PRACTICAL MANUAL

Course No. : **ESDM-231** Credits : 3(2+1)

Course Title : **Environmental Studies and Disaster Management**

Semester : III (New Course)

Course : B.Sc. (Hons.) Agriculture

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Exercise No. 1

Study of collection, processing and storage of effluent samples

What is mean by effluent ?

It is defined as wastewater or water containing organic substances and released during different processing like leather industry, sugar industry etc.

Purpose of effluent sampling : The effluent sample is collected :

1. To determine type of pollutant present in water sample
2. To decide the remedial measures to control it.

When and where to sample ?

Water sample from surface is collected in a plastic bucket, jug or bottles after rinsing these with the same water 3 to 4 times. Samples from bottom of shallow water can be collected by lowering a closed glass or polyethylene bottle to the bottom, opening and closing it. Thereby hands and taking out for collecting the subsurface samples in deeper water following water samplers are commonly used. Before use it is always desirable to rinse the water sampler thoroughly with the water to be collected by it.

1) Ruttner water sampler :

It is made of a cylinder of plexi-glass which have interconnected lids through a central shaft on its both the open ends. The two lids are held open with the help of trap mechanism provided on the upper part of the shaft. Graduated rope is used to lower the sampler in water to the desired depth and a messenger is released along the rope to open the trap and allow two lids to close the sampler. It is taken out of water and sample is drained through a trap provided in the lower lid.

2) Von Dorn water sampler

It is made of hallow cylinder of PVC which has two rubber valves on its both the open ends. These valves are interconnected by rubber tube. The valves are pulled out and strings are attached to a lock fitted outside the cylinder. This keeps the cylinder of sample open at both ends. The sampler in this condition is lowered through a graduated rope, to the desired depth and. metallic messenger is released along the rope which strikes the lock and releases two valves to close the sample. The sampler is pulled out of water with the sample of desired depth in it.

3) Dussart - flask water sampler

It consist of glass bottle with a rubber bung through which pass two narrow tubes. One reaching just below the bung, other to the bottom of the bottle. Outside the bung the short projecting ends of the tubes are linked by an n shaped tube or rod attached to the tubes by a short rubber tube. A weight is attached to the bottle which causes it to sink in water. The supporting cable is pass round the n shaped rod and then to the bottle neck, but a piece of sewing cotton attached further up to the cable and bottle neck takes

the weight, at desired depth a sharp jerk snaps the cotton pulls out the n shaped rod Gas escapes from the flask and is replaced by water.

4. Thermos flask water sampler :

This sampler consist of thermos flask with a cork at its mouth fitted with a thermometer. It has two cords , one to hold the sampler and other to open and close the cork. This sampler has an advantage over others that sample in its is brought to the surface in identical conditions , however, its double cord may get intertwined and make the operation difficult.

5) Pump sampler :

This sampler consist have a weighted and graduated rubber or plastic tube and a pump. The tube is lowered to the desired depth from which the water sample is to be taken. Though this tube the pump sucks continuous stream of water The more suitable pumps for this purpose are peristaltic type because there is no contact between metal and water in these pumps. The advantage of this type of sampler is that large samples may be obtained with causing little disturbances.

Handling and preservation of water sample

Sample from the sampler should be transferred to well rinsed, appropriately labelled, suitable sample containers (bottles). Containers made up of boro-silicate glass, polyethylene or polypropylene are suitable purpose, however for the analysis of parameters like dissolved oxygen, oil and grease the use of glass bottles is recommended.

Proper labeling should be made on each sample as follows.

Sample No. : _____

(1) Name and location of body of water: _____

(2) Date : _____

(3) Time of sampling : _____

(4) Depth of sampling : _____

After labelling, immediately the samples must be sent to the laboratory for analysis to avoid any change / deterioration in its quality due to chemical and microbial activity.

Parameters like temperature, pH free carbon dioxide, alkalinity, dissolved oxygen (by oxygen meter) and sulphide should be immediately estimated after collecting the sample. Dissolved oxygen if to be determined by Wirnkler's method should be immediately be fixed by adding Manganous sulphate and alkaline Potassium iodide solutions. For most other physical and chemical analyses some holding time is permissible.

Note :

The samples in well labeled and tightly capped containers should be brought to the laboratory in an ice box and kept in freezer to check the biological activity and preserve them (cryo-preservation) for estimation of metallic ions a sample may preserved by acidification (pH 2 to 3) by sulphuric acid but in such cases, conditions of alkalinity, conductivity and sulphate etc. are greatly altered. Mercuric chloride @ 50 mg per litre of sample is good preservative to check the biological activity but on other hand it interferes in the analysis of various nitrogen forms and chloride. The long term cryo or chemical preservation of sample may lead to alternations in chemical preservation of sample; hence it is advisable to carry out analysis in field or laboratory as early as possible after collection.

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Exercise No. 02

To estimate solids in water samples

Principle:

Salts like carbonates, bicarbonates, chlorides, sulphates, phosphates arid nitrates of calcium, magnesium, sodium, potassium, iron, and manganese etc. are dissolved in natural waters. The high content of dissolved solids increases the density of water and influences osmo-regulation of fresh water organism. They reduce solubility of gases (like oxygen) and utility of water for drinking, irrigation and industrial purpose

Materials:

1. Evaporation pan
2. Chemical balance
3. Desiccator
4. Hot water bath
5. Filterpaper (Whatman No. 4)

Method

1. Filter 250 to 500 ml of sample through Whatman no.4 filter paper in pre-weighed evaporating dish.
2. Evaporate the sample on hot water bath until whole water is evaporated
3. Note the weight of evaporating dish after it in a desiccator and calculate total dissolved solids.

Calculation:

$$TDS = \frac{\text{(Weight of dry solid + dish)} - \text{Weight of dish}}{\text{Volume of sample taken (ml)}} \times 100$$

Where, TDS = Total dissolved solids (g/ L): all the weights are taken in gram;

For determination of total solids, instead of total dissolved solids, do not filter the sample.

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Exercise No. 03

To measure the dissolved Oxygen (O_2) content in pond water by Winkler's Method .

Principle :

The manganus sulphate reacts with the alkali (KOH or NAOH) to form a White precipitate of manganaous hydroxide, which in presence of oxygen, gets oxidized to brown colour compound. In the strong acid medium maganic ions are reduced by iodide ions which gets converted to iodine equivalent to the original concentration of oxygen in the sample. The iodine can be titrated against sodium tiosulphate using starch as indicator.

Reagents : The following reagents are required to be prepared :

A) Sodium thiosulphate, 0.025 N : Dissolve 24.82 g. of $NaSO_2.5H_2O$ in boiled and distilled water and make the volume to one liter. Add 0.4 g. of borax or pallets of NaOH as stabilizer. This is 0.1 N stock solution. Dilute in to 4 times with boiled distilled water to prepare 0.025N solution (250 - 1000 ml). Keep in a brown colour glass bottle.

B) Alkaline potassium iodide solution : Dissolve 100 g. of KOH and 50 g. of KI in 200 ml. of boiled distilled water.

C) Manganous sulphate solution : Dissolve 100 g of $MnSO_4.4H_2O$ in 200 ml boiled distilled water and filter it.

D) Starch solution : Dissolve 1 g of starch in 100 ml of warm (80-90°C) distilled water and add a few drops of formaldehyde solution.

E) Sulphuric acid. (H_2SO_4) concentrated having specific gravity 1.84

Procedure :

1) Fill the sample in glass stoppered bottle (BOD bottle) of known volume (100 - 300 ml), carefully avoiding any kind of bubbling and trapping of the air bubbles in the bottle after placing the stopper.

2) Pour one ml of each $MnSO_4$ and alkaline KI solutions (in case volume of the is about 300 ml, instead of one ml of reagents add 2ml solutions), well below the surface from walls. The reagents can be also be poured at the bottom of the bottle with the help of special pipette syringes to ensure better mixing of reagents with the sample. Use always-separate pipette for these two reagents. A precipitate will appear.

3) Place the stopper and shake the contents well by inverting the bottle repeatedly. Keep the bottle for some time to settle down the precipitate. If the titration is to be prolonged for few days, keep the sample at this stage with the precipitate.

4) Add 1-2 ml of concentrated H_2SO_4 and shake well to dissolve the precipitate.

5) Remove either the whole contents or part of it (50 -100) in conical, flask for titration. Prevent any bubbling to avoid further mixing of oxygen.

6) Titrate the contents, within one hour of dissolution of the precipitate against sodium thiosulphate solution using starch as an indicator. At the end point initial dark blue co lour changes to colourless.

Calculation : When whole contents are titrated,

$$\text{Dissolved oxygen mg/l} = \frac{\text{(Ml X N) of titrant x 8 x 1000}}{V_1 - v}$$

When only a part of the contents has been titrated,

$$\text{Dissolved oxygen mg/l} = \frac{\text{(Ml X N) of titratant x 8 x 1000}}{V_2 = (V_1 - v/ V_1)}$$

Whereas,
V_1 = volume of sample bottle after placing the stopper.
V_2 = Volume of part of the contents titrated.
V = Volume of $MnSO_4$ and K1 added.

In oceanography, the unit ml/1 is prepared over mg/l. It can be obtained by dividing in mg by 1.43.

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Exercise No. 04

Estimation of Respirable and Non-respirable dust in the air by using Portable dust sampler

The air pollutants are generally categorized into **two parts** : **Gases and particulate pollutant**. The particulate matter comprises of 3 kinds of particles: **dust, suspended particulate matter and very fine particles**. The dust particles are collection of largest sized particles. It is produced in the atmosphere by natural process like erosion, storms etc. Cement factories, stone quashing etc. also produce considerable quantity of particulates. Fossil fuel burning also produces the particulates. Common air polluting gases are CO_2, SO_2 ,NO_2 and CO. In sunlight, they form photochemical smog, which damages vegetation. Particles around one micron in size, present in air in form of solid or liquid are generally called aerosol. Particles smaller than aerosol assume appearance of smoke and fumes while larger than aerosol are dust if particles are solid and mist if they are liquid droplets.

Table : Atmospheric pollution standards (ppm) in India.

Sr. No.	Pollutant	Tolerance Limit value (ppp)	Industrial Area	Residential Area	Hill Station.'
1.	SO_2	5.0	120 µg	50.0 µg	30.0 µg
2.	NOX	25.0	1.3 ppm	0.8 ppm	0.3 ppm
3.	CO	50.0	5.0 ppm	2.0 ppm	2.0 ppm
4.	H_2S (ppm)	10.0	0.012 to 0.002	0.003 to 0.004	--
5.	O_3 (ppm)	0.05	0.028 to 0.135	0.008 to 0.014	--
6.	Dust (<0.5µ)	0.5 mg/m3	--	--	--

Determination of dust fall:

The large particulate matter, which becomes suspended in the atmosphere by wind forces or mechanical means and other particulate matter are commonly called **dust fall**. They are estimated using open pan mouth container for a period of about one month. The samples so collected can be subjected to analysis of soluble and non-soluble fractions. From the non-soluble fraction particle size distribution and specific gravity can be calculated.

They can be also subjected to chemical analysis; acidity alkalinity or elements of specific interest can be estimated. The sensitivity of this method is 2 g / m2.

Apparatus :

A dust fall trap of size 7.5 inches diameter and 8.25 inches height should be used as a trap. This should be kept on a stand on the roof top of office building where they are apt likely to be disturbed. Some precaution is to be taken. For example if there should be any air pollution near by and the tallest building in the vicinity should not make an angle of less than 30° with the container..The support on which the container is kept should be firm.

Procedure:

About 200 ml distilled water is kept in the container and the container is kept open at the site for 27- 35 days. After words they are brought to the laboratory and screened through 30 meshes, scrubbed and original volume is made by adding distilled water. This water is evaporated and dust fall is calculated as per the following :

$$\text{Dust fall (g/m}^2\text{/ month)} = \frac{W}{a} \times \frac{30}{t}$$

where,

W = weight of dust
a = open area of container
t = time of exposure

Interference :

Algae, fungi, insect etc grow in water as well as bird droppings in container react with dust and change its nature. To avoid it, some pesticides like mercuric chloride and copper sulphate pentahydrate should be added

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Exercise No. 5

Determination of sound level by using Sound Level Meter

Definition of Noise pollution :

Noise Pollution : The word noise is derived from the Latin word **'Nausea'** and defined as **unwanted sound or sound with value which cause discomfort to the listener** or **wrong sound at wrong time at wrong place.** It is defined **as an acoustic fact, which is unpleasant, arouses disturbing feeling or as totally a unwanted undesired sound.** Unwanted sound dumped into the atmosphere.

Measurement of noise pollution :

The unit of measurement of noise is decibel (dB) which is equal to faintest sound that can be picked up and heard by the human ear. WHO has fixed 45 dB as safe noise level but it can be increased upto 90 dB for 8 hours day with much harmful effect.

Loudness and frequency are two most mosaic characteristics of sound.

Loudness : is the strength of sensation of sound perceived by the individual. It does not depend on energy of sound waves but also frequency and measured in **dB.** dB is the ratio of sound to the reference sound also expressed as sone.

1 sone = 40 dB / at 1000 MHz.

Frequency is defined as number of vibrations per second, denoted as **Hertz.** People hear sound from 16-2000 Hz, below 16 - infraudible, above - 2000 hz ultrasonic

Sources : Previously it was due to industrial activities. It may be due to natural thunder storm or man made like loudspeakers, horn or home appliances. (TV, Radio music system) machines etc. Now due to growing population heavy traffic and crowd, electrical entertainment are new sources of it. Ever since the industrial revolution there has been doubling every 10 years in environmental noise. Some source and their dB levels breathing - 10 whispering to 30, in to heavy automobile - 100 and jet aeroplane 120. Near airport, 82-55 dB, railway 90 dB, loud speaker 55 to 75 dB, Industries 90-98 dB. Noise level upto 50to 60 dB disturbs sleep while 80-90 dB causes irreversible changes. Long term expose to 55 dB for long time may lead to loss of hearing.

Effect of Noise : Noise is generally harmful and has direct effect on human health.

Effects of Noise pollution on human beings

Auditory effects Auditory fatigue and deafness.	Non auditory effect
Interference with speech	Annoyance ill temper loss of brisking Communication mental working Disorientation, violent efficiency behavior.

Physiological disorders :

Neurosis, anxiety, insomnia, hypertension, cardio-vascular diseases, hepatic stress, giddiness, fatigue, visual disturbance change in skin temperature and blood circulation quickening of human fetus rate and malformation of its nervous system.

i) Auditory effects :

a) Auditory fatigue : It appears in the 90 dB and may be associated with side effects such as whistling and buzzing in the ears.

b) Deafness : Exposure to continuous noise may lead to gradual decline in hearing ability and eventually deafness. The hearing loss may be temporary or permanent. Most temporary hearing loss occurs in frequency range between 4000 to 6000 Hz. Repeated or constant exposure to noise around 100 dB may result in permanent hearing loss due to noise pollution is called **sciocusis**.

ii) Non Auditory effects :

a) Interference with speech communication, frequencies in the range of 50-60 dB commonly produced by road traffic interferes with speech, making it unintelligible sound of warning are misunderstood or not heard. When speech and noise are equal in intensity, only about 30% of syllabus is understood.

b) Annoyance: This is a psychological response. Neurotic people (about 80% of population) are more sensitive to noise than balanced people, which express great annoyance with noise such as crowd highway traffic, radio, etc. The noise is annoying and the annoyance is related to emotion rather than its actual intensity e.g. sound of dripping tap at night becomes annoying when it repeats. It leads to communication disruption frustration indignities tiredness accidents etc.

c) Working efficiency : Symptoms of tiredness, deterioration in work efficiency.

d) Physiological response : Number of physiological disorders caused by interference of biological functioning of the body as a consequence of over exposure to noise are neurosis, anxiety, insomnia, hypertension, hepatic diseases, behavioral and emotional stress and increase in sweating, Giddiness, nausea and fatigue are common symptoms of noise exposure.

It is also believed that noise exposure causes visual disturbance, reduces the depth and quality of sleeping and thus may adversely affect overall mental and physical

health. Starting sounds can quicken human heart rate and cause its muscle to contract. It also affects unborn children also.

Control of Noise Pollution :

Noise is probably the easiest type of pollution to control. We have both the means and the money; all we need is the will. Noise control can be accomplished in three major ways :

(1) Reducing noise at it's source
(2) Contron of transmission
(3) Protection of exposed person

Table : Noise Sources and their intensity

Thunder storm	110
Jet flies (over 1000 ft) & Train	100 – 110
Whistle (at 50 ft)	
Stereos in discotheques	110 - 117
Sirens and loud horns	150
Commercial jet air craft (at 100 ft)	120 – 140

Table : High intensity noise and human health hazards.

Noise intensity (dB)	Health hazard
80	Annoying
90	Hearing damage
110	Stimulation of reception in skin
120	Pain threshold
130 – 135	Nausea, vomiting, Dizziness, Interference
140	Pain in ear, Prolonged Exposure causing insanity
150	Burning of the side.
160	Puncture of tymnhansic Membrane, other minor permanent damage if prolonged.

Determination of sound level by using sound level meter :
Conduct of experiment :
Procedure :

1. Take a sound level meter at different locations like glass room, heavy traffic road, market place or near mixer, TV or other machines like tractor etc.
2. There are different types of sound level meter like simple one which direct readings or advanced type where there is facility of recording maximum level, fast or slow recording continuous record or facility for transferring recorded data to computer where it can be analyzed.

3. Make the battery on. Select mode of recording fast/ slow. Hold to record the reading, maximum for recording maximum reading and record the observations at different places in following table.
4. Give what will the effects of these noise pollution on exposed persons.

Sr. No.	Name place	Time	Observation			
			I	II	III	Mean
1.						
2						
3						
4						
5						
6						
7						
8						

5. Suggest control for avoiding it.

Suggestions for avoiding it :

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_____

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Exercise No: 6

Study of Community structure

Community :
Definition :

It is defined as a group of species (similar or dissimilar) living together under more or less similar environmental conditions. When we want study, the community we have to study its different characteristics. Some of characteristics of community are as follows :

1. Species diversity
2. Growth form and structure
3. Dominance
4. Succession
5. Tropic structure
6. Stratification

Structure of community can be studied by Quantitative and Qualitative or Synthetic methods. For quantitative studies, the three usually employed methods are 1) Quadrat 2) Transect (Line or Belt) and 3) Point frame method, sampling units are area, line or point respectively

1) Quadrat method :

The sampling unit here is an area of definite size. Although, quadrats employed are of various shapes, the one which is mostly followed is the square. Before we proceed to study the community, it is necessary to determine

a) The minimum requisite size of the quadrat, and
b) The minimum number of quadrats to be laid down in the community.

a) To determine the minimum size of the quadrat by Species -Area-Curve method :

Requirements : A piece of string scale, four nails, hammer, graph sheet, herbarium sheet.

Procedure : With the help of the string and 3 nails make an L shape line in the field. With the help of another piece of string and a nail, make a square of an area of 10 x 10 cm^2. Note down the various species present within the area. Now increase the area to 20 x 20 cm^2, 40 x 40 cm^2 so on. Each time record the number of species occurring in that area. Continue this operation till there is no further increase in total number of species with increasing size of the quadrat. Fix specimen of each species recorded on the herbarium sheet. This is to be done in all the exercises that follow the study of structure of communities.

Observations : Tabulate the data as shown below.

Sr. No.	Area	Total no. of species present
1.	10 x 10 cm = 100cm^2	
2.	20 x 20 cm = 400cm^2	
3.	30 x 30 cm = 900cm^2	
4.	40 x 40 cm = 1600cm^2	

How to prepare species area curve?

Take a graph sheet and plot the number of species Y-axis against the areas on the X axis. Thus a curve would be obtained, known as species area curve. Note the point at which this curve starts flattening up. From this point find out the area of the quadrat. This would be the minimum size of quadrat to be taken for further study.

b) To determine the minimum number of quadrats to be laid down in the field under study.

Requirement : Quadrats of the definite size, graph paper, herbarium sheet, cello tape.

Procedure :

1. Lay down 25 to 50 quadrats of minimum size at random in the field at different sites.
2. List down the different species present in each quadrat, as shown in the table. With the help of data in table, find out the accumulating total number of species for each quadrat.
3. Now take a graph sheet and plot the number of quadrats on X-axis against accumulating total number of species on Y-axis. A curve would be obtained, and the point at which curve starts flattening up would give the minimum number of quadrats to be laid down in the field.

Observation:

Name of Species	Quadrat Number							
	1	2	3	4	5	6	7	..
A								
B								
C								
	Total							

2) Line transects method :

The sampling unit in this case is a line of suitable length. When we want to study the vegetation in particular direction the line transect method is used. Suppose we want to know the effect of constructing road in the forest in particular direction on that vegetation, we have to use line transect method.

Requirement : Measuring tape, graph sheet, herbarium sheet, cello tape.

Procedure : Run the measuring tape across the vegetation. Note down the species touching the tape in alternate segments of suitable (say I meter long). A number of transects may be laid down at random across the field at different sites. Now prepare a similar table that of quadrat method and prepare the graph in same way. The point at which it starts flattening will give the optimum number of transects to be studied for particular vegetation.

3) Point frame method :

In this case, sampling unit is a point. Point frame is a simple plank about 50 cm long and 50 cm high. It rests on wooden legs. The 10 pins (each about 50 cm long) are inserted through the holes in the frame. The plant species, which are in contact, are taken into account. This method is used when we want to take primary observations or in short time. But the accuracy of this method is less as compared to quadrat method.

Title: To determine the optimum number of points at which the observation to be taken while studying point frame method.

Requirement : Point frame apparatus, graph sheet, herbarium sheet cello tape.

Procedure : The apparatus with 10 pins is kept at a place is one sampling unit. Put the apparatus at random at number of places (20 or more) in the field and note down each time the various species hit by one or more of the 10 pins. This is one sampling unit. Put the apparatus at random at a number of places (20 or more) in the field and note down each time the various species hit by one or more of the 10 pins. Thus, one pin is one sampling unit. Here the number of plants of a species touching a pin is not counted. The observations are taken till there is no addition of new species. The specimen of each species is mounted on herbarium sheet with the help of cello tape.

Quantitative method :

Requirement : Quadrat of minimum size, graph sheet, herbarium sheet, cellotape.

Procedure: Lay down the required number of quadrats (as determined in previous exercise) of appropriate size in the area to be studied. In each quadrat note down the various species present and also the total number of individuals of each species. Prepare a table. Calculate the following community characters from the data by using the following formulae.

$$\text{Frequency (\%)} = \frac{\text{Total no. of quadrats in which species is present}}{\text{Total no. quadrats studied.}} \times 100$$

$$\text{Density} = \frac{\text{Total no. of individuals of the species}}{\text{Total no. of quadrats studied}}$$

The value of density of particular species will be for that specific quadrat. To compare the values at different areas it should be converted into quadrat of 100 x 100 cm. or one square meter size by the formula.

$$\text{Relative density (sq.m.)} = \frac{\text{Actual density}}{\text{Actual size of quadrat}} \times 100 \times 100$$

$$\text{Abundance} = \frac{\text{Total no. of individuals of the species}}{\text{Total no. of quadrats in which species was present.}}$$

Preparation of frequency distribution diagram :

On the basis of percent frequency values of each species assign it the frequency class as given by Raunkaier 1934 and record against that species in the observation table.

Frequency %	Frequency class
0 – 20	A
21 – 40	B
41 – 60	C
61 – 80	D
81 – 100	E

Now find out the representation of each class on percent basis by the following formula.

$$\text{Percent contribution of class} = \frac{\text{No. of species in the frequency class}}{\text{Total no. of species present in that area.}} \times 100$$

Take a graph sheet. Take five frequency classes on X axis and percent contribution on Y axis. Join the points and prepare the Histogram. This is known as frequency diagram. Along side draw a normal frequency diagram by the formula given by Raunkaier

$$A > B > C = D < E$$

Question No.1 : Mention the name of two species those are having maximum frequency value.

Answer : 1 _____ 2. _____

2) Find out whether the vegetation is homogenous or heterogenous. In general when classes B, C and D in the resulting frequency diagram are comparatively higher than their respective values in normal frequency diagram, the vegetation is heterogenous. Higher the value of class E (as compared to its normal frequency diagram), greater will be the homogeneity in the vegetation.

2) Transect Method :

Lay down the tape in the vegetation and select the no. of segment as per last exercise. Note down the no. of individuals of each species in contact with and prepare a similar table. Calculate the percent frequency and density of each species as done in quadrat method. Distribute the various species among five frequency classes, find out the percentage (of the total number of species) value of each frequency class, and prepare frequency diagram similarly as done quadrat method. Compare the frequency diagram with normal frequency diagram to draw possible conclusion.

Question : Give the name of two most frequent species and state whether the vegetation is homogeneous or heterogeneous.

Answer : 1. _____ **2.** _____

3) Point frame method :

Lay down point frame at no. of locations as determined in previous exercise Record the number of individuals of each in contact with the one of the pin. Prepare similar table. Calculate the percentage frequency and density of each species similar to quadrat method. Distribute the various species among five frequency classes; find out the percent contribution of each frequency class. Prepare frequency distribution diagram and compare it with normal frequency diagram to draw the conclusion.

Question : Give the name of two most frequent species and state whether vegetation is homogeneous or heterogeneous.

Table :

Sr. No.	Name of Species	Quadrat lay down							Total No. of individuals of species	Total no. of quadrat in which species occurred
		1	2	3	4	5	6	7		
1	2	3							4	5
1										
2										
3										
4										
5										
6										
7										
8										

Sr. No.	Name of species	Total no. quadrats studied	Frequency	Frequency Class	Density	Abundance
6	7	8	9	10	11	12
1						
2						
3						
4						
5						
6						
7						
8						

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Exercise No. 7

Study of Pond / River / Hill slopes ecosystem - Abiotic and Biotic components.

Study of Pond as an Ecosystem :

7.1 To record a biotic components i.e. pH, turbidity, temperature and light intensity of water in a pond ecosystem.

Requirements : Universal indicator, secchi disc, long thread, meter scale thermister, photometer (sealed in water tight containers with glass window):

Procedure :

For the pH value of pond water, collect sample during different months of the season and from different places and depths of the pond. From each sample take few ml. of water in test tube and add to it few drops of universal indicator. Compare the colour developed with the colour chart pasted on the indicator bottle, to find out the approximate pH value of the water sample.

Turbidity of pond water is recorded with the help of a round disc. Secchi disc with different strips of two contrasting colours, white and black. The degree of indistinction between two colours in the water determines the inded of turbidity of water. Lower the disc slowly and slowly in water and note down the depth, where the black and white colour become indistinguishable. This depth can be taken as **turbidity index.** Different ponds and / or different sites in same pond may be compared for turbidity index of water, where depth values may differ.

The temperature of pond water is measured by instrument. Thermistor based on the principles of thermocouples. The glass globule of thermistor is lowered at different depths in water with the help of an electric cord. The needle of the potentiometer outside the water gives the temperature values on the scale that can be directly read out.

For light intensity we use the similar photometer as used for air, except that the photocell is sealed in a transparent water proof case. It can be placed at different sites and depths of pond water to find out variation in light intensity values.

7.2 : To study the Biotic components of a pond ecosystem.

Requirements : Collection nets with different mesh size, metalic chains with hooks, specimen tubes, glass jars, hand lens, meter scale, scissors, forceps. centrifuge, microscope, suitable stains etc.

Procedure : The plant and animal population growing near the margins of the pond can be easily picked up by hand and placed in polythene bags. Boats may also be employed.

Metallic chains with hooks are used for collecting the large sized plants - microphytes especially submerged ones. The planktons (algae, protozones etc) are collected from different depths with the help of nylon nets and collected in bottles. These organisms are brought to the laboratory and properly identified. The decomposers are recorded cultivating them on suitable culture media.

Observations : The various organisms may be grouped as follows on the basis their position in the system.

Procedure :

1. Green plants mainly :

a.	Submerged	*Hydrilla, Vallisneria, Ceratophyllum, Chara*
b.	Free floating	*Spirodeilla, Pistia, Wolffia, Eichhornia, Azolla, Lemna*
c.	Rooted floating	*Nelumbo, Nymphaea* etc.
d.	Amphibious	*Typha, Ranunculus*
e.	Phytoplanktons	Members of chlorophyceae, Myxophyceae, Bacillariohyceae, Xanthophyceae.

2. Consumers (Macro-consumers) :

a.	Primary	Bottom fauna as molluscs and insects, zooplanktons
b.	Secondary	Small fish, insect, frogs
c.	Tertiary (top)	Big fish, birds

3. Decomposers (Micro-consumers) :

Bacteria and fungi especially species of *Aspergus, Penicillium, Fusarium, Paecilomyces, Rhizopus* etc.

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Exercise No. 8

Study of Grass land and Agro-ecosystem and measurement of their productivity

A) Grass land Ecosystem

This is a type of terrestrial ecosystem which occupies 19 per cent of earth's surface. The various components of Grassland Ecosystem are as follows :

I) Abiotic component :

These are nutrients present in soil and the aerial environment. Thus the elements like C, H, O, N, P, S etc are supplied by CO_2, water, nitrates, phosphates and sulphates etc present in air and soil of the area. In addition to the above some trace elements are also present in soil.

II) Biotic components :

1. Producers :

Mainly grasses as species of *Dichanthium, Cynodon, Desmodium, Digitaria, Dactylocetenium, Brachiaria, Setaria, Sporobolus* etc. Besides them a few herbs and shrubs.

2. Consumers : (Macro-consumers)

a. Primary : Mainly grazing animals such as cow, buffaloes, deers, sheep, rabbit, mouse etc. Some insects (Leptocorisa, Dysdercus, Oxyrhachis) termites and millipeds.

b. Secondary : Fox, jackals, snakes, frogs, lizards, birds etc.

c. Tertiary : Hawks.

3. Decomposers : (Micro-consumers) : Bacteria, Fungi and actinomycetes especially species of *Mucor, Aspergillus, Penicillium, Rhizopus, Fusarium.*

B) Agro-ecosystem

These are artificial or man engineered ecosystems.

I) Abiotic components :

These includes climatic condition of the region, where crop may grow most successfully and the various minerals like C, H, O, N, P. K present in soil and atmosphere. In such fields number of chemical fertilizers are added by man as and when required.

II) Biotic components : The various living organisms in the food chain occur as follows :

1. Producers : The dominant plant species and number of weeds.

2. Consumers :

a. Primary : Chiefly insects such as aphids, thrips, beetles etc. Larger animals are rabbits, rats, birds and man

b. Secondary : Carnivores like frogs and some insects that eat other small insects.

c. Tertiary : Carnivores like smaller birds, snake and hawk.

3. Decomposers : These are chiefly bacteria, actinomycetes and fungi. The plants use a part of this potential energy during respiration and whatsoever is left behind into the plants adds to the biomass. **Biomass is a manifestation of net production.** All the species do not have the same metabolic rate hence, their product performance within the community differs. These differences are also influenced by the age of the plants, their leaf area and the seasonal changes which affect the physiological processes of the organisms.

A knowledge of biomass production rate gives us a clue to the performance of the species within a community. **Species which possess more biomass and have higher production rate are dominant in the community and they also influence the appearance of physiognomy of the vegetation.**

Biomass is expressed as weight per unit area (mg or kg or ton/m^2 or hectare) and the rate of production indicates the speed of biomass accumulation in the plant which is expressed as weigh per unit area per unit time (g/m^2/day or tons/ha/year).

Productivity = Increase in Dry matter / Unit area / Unit time.

$$\text{Productivity : } = \frac{\text{Final dry weight - Initial dry weight}}{\text{Time and area}}$$

C) Determination of productivity of Grass land and crop ecosystem :

Requirements : Quadrat of a definite size (e.g. 40 x 40 cm^2), Polythene bags, spatula, hot air oven, balance.

Procedure :

Lay down a number of quadrats at random in the area. Clip the above ground parts (shoots) of all the plants present in the quadrat and collect them in a polythene bag. In other separate bags, collect the dead fallen parts of the plants. Similarly, dig out the underground parts of the plants and collect them separately.

Keep the different parts separately in an oven at 70^0C for 24 hours and find out the loss in their weight. Calculate the biomass (dry weight) per unit area as follows :

Fresh weight	:	x g
Weight after heating at 70^0C for 24 hours	:	x_1 g
Moisture present	:	$x - x_1$ g
Dry weight	:	x_1 g

Find out the biomass in per unit area. Suppose in this case size of quadrat was 40 x 40 = 1600 cm^2. Thus, 1600 cm^2 area has x_1 g dry matter. 100 cm x 100 cm (1m x 1m) will have

In 40 cm x 40 cm : x_1 (gm dry weight)
Therefore for 100 cm x 100 cm ..... ?

$$\frac{x_1 \text{ X } 100 \text{ cm X } 100 \text{ cm}}{1600} = x_1 \text{ g}$$

The biomass of shoots = x_2 g/m^2

The dry weight obtained in this way represents the biomass. For calculating **Net primary production,** the biomass is recorded at monthly interval. Net primary production can be calculated by summing up all positive values. The values of biomass and net primary production should be calculated for ungrazed (protected) and grazed areas. The differences in values should then be explained on the grounds of effect of biotic factor (grazing) in the area.

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Exercise No. 9

Crop Adaptation to different ecosystems (A) Hydrophytes

The plants grow in nature by utilizing the natural resources (water, mineral nutrients, CO_2, and solar energy). The plants differ in their requirements of those natural resources. Similarly, the availability of those resources also differs from place to place and season to season. This has resulted into the growth of certain plants in certain locations in certain season.

When the resources are not optimum (i.e. either available in excess or in short supply) the plants have ability to overcome these adversities by modifying their external features. These modifications are known as **morphological adaptations**. Soil supply the most of water required by plants as well as is the main source for almost all the minerals essential for the growth of the organisms. Besides this, it also provides space where plants take birth grew and die. Physical and chemical properties of soil changes with climate and type of vegetation, which develops on it. These characteristics of soil profoundly influence the germination, growth behavior and distribution of plants The plants has to face adversities of variation in availability of soil water, temperature and concentration of salts. The conditions under which plenty of water is available and which restrict the transpiration losses are known as **hydric condition** and the plants flavouring the habitat are known as **hydrophytes**.

The adaptations in external features of the plants are given below.

(A) Morphological adaptations of Hydrophytes.

Hydrophytes are divided in to:

1. Submerged plants: e.g. Elodia, Potomegaton, Hydrilla, Vallisneria, Chara.

a. Roots are greatly reduced in size. Mostly unbranched and lack of root hairs
b. Stem is thin and delicate due to lack of mechanical tissue.
c. Leaves are greatly reduced in size and thickness. They are thin linear or ribbon like to escape effects of strong water current.
d. Reproduction by vegetative mode.
e. Plants lack cuticle (cutin) or suberin, as they have to absorb water and nutrients directly through the entire surface of plant body.
f. Stomata absent or non- functional.

2) **Free floating :** e.g. Water hycinth, Pistia, Azolla, Wolffia, Lemna.

a. Roots are extremely reduced or absent. Root hairs are absent.
b. Stem is extremely reduced.
c. Leaves are quite well developed.
d. Mechanical tissues are completely absent.
e. Stomata on upper surface of the leaves.
f. Floating devices are present.

3) Floating but rooted at bottom: e.g. Lotus (Nelumbo), Colocasia (Nymphea).

a. Roots are poorly developed.
b. Stem is in the form of rhizome or corm.
c. Petioles are well developed and elongated.
d. Leaves are covered with wax to protect wetting of upper surface.
e. Stomata are present on upper surface only.

4) Amphibious: e.g. Jawanica, Polyganonum, Talim Khona and Pan kanis.

a. Roots are well developed.
b. Stems are rhizomes lying in the mud.
c. Leaves are heterophylly i.e. presence of more than one type of leaves.
   1. Submerged leaves are dissected, thin and linear.
   2. Aerial leaves are entire broad, stomata present.

B) Anatomical

1) Extensive air spaces are found in stem, leaves and roots.
2) Spongy and palisade cells are not well differentiated

C) Physiological

1. Water and nutrients are mainly absorbed throughout the entire plant body.
2. Osmotic concentration of the cell sap is equal to or slightly higher than water medium.

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Exercise No. 10

Crop Adaptation to different ecosystems (B) Mesophytes

The conditions of optimum available moisture and favouring optimum rates of transpiration are known as **'Mesic conditions'** and plants growing in such habitat are known as **Mesophytes**.

A) Morphological adaptations: e.g. Sunflower, Maize, etc.

1) Root system is well developed
2) Long tap root in dicot and fibrous root in monocot.
3) Root cap is developed, root hairs are also present
4) Stem is rigid and stout
5) Leaves are long thin and rich in chlorophyll
6) Waxy coating is absent
7) Cuticle is moderately developed

B) Anatomical adaptations:

1. Palisade is well developed and spongy tissue has large intercellular spaces
2. Conducting and mechanical tissues are well developed

C) Physiological adaptation:

1. Temporary wilting occurs at noon time.

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Exercise No. 11

Crop Adaptation to different ecosystems (C) Xerophytes

The environmental conditions the available water in the soil is inadequate and transpiration losses are maximum are known as **'Xeric conditions'** and the plants growing in such habitat are known a **'Xerophytes'**. Xerophytes plants have been classified into **four groups** depending upon their capability to withstand drought conditions.

1. Drought escaping (ephemerals):

These are annuals. They have a very short growing and flowering season. They complete their life cycle in 4 to 6 weeks a time before the advent of unfavourable dry season. They are mostly found growing in semi arid regions having brief rainy season.

2. Drought avoiding:

These plants are of very small size they have restricted growth and require very less water for growth and development. Due to small size they conserve whatever little moisture they get and thus evade drought.

3. Drought enduring : (non-succulent):

These are slow growing shrubs grow sparsely in deserts. They are small and have shunted growth. They endure long dry periods when there is acute shortage of water. The growth is extremely restricted; The leaves wilt and fall down. They resume growth when water is again available to the roots after a rainfall. e.g. Accasia, Ber, Safflower,

4. Drought resisting: (succulent): They are succulent thick and fleshy stems of leaves. They resist drought by storing a lot of water. Water is absorbed by well-extended root system whenever water is available. The stored water enables them to resist drought conditions. This helps them to continue growth and flowering and fruiting. e.g. Aloe, Agave, Cactus, Opunitia etc.

A) Morphological adaptations:

1) A deep and extensive root system reaching water at deep soil layers. Root system is several time longer than aerial portion.(shoot).
2) Stem is very hard, woody, and covered with thick bank
3) Leaves small, thick, leathery or absent (modified to spines or scales) to check transpiration.
4) Many Xerophytes shed leaves during dry season.
5) Some Xerophytes have shining leaves to reflect light and heat.
6) Leaves have waxy coating and a dense thickness of hair.
7) Some Xerophytes fold the leaves to avoid exposure of stomata.

B) Anatomical adaptations:

1) Leaves have thick cuticle on upper surface to check transpiration.
2) Epidermal cells are thick walled to reduce transpiration.
3) Stomata are greatly reduced to avoid direct light.
4) Spongy cells have very small intercellular spaces.
5) Palisade parenchyma is well developed on upper and lower surface of leaves.
6) Small cells and small vacuoles.
7) Conducting elements for water are well developed.

(C) Physiological adaptations:

1) Osmotic concentration of cell sap is relatively high.
2) Photosynthesis is carried out at a very low moisture conditions

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Exercise No. 12

Crop Adaptation to different ecosystems (D) Halophytes

The condition where the concentration of salt (Sodium, Calcium and magnesium) in the soil is more which increases concentration of soil solution so much high that it becomes more than concentration of cell sap of the plants. Hence the seeds of many plants normally can not absorb the water and start germination. If they absorb water, along with water salts are also absorbed and if their concentration goes on increasing it may become toxic to the protoplasm. This condition is called **saline** condition and the plants which grow under this condition are called **Halophytes** e.g. Mangrove plants and Rhizophora macronata

A) Morphological adaptation of Halophytes.

1) Plants on saline soils grow chiefly in rainy season when soil solution has been diluted and salts move down below root zone.
2) In majority of plants germination is greatly retarded and seedling survival is almost impossible..
3) Plants are usually shallow rooted.
4) Most of the plants are halophytes, which exhibit succulence
5) Leaves are highly cutinized
6) There is vast net work of prop roots
7) Presence of negatively geotropic **'Pneumatophores'** a specialized organ for respiration
8) Some halophytes exhibit vivpary

B) Anatomical features of plants growing under saline condition (Halophytes)

1) Cuticle is thick
2) Palisade parenchyma is prominently developed
3) Xylem and phloem is well developed
4) Endodermis is well developed

Physiological adaptations of Halophytes

Plant exhibit high transpiration rate, exudation of water containing salts.
Concentration of the cell sap of halophytes is much more than that of mesophytes.

Mangrove:

Mangroves are prevalent on seashores of Maharashtra, Kerala and Andaman Nicobar Islands. They grow on waterlogged soils. Habitat is characterized by sandy, muddy and saline soils, high rainfall, high humidity with almost no fluctuation in mean temperature through out the year e.g. *Rhizophora macronata*, *Sonneratia* sp. etc. They show (1) stilt roots, pneumatophores (respiratory roots) and show vivipary

Anatomical adaptation of Mangroves:

a) **Roots:** Aerial and subterranean

i) Several - layered cork

ii) Cortex is made of star shaped or satellite cells connected with each other by lateral arms, cells show peculiar thickening ridges which are lignified. Some cells are filled with oil and lignin.

iii) Pith cells thick walled with pitted thickening of lignin, oil, and tannin.

b) **Stem :**

i) Thick cuticle even at young stage

ii) Epidermis heavily thickened, almost squrish cells filled with oil and tannin

iii) Hypodermis several layered, heavily thick walled cells.

iv) Primary cortex possesses number of lacunae, cells thickened, filled with tannin and oil. Some cells possesses calcium oxalate crystals. 'H' shaped heavily thickened specules provide mechanical strength to cortex,

v) Inner cortex posses a number of branched, thick walled cells - sclereoids provide mechanical support.

C) **Leaf :**

i) Cuticle is well developed.

ii) Epidermal cells are heavily thickened and may contain calcium crystals.

iii) Stomata are confined only to lower surface and sunken.

iv) Below the upper epidermis, there are several, layers of thin walled cells that remain filled with water, outer layer filled with oil and tannin, cells of lower most layer are mucilaginous and remain embedded into palisade tissue

v) Mesophyll is well differentiated

vi) Corky areas are present on ventral side. Annuals grow during rainy season. Perennials show much pronounced xerophytes characters e.g. *Suaeda fruiticosa, Salsola foetida.*

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Exercise No. 13

Study and Visit of Flora and Fauna

Environmental Science lead to conserve the ecosystem in nature containing biota. The biota contains flora and fauna. Flora means those species content of plants in an area and fauna means species content of animals present in any area.

Main objectives of this experiment is to study of ecosystem contain flora and fauna in an area.

Observations to be recorded :

Exercise No. 14

Visit to local polluted site, observations and remedial measures

Pollution occurs from variety of sources and affects different aspects of our environment and thus our lives and health. **Polluted site includes urban, rural, agricultural and industrial areas.** The students will visit local polluted sites in order to know causes of particular type of pollution. What are the effects of that pollution? How that pollution can be controlled? etc. The Proforma for visit is given below.

1. Aim and Objective : To study the cause and effects of pollution at site.

2. Methodology : Certain key questions related to the polluted site are given below. Explore the site to answer the questions about the area you have visited.

a) What is the site ?
Rural : Agricultural area, polluted water body, polluted industrial area
Urban: Solid waste management site, polluted industrial area.

b) What do you observe at polluted site ?
Solid waste- garbage dump, polluted water at river or lake, gaseous effluents or smoke coming out of an industry area etc.

c) Explore the reasons for pollution:
Observe and document the components in garbage dump / polluted water body/ industrial chimneys.

d) Observe the area and list the waste that is seen in the garbage dump site. Categorize the waste into three types.

i) Degradable waste are those which are easily decomposed by microorganism. These include food waste, plant material, animal carcasses etc.

ii) Non-degradable waste those which are not easily decomposed, e.g. plastic, glass.

iii) Toxic waste are those are poisonous and cause long term effects, e.g. several chemicals, paints, sprays

3) Findings : What are the effects of pollutant? What actions can you take to pollution reduced ?

General observations :

The following aspects need to be observed and documented.

1. The type of land or water use in polluted site, its geographical characteristic, who uses the area ? who owns it ?
2. Map the area to be studied
3. Identify what is being polluted- air water, soil, the cause(s) of pollution and the polluting agents.
4. Asses the extent of pollution : severe / moderate / slight / nil / to air, water, soil, biodiversity.
5. Asses from literature, the health aspects associated with pollutant.
6. Ask local residents about its effect on their lives.
7. Make a report of above findings.

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Exercise No.15

Visit to Local polluted Site - Industrial - Observations and remedial control measures

Exercise No. 16

Collection, Identification, Herbarium, Maintenance and Study of Plants grown in various Ecosystems

An ecosystem is a discrete structural functional like sustaining system. In this system the life of various forms exist as a result of interaction between the Biotic and Abiotic components of a habitat due to which inorganic constituents are synthesized into organic structures. The organic structures i.e. life of various types exit by energy exchange processes.

In any ecosystem the amount of inorganic substances present in abiotic and biotic components together is known as **standing state** and the amount of biomass as **standing crop** which is usually expressed as fresh weight dry or cal / sq.m. etc. Structural characteristics of green plants (Primary producers) in any ecosystem can be studied from the following criteria:

1. Interdependence
2. Stratification
3. Dominance
4. Species diversity
5. Life form
6. Floristic composition
7. Distribution pattern
8. Phenology
9. Canopy cover on based area
10. Biomass

A) Study of Plants in Forest ecosystem

Student will collect the following forest species and will study the components of forest ecosystem by studying their interdependence, stratification, dominance, species diversity, life form, floristic composition, distribution pattern, phenology, canopy cover and basal area and biomass.

1	Tropical wet ever green	Shorea (North India, Hopea forest (South India), Forest (South India)
2	Tropical semi ever green forest	*Diptero carpus, Mangifera, Quercus, Albizzia Bombax, Eugenia*
3	Tropical moist deciduous forest	*Dalbergia, Cedrala toona, Terminalia, Adina, Pongamia, Ano geissus, Calotopis, Floribunds,* Teak
4	Littoral and swamp forest	Forest along coastal region species for one *Rhizophora, Avicennia, Sonneralia* spp.
5	Tropical dry decidudous forest	Tropical mansoon forest of Vindhya and South India teak sal.
6	Tropical thorn forest	*Euphorbia, Acasia, Zyzyphus*

7	Sub tropical broad leaved hill forest	Oak and Chestnuts
8	Sub tropical pine forest	Pine, *Shorea, Anogeisus, Pinus*
9	Sub tropical dry ever green forest	*Acacia* and *Dodonea* and numerous hard wood species
10	Montaneous temperate forest	Lichens and mosses
11	Himalayan moist temperate forest	Oak and Confiers species are *Quercus ineane Cedrus deodara* and *Tsugu*
12	Himalayan dry temperate forest	*Querous, Cafrus* and *Pinus, Gelardiana*
13	Sub alpine and Alpine forest	*Apics* and *Khododendron*

B) Study of the plants in grass land ecosystem :

Students will collect the following grassland species and will study then various ecological characteristics.

Sr. No.	Grassland types	Environment in which found
1	*Sehima dicanthium*	Black soil
2	*Dicanthium cenchrus*	Sandy loam
3	*Phragmitea seccharum*	Marshy locaties
4	*Bothriochloa*	Paddy tract and high rainfall belt
5	*Cymbopogon*	Low hills
6	*Arundinalla*	Mountains
7	*Deyen Cundinalla*	Mix temperate climate
8	*Deschampsia - Deyeuxia*	Temperate alpine climate

C) Study of plants in fresh water ecosystem

Students will collect the following plant species of fresh water ecosystem and will study their ecological aspects.

1. *Trapa bispinosa*
2. *Utricularia flexuosa*
3. *Axolle pinnate*
4. *Spirodaia polymiza*
5. *Eloucharais planta* - gingr
6. *Paspalum scrobiculatum*
7. *Hydrilla verticullata*
8. *Ipomoea reasens*
9. *Marailca minuta*
10. *Vallienoria spiralis*
11. *Potamogeton crispum*
12. Cara species

D) Study of plants in Agro-ecosystem :

Students will collect following crops species and will study the ecological aspects :

1. Sugarcane
2. Sugarbeet
3. Wheat
4. Paddy
5. Jowar
6. Bajara
7. Maize
8. Cotton
9. Pulses
10. Groundnut etc.

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