra, sugarcane in Uttar Pradesh.
Cover crops: These crops are planted to provide a cover for the soil and these are cultivated to prevent erosion such as pulses like green gram, black gram, and clover and rye.
Green manure crops: These crops are buried in the soil while still green in order to improve the soil properties as well as increase of organic matter content. The most of the legumes (like Sesbania, green gram, sunhemp) can be considered as green manure crop and some non-legumes (like amaranthus, jute) may also be treated.
Companion crops: In this case a crop can be intercropped with another one with a distinct row arrangement and each crop is harvested separately. For example, green gram can be intercropped with cotton crop, or black gram, groundnut and soybean with maize.
Silage crops: These crops are harvested in vegetative and preserved in a succulent condition by partial fermentation in a tight chamber and used as animal feed. They include corn, sorghum, forage grasses and legumes.

7. Based on life span
All field crops can be divided into three categories on the basis of the length of their life cycle which are as follows.
Annual crops: Annual crops are the plants those complete their life cycle (from seed to seed) in a single growing season. Most field crops are considered annual crops such as rice, wheat, barely, chick pea, maize, sorghum and others.
Biennial crops: These are the plants which complete their life cycle in two seasons. Vegetative growth occurs during the first season resulting in a rosette form but plants don’t start blooming. In the next season, the green plants give flowers and seeds. The crops of this category are onion, sweet clover and sugar beet.

Perennial crops: These crops are grown in the soil for more than two years (they can persist for more than two years) and they have an indefinite life span. They may either produce seed or not every year. Sugar cane, alfalfa and white clover are examples of perennial crops.

8. Based on root depth
The root system of field crops differs in structure, function and depth and on the basis of rooting depth the field crops are classified as follows.

Hallow root crops: The root system of these crops extends in the soil with in a depth of one meter such as wheat, barley and rye.

Intermediate crops: The depth of the root system of these intermediate crops ranges from 1- 1.5 meter as observed in faba bean and sugar beet.

Deep root crops: The root system of these plants goes to a depth more than 1.5 meter in soil as observed in alfalfa.

9. Based on method of CO₂ reduction
The reduction of carbon dioxide (CO₂) is called dark reaction as light is not necessary and dark reaction does not mean that it occurs only in night. With the energy supplied by ATP (produced during light reactions), CO₂ combines with hydrogen (supplied by NADPH) and forms carbohydrates. Based on the method of reduction of CO₂, plants are classified into the following categories.

C₃ Plants: The initial product of carbon assimilation is the three carbon compound. Net assimilation rate in these plants is low but compensation point is high. Stomata remain open during the day. Photo respiration is high in these plants and C₃ Plants have lower water use efficiency. The enzyme involved in the primary carboxylation is ribulose-1,5-biphosphaeate carboxylase. Example of C₃ plants are rice, soybeans, wheat, potato and so on. The C₃ plants include more than 95 percent of the plant species on earth.

C₄ plants: Net assimilation rate in these plants is high but compensation point is low. Stomata are open during the day. The primary product of C fixation is four carbon compounds which may be malice acid or aspertic acid. The enzymes responsible for carboxylation are phosphoenol pyruvic acid carboxylase and it has high affinity for CO₂ and capable of assimilation CO₂ even at lower concentration. Photosynthesis rate is higher and photo respiration is negligible in C₄ plants. Crops with C₄ type of photosynthesis are maize, sorghum, pearl millet and other minor millets.

CAM plants: The word ‘CAM’ stands for Crassulacean Acid Metabolism. In these plants the stomata open at night and large amount of CO₂ is fixed as a malic acid which is stored in vacuoles. During day stomata remain closed and there is no possibility of CO₂ entry. CO₂ which is stored as malic acid is broken down and released as CO2. In these plants there is negligible transpiration loss of water. C₄ & CAM plants have high water use efficiency compared to C₃ plants. CAM plants are highly drought resistant. Example of CAM plants are pineapple, sisal and agave.

10. Based on mode of pollination
Naturally self-pollinated crops: For these crops both pollen and embryo sac are produced in the same floral structure or in different flowers but within the same plant and pollination takes place naturally. Examples of naturally self-pollinated crops are wheat, rice, pulses, okra, and tomato.

Naturally cross-pollinated crops: Pollen transfer in these plants is from the anther of one flower to the stigma of another flower in a separate plant, although self-pollination may reach 5 percent or more. The natural cross-pollination is done by wind, rain, and insect and so on. Examples of cross-pollinated crops are corn, many grasses, avocado, grape, mango, many plants with unisexual or imperfect flowers.

Both self and cross-pollinated crops: these plants are mostly self-pollinated but cross-pollination also occurs to a varying extent. Examples of these category of crops are cotton and sorghum.

11. Based on leaf morphology
Broad leaved: Mustard, pea, potato, tobacco.
Narrow leaved: Rice, wheat, sugarcane, onion, ginger, ragi.

12. Based on cultural requirements
   - A. According to suitability of tropo-sequence

Crops grown on upand: Redgram, maize, jower, pearl millet.
Crops grown on medium land: Jute, potato, sugarcane, wheat.
Crops grown on low land: Rice, para grass.
   - B. According to suitability of the textural group of soils
Crops of sandy to sandy loam soil (light textured): Potato, sweet potato, sugarbeet, onion.
Crops of silty to silty loam soil (medium textured): Jute, sugarcane, maize, cotton.
Crops of clay to clay loam soil (heavy textured): Rice, sugarcane, maize, cotton.
   - C. According to the tolerance to the problematic soil
Crops tolerant to acidic soil: Potato, mustard, wet rice.
Crops tolerant to saline soil: Chillies, sugar beet, beet, sunflower, barseem.
Crops tolerant to alkaline soil: Barley, cotton, pea, barseem.
Crops tolerant to water logged soil: Rice, para grass, napier, job’s tier
Crops tolerant to soil erosion: Vetiver, moth bean, marvel grass.
   - D. According to tolerance to hazardous weather conditions
Frost tolerant crops: Sugar beet, beet.
Cold tolerant crops: Potato, cabbage, mustard.
Drought tolerant crops: Millets, barley, safflower, castor.
   - E. According to water supply
Irrigated crop: Boro rice, potato, tobacco.
Rainfed crop: Millets, upland rice, jute, castor, Dinanath grass.
Rainfed, but partially irrigated: Chick pea, mustard, maize.
Residual soil moisture crops: Tori, lathyrus, linseed.
Rainfed flooded crops: Deep water rice, makhana, water chestnut.
   - F. According to method of sowing or planting
Direct seeded: Upland rice, mustard, chick pea, lentil.
Planted: Potato, Napier, and citronella.
Transplanted: Transplanted rice, tobacco, onion.
   - G. According to requirement of inter-tillage and earthing-up
Intertilled crops: Potato, sweet potato, sugar beet.
Non-intertilled crops: Lentil, oats, chick pea, linseed.
   - H. According to crop duration
Very short (upto 75 days): Greengram, spinach.
Short (76-100 days): Upland rice, early potato.
Medium (101-125 days): wheat, jower, bajra, barley.
Long (126-150 days): Tobacco, barseem.
Very long (>150 days): Sugarcane, red gram.
   - I. According to method of harvest
Reaping: Rice, wheat, mustard.
Uprooting by pulling: Linseed, radish, beet.
Uprooting by digging: Potato, sweet potato.
Picking: Cotton, maize, okra.
Cutting: Barseem, napier.
Grazing: Para grass, pasture grasses.
   - J. According to post-harvest operation required
Curing: Tobacco.
Stripping: Jute, mesta, sunhemp.
Shelling: Groundnut, maize.
Ginning: Cotton.

13. Based on centre of origin of crops
The origin of crop plants is mandatory for plant breeding in order to locate wild relatives, related species, and new genes. To check genetic erosion, it is important to have knowledge of the origins of crop plants. The germplasm is lost due to several factors like loss of ecotypes and landraces, loss of habitat, choice of the growers and increased urbanization. Germplasm preservation is accomplished through gene banks and preservation of natural habitats (especially in centers of origin). So far eight Vavilovian centres of are there which further consist old and new world as origin of different crops.

Old World

I. Chinese Center: The largest independent center which includes the mountainous regions of central and western China, and adjacent lowlands. The plants under this category are listed below, amongst which a few are important crops.

Cereals and Legumes
Broomcorn millet (*Panicum miliaceum*); Italian millet (*Panicum italicum*); Japanese barnyard millet (*Panicum frumentaceum*); kaoliang (*Andropogon sorghum*); buckwheat (*Fagopyrum esculentum*); hull-less barley (*Hordeum hexastichum*); soybean (*Glycine max*); adzuki bean (*Phaseolus angularis*); velvet bean (*Stizolobium hassjoo*).

Roots, Tubers, and Vegetables
Chinese yam (*Dioscorea batatas*); radish (*Raphanus sativus*); Chinese cabbage (*Brassica chinensis, B. pekinensis*); onion (*Allium chinense, A. fistulosum, A. pekinense*); cucumber (*Cucumis sativus*).

Fruits and Nuts
Pear (*Pyrus serotina, P. ussuriensis*); Chinese apple (*Malus asiatica*); peach (*Prunus persica*); apricot (*Prunus armeniaca*); cherry (*Prunus pseudocerasus*); walnut (*Juglans sinensis*); litchi (*Litchi chinensis*).

Sugar, Drug, and Fiber Plants
Hemp (*Cannabis sativa*); sugarcane (*Saccharum sinense*); camphor (*Cinnamomum camphora*); Opium poppy (*Papaver somniferum*); ginseng (*Panax ginseng*).

II. Indian Center: This area has two sub-centers.

A. Main Center (Hindustan): Includes Assam and Burma, but not northwest India, Punjab, nor northwest Frontier Provinces. In this area, 117 plants were considered to be endemic.

Cereals and legumes
Rice (*Oryza sativa*); chickpea or gram (*Cicer arietinum*); pigeon pea (*Cajanus indicus*); urd bean (*Phaseolus mungo*); mung bean (*Phaseolus aureus*); rice bean (*Phaseolus calcaratus*); cowpea (*Vigna sinensis*).

Vegetables and tubers
Eggplant (*Solanum melongena*); cucumber (*Cucumis sativus*); radish (*Raphanus caudatus*); taro (*Colocasia antiquorum*); yam (*Dioscorea alata*).

Fruits
Mango (*Mangifera indica*); orange (*Citrus sinensis*); tangerine (*Citrus nobilis*); citron (*Citrus medica*); tamarind (*Tamarindus indica*).

Sugar, oil, and fiber Plants
Sugar cane (*Saccharum officinarum*); coconut palm (*Cocos nucifera*); sesame (*Sesamum indicum*); safflower (*Carthamus tinctorius*); tree cotton (*Gossypium arboretum*); oriental cotton (*Gossypium nanking*); jute (*Corchorus capsularis*); crotalaria (*Crotalaria juncea*); kenaf (*Hibiscus cannabinus*).

Spices, Stimulants, Dyes, and Miscellaneous
Hemp (Cannabis indica); black pepper (Piper nigrum); gum arabic (Acacia Arabica); sandalwood (Santalum album); indigo (Indigofera tinctoria); cinnamon tree (Cinnamomum zeylanticum); croton (Croton tiglium); bamboo (Bambusa tulda).

B. Indo-Malayan Center: Includes Indo-China and the Malay Archipelago. Fifty-five plants were listed, including:

Cereals and Legumes
Job’s tears (Coix lacryma); velvet bean (Mucuna utilis)

Fruits
Pummelo (Citrus grandis); banana (Musa cavendishii, M. paradisiaca, H. sapientum); breadfruit (Artocarpus communis); mangosteen (Garcinia mangostana).

Oil, sugar, spice, and fiber plants
Candlenut (Aleurites moluccana); coconut palm (Cocos nucifera); sugarcane (Saccharum officinarum); clove (Caryophyllus aromaticus); nutmeg (Myristica fragrans); black pepper (Piper nigrum); manila hemp or abaca (Musa textilis).

III. Central Asiatic Center: Includes Northwest India (Punjab, Northwest Frontier Provinces and Kashmir), Afghanistan, Tadjikistan, Uzbekistan, and western Tian-Shan. Forty-three plants are listed for this center, including many types of wheat.

Grains and Legumes
Common wheat (Triticum vulgare); club wheat (Triticum compactum); shot wheat (Triticum sphaerocoecum); pea (Pisum sativum); lentil (Lens esculenta); horse bean (Vicia faba); chickpea (Cicer arietinum); mung bean (Phaseolus aureus); mustard (Brassica juncea); flax (Linum usitatissimum); sesame (Sesamum indicum).

Fiber Plants
Hemp (Cannabis indica); cotton (Gossypium herbaceum).

Vegetables
Onion (Allium cepa); garlic (Allium sativum); spinach (Spinacia oleracea); carrot (Daucus carota).

Fruits
Pistacia (Pistacia vera); pear (Pyrus communis); almond (Amygdalus communis); grape (Vitis vinifera); apple (Malus pumila).

IV. Near-Eastern Center: Includes interior of Asia Minor, all of Transcaucasia, Iran, and the highlands of Turkmenistan. Eighty-three species including nine species of wheat were located in this region.

Grains and Legumes
Einkorn wheat (Triticum monococcum, 14 chromosomes); durum wheat, (Triticum durum, 28 chromosomes); poulard wheat (Triticum turgidum, 28 chromosomes); common wheat (Triticum vulgare, 42 chromosomes), oriental wheat (Triticum orientale); Persian wheat (Triticum persicum, Triticum timopheevi, 28 chromosomes); Wheat (Triticum macha, 42 chromosomes; Triticum vavilovanum, 42 chromosomes); two-row barley (Hordeum distichum, H. nutans); rye (Secale cereal); mediterranean oats (Avena byzantine); common oats (Avena sativa), lentil (Lens esculenta); lupine (Lupinus pilosus, L. albus).

Forage Plants
Alfalfa (Medicago sativa); Persian clover (Trifolium resupinatum); fenugreek (Trigonella foenum graecum); vetch (Vicia sativa); hairy vetch (Vicia villosa).

Fruits
Fig (Ficus carica); pomegranate (Punica granatum); apple (Malus pumila); pear (Pyrus communis); Quince (Cydonia oblonga); cherry (Prunus cerasus); hawthorn (Crataegus azarolus).
V. Mediterranean Center: Includes the borders of the Mediterranean Sea.

Cereals and Legumes
Durum wheat (*Triticum durum expansum*); emmer wheat (*Triticum dicoccum*); Polish wheat (*Triticum polonicum*); spelt (*Triticum spelta*); Mediterranean oats (*Avena byzantine*); sand oats (*Avena brevis*); Canarygrass (*Phalaris canariensis*); grass pea (*Lathyrus sativus*); pea (*Pisum sativum*); lupine (*Lupinus albus*).

Forage Plants
Egyptian clover (*Trifolium alexandrinum*); white clover (*Trifolium repens*); crimson clover (*Trifolium incarnatum*); serradella (*Ornithopus sativus*).

Oil and Fiber Plants
Flax (*Linum usitatissimum, L. angustifolium*); Rape (*Brassica napus*); black mustard (*Brassica nigra*); Olive (*Olea europaea*).

Vegetables
Garden beet (*Beta vulgaris*); cabbage (*Brassica oleracea*); turnip (*Brassica campestris*); lettuce (*Lactuca sativa*); Asparagus (*Asparagus officinalis*); celery (*Apium graveolens*); chicory (*Cichorium intybus*); Parsnip (*Pastinaca sativa*); rhubarb (*Rheum officinale*).

Ethereal Oil and Spice Plants
Caraway (*Carum carvi*); anise (*Pimpinella anisum*); thyme (*Thymus vulgaris*); peppermint (*Mentha piperita*); sage (*Salvia officinalis*); hop (*Humulus lupulus*).

VI. Abyssinian Center: Includes Abyssinia, Eritrea, and part of Somaliland.

Grains and Legumes

Miscellaneous
Sesame (*Sesamum indicum*); castor bean (*Ricinus communis*); garden cress (*Lepidium sativum*); coffee (*Coffea Arabica*); okra (*Hibiscus esculentus*); myrrh (*Commiphora abyssinica*); indigo (*Indigofera argentea*).

New World

VII. South Mexican and Central American Central: Includes southern sections of Mexico, Guatemala, Honduras and Costa Rica.

Grains and Legumes
Maize (*Zea mays*); common bean (*Phaseolus vulgaris*); Lima bean (*Phaseolus lunatus*); Tepary bean (*Phaseolus acutifolius*); jack bean (*Canavalia ensiformis*); grain amaranth (*Amaranthus paniculatus leucocarpus*).

Melon Plants
Malabar gourd (*Cucurbita ficifolia*); winter pumpkin (*Cucurbita moschata*); chayote (*Sechium edule*).

Fiber Plants
Upland cotton (*Gossypium hirsutum*); bourbon cotton (*Gossypium purpurascens*); chayote (*Sechium edule*).

Miscellaneous
Sweet potato (*Ipomoea batatas*); arrowroot (*Maranta arundinacea*); pepper (*Capsicum annuum, C. frutescens*); papaya (*Carica papaya*); guava (*Psidium guajava*); cashew (*Anacardium occidentale*); wild black cherry (*Prunus serotina*); cochenial (*Nopalea coccinellifera*); cherry tomato (*Lycopersicum cerasiforme*); cacao (*Theobroma cacao*); tobacco (*Nicotiana rustica*).
VIII. South American Center: Three sub-centers are found under south American centre.

A. Peruvian, Ecuadorean, and Bolivian Center: Comprised mainly of the high mountainous areas, formerly the center of the Megalithic or Pre-Inca civilization. Endemic plants of the Puna and Sierra high elevation districts included:

   **Root Tubers**
   Andean potato (*Solanum andigenum*, 96 chromosomes) and other endemic cultivated potato species, fourteen or more species with chromosome numbers varying from 24 to 60; edible nasturtium (*Tropaeolum tuberosum*), edible canna (*Canna edulis*); potato (*Solanum phureja*, 24 chromosomes).

   **Grains and Legumes**
   Starchy maize (*Zea mays amylacea*); lima bean (*Phaseolus lunatus*, secondary center); common bean (*Phaseolus vulgaris*, secondary center).

   **Vegetable Crops**
   Pepino (*Solanum muricatum*); tomato (*Lycopersicum esculentum*); ground cherry (*Physalis peruviana*); Pumpkin (*Cucurbita maxima*); pepper (*Capsicum frutescens*).

   **Fiber Plants**
   Egyptian cotton (*Gossypium barbadense*).

   **Fruit and Miscellaneous**
   Passion flower (*Passiflora ligularis*); guava (*Psidium guajavai*); heilborn (*Carica candamarcensis*); Quinine tree (*Cinchona calisaya*); tobacco (*Nicotiana tabacum*).

B. Chiloe Center (Island near the coast of southern Chile)

Common potato (*Solanum tubersum*, 48 chromosomes); wild strawberry (*Fragaria chiloensis*).

C. Brazilian-Paraguayan Center

Manioc (*Manihot utilissima*); peanut (*Arachis hypogaea*); rubber tree (*Hevea brasiliensis*); pineapple (*Ananas comosa*); Brazil nut (*Bertholletia excels*); cashew (*Anacardium occidentale*); Purple granadilla (*Passiflora edulis*).

Question Bank

1. Why crops are classified? Mention the agronomic classification of crops.
2. Write short notes on the following.
   a) CAM plant; b) Fibre crops; c) Naturally cross pollinated crops;
3. Give example of the following.
   a) C₃ plant; b) C₄ plant; c) Forage plant; d) Legumes; e) Green manure crops