BOTANY
Lab Manual

BSc.-III Medical

Semester VI
EXPERIMENT 1

Experiment: To determine minimum number of quadrats required for reliable estimate of biomass in grassland through species area curve.

Theory
Quadrats are quadrangular areas selected to study vegetation profile of a particular geographical area. Its size may vary depending upon the diversity of plant species in an area for reliable estimate of biomass. Biomass is defined as the quantity of living matter present in an organism which can be expressed on fresh or dry weight basis.

Requirements
Wooden Quadrat frame of size 50x50 cm², graph paper, pencil.

Procedure
1. Determined minimum size of quadrat required for a particular grassland.
2. Laid down 10-15 quadrats of known size (50x50 cm²).
3. Listed different type of species present in each quadrat.
4. Determined total number of species for each quadrat.
5. Plotted number of quadrats on x-axis and total number of species types on y-axis.
6. Joined all the points and determined the number of quadrats required for reliable estimate corresponding to the point after which no new species is encountered.

Precautions
1. Minimum 10-15 quadrats should be laid.
2. Number of species should be recorded carefully.
3. Quadrats should be of same size.

Observation Table

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Number of Quadrat</th>
<th>Number of Species</th>
<th>Total Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A</td>
<td>B</td>
</tr>
</tbody>
</table>

Conclusion
Minimum number of quadrats required for reliable estimate of biomass in grassland was ........
EXPERIMENT 2

Experiment: To determine moisture content and water holding capacity of grassland and woodland soil.

Theory
The moisture content of soil depends upon its texture and composition. More sandy a soil is, lesser would be its moisture content whereas more organic content helps retaining moisture. Water holding capacity is the maximum amount of water held by soil per unit weight in grams.

Requirements
Weighing balance, soil samples, blotting sheet, hot air oven, funnel, beaker, tripod stand, measuring cylinder etc.

Procedure
1. Collected the soil samples from grassland and woodland areas.
2. Removed debris or any pebble from soil samples.
3. Crushed soil samples to make fine powder.
5. Noted the weight and placed them in oven at 100°C for 5 – 6 hrs.
6. Noted the weight of soil samples after complete drying.
7. Calculated moisture content by subtracting the dry weight from fresh weight.
8. To determine water holding capacity, weighed 50g of soil samples after drying.
9. Lined glass funnels with filter paper and put soil in it.
10. Poured 100 ml of water in both samples and waited till the water stopped tickling.
11. Measured the volume of water collected in beaker and absorbed by filter paper and determined water retained by soil by subtracting from 100ml.
12. Expressed water holding capacity on weight basis.

Precautions
1. Weight of soil should be determined carefully.
2. Soil samples should be dried properly.
3. Volume of water absorbed by filter paper should be subtracted before calculation.
### Observations & Calculations

<table>
<thead>
<tr>
<th>Soil Sample</th>
<th>Replicates</th>
<th>Fresh Weight of Soil (g) x</th>
<th>Dry Weight of Soil (g) y</th>
<th>Moisture content (x-y)</th>
<th>Water Holding Capacity (cc/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland Soil</td>
<td>1</td>
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<td>Mean:</td>
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<tr>
<td>Woodland Soil</td>
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<tr>
<td>Mean:</td>
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</tbody>
</table>

### Conclusion

Moisture content and water holding capacity of grassland soil as more as compared to woodland soil.
EXPERIMENT 3

**Experiment:** To estimate pH, transparency and temperature of different water bodies.

**Theory**
pH is negative logarithm of H$^+$ ion concentration which is represented as $-\log [H^+]$. Temperature is the degree of hotness or coldness of a body.

**Requirements**
pH strips, beakers, water samples, thermometer, blotting sheet etc.

**Procedure**
1. For determining pH, a pH strip was taken and dipped in water samples.
2. Matched the colour of strips with standard colour palette.
3. Noted down the pH of water samples.
4. For determining temperature of water samples, suspended two thermometers in beakers containing water samples with the help of stands.
5. Noted down the temperature of water samples after 10 min.
6. The water was checked for turbidity.

**Precautions**
1. pH of samples should be determined carefully.
2. Thermometer should not touch the base of beaker.

**Observation Table**

<table>
<thead>
<tr>
<th>Water Samples</th>
<th>pH</th>
<th>Temperature</th>
<th>Transparency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond Water</td>
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<tr>
<td>Canal Water</td>
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<tr>
<td>Tap Water</td>
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</tbody>
</table>

**Conclusions**

pH and temperature of .......... water sample was maximum.
EXPERIMENT 4

Experiment: To determine dust holding capacity of leaves of different species.

Theory
Dust holding capacity is the amount of dust carried by leaves with respect to its weight. Leaves with trichomes or silica deposits on their epidermis have rough surface therefore higher dust holding capacity as compared to smooth leaves.

Requirements
Leaves of different plant species, cotton, weighing balance, blotting sheet etc.

Procedure
1. Collected leaves of different plant species viz. mango, Cassia, peepal etc. from roadside trees growing in heavy traffic area.
2. Weigh minimum three leaves of each species.
3. Cleaned leaves with water and dried with the help of cotton or blotting sheets to remove dust.
4. Weighed clean leaves again.
5. Calculated the difference between weight of leaves before and after cleaning.
6. Determine the percentage of dust holding capacity of different leaf samples.

Precautions
1. Weigh equal number of leaves of all plant species.
2. Clean the leaves properly.
3. Weighing should be done carefully.

Observations & Calculations

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Weight of uncleaned leaves x (g)</th>
<th>Weight of Cleaned leaves y (g)</th>
<th>Weight of Dust x-y=z (g)</th>
<th>Dust holding capacity z/y x 100 (%)</th>
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</thead>
<tbody>
<tr>
<td>Mango</td>
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<tr>
<td>Peepal</td>
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<tr>
<td>Cassia</td>
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</table>

Conclusions
Dust Holding Capacity of …………. was maximum.
EXPERIMENT 5

Experiment: To estimate salinity of different water samples.

Theory
Water samples collected from different locations such as canal, pond, rivers etc. contain different level of salts dissolved in it. The salinity is the percentage of dissolved salt value in respective water sample. More the salt content, higher is the toxicity or salinity of that sample.

Requirements
Different water samples, china dish, weighing balance, hot plate, spirit lamp, tripod stand, wire gauge, measuring cylinder, match box etc.

Procedure
1. Two crucibles were washed, cleaned and dried properly.
2. Weighed the crucibles using weighing balance.
3. 30ml of the water sample was taken in crucible and heated till evaporated completely.
4. Weighed the crucible again.
5. Repeated same for different water samples.

Precautions
1. The crucible should be clean and properly dried before weighing.
2. Same volume of water samples should be used.
3. Crucible should be heated over wire gauge using spirit lamp or hotplate.

Observations

<table>
<thead>
<tr>
<th>Sample</th>
<th>Initial Weight of Crucible x (g)</th>
<th>Final Weight of Crucible y (g)</th>
<th>Amount of Salt y-x = z (g)</th>
<th>Salinity z/30 x100 (%)</th>
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</thead>
<tbody>
<tr>
<td>Tap Water</td>
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<tr>
<td>Pond Water</td>
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<tr>
<td>Canal Water</td>
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</table>

Conclusions
Salinity of Pond water was more as compared to tap water i.e. ……& per unit volume.
EXPERIMENT 6

Experiment: To determine percent leaf area injury of different leaf samples collected around polluted sites.

Theory
Trees around polluted areas show many symptoms of injury such as chlorosis, necrosis, insect or pathogen attack etc. The level of injury can be calculated as follows

\[
\text{Percent Leaf Area Injury} = \frac{\text{Total Injured Leaf Area}}{\text{Total Leaf Area}} \times 100
\]

Requirements
Graph paper, injured leaves, pencil, scale, cotton etc.

Procedure
1. Collected mature leaves from polluted areas such as industrial or heavy traffic areas.
2. Observed injury marks such as chlorosis, insect bites, necrosis etc. on leaf surface.
3. Cleaned the leaf and placed on graph paper to plot margin along with injured areas.
4. Calculated total leaf area by counting number of squares on graph and expressed in terms of sq. sm.
5. Repeated same procedure for different leaves.
6. Calculated percent leaf injury using formula.

Precautions
1. Multiple leaves of same plant species should be analyzed.
2. Leaf area should be calculated carefully.
3. Percent leaf injury should be expressed as mean value of different leaf samples.

Observations

<table>
<thead>
<tr>
<th>Leaf Sample</th>
<th>Total Leaf Area (cm²)</th>
<th>Injured Area (cm²)</th>
<th>% Leaf Injury y/x x100</th>
</tr>
</thead>
<tbody>
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<td>3.</td>
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</table>

Mean:

Conclusions
The percent leaf area injury in leaves of ............... plant species collected from heavy traffic area was ........%.
EXPERIMENT 7

Experiment: To measure the vegetation cover of grassland by Point Frame Method.

Theory
Point frame apparatus is a wooden frame having rectangular bracket shape with number of holes to accommodate pins. It is used to measure vegetation cover in particular area. Other methods used to determine vegetation cover include line intercept method.

Requirements
Point Frame Apparatus, Notebook, Pencil etc.

Procedure
1. Placed the apparatus randomly at five different places in a grassland.
2. Noted down the number of species hit by one or more times whenever apparatus is used.
3. Measured the length and basal area of these plants and calculated vegetation cover.

Precautions
1. Point frame apparatus should be placed carefully.
2. Number of species should be noted down carefully.
3. Length or diameter of plant should be measured accurately.

Observations and Calculations

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Length of Plants in Area</th>
<th>Length of Species x (cm)</th>
<th>Vegetation Cover x/y x 100</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I II III IV V</td>
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</tbody>
</table>

Total Length y = cm

Conclusions
The vegetation cover occupied by ……. Species was maximum.
EXPERIMENT 8

Experiment: To study the frequency of herbaceous species in grassland and to compare the frequency distribution with Raunkiär’s Standard Frequency Diagram.

Theory

Frequency refers to the degree of dispersion of individual species, in an area. The number of time a species is represented in the sampling unit is called species frequency. It is represented as:

\[
\text{Frequency} = \frac{\text{No. of quadrats in which species appeared}}{\text{Total no. of quadrats}} \times 100
\]

Raunkiär classified species into five frequency classes: A (0 – 20%), B (21 – 40%), C (41 – 60%), D (61 – 80%) and E (81 – 100%).

Procedure

1. Laid quadrats randomly in selected areas.
2. Recorded presence or absence of plant species in each quadrat.
3. Calculated % frequency of each species.
4. Arranged % frequency according to Raunkiär Frequency classes.
5. A graph was plotted with % frequency along y-axis and frequency class along x-axis.

Precautions

1. Quadrats should be laid down properly.
2. Presence of species should be observed carefully.
3. Species should be arranged as per Raunkiär’s frequency classes.

Observations & Calculations

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Occurrence of Plants in Quadrat</th>
<th>Total no. of quadrats in which species appeared</th>
<th>% Frequency</th>
<th>Raunkiär Class</th>
</tr>
</thead>
<tbody>
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<td>I</td>
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<td>III</td>
<td>IV</td>
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</tbody>
</table>

Relative Frequency of Raunkiär’s Class = \( \frac{\text{Number of times Raunkiär class appeared (A/B/C/D/E)}}{\text{Total No. of Raunkiär Classes}} \)

Conclusions

% Frequency of Raunkiär class .... was maximum whereas class ..... was minimum.
EXPERIMENT 9

Experiment: To estimate the Importance Value Index (IVI) for grassland species on the basis of relative frequency, relative density and relative dominance in protective and grazed grassland.

Theory
IVI denotes total picture of ecological importance of species. It plays as important role in study of plant community, abundance which gives complete information about importance of species in relation to community structure.

IVI = Relative Density + Relative Frequency + Relative Dominance

Requirements
Wooden quadrats, scale, thread, notebook, pencil etc.

Procedure
1. Many quadrats (50x50 cm²) were laid in the grassland and determined occurrence and basal area of all plant species.
2. Recorded presence or absence of plant species in each quadrat to determine relative frequency.
3. Recorded number of individuals of a species in each quadrat to determine relative density.
4. Calculated diameter of all individuals of a species to determine relative dominance.

Precautions
1. Quadrats should be laid down properly.
2. Number of species in an area and nu. Of individuals of a particular species should be noted down carefully.
3. All calculations should be made properly.

Observations & Calculations

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Quadrats</th>
<th>Total no. of quadrats in which sp. Appeared</th>
<th>Relative Frequency x/y x 100</th>
</tr>
</thead>
<tbody>
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<td></td>
<td>II</td>
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<td>III</td>
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<td>IV</td>
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<td></td>
<td>V</td>
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</tbody>
</table>

Total occurrence y=
Table 2.

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>No. of plants in Quadrat</th>
<th>Total no. of individuals of a species ( x )</th>
<th>Relative Density ( \frac{x}{y} \times 100 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I II III IV V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>I II III IV V</td>
<td></td>
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<tr>
<td>C</td>
<td>I II III IV V</td>
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<td>D</td>
<td>I II III IV V</td>
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<tr>
<td>E</td>
<td>I II III IV V</td>
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<tr>
<td><strong>Total no. of plants of all species</strong> ( y= )</td>
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</tbody>
</table>

Table 3.

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Basal Area of plants in Quadrat</th>
<th>Total Basal Area of all plants of a specie ( x )</th>
<th>Relative Dominance ( \frac{x}{y} \times 100 )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I II III IV V</td>
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<td></td>
</tr>
<tr>
<td>A</td>
<td>I II III IV V</td>
<td></td>
<td></td>
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<tr>
<td>B</td>
<td>I II III IV V</td>
<td></td>
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<tr>
<td>C</td>
<td>I II III IV V</td>
<td></td>
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<td>D</td>
<td>I II III IV V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>I II III IV V</td>
<td></td>
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<tr>
<td><strong>Total basal Area of all plants of all species</strong> ( y= )</td>
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</tbody>
</table>

Table 4.

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Relative Density</th>
<th>Relative Frequency</th>
<th>Relative Dominance</th>
<th>Importance Value Index (IVI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
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</tbody>
</table>

Conclusions

The IVI of species …… was maximum whereas species …… was minimum.
EXPERIMENT 10

Experiment: To measure the above ground plant biomass in a grassland.

Theory

Biomass is defined as the quantity of matter contained in an organism expressed on dry weight or fresh weight basis per unit area.

Requirements

Polythene bag, hot air oven, weighing balance, scissors, blotting sheets etc.

Procedure

1. A small sampling area (50x50cm²) was chosen in grassland.
2. Plants were cut down with the help of scissors above ground in that area.
3. Recorded fresh weight of plant sample per quadrat basis and kept in an oven at 80°C for minimum 36h.
4. Noted down dry weight of plant biomass and expressed as mean on per unit area basis.

Precautions

1. Quadrats should be of same size.
2. Plant biomass should be collected above ground.
3. Dry weight of plants should be recorded after proper drying.

Observations & Calculations

<table>
<thead>
<tr>
<th>Quadrat</th>
<th>Fresh weight of plant species x (g)</th>
<th>Dry weight of plant species y (g)</th>
<th>Biomass on fresh weight basis (g/cm²)</th>
<th>Biomass on dry weight basis (g/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
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<tr>
<td>II</td>
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<tr>
<td>III</td>
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</tbody>
</table>

Conclusions

Above ground plant biomass in selected grassland was …….g/cm² on fresh weight basis and …….g/cm² on dry weight basis.
EXPERIMENT 11

Experiment: To estimate bulk density and soil porosity of grassland and woodland soil.

Theory

Bulk density is defined as dry weight per unit volume of soil (g/cm³). Soil porosity is defined as the space available among soil particles and its calculated as

\[
\text{Specific Density of Soil} - \text{Bulk Density} = \frac{\text{Specific Density}}{\text{Specific Density}}
\]

Bulk density is inversely proportional to soil porosity.

Requirements

Soil sample, measuring cylinder, oven, weighing balance, blotting sheet etc.

Procedure

1. Collected soil from grassland and woodland areas.
2. Noted the weight of wet soil and dried it in oven at 80°C for 4-6 h.
3. Noted the dry weight of soil sample.
4. Determined the volume of dried soil using measuring cylinder.
5. Calculated bulk density and soil porosity using formula.

Precautions

1. Soil sample should be free from any pebbles and debris.
2. Soil sample should be dried properly.

Observations and Calculations

<table>
<thead>
<tr>
<th>Soil Sample</th>
<th>Fresh weight (g)</th>
<th>Dry weight x (g)</th>
<th>Volume of Soil y (cc)</th>
<th>Bulk Density z=x/y (g/cc)</th>
<th>Soil porosity (\frac{2.6-z}{2.6} \times 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grassland</td>
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<td>Woodland</td>
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</tbody>
</table>

Conclusions

Bulk density of grassland soil was .....g/cc as compared to woodland soil ......g/cc whereas soil porosity of grassland soil was .....% as compared to woodland soil i.e. ......%.

Thus both established an inverse relationship.
EXPERIMENT 12

Experiment: To determine diversity indices (richness, simpson & Shannon-weiner) in grazed and protected grassland.

Theory
Density indices are measures of species diversity in a community. These take into account the number of species as well as its abundance. These provide information about rarity and commonness of species in a community. Common indices are Index of Richness (S), Simpson Index (D) and Shannon Weiner Index (H).

Requirements
Wooden quadrat, scale, thread, nails, notebook, pencil etc.

Procedure
1. A grazed or protected grassland was selected and laid quadrat of size 50x50 sq.cm.
2. Calculated total number of plants of different species in that area.
3. Repeated same for 5 – 8 quadratic areas in same grassland.
4. Calculated different diversity indices by applying formula.

Precautions
1. Quadrats should be laid down properly.
2. Indices should be calculated carefully.

Observations and Calculations

<table>
<thead>
<tr>
<th>Plant Species</th>
<th>Quadrats</th>
<th>Total no. of plants (n)</th>
<th>p_i (n/N)</th>
<th>(p_i)^2</th>
<th>p_i ln p_i</th>
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Index of Richness $S = \sum \text{Type of Plant Species}$
Simpson Index $D = \sum (p_i)^2$
Shannon Weiner Index $= \sum p_i \ln p_i$

Conclusions
Species Richness of grassland was ....
Simpson’s index of grassland was ....
Shannon Weiner Index of grassland was ....
Wheat belongs to the tribe Triticeae (= Hordeae) in the grass family Poaceae (Gramineae) (Briggle and Reitz, 1963) in which the one to several flowered spikelets are sessile and alternate on opposite sides of the rachis forming a true spike. The plant is made up of a root and shoot system. Two types of roots are found, the seminal roots and the nodal roots (adventitious or crown roots), which arise from the lower nodes of the shoot. The shoot is made up of a series of repeating units or phytomers, each potentially having a node, a leaf, an elongated internode and a bud in the axil of the leaf. The portion of the shoot with elongated internodes is the elongated stem or culm. In the proximal or basal units, the internode remains short and the nodes are packed closely together. A leaf is inserted at each node although at maturity the basal leaves are usually dead and may have disappeared. The shoot is terminated by an ear or spike bearing about 20 spikelets. In the ear, the phytomer is made up of the spikelet (the axillary bud) and the rachis (node and internode); the development of the leaf is suppressed. Each leaf comprises the sheath, wrapping around the subtending leaf, and a lamina (blade). At the junction of the sheath and
lamina, there is a membranous structure, the ligule, and a pair of small, hairy projections, the
auricles. The base of the leaves on the culm is thickened to form a hard knot or pulvinus.

**Economic Importance**
1. Wheat is the staple food of north Indian people.
2. Wheat grains are grounded into flour (atta) and consumed in the form of chapatee i.e. 80-85%.
3. Soft wheat is used for making chapatee, bread, cake, biscuits, pastry and other bakery products.
4. Hard wheat is used for manufacturing rawa, suji and sewaya.
5. In areas where rice is a staple food grain, wheat is eaten in the form of puri and uppumav.
6. It is also used for making flakes and sweet meats like kheer, shira, etc.
7. Wheat grain is used for preparing starch.
8. Wheat straw is used as fodder, padding material and mulching material.
Rice – *Oryza sativa*

Rice (*Oryza sativa*) belongs to the family of cereal grasses, along with wheat, corn, millet, oats, barley, rye, and numerous others. The grass family provides the world with over 60% of its caloric intake and over 75% of the protein for developing nations.

The rice plant is an annual grass (it normally grows for only a year and then dies) with round, hollow, jointed culms (stems), flat leaves, and a terminal panicle (flower cluster). It is the only cultivated cereal plant adapted to growing in both flooded and non-flooded soils. Grown under a wide range of climatic and geographical conditions on all five continents, it serves as the staple food throughout much of the world. As the underground portion of the plant, the roots serve as support, draw food and water from the soil, and store food. They are fibrous and consist of rootless and root hairs. The embryonic roots, or those which grow out of the seed when it germinates, have few branches. They live for only a short time after germination. Secondary adventitious roots (i.e. roots appearing in an irregular pattern) emerge from the underground nodes of the young culm and replace the embryonic roots. The role of the stem (or culm) is to support the leaves and reproductive structures, and to transfer essential nutrients between the
roots, the leaves, and the reproductive structures. The stem is made up of a series of nodes and internodes in alternating order. The node (corresponding to the "joint" between two sections of the stem) bears a leaf and a bud which, if it is on the lowermost node, may grow into a tiller, or shoot. The mature internode is hollow and finely grooved. Its outer surface is hairless. It varies in length, generally increasing from the lower to the upper internodes. The lower internodes at the base of the stem are short and thickened into a solid section. The internodes have the capacity to elongate in deep water in order to keep a portion of the plant above water to carry on photosynthesis. The leaves function as the principal organs of photosynthesis and respiration (i.e. they contain chlorophyll-containing cells which convert sunlight to chemical energy and synthesize organic "fuel" compounds from inorganic compounds). The leaves are borne at an angle on the stem in two ranks – one at each node. The blade, or extended part of the leaf, is attached to the node by the leaf sheath. The sheath envelops the internode toward, and in some cases even beyond, the next node. On either side of the base of the blade are pairs of small, earlike appendages known as auricles. Just above the auricles is a tissue-like, triangular structure called the ligule. Rice plants have both auricles and ligules and a ligule at every internode; this characteristic is often helpful in differentiating between rice and grassy weeds, which can have auricles or a ligule but not both. The uppermost leaf below the panicle, the flag leaf, provides the most important source of photosynthetic energy during reproduction. The panicle, or flower cluster, contains the reproductive organs of the rice plant. Borne atop the uppermost node on the stem, the panicle is divided into primary, secondary, and sometimes tertiary branches bearing the spikelets. The branches may be arranged singly or in pairs. The panicle stands erect at blooming, but it usually drops as the spikelets fill, mature, and develop into grains. Varieties differ greatly in the length, shape, and angle of the primary branches, as well as in the weight of the overall panicle.

**Economic Importance**

1. Rice is the only major cereal crop that is primarily consumed by humans directly as harvested, and only wheat and corn are produced in comparable quantity. As a food rice is low in fat and (compared with other cereal grains) in protein.
2. For feeding domestic animals, the bran, meal, and chopped straw are useful, especially when mixed with the polishings or given with skim milk.
3. The polishings are also an important source of furfural and other chemurgic products.
4. The straw, which is soft and fine, is plaited in East Asia for hats and shoes, and the hulls supply mattress filling and packing material.
5. Laundry starch is manufactured from the broken grain, which is also used by distillers.
6. A distilled liquor called arrack is sometimes prepared from a rice infusion, and in Japan the beverage sake is brewed from rice.
7. Rice paper is made from a plant of the ginseng family.
Maize – *Zea mays*

The maize plant is often 2.5 m (8 ft) in height, though some natural strains can grow 12 m (40 ft). The stem has the appearance of a bamboo cane and is commonly composed of 20 internodes of 18 cm (7 in) length. A leaf grows from each node, which is generally 9 cm (3.5 in) in width and 120 cm (4 ft) in length. Ears develop above a few of the leaves in the midsection of the plant, between the stem and leaf sheath, elongating by ~ 3 mm/day, to a length of 18 cm (7 in) (60 cm or 24 in being the maximum observed in the subspecies. They are female inflorescences, tightly enveloped by several layers of ear leaves commonly called husks. Certain varieties of maize have been bred to produce many additional developed ears. These are the source of the "baby corn" used as a vegetable in Asian cuisine.

The apex of the stem ends in the tassel, an inflorescence of male flowers. When the tassel is mature and conditions are suitably warm and dry, anthers on the tassel dehisce and release pollen. Maize pollen is anemophilous (dispersed by wind), and because of its large settling velocity, most pollen falls within a few meters of the tassel. Elongated stigmas, called silks,
emerge from the whorl of husk leaves at the end of the ear. They are often pale yellow and 7 in (178 mm) in length, like tufts of hair in appearance. At the end of each is a carpel, which may develop into a "kernel" if fertilized by a pollen grain. The pericarp of the fruit is fused with the seed coat referred to as "caryopsis", typical of the grasses, and the entire kernel is often referred to as the "seed". The cob is close to a multiple fruit in structure, except that the individual fruits (the kernels) never fuse into a single mass. The grains are about the size of peas, and adhere in regular rows around a white, pithy substance, which forms the ear (maximum size of kernel in subspecies is reputedly 2.5 cm/1 in). An ear commonly holds 600 kernels. They are of various colors: blackish, bluish-gray, purple, green, red, white and yellow.

Economic Importance

1. Corn and cornmeal (dried, ground corn) are staple foods in countries all over the world.
2. The ears can be cooked and eaten from the cob as a vegetable or the kernels can be removed and either eaten as is or used to produce a wide variety of foodstuffs including cereals and flour.
3. Corn is also a major source of starch and the starch can be processed into oils and high fructose corn syrup.
4. Corn is also commonly grown as a feed for livestock.
5. Some industrial uses of corn include filler for plastics, packing materials, insulating materials, adhesives, chemicals, explosives, paint, paste, abrasives, dyes, insecticides, pharmaceuticals, organic acids, solvents, rayon, antifreeze, soaps, and many more.
6. Corn also is used as the major study plant for many academic disciplines such as genetics, physiology, soil fertility and biochemistry.
Potato – *Solanum tuberosum*

Potato plants are herbaceous perennials that grow about 60 cm (24 in) high, depending on variety, with the culms dying back after flowering, fruiting and tuber formation. They bear white, pink, red, blue, or purple flowers with yellow stamens. In general, the tubers of varieties with white flowers have white skins, while those of varieties with colored flowers tend to have pinkish skins. Potatoes are mostly cross-pollinated by insects such as bumblebees, which carry pollen from other potato plants, though a substantial amount of self-fertilizing occurs as well. Tubers form in response to decreasing day length, although this tendency has been minimized in commercial varieties. After flowering, potato plants produce small green fruits that resemble green cherry tomatoes, each containing about 300 seeds. Like all parts of the plant except the tubers, the fruit contain the toxic alkaloid solanine and are therefore unsuitable for consumption.

**Economic Importance**

1. Potatoes are used to brew alcoholic beverages such as vodka, potcheen, or akvavit.
2. They are also used as food for domestic animals.
3. Potato starch is used in the food industry as, for example, thickeners and binders of soups and sauces, in the textile industry, as adhesives, and for the manufacturing of papers and boards.
4. Maine companies are exploring the possibilities of using waste potatoes to obtain polylactic acid for use in plastic products; other research projects seek ways to use the starch as a base for biodegradable packaging.

5. Potato skins, along with honey, are a folk remedy for burns in India. Burn centers in India have experimented with the use of the thin outer skin layer to protect burns while healing.

6. Potatoes (mainly Russets) are commonly used in plant research. The consistent parenchyma tissue, the clonal nature of the plant and the low metabolic activity provide a very nice "model tissue" for experimentation. Wound-response studies are often done on potato tuber tissue, as are electron transport experiments. In this respect, potato tuber tissue is similar to *Drosophila melanogaster*, *Caenorhabditis elegans* and *Escherichia coli*: they are all "standard" research organisms.

7. Potatoes are prepared in many ways: skin-on or peeled, whole or cut up, with seasonings or without. The only requirement involves cooking to swell the starch granules. Most potato dishes are served hot, but some are first cooked, then served cold, notably potato salad and potato chips/crisps.
Sugarcane – *Saccharum officinarum*

*S. officinarum*, a perennial plant, grows in clumps consisting of a number of strong unbranched stems. A network of rhizomes forms under the soil which sends up secondary shoots near the parent plant. The stems vary in colour, being green, pinkish, or purple and can reach 5 m (16 ft) in height. They are jointed, nodes being present at the bases of the alternate leaves. The internodes contain a fibrous white pith immersed in sugary sap. The elongated, linear, green leaves have thick midribs and saw-toothed edges and grow to a length of about 30 to 60 cm (12 to 24 in) and width of 5 cm (2.0 in). The terminal inflorescence is a panicle up to 60 cm (24 in) long, a pinkish plume that is broadest at the base and tapering towards the top. The spikelets are borne on side branches and are about 3 mm (0.12 in) long and are concealed in tufts of long, silky hair. The fruits are dry and each one contains a single seed. Sugarcane harvest typically occurs before the plants flower, as the flowering process causes a reduction in sugar content.
Economic Importance

1. Portions of the stem of this and several other species of sugarcane have been used from ancient times for chewing to extract the sweet juice. Extraction of the juice by boiling was probably first done in India more than 2000 years ago.
2. *S. officinarum* and its hybrids are grown for the production of sugar, ethanol, and other industrial uses in tropical and subtropical regions around the world.
3. The stems and the byproducts of the sugar industry are used for feeding to livestock.
4. Pigs fed on sugarcane juice and a soy-based protein supplement produced stronger piglets that grew faster than those on a more conventional diet.
5. As its specific name (*officinarum*, "of dispensaries") implies, it is also used in traditional medicine both internally and externally.
Black Pepper – *Piper nigrum*

Black pepper (*Piper nigrum*) is a flowering vine in the family Piperaceae, cultivated for its fruit, which is usually dried and used as a spice and seasoning. The pepper plant is a perennial woody vine growing up to 4 metres (13 ft) in height on supporting trees, poles, or trellises. It is a spreading vine, rooting readily where trailing stems touch the ground. The leaves are alternate, entire, 5 to 10 cm long and 3 to 6 cm across. The flowers are small, produced on pendulous spikes 4 to 8 cm long at the leaf nodes, the spikes lengthening up to 7 to 15 cm as the fruit matures. The fruit of the black pepper is called a drupe and when dried it is a peppercorn. The plants are propagated by cuttings about 40 to 50 centimetres long, tied up to neighbouring trees or climbing frames at distances of about two meters apart; trees with rough bark are favoured over those with smooth bark, as the pepper plants climb rough bark more readily. Competing plants are cleared away, leaving only sufficient trees to provide shade and permit free ventilation. The roots are covered in leaf mulch and manure, and the shoots are trimmed twice a year. On dry soils the young plants require watering every other day during the dry season for the first three years. The plants bear fruit from the fourth or fifth year, and typically continue to bear fruit for seven years. The cuttings are usually cultivars, selected both for yield and quality of fruit. A single stem will bear 20 to 30 fruiting spikes. The harvest begins as soon as one or two fruits at the base of the spikes begin to turn red, and before the fruit is fully mature, and still hard; if allowed to ripen completely, the fruit lose pungency, and ultimately fall off and are lost. The spikes are collected and spread out to dry in the sun, then the peppercorns are stripped off the spikes.
Economic Importance

1. Like many eastern spices, pepper was historically both a seasoning and a folk medicine.
2. Black pepper (or perhaps long pepper) was believed to cure illness such as constipation, diarrhoea, earache, gangrene, heart disease, hernia, hoarseness, indigestion, insect bites, insomnia, joint pain, liver problems, lung disease, oral abscesses, sunburn, tooth decay, and toothaches.
3. Various sources from the 5th century onward also recommend pepper to treat eye problems, often by applying salves or poultices made with pepper directly to the eye.
4. Black pepper, either powdered or its decoction, is widely used in traditional Indian medicine and as a home remedy for relief from sore throat, throat congestion, cough, etc.
5. Pepper is known to cause sneezing. Some sources say that piperine, a substance present in black pepper, irritates the nostrils, causing the sneezing.
6. Piperine is under study for its potential to increase absorption of selenium, vitamin B, beta-carotene and curcumin as well as other nutrients.
7. Pepper contains phytochemicals, including amides, piperidines, pyrrolidines and trace amounts of safrole which may be carcinogenic in laboratory rodents.
8. Piperine is under study for a variety of possible physiological effects, although this work is preliminary and mechanisms of activity for piperine in the human body remain unknown.
Clove – *Syzygium aromaticum*

*Clove* are the aromatic flower buds of a tree in the family Myrtaceae, *Syzygium aromaticum*. The clove tree is an evergreen tree that grows up to 8–12 m tall, with large leaves and sanguine flowers grouped in terminal clusters. The flower buds initially have a pale hue, gradually turn green, then transition to a bright red when ready for harvest. Cloves are harvested at 1.5–2.0 cm long, and consist of a long calyx that terminates in four spreading sepals, and four unopened petals that form a small central ball.

**Economic Importance**

1. Cloves are used in the cuisine of Asian, African, and the Near and Middle East, lending flavor to meats, curries, and marinades, as well as fruit such as apples, pears or rhubarb.
2. Cloves may be used to give aromatic and flavor qualities to hot beverages, often combined with other ingredients such as lemon and sugar.
3. They are a common element in spice blends such as pumpkin pie spice and *speculoos* spices.
4. In Mexican cuisine, cloves are best known as *clavos de olor*, and often accompany cumin and cinnamon.
5. A major component of clove taste is imparted by the chemical eugenol, and the quantity of the spice required is typically small.
6. The spice is used in a type of cigarette called karetek in Indonesia.
7. Clove may be used as an ant repellent.
8. They can be used to make a fragrance pomander when combined with an orange.
9. When gifted in Victorian England, such a pomander indicated "warmth of feeling."
10. Its essential oil is used as an anodyne (painkiller) for dental emergencies.
11. Cloves are used as a carminative, to increase hydrochloric acid in the stomach and to improve peristalsis.
12. Cloves are also said to be a natural anthelmintic.
13. The essential oil is used in aromatherapy when stimulation and warming are needed, especially for digestive problems.
14. Topical application over the stomach or abdomen are said to warm the digestive tract.
15. Applied to a cavity in a decayed tooth, it also relieves toothache.
16. It is used in formulas for impotence or clear vaginal discharge from yang deficiency, for morning sickness together with ginseng and patchouli, or for vomiting and diarrhea due to spleen and stomach coldness.
17. Cloves may be used internally as a tea and topically as oil for hypotonic muscles, including for multiple sclerosis.
18. Some recommend avoiding more than occasional use of cloves internally in the presence of pitta inflammation such as is found in acute flares of autoimmune diseases.
Cinnamon – *Cinnamomum zeylanicum*

Cinnamon is a spice obtained from the inner bark of several trees from the genus *Cinnamomum* that is used in both sweet and savoury foods. It is a bushy evergreen tree of the laurel family (Lauraceae) native to Sri Lanka (Ceylon), the neighbouring Malabar Coast of India, and Myanmar (Burma) and also cultivated in South America and the West Indies for the spice consisting of its dried inner bark. The tree grows to around 10 m (30 ft), and has leathery leaves, usually opposite, that are lanceolate to ovate, 11 to 16 cm (4.5 to 6.25 in) long, with pointed tips. The inconspicuous yellow flowers, which are tubular with 6 lobes, grow in panicles (clusters) that are as long as the leaves. The fruit is a small, fleshy berry, 1 to 1.5 cm (0.25 to 0.5 in) long, that ripens to black, partly surrounded by a cup-like perianth (developed from the outer parts of the flower). The spice is light brown in colour and has a delicately fragrant aroma and warm, sweet flavour. Cinnamon contains 0.5 to 1 percent essential oil, the principal component of which is cinnamic aldehyde.

**Economic Importance**

1. The use of cinnamon dates back thousands of years to at least 2700 b.c. Chinese herbals from that time mentioned it as a treatment for fever, diarrhea, and menstrual problems.
2. By the seventeenth century, cinnamon was considered a culinary spice by Europeans.
3. American nineteenth century physicians prescribed cinnamon as a treatment for stomach cramps, nausea, vomiting, diarrhea, colic, and uterine problems.
4. Cinnamon bark is a common ingredient in many products such as toothpaste, mouthwash, perfume, soap, lipstick, chewing gum, cough syrup, nasal sprays, and cola drinks.
5. A popular food flavoring, it is valued as one of the world's most important spices. It is also valuable in the treatment of various ailments.
6. Modern herbalists prescribe cinnamon bark as a remedy for nausea, vomiting, diarrhea, and indigestion.
7. Chinese herbalists recommend it for asthma brought on by cold, some digestive problems, backache, and menstrual problems.
8. The active ingredients of the bark contain antibacterial, antiseptic, antiviral, antispasmodic, and antifungal properties. A study published in 2002 indicates that oil from cinnamon bark inhibits the production of listeriolysin, a protein released by *Listeria* bacteria that destroys healthy cells.
9. Eugenol, another component, contains pain-relieving qualities.
10. Cinnamon bark is helpful in strengthening and supporting a weak digestive system.
11. It is used to treat nausea, vomiting, diarrhea, stomach ulcers, acid indigestion, heartburn, lack of appetite, and abdominal disorders.
12. It is also helpful in relieving athlete's foot.
13. Cinnamon bark is a frequent ingredient in toothpaste, mouthwash, and other oral hygiene products because it helps kill the bacteria that causes tooth decay and gum disease.
14. Inflammations of the throat and pharynx may be relieved through its use.
15. Cinnamon bark is also known to control blood sugar levels in diabetics.
16. The spice has also garnered quite a reputation as an aphrodisiac.
17. Cinnamon bark promotes menstruation. It has been used to treat menstrual pain and infertility. Women in India take it as a contraceptive after childbirth.
18. More recently, cinnamon bark has been shown to be an effective natural snake repellent that is safer to use than synthetic pest management chemicals.
19. The oil is distilled from the fragments for use in food, liqueur, perfume, and drugs. The aldehyde can also be synthesized.
Coconut – *Cocos nucifera*

The coconut tree (*Cocos nucifera*) is a member of the family Arecaceae (palm family). It is the only accepted species in the genus *Cocos*. The term *coconut* can refer to the entire *coconut palm*, the seed, or the fruit, which, botanically, is a drupe, not a nut. *Cocos nucifera* is a large palm, growing up to 30 m (98 ft) tall, with pinnate leaves 4–6 m (13–20 ft) long, and pinnae 60–90 cm long; old leaves break away cleanly, leaving the trunk smooth. Coconuts are generally classified into two general types: tall and dwarf. On very fertile land, a tall coconut palm tree can yield up to 75 fruits per year, but more often yields less than 30, mainly due to poor cultural practices. Given proper care and growing conditions coconut palms produce their first fruit in six to ten years, it takes 15 – 20 years to reach peak production. The palm produces both the female and male flowers on the same inflorescence; thus, the palm is monoecious. Other sources use the term polygamomonoecious. The female flower is much larger than the male flower. Flowering occurs continuously. Coconut palms are believed to be largely cross-pollinated, although some dwarf varieties are self-pollinating.

**Economic Importance**
1. The coconut palm is grown throughout the tropics for decoration, as well as for its many culinary and nonculinary uses; virtually every part of the coconut palm can be used by humans in some manner and has significant economic value.

2. Coconuts' versatility is sometimes noted in its naming. In Sanskrit, it is kalpa vriksha ("the tree which provides all the necessities of life"). In the Malay language, it is pokok seribu guna ("the tree of a thousand uses"). In the Philippines, the coconut is commonly called the "tree of life".

3. The seed provides oil for frying, cooking, and making margarine.

4. The white, fleshy part of the seed, the coconut meat, is used fresh or dried in cooking, especially in confections and desserts such as macaroons.

5. Desiccated coconut or coconut milk made from it is frequently added to curries and other savory dishes.

6. Coconut flour has also been developed for use in baking, to combat malnutrition.

7. Coconut chips have been sold in the tourist regions of Hawaii and the Caribbean.

8. Coconut butter is often used to describe solidified coconut oil, but has also been adopted as a name by certain specialty products made of coconut milk solids or puréed coconut meat and oil.

9. Dried coconut is also used as the filling for many chocolate bars.

10. Some dried coconut is purely coconut but others are manufactured with other ingredients, such as sugar, propylene glycol, salt, and sodium metabisulfite.

11. Some countries in South East Asia use special coconut mutant called Kopyor (in Indonesian) or macapuno (in Philippines) as a dessert drinks.
Groundnut – *Arachis hypogaea*

The peanut or groundnut (*Arachis hypogaea*) is a species in the family Fabaceae (commonly known as the bean, pea or legume family). The peanut was probably first domesticated and cultivated in the valleys of Paraguay. It is an annual herbaceous plant growing 30 to 50 cm (1.0 to 1.6 ft) tall. The leaves are opposite, pinnate with four leaflets (two opposite pairs; no terminal leaflet); each leaflet is 1 to 7 cm (⅜ to 2¾ in) long and 1 to 3 cm (⅜ to 1 inch) across. The flowers are a typical peaflower in shape, 2 to 4 cm (0.8 to 1.6 in) (⅛ to 1½ in) across, yellow with reddish veining. The specific name, *hypogaea* means "under the earth"; after pollination, the flower stalk elongates, causing it to bend until the ovary touches the ground. Continued stalk growth then pushes the ovary underground where the mature fruit develops into a legume pod, the peanut – a classical example of geocarpy. Pods are 3 to 7 cm (1.2 to 2.8 in) long, normally containing 1 to 4 seeds. Because, in botanical terms, "nut" specifically refers to indehiscent fruit, the peanut is not technically a nut, but rather a legume.

**Economic Importance**

1. Peanuts can be eaten raw, used in recipes, made into oils, textile materials, and peanut butter, as well as many other uses.
2. Popular confections made from peanuts include salted peanuts, peanut butter (sandwiches, peanut candy bars, peanut butter cookies, and cups), peanut brittle, and shelled nuts (plain/roasted).
3. Peanut butter has been a tradition on camping trips and the home due to its high protein content and resists spoiling.
4. Boiled peanuts are a preparation of raw, unshelled green peanuts boiled in brine and often eaten as a snack.
5. More recently, fried peanut recipes have emerged, allowing both shell and nut to be eaten.
6. Peanuts are also used in a wide variety of cosmetics, plastics, dyes and paints.
7. Peanut oil is often used in cooking, because it has a mild flavor and a relatively high smoke point. Due to its high monounsaturated content, it is considered healthier than saturated oils, and is resistant to rancidity.
8. Peanut flour is lower in fat than peanut butter, and is popular with chefs because its high protein content makes it suitable as a flavor enhancer. Peanut flour is used as a gluten-free solution.
9. Peanuts can be used like other legumes and grains to make a lactose-free milk-like beverage, peanut milk.
10. Peanut plant tops are used for hay.
11. The protein cake (oilcake meal) residue from oil processing is used as an animal feed and as a soil fertilizer. Raw peanuts are also widely sold as a garden bird feed.
12. Paint, varnish, lubricating oil, leather dressings, furniture polish, insecticides, and nitroglycerin are made from peanut oil.
13. Soap is made from saponified oil, and many cosmetics contain peanut oil and its derivatives.
14. The protein portion is used in the manufacture of some textile fibers.
15. Peanut shells are used in the manufacture of plastic, wallboard, abrasives, fuel, cellulose (used in rayon and paper) and mucilage (glue).