# NATIONAL CHILDREN'S SCIENCE CONGRESS

**A Programme of**

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**Department of Science and Technology**

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# DRAFT ACTIVITY GUIDEBOOK – 2020 & 2021

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# Science for Sustainable Living

***"No one will protect what they don't care about, and no one will care about what they have never experienced."***

**– David Attenborough**

Human life is plagued by environmental issues related to pollution, climatic calamities, degradation of natural resources (land, soil, water, flora and fauna etc.). These drastically affect ecological balance and ultimately lead to problems like climate change (both at micro and macro levels) which, in turn, influence the overall quality of life (QoL) for most of the life-forms on Earth. One of the main reasons for such deleterious effect is due to human activities driven by unjustified value systems based on the spirit of *'more you consume or use, more you will develop'*, and '*faster is smarter'*. In this context, there is a global consensus for rethinking and redesigning of our thought processes, values and activities that aim for 'Sustainable Living'.

Sustainable living is the practice of reducing demand of the human being on natural resources both at personal and community levels, with suitable replacement(s)/alternative(s). It pleads for a lifestyle which reduces the impact of human way of life on planet Earth, through judicious use of natural resources preventing pollution, rational decision-making in the use of materials, judicious consumption of energy, alternative method(s) of transportation and recreation, etc.

In fact, "*sustainable lifestyle"* is a cluster of habits and patterns of behaviour embedded in a society and facilitated by institutions, norms and infrastructures that frame individual choice, in order to minimize the use of natural resources and generation of wastes, while supporting fairness and prosperity for all (UNEP, 2016).

It is essential to keep in mind that the accumulated environment and climate related challenges exert long-term impacts on our life; and sustainable living basically encourages reducing such problems, strengthens environmental safety and ecological security along with reducing our stress on the way of living, as depicted below (Table-1).

**Table-1.** Emotional reflection of ways of life - from troubled situation to sustainable state

| **Basic Aspects** | **Emotion, if threatened, when environment is in trouble** | **Emotion, if satisfied, when environment is sustainable** |
|---|---|---|
| **Existence** | Fear (even fear of death) | Joy of life |
| **Subsistence** | Hunger, thirst, pain, etc. | Satisfaction, feeling well |
| **Effectiveness** | Irritation, frustration, etc. | Feeling of accomplishment |
| **Security** | Anxiety and fear | Feeling sheltered, safe |
| **Adaptability** | Impatience, uncertainty, boredom, curiosity | Joy of learning, awakening |
| **Coexistence** | Jealousy, hate, envy, powerlessness | Love, solidarity, friendship |
| **Reproduction** | Loss of continuity | Joy and pride of parenthood |
| **Psychological needs** | Self-doubt, inferiority complex, humiliation | Confidence |
| **Ethical orientation** | Futility (uselessness), unreliability, irresponsibility | Meaning, order, reliability, responsibility |

**Source :**Bossel Hartmut ( 1998) Earth at a crossroads – paths to a sustainable future, *Cambridge University Press* , p. 82

In the above-mentioned perspective, approach of sustainable living emphasizes on five basic principles viz. (i) Respect for all, (ii) Leading a community life, (iii) Inculcate the habit of saving, (iv) Adopting minimalism and (v) Responsible decision-making. Against each of these principles, there are targeted focuses (Table-2) which lead to environmental safety and ecological, economic and social security besides harmony as well as both societal and personal wellbeing.

**Table-2.** Required principle to develop a sustainable living

| Targeted principle needs to adopt | Focuses |
|---|---|
| Respect and care for all | To understand how our daily activities are linked to ecosystem where we live in; accordingly, we are required to design our activities so that every living being in our environment gets what they need for their own survival and growth. Therefore, there is a need to inculcate a practice to respect for all living being. |
| Leading a community life | To shift from individualism to collectivism, and to consider as a member of society. We are required to establish collective initiatives to fulfill our needs, facilitate our aspirations and growth; remove the disparity between '*haves'* and '*have-nots*'. |
| Inculcate the habit of saving | To cultivate the habit of judicious use removing the practice of misuse, wastage, exploitation; practice to save Earth's resources; material, energy; and means of welfare and recreation |
| Adopt minimalism | Inculcate the approach of minimum input to get maximum output through increasing the efficiency of processes involved in production, distribution and consumption systems. |
| Responsible decision making | To remember that everyone is responsible for their own decision. If any negative impact occurs to environment, life form or fellow human beings, they have to rectify their decisions and take corrective action(s) to reduce and stop the negative impact(s). |

However, for more than two and half centuries, since the dawn of industrial revolution, our thoughts and value systems have been leaning mostly towards maximization, speed and expansion. Such attitudes of the civilized people demand more resources and energy resulting ecological insecurity, which ultimately lead to widening the gaps between '*haves*' and '*have-nots*'. Under such circumstances there is a need for a new scientific study, exploration and experimentation in all aspects of life and society to establish the effectiveness of sustainable living principles. This calls for inculcating/practicing new thoughts and value-systems in the line- '*bigger is not always better'*, 's*mall is beautiful and sustainable*', '*slower can be smarter'*, '*less can give more in future*' along with empirical evidences. The individual and collective efforts of systematic scientific study/ experimentation can help one to establish sustainable living.

Scientific understanding and application of methods of science help us in analysis and rational decision making. Process of scientific inquiry further equips us to find out solutions for problems that we come across in our daily walks of life. Therefore, science education should be directed at '*inquiry-based learning*' embedded with '*learning through doing*' to develop the learning outcomes one of the key tools for human endeavour for future security. In fact, the increasing rate of extraction and exploitation of natural resources for industry, urbanization and various developmental activities severely affected degradation, destruction and depletion of natural resources leading the Earth to become inhabitable for most of the organisms. Hence, from nineties onwards concern increased to a large extent on environmental challenges and rate of extraction and exploitation of natural resources. In other words, the question of sustainability of mankind has become a concern to one and all across the globe. Hence, the concept of sustainable development came up in 1992 embedding education as "*Education for Sustainable Development* (ESD)" with major focus on "Education for Sustainable Development Goal (ESDG)" to achieve the 17 SDGs by 2030. In this contemporary perspective, the education was focused on (i) *learning to know*, (ii) *learning to do*, (iii) *learning to live together* and (iv) *learning to be* which has the basic concern for inculcating the broader perspectives of sustainable living. The ESDG also focuses for inbuilt processes of cognitive learning, social and emotional learning as well as behavioural learning for understanding the living environment and ecosystem along with people and society.

It is expected that this holistic approach would create self-awareness, self-management, social awareness, relationship skills and responsible decision-making by our children for a beautiful future. Therefore, the proposed focal theme of National Children's Science Congress for the years of 2020 and 2021, ***"Science for Sustainable Living",*** is considered to be the most appropriate and useful. The broader perspectives of it are to foster the method of science among the young minds of the country. The children will, thereby, be able to adopt the principles of sustainable living and leverage science and technology to create the path for sustainable development through their project-based endeavours.

Considering the core aspects of the focal theme and easy understanding of the stakeholders, following five sub-themes have been identified and proposed –

I. Eco System for Sustainable Living
II. Appropriate Technology for Sustainable Living
III. Social Innovation for Sustainable Living
IV. Design, Development and Modelling for Sustainable Living
V. Traditional Knowledge System (TKS) for Sustainable Living

## Goal

An approach to introduce methods of science for personal and community level decision-making to lead the daily walks of life and leveraging the outcome of science and technology for establishing the sustainable way of life ('genre *de vie*') towards improving/upgrading quality of life (QoL), through conservation of nature and ecosystem vis-à-vis to achieve equity, equality, happiness, peace and harmony.

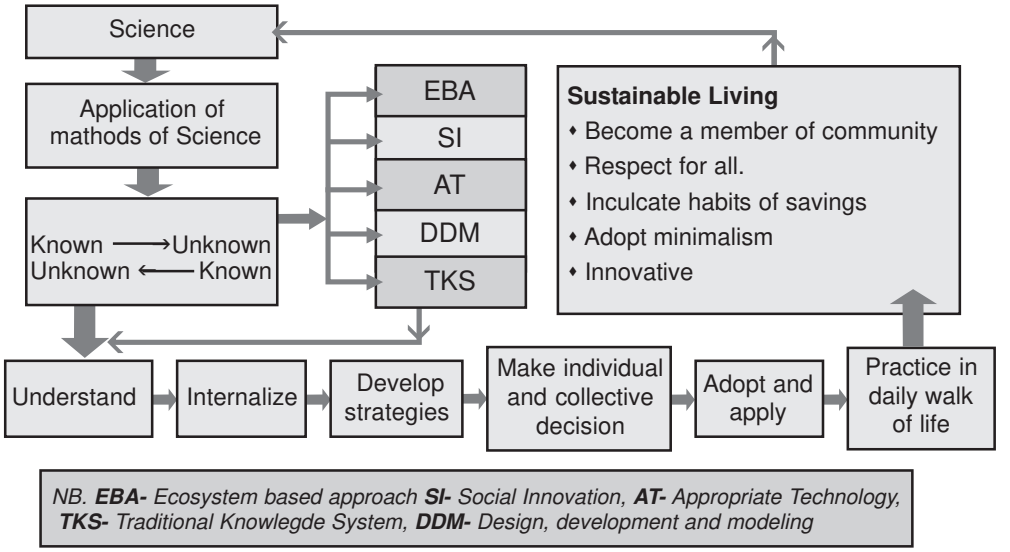
## Objectives

Motivating and engaging the children for inquiry-based learning:

1. To learn and understand about ecology, economy and society
2. To apply scientific understanding in day-to-day decision-making
3. To design and develop approach and / or solution for tapping potentials and overcoming the challenges

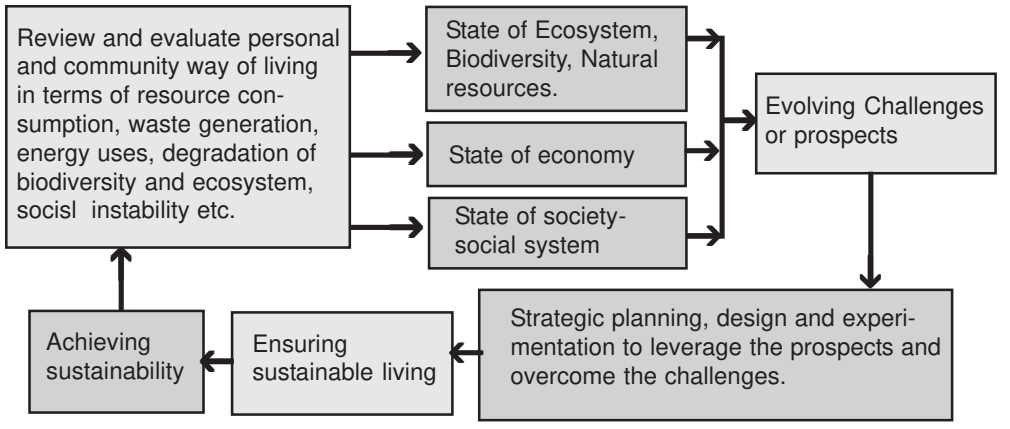
4. To take transformative initiatives to community and society and for personal reflection, which means an opportunity to reconsider events, thoughts and feelings from a fresh perspective.

## Core approach




*NB.* ***EBA-*** *Ecosystem based approach* ***SI-*** *Social Innovation,* ***AT-*** *Appropriate Technology,* ***TKS-*** *Traditional Knowlegde System,* ***DDM-*** *Design, development and modeling*

## Proposed Framework for Inquiry




## Expectation

Start with own, understand method of science, validate through experiment, interpret result, set example, communicate, and make an effort for promotion.

## Sub-theme: I

# Eco System for Sustainable Living

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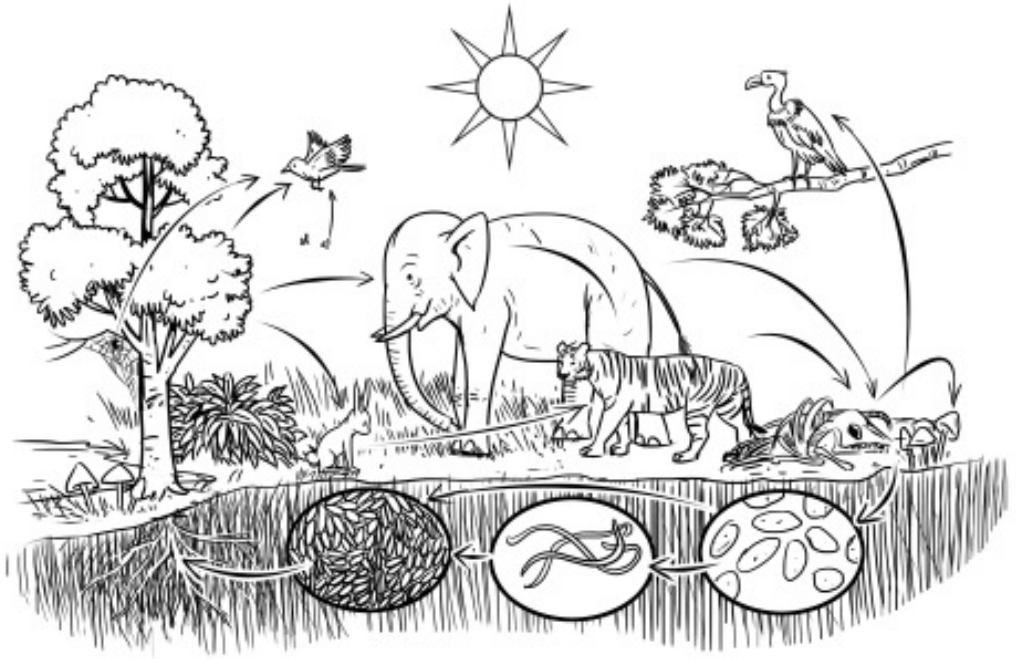
# Eco System for Sustainable Living

***"We cannot solve our problems with the same thinking we used when we created them."*– Albert Einstein**



'Eco' means natural habitat. The system for the existence of natural habitat of biological community (of organisms) interacting with their physical environments is the ecosystem. It includes all the living things (plants, animals, and organisms) in a given area that interact with each other, as well as with the non-living entities (weather, earth, sun, soil, climate, atmosphere, land) around them. The living and non-living (i.e. physical) components are linked together through nutrient cycles and energy flows. All the plants and animals (both macro and micro) on the Earth rely on the respective ecosystems for food and habitation. Therefore, the ecosystems must maintain a delicate balance in order to stay vital. Human beings like other organism, also rely on ecosystems to have food and natural resources. Depending on various characteristics, the eco-system has been classified primarily as Terrestrial and Aquatic; but there

are many sub-groups as shown in Box – I & II. It is to be understood, when natural resources are harvested out of an ecosystem, it can disrupt the delicate balance if not done in a rational and responsible way. Nevertheless, following diagram (Fig.1.1) shows the different components of ecosystem.

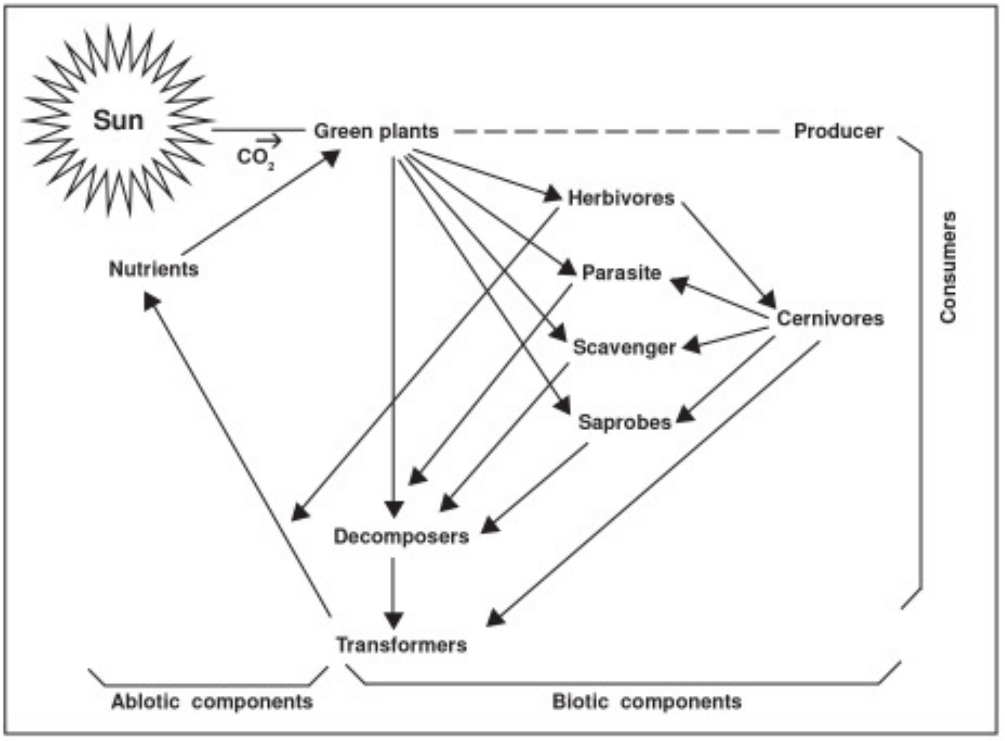



***Fig.1.1.*** *Different component of ecosystem*

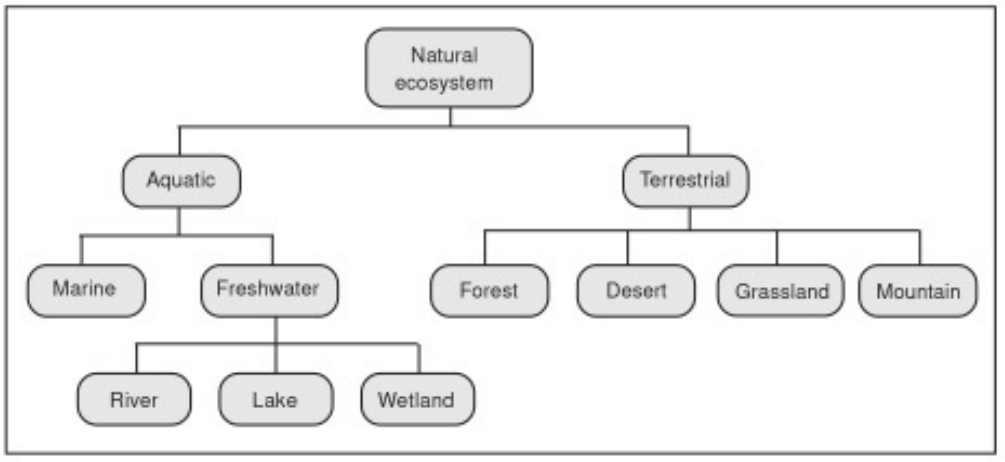



***Fig.1.2*** *Types of Ecosystem*

India has some of the world's most enriched ecological zones or 'eco-zones', which has been depicted through figure-1.2; and because of the country's diverse physical features and climatic conditions a variety of ecosystems have resulted. By and large these ecosystems harbour and sustain high biodiversity and contribute to overall well-being of man and animal. But, climate change, pollution and other environmental factors affect ecosystem processes (functions and services) affecting sustainable living and livelihood. Critically, sustainability includes health of the land, air and sea.

## How Ecosystem Helps Us

An ecosystem provides habitat to wild plants and animals and supports different food chains and food webs. It regulates essential ecological processes and supports lives. It also helps in recycling of nutrients through biogeochemical cycle between biotic and abiotic components of the Earth. All these activities are termed as **Ecosystem Functions**. Fundamentally, the functions of ecosystem (Fig. 1.3) are exchange of energy and nutrients in the food chain, which sustain plant and animal life, including human being, on the planet. The decomposition of organic matter and the production of biomass are also the result of ecosystem functions. These functions, within the ecosystem, help in maintaining Earth's natural balance. So, it is a vital process related to our sustenance.

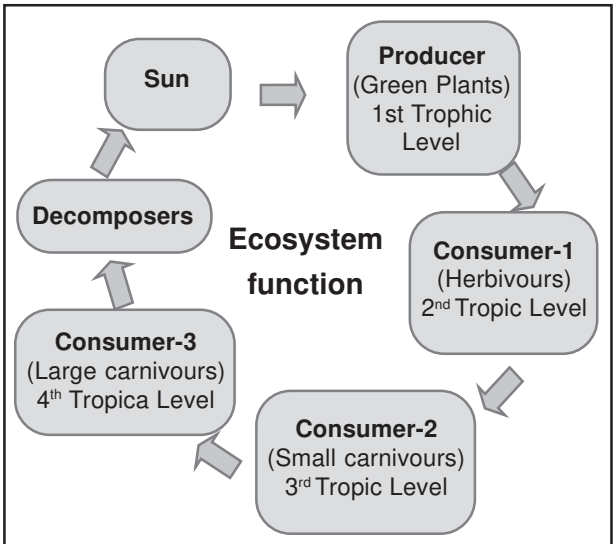



***Fig. 1.3.*** *Ecosystem functions*

Nevertheless, as a result such functions the living organisms on the earth, including human beings, get benefit directly and indirectly from ecosystems in many a ways and these benefits are known as **E*cosystem Services*** *(Fig.1.4)*. The benefits obtained from ecosystems can be categorized as *Provisioning Services*(also known as goods) such as food and water; *Regu-*

*lating Services* such as flood, pest, and disease; *Cultural Services* such as spiritual and recreational benefits; and *Supporting Services* such as nutrient cycling, soil formation, carbon sequestration, primary production and so many. These services of the ecosystems primarily are the result of interaction among soil, animals, plants, water and air. The goods and services they provide are vital to sustaining not only well-being of society, but also vital to future economic and social development. It is to be noted by the beneficiaries of any ecosystem that a healthy ecosystem cleans our water, purifies our air, maintains good health of our soil, regulates climate, recycles nutrients and provides us food. They also provide raw materials and resources for shelter, industry and many other purposes to cater our various needs. They are the foundation of all civilisation and economic growth.

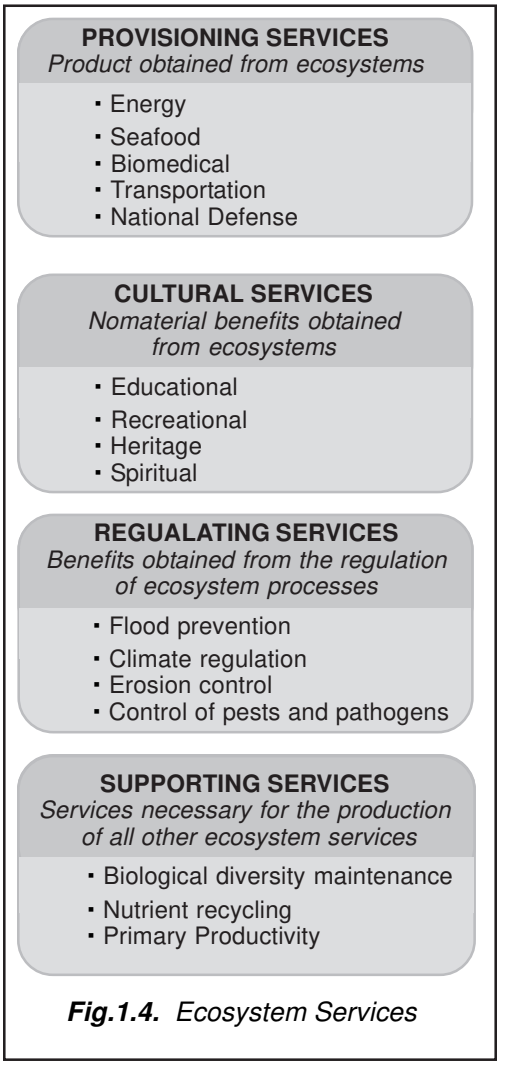
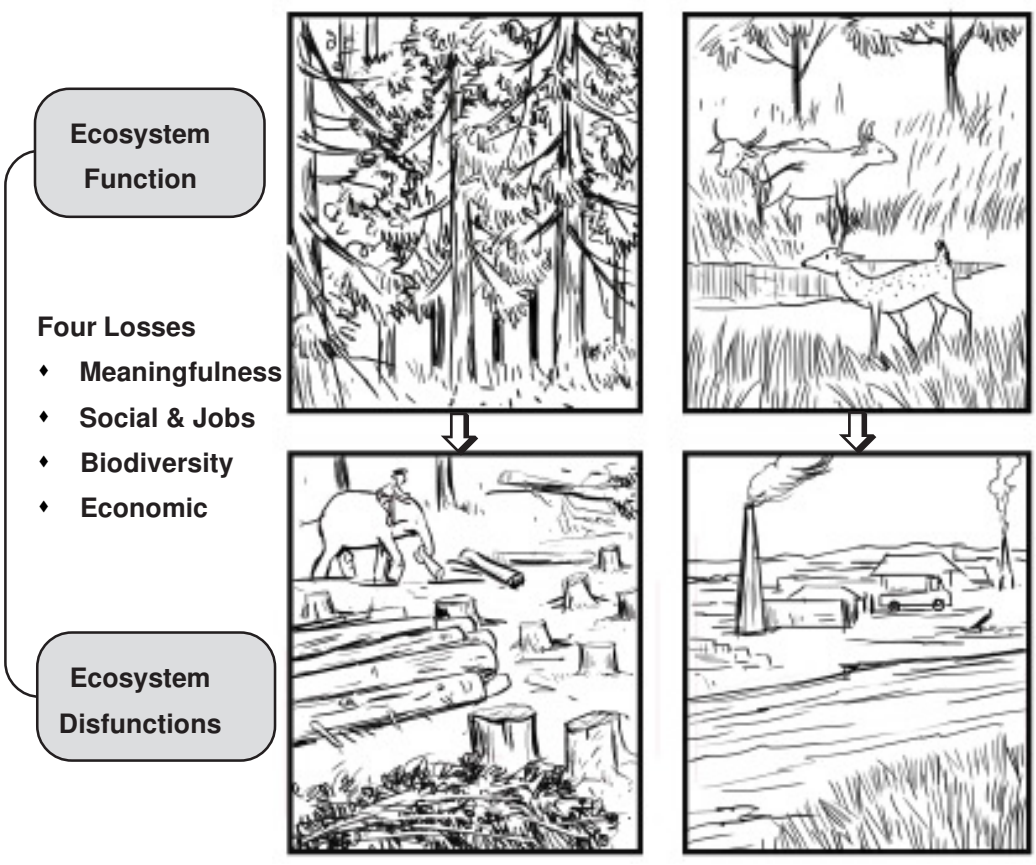



***Fig.1.4.*** *Ecosystem Services*

## Effects of Ecosystem Degradation

Human society is using the ecosystem resources for living and livelihood from time immemorial. Exploitation of natural *resources* is an essential condition of *human* existence throughout the history of mankind. H*umans* have exploited natural *resources* to produce the materials they needed to sustain growing *human* populations. But the way they use resources often provokes irreversible ecological change. According to the Millennium Ecosystem Assessment (MEA) sponsored by the United Nations, 60% of the ecosystems on Earth are being used up faster than they can replenish themselves. Virtually,

the degradation of ecosystems is an environmental problem that diminishes the capacity of species to survive. This degradation occurs in different ways and is manifested in a reduction in the richness of the ecosystems as well as their biological diversities, and also in the goods and services they can offer, thereby affecting both indigenous and/or migratory species. The degradation of ecosystems due to overexploitation of their resources, though serving a short-term economic goal, has had direct negative effects on social welfare. One of the main causes that contribute to the degradation of ecosystems is the deforestation due to the advancement of the agriculture and indiscriminate exploitation of forest resources. More lands are deforested for commercial agriculture and livestock rearing, and due to overexploitation of forest for wood, energy and urbanization. To be very specific, ecosystem degradation creates four major losses-




*Degradation of Ecosystemaffecting four major losses*

job loss, economic loss, biodiversity loss, and meaningfulness loss. These losses increase over the time if functional ecosystems degrade and cease to provide ecosystem services. If an ecosystem is not degraded, it represents a source of wealth for society, hence the importance of keeping it in good condition.

In fact, biodiversity boosts ecosystem productivity where each species, no matter how small it is, have important role to play. For example, a large number of plant species means a greater variety of crops. Greater species diversity ensures natural sustainability for all life forms including human beings.

## Ecosystem and Sustainable Living

Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of the Earth's natural resources and personal resources. Its users or beneficiaries often attempt to reduce their ecological footprint (including carbon footprint) by altering their methods of transportation, energy consumption, and/or diet. Its proponents aim to conduct their lives in ways that are consistent with sustainability, naturally balanced, and respectful symbiotic relationship with the Earth's natural ecology. The practice and general philosophy of ecological living closely follows the overall principles of sustainable development.

Moreover, sustainable economic growth promotes jobs and improves economies. In fact, a sustainable society is one that can continue indefinitely. Its level of consumption should reflect environmental and resource balance. It should assure its citizens equality, freedom and a healthy standard of living. So developing measurement standards that clearly define personal, social and environmental health is the need of the day and the responsibility lies in the hands of our future generation. They should think and act for the health of the ecosystem they are attached to.

## Framework

With the aim of sustainable living, it is necessary to develop an understanding of structure and functioning of the ecosystems from which we draw resources for our survival. These ecosystems, therefore, should be subjected to rapid and long term empirical studies to assess the services they provide. It is only then present and the future generations would be able to manage the ecosystems for posterity better and will be able to address the harmful threats the ecosystems are undergoing in general. Keeping these in view, the framework has been depicted below through figure-1.5.

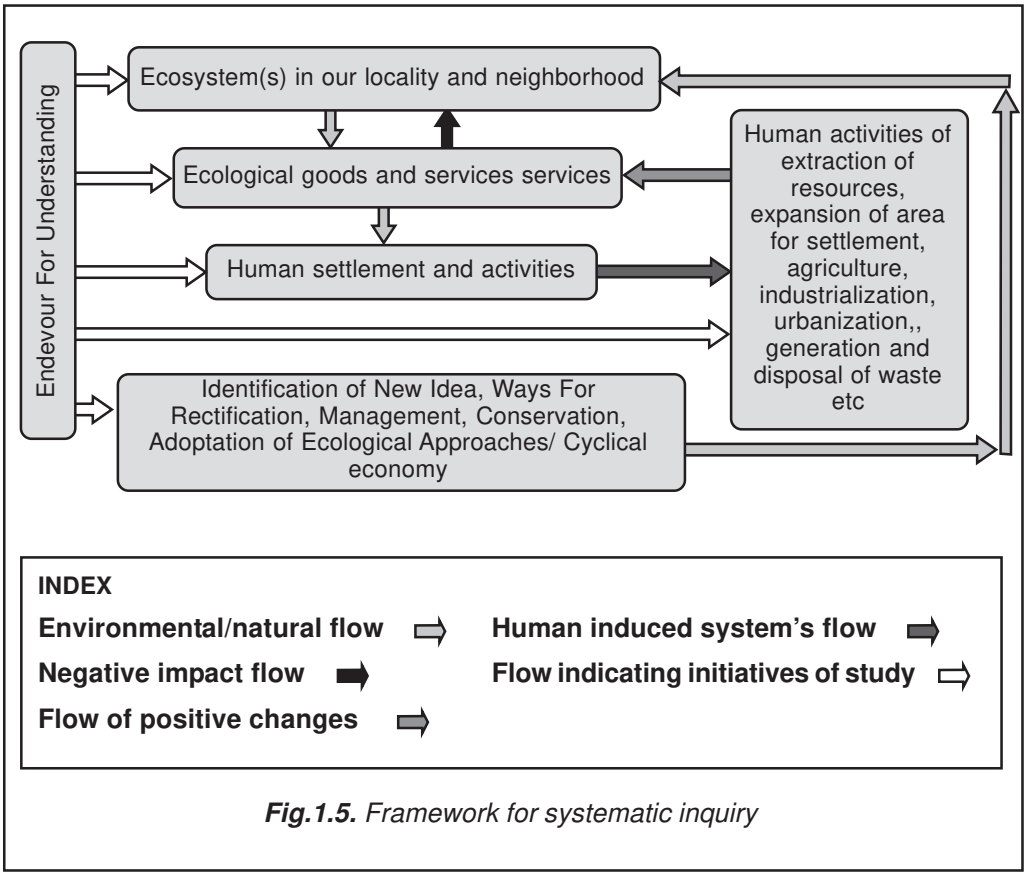



***Fig.1.5.*** *Framework for systematic inquiry*

**BOX-1.1**

## Types of Ecosystem

There are essentially two kinds of ecosystems, which may be categorized into the following sub-categories-

**(I) Terrestrial ecosystems**

Terrestrial ecosystems can be found anywhere apart from heavily saturated places. They are broadly classed into:

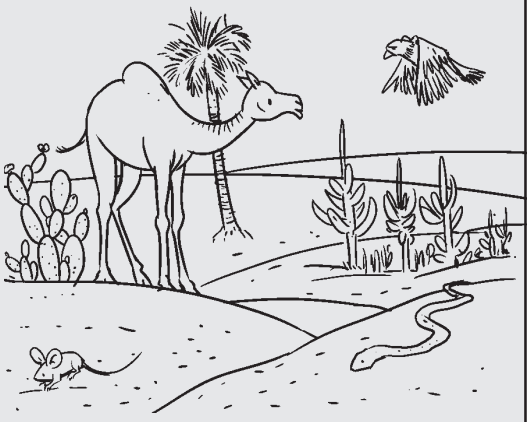
**(a)** ***Forest Ecosystems***

Under this ecosystem an abundance of flora and fauna, is seen in relatively small space. Therefore, density of living organisms is quite high. A small change in this ecosystem could affect the whole balance, bringing down the whole ecosystem services. They are further divided into:

- **Tropical evergreen forest:** The forests are characterised by dense vegetation which comprises tall trees at different heights. Each level is shelter to different types of animals.
- **Tropical deciduous forest:** Shrubs and dense bushes rule along with a broad selection of trees. This type of forest is found in quite a few parts of the world where a large variety of fauna and flora live.
- **Temperate evergreen forest:** Those have quite a few numbers of trees as mosses and ferns make up for them. Trees have spiked leaves in order to minimize transpiration.
- **Temperate deciduous forest:** The forest is located in the moist temperate places that have sufficient rainfall. Summers and winters are clearly defined and the trees shed the leaves during the winter months.

- **Taiga:** Situated just before the arctic regions, the taiga is defined by evergreen conifers. As the temperature is below zero for almost half a year, the remainder of the months, it buzzes with migratory birds and insects.

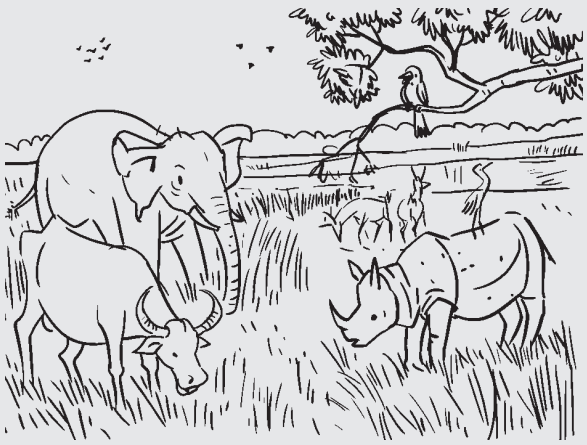
**(b)** ***Desert Ecosystem***



Desert ecosystems are located in regions that receive an annual rainfall less than 25cm. They occupy about 17 per cent of all the land on our planet. Due to the extremely high temperature, low water availability and intense sunlight, fauna and flora are scarce and poorly developed. The vegetation is mainly shrubs, bushes, few grasses and rare trees. The stems and leaves of the plants are modified in order to conserve water as much as possible. The best known are the succulents such as the spiny leaved cacti. The animal includes insects, birds, camels, reptiles all of which are adapted to the desert (xeric) conditions.

**(c)** ***Grassland Ecosystem***

Grasslands are located in both the tropical and temperate regions of the world though the ecosystems vary slightly. The area mainly comprises grasses with a little number of trees and shrubs. The main vegetation includes grasses, plants and legumes. A lot of grazing animals, insectivores and herbivores inhabit the



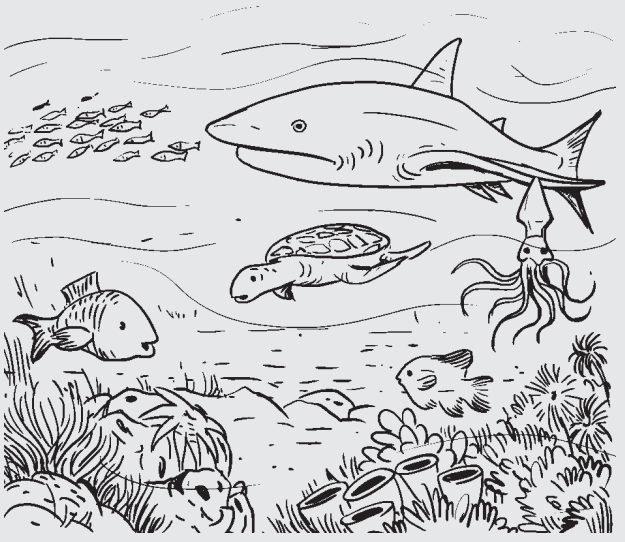
grasslands. The two main kinds of grasslands ecosystems are Tropical and Temperate –with several sub categories within each type.

**(d) Mountain Ecosystem**

Mountain land provides a scattered and diverse array of habitats where a large number of animals and plants can be found. At the higher altitudes, the harsh environmental conditions normally prevail, and only the treeless alpine vegetation can survive. The animals that live there have thick fur coats for prevention from cold and hibernation in the winter months. Lower slopes are commonly covered with coniferous forests.

**(II) Aquatic Ecosystems**

The aquatic ecosystem is found in a body of water. It encompasses aquatic flora, fauna and water properties, as well. There are two main types of aquatic ecosystem - Marine and Freshwater.



**(a) *Marine Ecosystem***

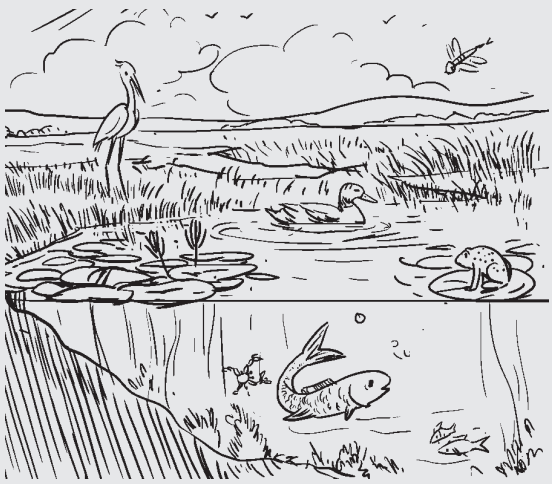
Marine ecosystems are the biggest ecosystems, which cover around 71% of Earth's surface and contain 97% of our planet's water. Water in marine ecosystems

features in high amounts of dissolved minerals and salts. The main different divisions of the marine ecosystem are:

- Oceanic: A relatively shallow part of oceans which lies on the continental shelf.
- Profundal: Deep or bottom water.
- Inter-tidal: The place between low and high tides.
- Estuaries
- Coral reefs
- Salt marshes
- Hydrothermal vents where chemosynthetic bacteria make up the food base.

Of the many kinds of organisms living in marine ecosystems a few are- Brown Algae, Corals, Cephalopods, Echinoderms, Dinoflagellates and Sharks.

**(b) *Freshwater Ecosystem***



Contrary to the marine ecosystems, the freshwater ecosystem covers only 0.8% of Earth's surface and contains 0.009% of the total water. Three basic kinds of freshwater ecosystems are:

- Lentic: Slow-moving or still water like pools, lakes or ponds.
- Lotic: The ecosystem of a river, stream or spring.
- Wetlands: Places in which the soil is inundated or saturated for some lengthy period of time. It may be coastal or tidal. These ecosystems are habitats of reptiles, amphibians and around 41% of the world's fish species.

## How to Go About

This sub-theme has wide scope of work in diverse areas related to the ecosystem functions and services in relation to sustainable living. But they must have to understand and explore the scientific phenomenon behind the ecosystem processes. In addition, they are to reveal the cause(s) and effect(s) of ecosystem degradation and its effect on sustainable living. The suggested areas of work for the children are-

Understanding the nature and characteristic of the eco-system; Environmental impacts of improved agriculture on environment and sustainable living; Conventional food distribution and long distance transport; Exploration of local and seasonal foods; Organic farming; Food preservation and storage; indoor home appliances; Harnessing renewable energy; Sustainable construction and many more. Moreover, children as practitioners of sustainable living can attempt to reduce their carbon footprint by altering methods of transportation, energy consumption, and diet.

## Model Projects

***Project 1: Study of an Agroecosystem.***

## Background

The existence of biotic and abiotic component in an agricultural land, their status and functional relationship are considered as agricultural ecosystem or agro ecosystem. In many cases, the crop cultivated by farmer in an agricultural field give different inputs to farm, all these together are part of biotic and abiotic components of agricultural ecosystem. Therefore, agricultural ecosystems are considered as man-made ecosystem.

Agricultural ecosystem is one of the important man-made ecosystems, which has highly evolved for last few decades due to introduction of modern inputs like mechanical tools, high yielding varieties, irrigation, chemical fertilizers, pesticides etc., to facilitate more production. Intensive monoculture practices, exercising higher cropping intensity make agro-ecosystem more vulnerable for other organisms and take away from sustainable approach. Diversity of agro-

ecosystems in terms of crops, cultivation practices, landscapes, seasons, agro-climatic conditions etc. in the country is significant and represent high volume of information of variability of biotic and abiotic components. By considering the prospect and importance in present scenario, several projects may be undertaken in this aspect-

The child scientist can ask questions to formulate the projects like what are different types of agro ecosystem available in the area; what are the different crops cultivated; how different slopes of land are utilized for different crops; how are they cultivated; what are the inputs (traditional plough/tractor/fertilizer etc.); how and in which way each agro-ecosystem supports livelihood in your area (staple food, vegetables, housing materials etc.); which agro-ecosystem is most sustainable; how other agro-ecosystem can be made sustainable etc.

## Objective

To understand different agro-ecosystems for sustainable services

## Methodology

The study is to be carried out step-by-step, as mentioned below.

1. List out the agro-ecosystem in your area e.g. rice agro-ecosystem, mustard agro-ecosystem, homestead garden agro-ecosystem, potato agro-ecosystem etc.
2. List out the crops in field in each ecosystem e.g. Rice in rice ecosystem; potato, amaranthus, pumpkin etc. in potato ecosystem; chilli, potato, tomato, vegetables.
3. Study the method of cultivation whether it is organic or inorganic. List out the inputs commercially procured and indigenously prepared. Calculate the

cost of production. Document the pest problems and major pests with natural enemies

4. List out the inputs of each ecosystems like pesticides (herbicides, insecticides, fungicides, acaricides etc.), fertilizers (Urea, Di-ammonium Phosphate, Single Super Phosphate, Murate of Potash, Micronutrients etc.), Seeds (high yielding variety, hybrid variety, local seeds), farm machineries (plough, seeders/ planters, weeder, sprayer, harvester etc.). Study how crop ecosystems are dependent on different inputs and their relation to each other. Calculate the cost of inputs and production with output in different ecosystem.

5. List out the produces in each ecosystem. List out the local need of agri product with volume of production of each crop and consumption. Calculate the income from marketable product from each ecosystem in local and outside market

6. List out the crops, input expenditure, labour cost and outcome of each ecosystem. Correlate these with productivity and sustainability.

7. List out factors responsible for increasing productivity. List out factors which are limiting in the studied ecosystem. Correlate your findings with sustainable factors for productivity.

8. Document current practice of each ecosystem. Find out advantages and disadvantages of the system. Make plan for sustainability.

## Significance

Child scientists will know how ecosystem of each crop is different and significant difference of agricultural ecosystem due to crop diversity (monoculture vs multi-crop culture, crop rotation, cropping diversity etc.), inputs, mechanisation, irrigation, nature (organic vs inorganic) etc. They will learn the present prospect and constrain of each crop ecosystem and how sustainable they are ; what plan is required to make agro ecosystem more eco-friendly and sustainable ? How agro-ecosystems are linked and connected with other ecosystems? These issues will be realised by the child scientists and these will make them more curious towards the dynamisms of agro-ecosystems.

## *Project 2: Conservation status of Dellinia indica in Northeast India.*

### Background:

It can be seen that certain tree species are more valued for their cultural, economic significance and medicinal properties in the homesteads and villages. Species like *Dillenia indica* in northeast, *Madhuca* and tendu (*Diospyros melanoxylon*) in Central India, *Garcinia* in South India *Sterculia urens* and Khejeri in Western India, *Quercussemi carpifolia* (Oak) in Kumaon and Garhwal are some examples to be mentioned. Children would explore and map the distribution using low cost GPS. They will explore other species they associate with. They would calculate the abundance and the present status. People keep some trees in their homestead garden. The naturally grown trees have significant value in society in terms of its use in different aspects like role to support other lives as well as being used as medicines.

### Objectives

1. To understand the distribution and status of *D. indica*
2. To learn tools and techniques to map distribution of tree species
3. To assess the cultural, social and economic linkages of the tree

### Methodology

1. Reconnaissance survey
2. Recognising suitable locations
3. Collect coordinates for occurrence with low cost GPS
4. Lay quadrates of suitable size and calculate relative density and abundance
5. Ascertain if the species show an association with other species in the area
6. Questionnaire survey and analysis

### Significance

The child will develop an idea of the habitat of *D indica*. Map will show the distribution of the tree in identified study area. Student has to prepare a report on preliminary vegetation analysis. The project will provide the provisioning and cultural ecosystem services and livelihood linkages of human with the tree.

## *Project 3: Evaluation of pollinator diversity in ecosystems*

### Background

Pollination is a keystone process in both human-managed and natural terrestrial ecosystems. It is critical for food production, human livelihood and directly linked to wild ecosystems with agricultural production systems. The vast majority of flowering plant species produce seeds only if animal pollinators move pollen from the anthers to the stigmas of their flowers. Without this service, many interconnected species and processes functioning within an ecosystem would collapse. The proposed project is to examine the pollination services in different ecosystems

### Hypothesis

The anthropogenic activities affect sustenance of pollinators in different ecosystems

### Objectives

1. To estimate the population and diversity of pollinators in selected ecosystems
2. To assess the ecosystem services rendered by the pollinators
3. Developing awareness about pollinators and their services in the ecosystems

## Methodology

### *(A) Materials Required*

Field guides to identify plants, birds and insect species, polythene bags, camera, binoculars, GPS instrument, measuring tape, hand lens, gloves, data sheets etc.

### *(B) Experimentation*

1. Reconnaissance visit to different ecosystems (sacred groves, agricultural lands, fallow lands etc.) in a landscape. Observation at different time intervals on different plant species (including keystone and umbrella species); floral morphology evaluation (i.e. which pollinator species were feeding on which flowering plant species).
2. Classification of flora based on type of pollination system/pollinating agent.
3. Specific observation on host plant availability for larval and adult stages of pollinating insects.
4. For keystone and umbrella species consolidate the pollinator species complex.
5. Identify common characters of pollinator species pollinating each specific species.
6. Identify and describe the niche of at least a few pollinating species.
7. List out the impacts of human interference, if any, in the system

## Significance

1. Understanding about different ecosystems which support and sustain plant productivity and pollinator diversity
2. Predict niche loss of the pollinating species

## *Project 4: A study of urban habitat as Refugia to Avifauna*

## Background

Urban habitat is rather a man-made habitat. Rapid urbanisation for the last few decades has made this habitat more prominent. Several animal species adopted the urban habitat and evolved to fit into the new habitat. It will be interesting to study how different bird species adapt themselves to fit in to the urban habitat.

## Objective

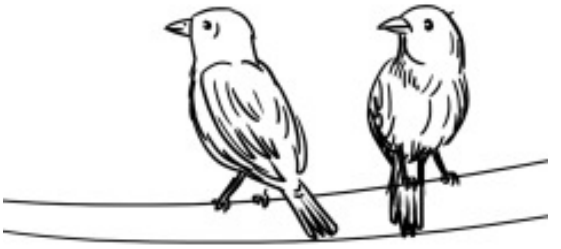
To understand the role of birds in an urban ecosystem

## Methodology

Following are the steps to be followed to conduct the study.

1. Reconnaissance survey
2. Observation and categorisation of micro habitat
3. Identify and prepare checklist of birds
4. Refer to bird guide book and collate information
5. Prepare criteria for short listing for details
6. Organise data collection on social behaviour,

a. Nesting habitat
b. Roosting habit
c. Feeding habit
d. Prey and predator
e. Prefer to be solitary or in group
f. Nature of call and signs



7. Survey preference of seasons
8. Ascertain if resident or migratory
9. Assess relative abundance
10. Consult local avifauna experts
11. Assess level of threats and conservation status

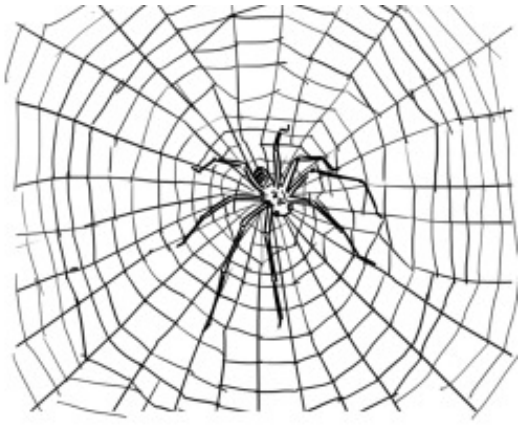
Prepare a report based on above mentioned observations.

## Significance

The project will be useful to understand the adaption strategies of birds in a comparatively new man-made habitat i.e. urban habitat. The cost of this adaption can also be documented. The project will help to compare the nature of adaption in man-made and nature habitat.

## *Project 5. Studies of different type of web-forming spiders and their preys in the ecosystems at your locality*

### Background



Spiders play an important role in every ecosystem. They are generalist predators and prey upon wide variety of insects like agricultural pests, mosquito, housefly etc. Some spiders directly capture preys which are called hunting spiders. Other are web-forming spiders that form webs with silk and sit, wait for capturing preys in the web. Web forming spiders prepare different size and pattern of webs for capturing varieties of prey. Their web-forming sites are different which allow specific prey only. In agricultural ecosystem, some spiders prepare web twisting the crop leaves; house-dwelling spiders make their web in the walls and roof; tree-dwelling spiders construct web in the tree.

### Objective

To study web forming spider diversity in different ecosystems with patterns and type of webs and nature of preys

### Methodology

(i) Survey different ecosystems (forest, grass lands, agricultural crops like rice, maize, sugarcane, millet etc.) in your locality through trail walk method. Organic and inorganic agro-ecosystems may also be targeted to document diversity and numbers of spider species.

(ii) Document the diversity of spiders (draw diagram, size, colour, take photograph) and document both the sexes - generally, female is larger and

mainly sits and waits for the prey, male is much smaller and remains in one corner of the web.

(iii) Draw the pattern of each web of different species of spiders and measure their size (radius)

(iv) Measure and count different parts of spider web (bridge thread, anchor thread, anchor point, auxiliary spiral, capture spiral etc.) in different species.

(v) Observe the behaviour of web forming and capturing prey of different species

(vi) Document the types of prey captured by each species per day.

### Significance

The project will help introduce the child scientist to the fascinating life of spiders and particularly web forming spiders and their various activities. It will also be useful for them to understand the predatory potential of spiders and their importance in the food chain and ecosystem functioning. Every ecosystem has preys and predators with different survival strategies.

## *Project 6. A systematic study of different fruit-bearing plants in a homestead garden*

### Background

Plants are one of the essential components of ecosystem. They are the one which can directly store energy from sunlight and convert them to food source available for other organisms. Plants include trees, shrubs, herbs, grasses, ferns, mosses.

### Objectives

(i) To understand the role of homestead gardens in sustainable living

(ii) To study the best practices of homestead garden

## Methodology

The study is to be conducted following the steps mentioned below.

1. Measure the extend of homestead garden in acres/bigha
2. Reconnaissance survey
3. Observation and identification of plant species and preparing a check list
4. Interview with the owner of the homestead garden/Interview with farmer
5. Consult with agriculture/nutrition expert
6. Assessment of nutrient/calorific value of the fruit harvested.
7. Economy of fruits harvested
8. Different types of tools used for propagation, sowing, planting and cleaning of homestead garden
9. Fertilizers used (organic and inorganic)
10. Source of fertilizer used.
11. Periodicity of input of fertilizers
12. Refer to plant guide book

## Significance

This study will enhance the observation skills. This will also help to understand the ecosystem services of homestead garden and how it is contributing to the livelihood and sustenance of a family.

### *Project 7. Study on the association of bird diversity in a homestead garden*

## Background

Birds are one of the easily found groups of biotic component of an ecosystem. They are found everywhere and in all types of habitats and ecosystems. Birds play important ecological role as pollinators, in seed dispersal, pest control, food source, etc.

## Objectives

(i) To understand the habitat utilisation, ecosystem services provided by birds in a homestead garden

(ii) Conservation of birds in the habitat

## Methodology

The step-by-step procedure has been explained below for conducting the study.

1. Survey and identification of birds using bird guides.
2. Enlist migratory/resident birds in the area
3. Study the seasonality and social structure
4. Social behaviour data (nesting/roosting/feeding/predator/prey)
5. Study the threats and impacts of human activities

## Significance

Children will learn how to observe and identify birds. They will know about diversity of birds in their locality and the seasonality, instigating them to think about the phenomenon of bird migration. The children understand the ecosystem services provided by the bird community and the need to conserve them

## *Project 8. Understanding impact of human activities on flora/fauna and their abundance*

### *Background*

Ecosystems provide us different types of services to live a quality life. With increase in population of humans and reduced forest areas, different habitats are under pressure due to anthropogenic activities. Humans repeatedly use such habitat and collect natural resources for livelihood and sustenance. This impacts the habitat and biodiversity in it which, in

turn, impacts its services to nature and humans. Increase in human disturbances probably reduces the biodiversity and abundance in the habitat of species. Through this exercise, child scientist is expected to understand the impact of human disturbances on a habitat in the neighbourhood and on ecosystems at large.

## Hypothesis

Human disturbances have direct impact on biodiversity and its abundance.

## Objectives

(i) To estimate flora/fauna of an area
(ii) To record different types of human disturbances
(iii) To estimate impact of human disturbances on flora/fauna and ecology
(iv) To create awareness about impact of human activities on ecosystem functioning

Undisturbed habitats are richer in biodiversity and abundance compared to disturbed habitats. Human venture into habitats for its day-to-day needs and presence of human and ancillary activities causes disturbances to flora and fauna. An undisturbed/least disturbed habitat when compared with similar habitat which is disturbed, is likely to have more diversity and abundance.

## Methodology

### *(A) Materials Required*

Field guides to identify plants, birds and insect species, polythene bags, camera, binocular, GPS instrument/maps, measuring tape, 1x1 m quadrate rope, hand lens, gloves, data sheets, etc.

### *(B) Experimentation*

1. Reconnaissance visit to identify two similar habitats (at least 10 ha area) where one is undisturbed/least disturbed and other is frequently disturbed by human activities (Cutting, lopping, firewood collection, cattle grazing, construction work, fishing, etc.).
2. Observe the area on regular intervals (e.g. weekly or monthly).
3. Record and classify different types of human disturbances as mentioned above.
4. Walk 50m trail on each habitat and record different types of human disturbances on the datasheet.
5. Record, signs (hoof mark, scratch mark, dropping of animals) both wild and domestic separately.
6. Record number of such signs of each identified species in the 50m trail.
7. At the beginning and end of the 50m trail, lay 1x1m quadrate and record different species of plants observed on a datasheet.
8. On the trail, observe different species of fauna and number of individuals of a species observed and record on datasheet.
9. Repeat the trail survey at regular interval, ensure equal number of repeats in the early morning and late afternoon.

## Significance

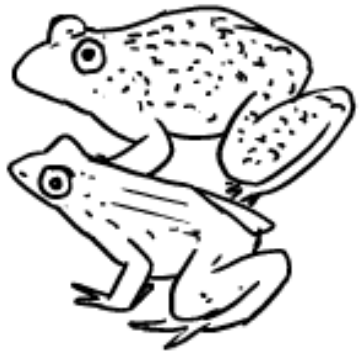
1. Understanding the habitats and multiple habitat parameters those enrich an ecosystem and its services.
2. Understanding impact of human disturbances on a habitat or an ecosystem by measuring observable components.
3. Evolving approaches for protecting ecosystems for sustainable future.

## *Project 9. Study of Amphibian diversity by observing the morphological features of amphibians in an area.*

### Background

Amphibians play various roles in the ecosystem by providing a number of ecological services such as acting as a secondary consumer as well as prey for other carnivores in different food chains and also perform the services as indicator species and biological pest controllers, etc. Amphibians are very sensitive to any change in the environment that helps us to assess various environmental threats as mentioned below -

1. Habitat fragmentation
2. Ecosystem stress that poses a serious threat to productivity of the ecosystem
3. Impact of pesticides and chemical fertilizers
4. Anthropogenic activities, etc.
5. Climate change



Moreover, amphibians have immense socio-cultural value due to their age-old integration into the art, literature and culture of different communities; e.g. holding frog marriages to please Lord *Indra* for rain is a common practice among various communities of Assam and some other states. We can see incorporation of amphibians, mainly the anurans (an order of animals in the class Amphibia ) in major art forms of India such as-

| Sl. No. | Art Form | Region in which practised |
|---|---|---|
| 1 | Madhubani | Bihar |
| 2 | Pichwai | Rajasthan |
| 3 | Warli | Maharashtra |
| 4 | Gond | Madhya Pradesh |
| 5 | Patachitra | Odisha & West Bengal |

***Source:****https://scroll.in/magazine/865512/frogs-have-an-abiding-presence-in-indian-art-and-mythology-then-why-dont-we-try-to-conserve-them*

Such cultural integration caters greatly in favour of conservation of amphibian species due to their relevance and importance to the society.

## Objectives

1) To study the diversity of amphibian species in a particular area
2) To study the relative abundance of selected species
3) To study the conservation aspects of amphibians

## Methodology

The following methods are suggested for this study-

***1) Visual Encounter Survey***Amphibians can be found and examined while walking through the study area during the time when they are most active (June-August, rainy days). Surveys to be carried out during evening hours 18.00 hours to 22.00 hours, subject to variation with respect to the region in which the study is conducted. One of the most effective sampling methods is trail walk (walk in any trail which can be of length say 50 meters in a frogs' habitat).

***2) Listening/recording frog calls*:** One of the major features of amphibians are that every species has a different type of call. Children may record such calls of the organisms and get them verified by experts to identify the species.

## Method of Identification

Identification of the amphibian species are done in various ways. But, the most basic and widely practised method for beginners is identification through examination of the morphology, that can only be obtained if good photographs have been taken from various angles for proper assessment and comparison. Some of the methods of identification are:

1) Comparing the morphological features from the photographs with a field guide.
2) Consulting with a qualified herpetologist for maintaining accuracy of the specimens identified

## Significance

These studies will help children understand amphibians that are available in and around their locality and create an awareness towards significance of these much neglected but a major group of organisms in terms of maintaining

equilibrium in the ecosystem. Therefore, the ultimate goal of this study will be conservation of amphibians by involving children and propagate the message of biodiversity conservation and coexistence.

### *Project 10. Status of Invasive Alien Species, their/its Impacts on Local Biodiversity and Control Measures*

#### Background

Different habitats differ in susceptibility to invasion by alien species. It is not essential that an invasive species reaching a habitat will always succeed in naturalising in the new habitat. There are many attributes that make a habitat susceptible to invasion such as species poverty, poorly adapted native species, gaps created by disturbances, constant harvesting of indigenous vegetation for various purposes, vacated habitats of native species, etc. Proposed activity attempts to identify and investigate the distribution of invasive alien species in an area and their impacts on the local biodiversity with the aim of thinking and trying out their control**.**

#### Hypothesis

Occurrence and distribution of invasive alien species are harmful to the native biodiversity as well as the local livelihood opportunities.

#### Objectives

1) Preparation of inventory of invasive alien species in the area along with their occurrence and distribution.

2) Estimation of their impacts on native biodiversity, both qualitatively and quantitatively.
3) Design and try control/management options for invasive alien species so as to protect the local biodiversity and its ecosystem functions.

## Methodology

(A) **Materials Required**

Field guides to identify plants and animal species (samples of invasive plant species may be taken from herbarium), camera, designed data sheets, herbarium sheet, cadastral map, GPS instrument or simply mobile GPS function can be used as an alternative tool for recording geographical location and mapping etc.

(B) **Experimentation**

***(I) Finding Status of Invasive Alien Species in the Area***

i) It is good to undertake reconnaissance visit of the area marked for the study and prepare the list of plants and animal species occurring there. Taking help from the village elders is a good option for the purpose of knowing local names of the species and also the timeline when certain (invasive alien) species appeared in the area and its (their) distribution trend during the past years.

ii) Collection of samples of plant species that are identified as invasive alien (take help of local elders, guide teacher and experts. To know about invasive species in India one can visit - http://www.bsienvis.nic.in/Database/Invasive_Alien_species_15896.), prepare their herbarium record for further reference and make a list assigning their codes.

iii) Take the cadastral map of the area and divide it in grids of uniform size (mention the scale of the grid in reference to the actual area size, viz. 1 cm = 100 meters). If cadastral map is not available, you can draw one.

iv) Refer the cadastral map of the area to observe the occurrence and number of individuals of the species (for tree & shrub and animal species like Giant

African Snail) found in the particular grid. Also do the same listing of other (native) tree and shrub species. In case of dense shrubs, if counting of the individual plants is not possible then mark their proportionate area of occurrence in the respective grid.

v) Mark the grids where certain (alien) species appeared or extended for the first time (year/month) in consultation with the guide teacher, village elders, experts and with help of secondary information.

vi) Calculate the frequency, density and abundance of invasive alien species as well as native tree and shrub species with the help of structured data sheets. In case of proportionate area as marked in the grid, you can tabulate the proportionate area occupied by the thickets of the species.

***(II) Assessment of threats/impacts by Invasive Alien Species***

a. List out the native species that are facing competition from alien invasive species in existence, distribution and regeneration in consultation with the local elders, guide teacher, experts and referring secondary information, if any.

b. You can also calculate the proportional area affected by invasive alien species by using the grid map. Referring to above point '(v)' you can also draw the timeline map of spre

c. Collect the information through structured data sheets and interview forms regarding occurrence of fodder species as well as their availability for the local livestock previously as well as currently and the changes in the availability of the fodder plants in the area.

d. To ascertain the impact of invasive alien species on native plants, you can set experiments using their seeds, leaf extracts, root extracts and soil samples etc.

e. You can also ascertain the comparative soil characteristics of the area affected and not-affected by the invasive alien species.

f. Record the anthropogenic factors causing adverse changes (use photographic / mapping tools like cadastral map for marking the reference points e.g. points of human activities; disturbances etc); record human activities affecting the overall habitats, lifecycle and diurnal activities of animals and plants in relation to time and space (grazing pattern, lopping and cutting of local species, mining or industrial emissions/release nearby etc).

***(III) Control measures***

Design options for control / management of invasive alien species and lab / field trials so as to prove the efficacy of the designed measure.

## Calculation

Following are the formulae for calculating different parameters-

**Frequency** = Number of units in which the species occur/ Total number of grids X 100

**Density** = [(Individuals per square unit area) – (Total number of individuals of the species)] / Total area of sampling

**Abundance** = Total number of individuals of a species / Total area of units in which the species found occurring

***(IV) Tabulation and Interpretation***

- Designing of data table will depend on the criteria set for the investigation. For example, to fulfil the part of first objective a suggestive data table is given below for listing of Invasive Alien Species found in the study area -

| S. No. | Name of Species | Scientific Name | CommonName (Vernacular) | Habit of Plant |
|---|---|---|---|---|
| | | | | |

- For compiling the information of occurrence and distribution of each species, the occurrence points in the grid map can be tabulated as suggested in table –

| S. No. | Name of Species | Number of grids in which the species found occurring | Percentage of the total grids in which the species was out of the total study area | Proportional area occupied by the species |
|---|---|---|---|---|
| | | | | |

## Significance

The record of invasive alien species in the country, their total number and impact on native biodiversity has been hardly studied till date. Lack of baseline information about their regional occurrence has been a major hindrance in their proper evaluation and devising control strategies. This study is an attempt to orient the investigators towards addressing the issue.

### *Project 11: How does organic component influence soil properties of different ecosystem?*

## Background

Organic materials are very important to agriculture. Farmers and gardeners use it to increase the nutrients in their soil. Organic materials retain higher amount of water and in turn, supply it to the plants on which they grow. Moreover, organic matter may influence various soil properties like soil colour, pH, organic-carbon content etc. So, studying soils containing different level of inherent organic materials in it will provide a relative idea of water availability, soil colour, organic-carbon content, soil pH etc. Organic material also supply nutrients into soil and plants can take both water and nutrient from soil. This assists better plant growth.

## Hypothesis

Organic components of soil influence soil properties irrespective of ecosystems.

## Objectives

1. To study variation of organic content of soils under different land use
2. To determine the water retention capacity of soils under different land use
3. To determine the colour, pH, organic-carbon content of soils under different land use

## Methodology

### *(A) Materials Required*

1. Select three ecosystems in your locality viz. agricultural, forest and grass lands.
2. Spade/ khurpi, colour chart, wash bottle, sieve set, sample collection bags, paper tags/label, perforated container.
3. Soil test kit for organic carbon

### *(B) Experimentation*

1. Prepare a land use map of your locality
2. Collect representative surface (0-15 cm) soil sample from each land type and land use (for example, forest land, grass land, barren land, steep land, soil under agricultural crops, orchards, etc.). Air dry the samples, grind and pass through 2mm sieve for studying the following parameters-

### *1. Water holding capacity*

1. Take 500g soil sample in perforated containers add the soil slowly followed by tapping so that soil of the container comes to natural compaction.
2. Place beaker under each container to collect the leachate drain out water.
3. Pour measured volume of water from a measuring cylinder to each container and record the volume of water needed to completely saturate the column. Add approximately 100 ml of water additionally to form a thin film of water over the soils of the container.
4. Wait for 12 hours
5. Measure the volume of water collected in the beaker, then subtract this from total quantity of water added.
6. Repeat the experiment three times for soils of each land type/use

## Observations

| ***Land use*** | ***Agricultural land*** | ***Forest land*** | ***Grass land*** |
|---|---|---|---|
| *Replication* | *I II III* | *I II III* | *I II III* |
| ***Observation 1*** *WHC* *Soil Colour* *Soil pH* *Organic Carbon* | | | |
| ***Observation 2****WHC* *Soil Colour* *Soil pH* *Organic Carbon* | | | |
| ***Observation 3*** *WHCSoil* *Colour* *Soil pH* *Organic Carbon* | | | |
| ***Mean value*** *WHC* *Soil Colour* *Soil pH* *Organic Carbon* | | | |

### *2. Soil Colour*

Take a table-spoon of soil and place into individual petri-dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Now compare the colour of the soil with the Munsell colour chart (may be collected from Soil/Agriculture Department) and note their dominant colours (red, brown, grey, yellow, yellowish red etc.). Moist the soil

In colorimetry, the **Munsell colour system**is a colour that specifies colours based on three properties of colour: hue(basic colour),chroma (colour intensity), and value (lightness). It was created by Prof. Albert H. Munsell in the first decade of the 20th century.

with few drops of water and record the moist colour also. Repeat the experiment three times for soils of each land type/use.

***3. Soil pH***

Take a tablespoon of soil and place into individual petri-dishes or any similar glass or plastic containers. Be sure to label each dish properly. Wet each soil sample with 2 tablespoons of distilled water. Allow to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. (Use pH paper with a range from at least 5-10). Determine the approximate pH or acid/base level of your soil. Repeat the experiment three times for soils of each land type/use.

**4. Soil OrganicCarbon (*Kit Method*)**

Take 1 gram of soil in test tube. Add 2 ml of organic carbon reagent I ( 1N $K_2Cr_2O_7$ )and 2 ml of organic carbon Reagent II ( Conc. Sulphuric Acid) in the test tube. After 15 minutes stay, determine the approximate organic carbon content of the soil under experiment from the colour chart matching. Repeat the experiment three times for soils of each land type/use.

| Colour | Oxidizable organic Carbon,(%) | SoilQuality |
|---|---|---|
| Dark green | >0.75 | High |
| Red | 0.50 – 0.75 | Medium |
| Orange | < 0.50 | Low |

## Results

Water drained from the soil was measured exactly 12 hours after the water had been initially added.

Then draw inference of the experiment

## Relevance

The study will throw light on the variation of water retention capacity, colour, pH, organic carbon content of soils under different land type and land use. It will give an idea of importance of organic matter in controlling the availability of water, regulation of temperature due to colour, soil pH and organic carbon content thus nutrient availability for plant growth.

**BOX- 1.2**

**Tragedy of the Commons**

In 1833, the English economist William Forster Lloyd published a pamphlet which included a hypothetical example of over-use of a common resource. This was the situation of cattle herders sharing a common parcel of land on which each of them were entitled to let their cows graze, as was the custom in English villages. He postulated that if a herder put more than his allotted number of cattle on the common, overgrazing could result, which ultimately caused the collapse of the commons. "Tragedy of the commons" is a phrase later coined by Garrett Hardin in 1968 to explain why much of the public-owned land and other natural resources collapsed because of the greed and deeds for short term gains. In our country, this tragedy of the commons plays out daily in our lives in a thousand different ways. At the macro- level our "commons" are our national resources. These include the air we breathe, the land we live on, and our water bodies, rivers and seas.

Many examples can be drawn in establishing how the over exploitation of the natural resources resulted in intensifying the tragedy in the context of natural disaster like flood and drought. We are leaving behind a poor legacy for the future generation. The indiscriminate destruction of the forests in the Himalayas and the Western Ghats intensified the landslides and fury of the flood manifold in the recent calamities. The intensified air pollution in seasons in Delhi and resultant suffering of the inhabitants is another example.

**BOX – 1.3**

**The Ecosystem Approach**

The ecosystem concept is considered as a valuable framework for analyzing and acting on the linkages between people and their environment. The Convention on Biological Diversity (CBD) and the Millennium Ecosystem Assessment (MA) conceptual framework have endorsed the ecosystem approach. The CBD defines the ecosystem approach as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. The ecosystem approach aims to attain a balance of the three objectives of CBD: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The ecosystem approach is based on the essential structure, processes, functions and interactions among organisms and their environment. The approach recognises humans as an integral component of many ecosystems. The ecosystem approach depends on local, national, regional, and global conditions.

**BOX – 1.4.**

**Broader natural and man-made ecosystems in India**

Let us develop an understanding of Ecosystems in India which are both natural and man-made. These could be broadly categorised into:

1. Wetlands, 2. Marine, 3. Coastal, 4. Forest, 5. Island, 6. Desert, 7. Urban, 8. Mountain, 9. Freshwater, 10. Agricultural

Each of these ecosystems can be further categorised. For example, forest ecosystems are of the following types:

- Tropical wet evergreen forests
- Tropical dry evergreen forest
- Tropical moist deciduous forests
- Tropical dry deciduous forests
- High altitude montane shola -grasslands
- Scrub jungle

- Subtropical pine forests
- Himalayan wet/ moist temperate forests
- Himalayan dry temperate forests
- Mangroves
- Sal forests
- Littoral swamps
- Alluvial grasslands
- Dry alpine

## Additional Project Ideas

1. Ecological significance of the ecosystem (forest, river, mountain, tea garden, grassland) and how local people are getting benefit from that ecosystem.
2. Dependency of local people on ecosystem services from the ecosystem
3. An integrated assessment of effects of human impacts on an ecosystem-biodiversity assessment, ecosystem assessment and livelihood assessment
4. Mapping of invasive plant species in various ecosystem and its various alternative uses.
5. Impact of invasive alien plants on terrestrial native vegetation (grasses / gardens / forest)
6. Butterflies/insect diversity in our locality and their role in ecosystem
7. Ecological importance of mosquitoes
8. Monitoring of bird nesting/bat colonies in urban environment
9. Human-wildlife conflict pattern in your locality and its various mitigation methods.
10. Seasonal monitoring diversity of birds and their roosting site around your village.
11. Inventory and monitoring different species of insects visiting the school garden/grassland patch.
12. Seed germination period and performance of different types of soil.
13. How ecosystem services contributing in your neighbourhood.
14. Document ecosystem services monthly or seasonally in nearby areas.
15. Role of spider/ant in the ecosystem

16. Study on the feed plants of local livestock in relation to their sustainable availability
17. Sacred groves as repositories of native germplasm
18. Role of lower plants in local ecology
19. Dust capturing capacity of roadside plants and suggestive measures for creating road-side green belts.
20. Understanding wetland health through diversity and distribution of fish fauna
21. Urban cemeteries as hot spots of local biodiversity
22. Indicator plants for ground water prospecting
23. Symbiotic relationship between two or more species helping each other's life cycle.
24. Study of biodiversity hotspots in urban environment
25. Assessment of living and non-living components of an intermediate zone (Ecotone) and its associated conservation issues.
26. Beach Erosion - causes, impacts and restoration
27. Change in drainage pattern due to land use changes and impact on ecosystem characteristics
28. Grazing and spread of plant species through dung/excreta
29. Invasive alien fishes and their impact on the aquatic ecosystem
30. Study on the natural seasonal changes in a garden or natural grove and impact of anthropogenic activities.
31. Relationship of small mammal species and their host plants
32. Role of sacred groves in regulation of micro-climatic conditions
33. Habitat mapping of mammalian species on the basis of direct and indirect evidences
34. A market survey to estimate potential demand for various medicinal plants in your locality
35. Understanding impact of human in different ecosystems
36. Understanding pollination and role of pollinating insects
37. Non-biodegradable polythene load in selected drainage of an urban area and its impacts.

## Sub-Theme-II

# Appropriate Technology for Sustainable Living

## Sub-Theme-II

# Appropriate Technology for Sustainable Living

***"We are stuck with technology when what we really want is just stuff that works."*** **– Douglas Adams**

### Introduction

Technology has been the driving force of civilization as we know. Earlier, technologies used to be small in scale, responsive to local skills and needs. These evolved slowly over a long period of time and catered to the local needs. Today, the technologies have grown in scale with high production rates, consuming large quantities of energy and resources, requiring large capital and highly-skilled manpower. The high production rate, consuming large quantities of natural resources has been damaging the ecosystem by indiscriminate extraction and the resulting environmental degradation. It is clear that present mode of production is unsustainable and damaging to the society. For example, ill effects of pesticides and fertilizers used in agriculture, have now become the concern of all. Hence, there is need to consider alternative ways of meeting our needs without damaging our ecosystems.

Appropriate technologies (AT) refer to technologies that are adaptable to local needs, acceptable to users and made using locally available materials with the aim to improve the lives and livelihoods of people in resource-constrained environments. Appropriate technology is used to address wide range of issues. The concept of appropriate technology is multi-faceted; in some contexts, appropriate technology can be described as the simplest level of technology that can achieve the intended purpose, whereas in others, it can refer to engineering that takes adequate consideration of social and environmental ramifications and connected to sustainable living.

**Box 2.1**

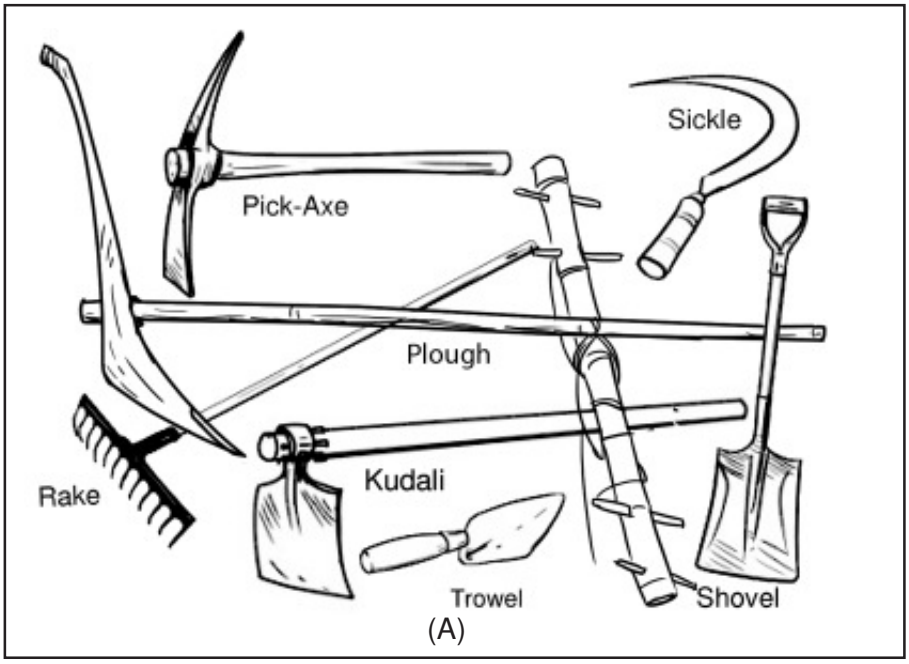
**Characteristics of Appropriate technologies (AT)**

- Require only small amount of capital
- Use of locally available materials
- Relatively labour intensive but more productive than many traditional technologies
- Small enough in scale to be affordable to individual families or small group of families
- Can be understood, controlled and maintained by villagers whenever possible, without a high level of special training
- Can be produced in villages or small workshops
- Suppose that people can and will work together to bring improvements to the Communities
- Offer opportunities for local people to become involved in the modification and Innovation process
- Are flexible, can be adapted to different places and changing circumstances
- Can be used in productive ways without doing harm to the environment

As it is not possible to go back to older methods of production; there is a need to revisit the technological alternatives available and such technologies are referred to as AT (Box-2. I**).** AT is just the technological change(s)/ modification(s) or even innovation to meet the specific need and purposes of the community. It is also a search for suitable technologies that havebeneficial effects on income distribution, human development, environmental quality and the distribution of political power- as well as productivity – in the context of particular communities and geographical regions

In fact, these technologies are developed keeping in mind the people who use it, the context and place of its use. These also enable the community regarding its operation and maintenance. It is adaptable to varying requirements. We can see the existence of many such tools and devices that have been evolved with the need of mankind. It could be a plough, hand pump, stove, handloom, water wheel, wind mill, biogas plant, etc. Many artisanal skills in textile, carpentry,

metal work, pottery, stone work, weaving etc. already exist across rural India. Use of ATs is inevitable for sustainable living and livelihoods. It works on the principle of decentralization of production systems, using renewable energy (solar, wind, or water) to the maximum extent possible. These energy sources are available almost everywhere and need only the right technology to harness those. Locally available energy resources, unlike conventional energy sources like coal and oil, have lesser impact on the environment. Moreover, they do not need to be transported over long distances.




(A)

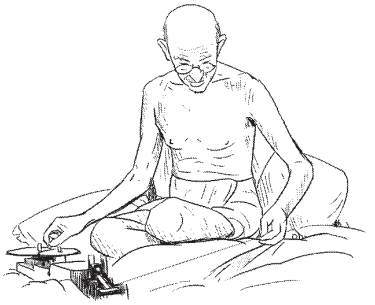
***Fig. 2.1.*** *Pictures showing tools and implements used since (A ) ancient times and (B) the recent technology developed for lighting a rural poor man's house*

Similarly, at local ecosystem level, food, energy, water, and waste disposal are also handled locally by ecological systems. These are systems that conserve resources by recycling organic nutrients back into the soil and re-using manufactured goods in innovative ways. Thus, appropriate technology makes it possible to satisfy our basic human needs while minimising our impact on the environment.

(B)

**"*Technology should empower, not enslave.*" –Mahatma Gandhi.**

Mahatma Gandhi set out to reform our civilization by re-interpreting the central principles in the light of the needs of the present age. He would claim to be extending, deepening, discovering "true meaning". This he did through following three strategies-



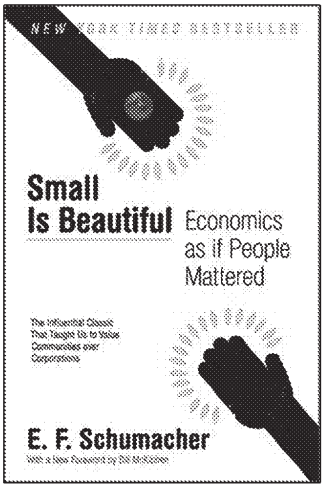
1.Using tradition as resource that we are free to pick and choose

2.Treating tradition to critical evaluation and revision like a scientific theory

3.Drawing upon insights of other traditions

**Small is Beautiful**

A study of economics as if people mattered as Gandhi said, the poor of the world cannot be helped by mass production, only by production by masses. This mobilises the priceless resources which are possessed by human beings, their clever brains and the skillful hands, and supports them with first class tools. The technology of mass production is inherently violent, ecologically damaging, self-defeating in terms of non-renewable sources, and studying for the human person. The technology of production by the masses making use of the best modern knowledge and experience, is conductive to decentralization, compatible with the laws of ecology, gentle in its use of scares resources, and designed to serve the human person instead of making them servant of the machine. I have named it intermediate technology to signify that it is vastly superior to the primitive technology of bygone ages but at the same time much simpler, cheaper, and freer than the super-technology of the rich. One can also call it self-help technology, or democratic or people's technology to which everybody can gain admittance and which is not reserved to those already rich and powerful.



It is admitted on all hands that the poor of the world cannot be helped by mass production, but only by production by the masses. This mobilises the resources which are possessed by human beings. It is also admitted that the technology of mass production is inherently violent, ecologically damaging, self-defeating in terms of non-renewable sources. Hence, people need such small and effective technologies which evolve out of the available resources by the community and for the community. So, these technologies, as termed Appropriate Technology, are usually small. And as E. F. Schumacher, the renowned economist correctly mentioned 'Small is Beautiful.' However, it needs to be clear enough that the AT is NOT restricted to only design and development of tools, but new methods and technique also.

The expected outcomes of a technology are compared to a list of characteristics generally associated with "appropriateness." These characteristics are defined in terms of the expected socio-economic impacts on the poor in rural and/or urban areas, and the environmental impacts. Technology specifications lists are also subjective and often considers short-term and long-term impacts

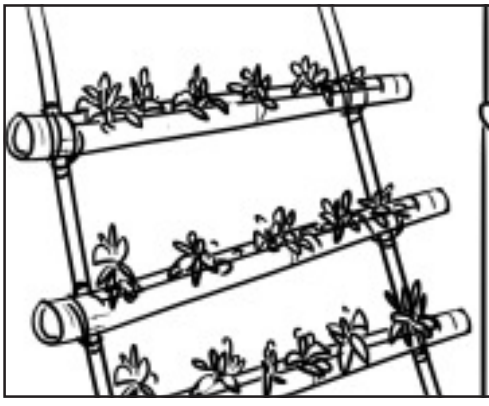


**Fig.-2.2.** Hydroponics

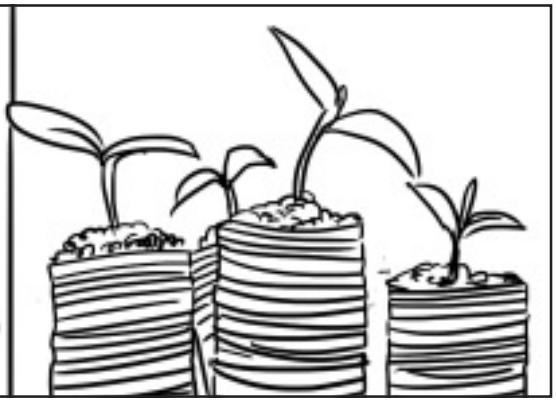


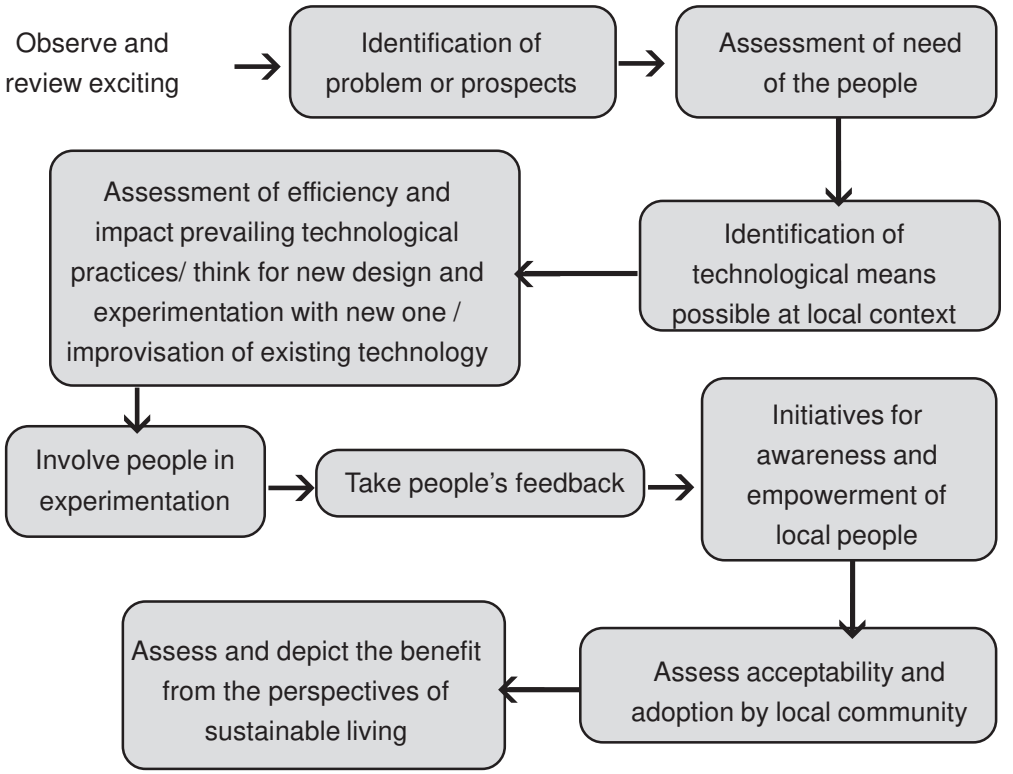
**Fig.2.3.** An eco-friendly technology for raising seedlings

## A. **Concept of Appropriate Technology in Sustainability Framework**

Appropriate Technology based development focuses on development within an ecosystem limit with emphasis on regenerative development to strengthen the process of self-reliance of the community with appropriate Science and Technology Literacy and Eco-literacy. In the process it stresses on developing knowledge and skill of community on scientific understanding of daily work and

life and equally ecological understanding of their context, so that appropriately they can design their daily walk of life with more hand print and reduced foot print. In order to make it more efficient, it leverages through appropriate technology design which is developed locally, as per their requirement. Here, technology is designed with principle of minimalism, energy efficiency, more option of renewability, regenerative cycle, more user friendly so that everyone is empowered through the process of its application. Entire inquiry-based learning in the context of AT followed a framework as mentioned below.

## B. **Frame work**




## C. **Focus**

No technology by itself can be considered as Appropriate Technology as it is always with reference to the context. An 'appropriate technology 'in one place may be inappropriate at another place. Hence, the understanding the local context is to be used and evolved accordingly.

Some of the areas where appropriate technologies are widely used are:

I. Water
II. Renewable Energy
III. Transportation
IV. Agriculture
V. Habitat
VI. Livelihoods
VII. Disaster Management
VIII. Food preservation
IX. Education.

**Box- 2.2. Footprints and handprints**

The **Environmental footprint** measures human demand on nature and its impacts. This serves as composite measure of the negative impact of human endeavour on the environment.

This is made up of several specific footprints like **carbon footprint** ($CO_2$ emission due to fossil fuel), **water footprint** (per capita consumption of water, direct and indirect), **ecological footprint** (Quantity of nature it takes to support people) etc. Hand prints are about the positive actions we take now to reduce the footprint.

*Human ingenuity is required 'now' to increase the handprint and reduce the footprint and assume human scale.*

'We can think of the difference between handprints and footprints in these simple terms: Footprints are the negative consequences of all that it takes to sustain a person or an organisation for a year—the total planetary "cost" of your presence.

Handprints represent the benefits of your presence: they're the positive changes that you bring into the world during this same year. If footprints are what we unavoidably take, handprints are what we intentionally give'.

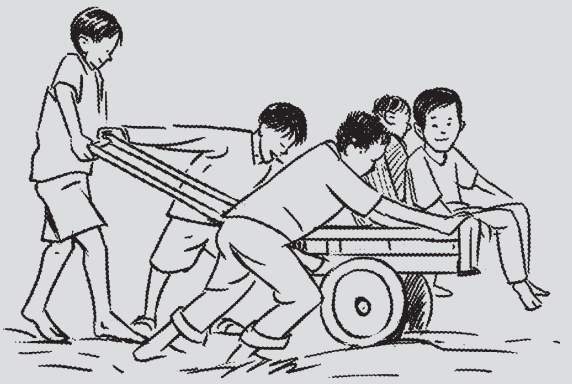
*The image of our limb prints resemble that of a Jurassic creature with huge footprints and small hand prints, with voracious hunger.*

Appropriate technologies are a way of enhancing our hand prints.

**Traditional Knowledge Systems and practices are rich source of examples for Appropriate Technologies**.

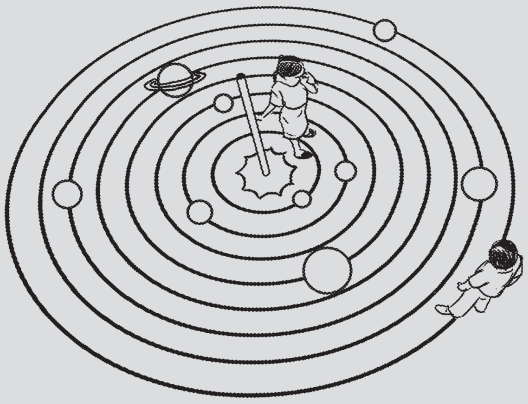
**BOX-2.3**

Traditional Technical Knowledge (TTK) is related with design and uses tools and implements in day-to-day life, including design and construction of traditional housing, boat, musical instruments, etc. TTK always works along with Traditional Ecological Knowledge Systems (TEKS) and Traditional Values and Ethics (TVE)Some important areas of TKS which children need to be exposed to and encouraged to explore are – traditional agricultural planning, crop calendar, traditional cultivar, agro-biodiversity, seed preservation, crop storage, post-harvest processing, forestry practices, sacred flora and fauna, ethno-medicinal practices, non-cultivated edible sources, water conservation, traditional housing, handloom practices including traditional design and its association with nature and environment, social institutions, cultural activities linking to cropping cycle etc. Such exposure may help the learner to gather many information about local practices linking environmental stewardship, social responsibility and community-based sharing, cultural practices, its sources and meaning etc. At the same time, it will help to accrue idea and skill on climate change adaptation, disaster risk reduction and designing a sustainable life style.4



**BOX-2.4**

BaLA – Building as a learning aidIt is about reimagining school as space for children. BaLA is about developing the school's entire physical environment as a learning aid – the inside, the outside, the semi-open spaces – everywhere.At the core, it is about maximising the educational 'value' of a built space. It is based on 'how children learn'. Building as a Learning Aid (BaLA) aims to use the built elements like the floor, walls, pillars, staircases, windows, doors, ceilings, fans, trees, flowers, or even rainwater falling on the building as learning resource. This is Appropriate Technology at work.



*Learning, Playing, Acquiring life skills Adaptation*

**BOX-2.5**

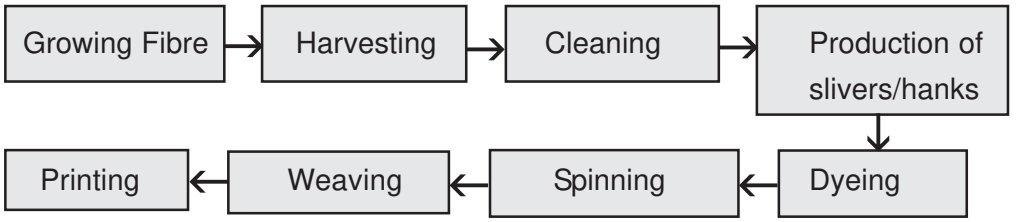
**Teaching Science by Creating Toys from Trash** – Aravind GuptaFor almost 30 years now, Arvind Gupta has been taking his love for science and learning to the children of India. He's the dream teacher we all yearned for. Gupta has travelled to over 3000 schools, demonstrating captivating science experiments to wide-eyed children. What sparks their imagination further is that Gupta uses only everyday garbage as the building blocks of these experiments. "All teaching aids we use are hand-made. It is important for children to see that you don't need fancy materials. Science can also help you look critically at materials that are often considered trash, there is a lot of learning in that itself"

## .Example from community

### *(i) Vibrant fabrics of India*

India was a pioneer and world leader in textile making. Inventions of machines for large scale production of textiles saw India lose its prominent place besides loss of livelihoods in the sector. Today, there is renewed interest in these traditional practices because they are inherently sustainable, capable of creating local employment and livelihood options and are safe for the environment.

Production of fabric from growing fibre to making cloth involves several processes. These vary from place to place to cater to local availability of fibre, community aspirations and constraints, existing materials and skills etc. Hence, there is a scope for understanding and appreciating the practices in local context and if possible improve upon it.

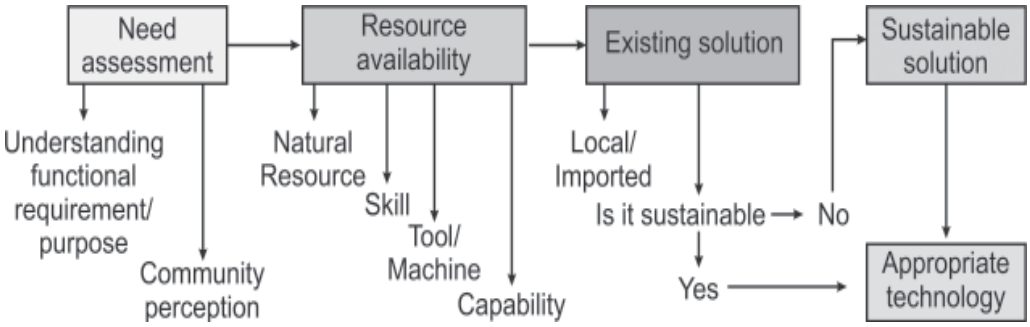



### *(ii) Traditional fishing practices*

Fish farms provide a major part of food for large number of people. A large population in India is engaged in harvesting fish. Though traditional practices exist, commercial fishing has emerged in a big way dominating the fishery sector. Large scale mechanized fishing is found to be unsustainable and damaging to the environment. Traditional practices of fishing demonstrate a

good understanding of behaviour of fishes, their reproduction cycle, seasonality, use of local materials and skills to catch them and sustainability of resource. Each part of the country shows diversity in practices to suit the local context. Hence, it is increasingly relevant today to revisit, study, understand and appreciate traditional practices in fishing and explore scope for improvement of different nets, tarps, methods, sacred pools, sustainable harvesting etc.

Thematic examples are given to improve the focus. Appropriate technologies also work on synergies. They tend to address several issues simultaneously. Suggested steps for identifying and approaching AT solutions.

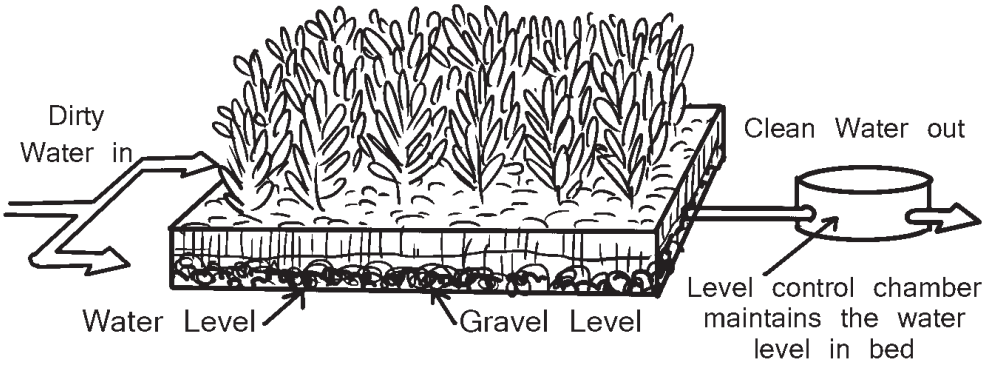



## Model Projects

### *Project -1: Waste water treatment using reed bed*

### Background

Water is basis of life and fresh water is becoming scarce day-by-day because of different reasons. Some uses like drinking, cooking and washing require good quality water while other uses like gardening, flushing of toilet can be possible with poor quality water. Hence there is need to conserve, recycle and reuse water to reduce fresh water requirement in the house. Fresh water used in the house can be treated and reused for secondary purposes at the household level.




## Objective

To assess the efficiency of biological treatment system in treating household grey water for reuse

## Methodology

### (A) Materials required

Drum / tub, pebbles, pH strips, test tubes & chemicals, cow dung slurry, plants

### (B) Experimentation

The experiment is to be conducted step-by-step as described below-

- Take a used drum /tub (approximate capacity of 200 litres) and make suitable inlets and outlets (figure needs to be included)
- Fill the drum / tub with pebbles up to 75 % of its capacity
- Collect the grey water from the household in a suitable container
- Assess the quality of water by studying pH, colour, odour, ammonia, sulphide etc. (whichever is feasible)
- Known quantity of water needs to be passed on to the drum and allow it to retain for a week time
- After four days, outlet water may be assessed for the same parameters which has been measured earlier at different time intervals (2, 4, 6 , 12, 24 hours etc.)
- Repeat this for three times for standardising the same
- Next step is along with the same set up and requires to add cow dung slurry or any micro-organisms into the pebbles and repeat the same experiment

- Suitable aquatic / terrestrial plants viz., Canna, Salvinia, Grass or any locally available plants etc., can be grown over the same set up and repeat the experiment
- Observe the change in parameters of water quality by analysis, collect the data and draw the inferences

### Outcome

- Understand the efficiency of different biological treatment systems
- Understand the scientific principles involved in water quality monitoring, analytical skills, interpretation of observed data and ultimately understanding the mechanisms of natural wetland

## *Project - 2: Preservation of food products by drying*

### Background

Food availability in nature is seasonal. In order to make it available off season, it needs to be preserved. One of the simplest methods used is drying. Fish, meat, vegetables, fruits herbs etc. have been dried and used since antiquity. Present project tries to understand the dynamics of drying process under varying conditions

### Objective

To understand the dynamics of preservation of food by drying

### Methodology

**(A) Materials required**

Food products, tray, thermometer, weighing scale

**(B) Experimentation**

This is to be conducted step-by-step as described below-

- Select the material to be dried from the locality (e.g. ginger/ fish etc.).
- Prepare a tray (metal, bamboo, wood) of a convenient size (square or round).
- Keep the material to be dried in the tray and keep it in a shade outside the house.
- Measure the temperature at the tray and weight of the tray and product every one hour and measure the ambient temperature also.
- Repeat the experiment by keeping the tray in Sun and record the values.
- Upgrade the tray with a glass /plastic cover (with adequate ventilation) and repeat the experiment.
- Draw graphs of time Vs temperature and time Vs moisture.
- Observe – explain the change in the rate of drying in different systems.
- Suggest the methods to improve the performance.

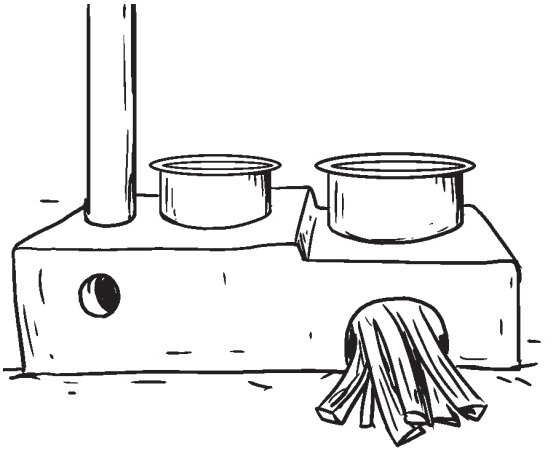
## Expected Outcome

An understanding of the dynamics of the process of drying and the influence of various parameters involved.

## *Project - 3: Performance Assessment of Biomass based Cooking Stoves*

### Background

Biomass is traditionally used fuel for cooking in most part of rural India. Biomass in form of twigs of tree branch, tree leaves, waste biomass, bio-residue like rice straw, cotton stalks etc., are used in traditional cook stove in the rural areas. Biomass cooking stove is heated by burning wood, charcoal, animal dung



or crop residue. These types of stoves are the most common way of cooking and heating food in developing countries. Varieties of cooking stoves in terms of its design, purpose and available resources in that particular area are in use. Biomass burnt in these stoves to generate heat energy, which is used for boiling of water and cooking of food items. In this study, students will assess the various cooking stoves in terms of design available in the neighbourhood.

## Objectives

1. To assess the design variations in the various types of biomass based cook stoves.
2. To assess the performance of various types of biomass based cook stoves.

## Methodology

### (A) Materials required

Different types of fuel and stoves, thermometer, weighing scale

### (B) Experimentation

The experiment is to be conducted step-by-step as mentioned below-

- Identify the different types of cooking stoves that are in use in the neighbourhood and marked with A, B, C
- Identify the design variations of all these stoves and identify the significant variations in the design.
- Consider at least three different types of fuels and pot for boiling of water for all different cook stoves.
- Boil one litre of water. Note the initial water temperature and time taken to raise the water temperature to 100 0C. Also note the amount of biomass consumed during this period of time.
- Repeat the experiment at least three times for each case.

## Expected Outcome

1. Understanding the performance of each type of stoves for different type of biomass fuels.
2. Understanding the scientific rationality and the difference in performance among the different type of stoves and fuels.

## *Project -4: Potential of charcoal for sustainable agriculture*

### Background

Charcoal can be used as a soil amendment for improving its properties. It improves water retention capacity, soil fertility, increases the microbial population and ultimately improving the plant growth and productivity. Application in soil also leads to carbon sequestration, as carbon captured by the plants from the atmosphere are buried in the soil for a long time

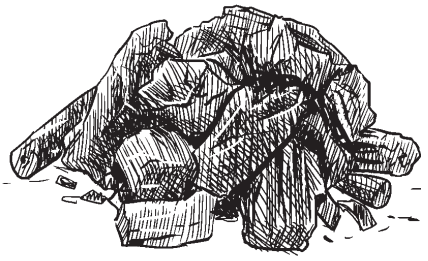
### Objective

To assess the impact of charcoals on water retention properties and plant growth

### Methodology

***(A) Materials required***

Charcoal, pots, plant seeds



**(B) Experiment**

This is to be conducted step-by-step as described below-

- Take 5 pots and fill it with same type and quantity of sand or soil
- Add 0 (control), 5, 10, 15 & 20 g of uniformly powdered charcoal in each pot and mix it uniformly
- Irrigate the pot with the same quantity of water slowly and measure the quantity in outlet and quantify the same.
- In addition soil moisture at periodical intervals (4, 8, 12, 24 hours) may be estimated by difference in weight (gravimetric method)
- Sow the seeds of any vegetable in the pot (three to five plants as replicates)
- Study the growth pattern over the period of time viz., germination per cent, plant height, number of leaves, number of branches, leaf area and yield (if time period permits)
- Collect the data, analyze the same and draw the inferences

### Outcome

Understand the impact of charcoal on water retention properties and plant growth

## *Project -5: Comparative study of thermal performance of traditional and modern houses*

### Background

Traditional houses were inherently responsive to the local climate. They were built with simple materials but sophisticated thinking to make them comfortable and liveable with changing seasons. Modern construction by contrast is not responsive to climate and requires lot of external energy to keep cool. The purpose of the project is to compare the thermal performance (during summer and winter months) and evaluate their suitability.

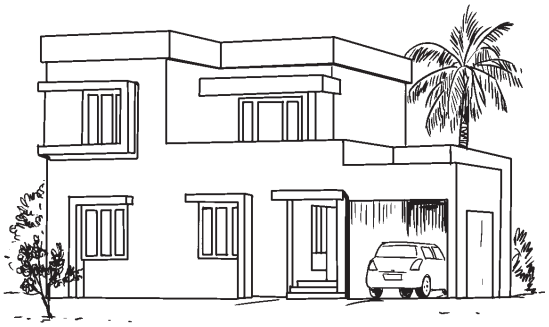
### Objective

Evaluate the thermal performance of traditional and modern houses

### Methodology

**(A) Material required:**

A laboratoryThermometer



**(B) Experimentation**

Step-1: Select a single storied traditional house and modern house for the study with the same area

Step-2: Measure the temperature outside and in various parts of thermometer at suitable intervals (of half an hour or 1 hour)

Step-3: Draw graphs of Temperature vs.Time

Step-4: Compare the two systems for thermal comfort

Step-5: Inference: Relate the result to the materials of construction and design of the house and scientific reason behind it

## Expected Outcome

Understand the thermal performance of traditional and modern houses and the scientific reasons behind the differences

## Additional Project ideas

1. Design optimization of solar cooking system
2. Use of traditional methods of storing food grains
3. Use of simple ropeways for transportation of materials
4. Use of natural additives in making handmade paper resistant to insect attack
5. Foot operated pumps for water lifting / energy efficient water lifting devices
6. Accessories for rainwater harvesting systems to prevent initial dirty water entering the storage
7. Technology for Aquaponics / hydroponics for fodder –livestock
8. Use of micro / wick irrigation method
9. Community-based warning system for natural disaster
10. Community-base warning systems to avoid human-animal conflict
11. Low wattage solar pumping system for domestic water lifting
12. Comparative study of different types of fishing traps/gear used in traditional systems
13. Study on floating decks for growing food crops on water bodies
14. Performance study of e-rickshaw
15. Water lifting/ power generation from hill streams
16. Managing drinking water during flood
17. Evaluation of impact of a new technology replacing the old practices/ technology in day-to-day life
18. Studying an existing cottage industry in our locality, evaluating needs and constraints and suggesting solution
19. Traditional water harvesting in arid region and their relevance
20. Harvesting water from atmosphere

## Sub-theme-III

# Social Innovation for Sustainable Living

## Sub-theme-III

# Social Innovation for Sustainable Living

"***The betterment of society is not a job to be left to a few. It's a responsibility to be shared by all.***" **– David Packard**

***It is about 'new idea that works'***

### Introduction

***A*** social entrepreneur from Tamil Nadu Mr. Arunachalam Muruganantham invented a low-cost sanitary pad making machine, and developed grass-roots mechanisms for generating awareness about traditional unhygienic practices followed during menstruation, particularly in urban slums and rural India. In fact, the film,' *Pad Man* ' released in 2018 popularised sanitary pad among the women for their safe reproductive health and hygiene, also depicted about the prevailing taboos and stigmas on such natural phenomenon of womenfolk.


Perhaps, *Pad Man* is one of the finest success stories of our times that show how a minor innovation can bring about major change in the life of women. When a small innovative step leads to a great impact on the society at large, such an innovation is known as social innovation. It means- '***It is about new idea that works'.***Thus, social innovations are new idea(s) viz. products, process, services and models that simultaneously meet social needs and create new social relationships or collaborations. In other words, these are the innovations which are both good for society and enhance society's capacity to act (Murray, *et al*., *2010).*

Some social innovations have found way in mainstream due to their immense utility for one and all. For example, some of these have successfully managed to integrate *Divyangjan* (Specially able) into the society by helping them overcome their challenges. The smart white cane specially designed for the visually challenged, detects obstacles to help them to navigate easily.

Similarly the Swachhta Abhiyan has led to a significant behavioural change which has been witnessed by everyone. These are the indicators of the society's capacity to act. It is noteworthy that catering to the need of the multi-linguistic requirements of our country is one of major factor behind success of Swachhta Abhiyan. So involving community through proper socio-cultural interlinks where one can accept the programme as their own is an another important dimension of such social action related drive.

Ecology, economy and society being three pillars of sustainable development, act as a support system not only in the life of an individual but society at large. In context of the proposed focal theme society is interlinked with science and sustainability. In the process of this linking, society plays a dual role, that of a benefactor as well as of a beneficiary. When society, through the usage of science or innovation impacts the sustainability, it is acting as a benefactor, whereas when sustainable living influences the social network, it becomes a beneficiary. Such innovations when fulfil societal needs, are termed as social innovations.

There is a growing consensus among practitioners, policy makers and the research community that technological innovations alone are not capable of overcoming the social and economic challenges modern societies are facing. Social innovations appear in a variety of forms and influence our lives. They change the way we live together, travel, work, or handle crises, and they are driven by different societal sectors and cross-sectoral networks (Howaldt *et al*, 2017). Environmental damage, resource scarcity, and persistent poverty for a significant section of the population have clouded the country's focus on economic growth over the past few decades and social innovation can address deep-rooted economic, environmental, and social challenges via innovative processes and community engagement (Prasad and Manimala, 2018).

Social innovation is used globally to describe and identify quite different activities that are focused on compelling social problems and equally compelling social values. The urgency of addressing these compelling social problems calls for new and decisive solutions (innovations) that have both the intent and effect of equality, justice and empowerment. These innovations are found to be a novel solution to a social problem, that is more effective, efficient, sustainable, or just than existing solutions and for which the value created across primarily to society as a whole rather than any particular individual.

More recently, there is an emerging literature that focuses on learning from frugal or '*jugaad*' approaches to innovation, which is about improvising solutions to problems using scarce resources, based on a rich understanding of local needs. These frugal approaches to innovation are now impacting on societal ideation processes, where frugal approach is an approach of innovation or engineering process to reduce the complexity and cost of goods and its production.

Another way to understand social innovation is to peep through the lens of needs. The Social Innovation Exchange, for example, emphasises on finding new ways to 'meet pressing unmet needs.' Thus, the social in social innovation can refer at a minimum, to values, needs, well-being, and social impact that demonstrate its complexity and multi-faceted nature. In fact, an understanding of social innovation needs to have a historical perspective as well as all successful traditional knowledge evolved as innovative attempts to solve problems that

existed at those points of times. Thus, Traditional knowledge (TK) is a source of innovation both within the local context of TK communities and outside.

Since there is no single, commonly agreed definition of social innovation, it reflects the fact that social innovation is predominantly a practice-led field in which definitions and meanings have emerged through people doing things in new ways rather than reflecting on them in an academic way. Social innovation encompasses a very broad range of activity, which includes the development of new products, services and programmes; social entrepreneurship and the activity of social enterprises; the reconfiguration of social relations and power structures; workplace innovation; new models of local economic development; societal transformation and system change; non-profit management; and enterprise-led sustainable development (Pue, Vandergeest and Breznitz, 2015).

As an agent of social change, social innovation contributes to: (i) satisfy human needs that would otherwise be ignored; (ii) empower individuals and groups and (iii) change social relations. In order to witness these changes, science and technology is playing a significant role.

In present age of digitalisation, technology is not only being used for its application to improve the quality of life but also to empower the end users, wherein service providers of the technology act as catalyst to the changes taking place. Social entrepreneurs, or those who use innovative approaches to social problems such as poverty, lack of access to healthcare in rural areas, difficulties in bridging the gap between employability and unemployed youth, and problems such as lack of access to credit for women. In these and other cases, technology plays a

prominent role. Not only is technology inherently innovative but also it has become increasingly cost effective to deploy technology to solve social problems.

The Information and Communication Technology (ICT)-enabled social innovations have been assisting farmers, who need real-time updates on weather patterns as well as sowing schedules so that they can plan harvest accordingly. Further, fishermen in coastal areas need to be intimated of approaching storms and hence mobile-based apps that can do this job are preferred. Some other applications of these innovations include IT-based kiosks in rural areas wherein people, teenagers and the youth in particular can pick up IT skills, which would enhance their employability in future. Moreover, through mobile apps, micro-credit institutions and the people they finance can keep in touch with each other leading to better credit utilisation as well as repayment.

People make use of science and technology in everyday for household purposes. The emergence of electricity brought people to an entirely new world. The domestic appliances help people economize time, money, and effort. The integrated communication system also created a way to end the gap of no communication or miscommunication. The internet provides people the entertainment as well as the information they need on a daily basis. It is interesting to note that how existing technologies are put to innovative use by fishermen in trading of their catch while still being at sea and directly unload the catch to those markets which offer better returns compared to others.

The advancement of technology brings unprecedented improvement in the field of medicine too. A lot of diseases considered incurable before are now treatable, and medical procedures have become more reliable and safer. Remote medicine or Tele-medicine is an

innovative way for the poor to access expert medical help and screening followed by customised and precise referrals to speciality hospitals. Most of the times, it is these innovations which make technology accessible to the poor rather than the technology itself which qualify for social innovation and we need to understand the difference between high-tech S&T and innovative delivery mechanisms.

However, every coin has two sides. Though there are increasing problems from the rapid advancement of technology and its misuse, disregarding its means is not justifiable. Thus social innovations make the advancement of science and technology more accessible, creating better opportunities for people who need help leading to better quality of life.

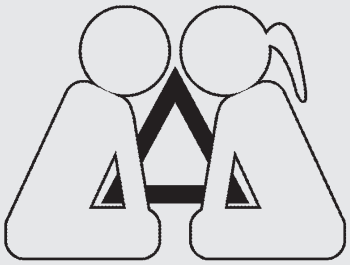
Taking a cue from the examples mentioned hereinabove, teacher guides and child scientists may look around for what social innovation strategies, approaches, or techniques have been impacting the lives in the society and how? Identifying a research problem and working on it would be quite simple, once the context of the problem converted into an opportunity leading to practical solutions is analysed and understood.

*Indicators of the activity of innovation are not as well developed as those for research and development in science and technology, or technological innovation, in short. Development of social innovation has greater potential for social impact because this innovation is not confined to the laboratory; it is a market place phenomenon and has more immediate impact than research and development that can take years to effect change through technological innovation.*

**Box- 3.1**

**Brief History of Social Innovation**

**Social innovations** are new social practices that aim to meet social needs in a better way than the existing solutions, resulting from working conditions, education, community development or health. These ideas are created with the goal of extending and strengthening civil society. Social innovation includes the social *processes* of innovation, such as open source methods and techniques and also the innovations which have a social purpose—like activism, online volunteering, microcredit, or distance learning. The innovation should be at least "new" to the beneficiaries it targets, but it *does not* have to be new to the world. It focuses on the process of innovation; more precisely in relation to how innovation and subsequent influenced new work and new forms of cooperation especially on those who work towards the attainment of a sustainable society.



In 1060s social innovation was discussed in the writings of Peter Drucker and Michael Young, founder of the Open University. It also appeared in the work of French writers in the 1970s. However, the themes and concepts in social innovation existed even long before. Benjamin Franklin talked about small modifications within the social organisation of communities that could help to solve everyday problems. In recent years, social scientists rediscovered the work of Gabriel Tarde on the concept of imitation in order to understand better the social innovation and its relation to social change. Othertheories of innovation have become prominent in the 20th century, and many of which had social implications, without putting social progress at the centre of the theory. Beginning in the 1980s, writers on technological change increasingly addressed how social factors affect technology diffusion and how social innovations are dependent on history and the change in institutions like-*Charter Schools, Community-Cantered Planning, Emissions Trading, Fair Trade, Habitat Conservation Plans, Individual Development Accounts, International Labour Standards, Microfinance, Socially Responsible Investing, and Supported Employment*

## Focus

Social innovations move through '4i' process


The social challenges that we are facing range from climate change to ageing societies, poverty, social exclusion, migration and social conflicts. The main focus of social innovation is on the fundamental transformation of the social system and the structures that support it. In other words, transformation of the order as well as institutional structure of society.

The strength of such a concept of social innovation grounded in social theory is that it enables us to discover how social phenomena, conditions and constructs come into being and transform. The countless and nameless inventions and discoveries change society and its practices through equally countless acts of imitation and only as a result do they become a true social phenomenon.

Social innovations open up opportunities for the development of new social practices.

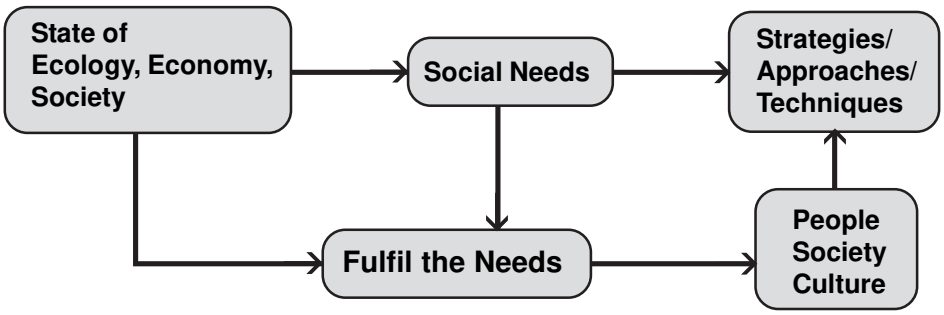
An innovation is therefore social to the extent that it varies social action and is socially accepted and diffused in society (be it throughout society, larger parts, or only in certain societal sub-areas affected). Like any innovation, social innovations too, regardless of the intentions, are in principle ambivalent in their effects and new social practices are not the "right" response to the major social challenges and the normative points of reference and goals associated with social transformation processes. With their orientation to the solution of social and ecological problems that cannot be sufficiently dealt with via traditional forms of economic and government activity, many social innovations to a certain extent carry out repair. Social innovations open up opportunities for the development of new social practices.

All social innovations move through a "4i" process: an idea, intervention, implementation, and finally impact (Hochgerner, 2012). A social innovation cannot be considered as such until it has reaches the final stage – impact. Until a social

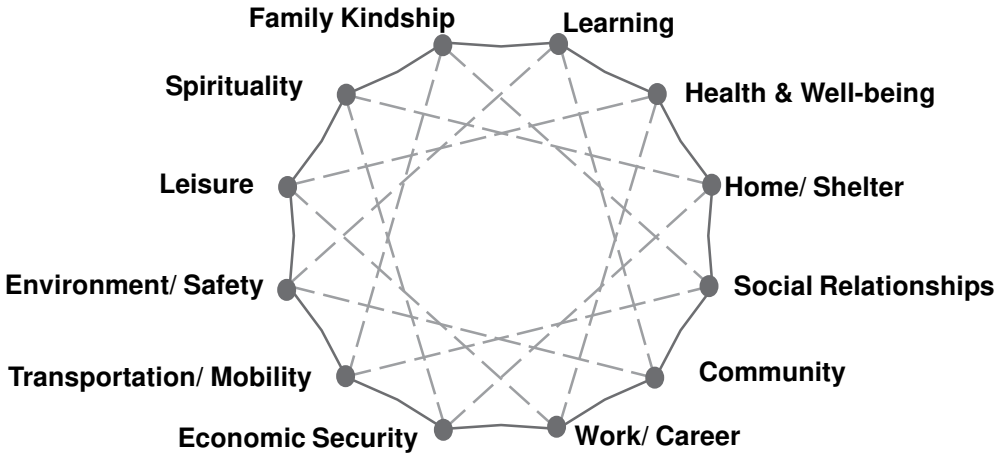
innovation has some form of effect, it is merely an ananidea. For Social Innovation to be effective in creating an impact, it must follow the following criteria:

1. It must be new or fresh or novel
2. It must address a social challenge
3. The intent must be to create equality, justice and empowerment
4. The effect or end result must be equality, justice and empowerment.

## Framework




The focus of the present context would therefore be on the basic needs of any individual, who is the unit of a society. Thus, the scope of this sub-theme would basically be to satisfy one or many of these needs through social innovation approach.




**(A)**

Basic social needs
where innovation could be thought of

- Food
- Clothing
- Shelter
- Livelihood
- Healthcare
- Education
- Communication
- Transportation

(B)

***Fig. 3.1.*** *Twelve Basic Needs (A) and Basic Social needs (B)*

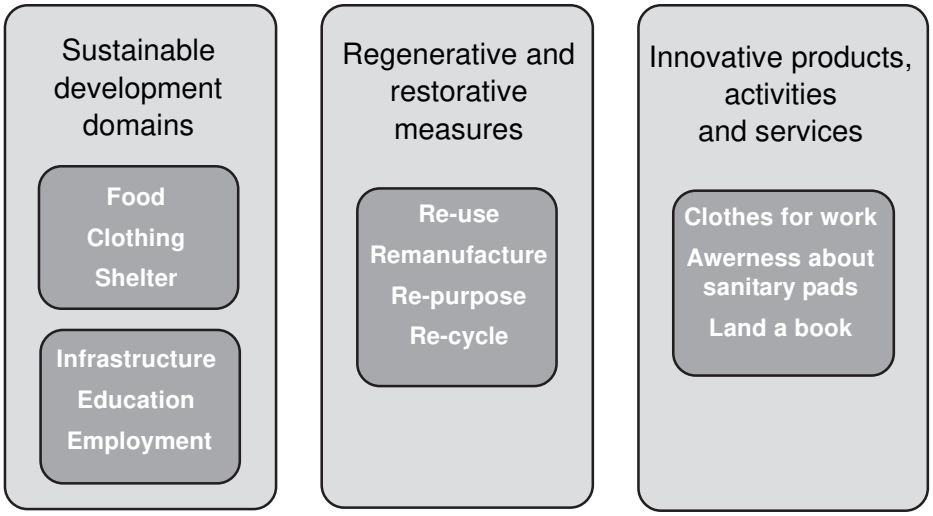



***Fig. 3.2.****Schematic diagram showing relationships among 4Rs and innovative products towards sustainable development*

## Model Projects

### *Project – 1: Observe Earth Hour Every day for Illuminated Future*

### Background

Earth Hour is a worldwide movement organized by the World Wide Fund for Nature (WWF). The event is held annually encouraging individuals, communities, and businesses to turn off non-essential electric lights, for one hour, from 8.30 to 9.30 pm on a specific day towards the end of March, as a symbol of commitment to the planet. Since 2007, when it was started, it has grown to engage more

than 7000 cities and towns across 187 countries and territories to raise awareness on energy consumption and effects on the environment.

## Objectives

- Sensitize and create awareness among the society at large
- Realize optimal use of limited resources
- Save energy, environment and economy

## Methodology

- Collect information (e.g. from 20 households) on energy consumption, to form a baseline or primary data
- Keeping 10 households as control, do not change their pattern of energy consumption
- In remaining 10 households, observe Earth Hour on daily basis, by switching off the lights for one hour, between 8.30 and 9.30 pm, for a period of minimum one month
- After one or two months of observance, compare the energy consumption patterns in both the groups

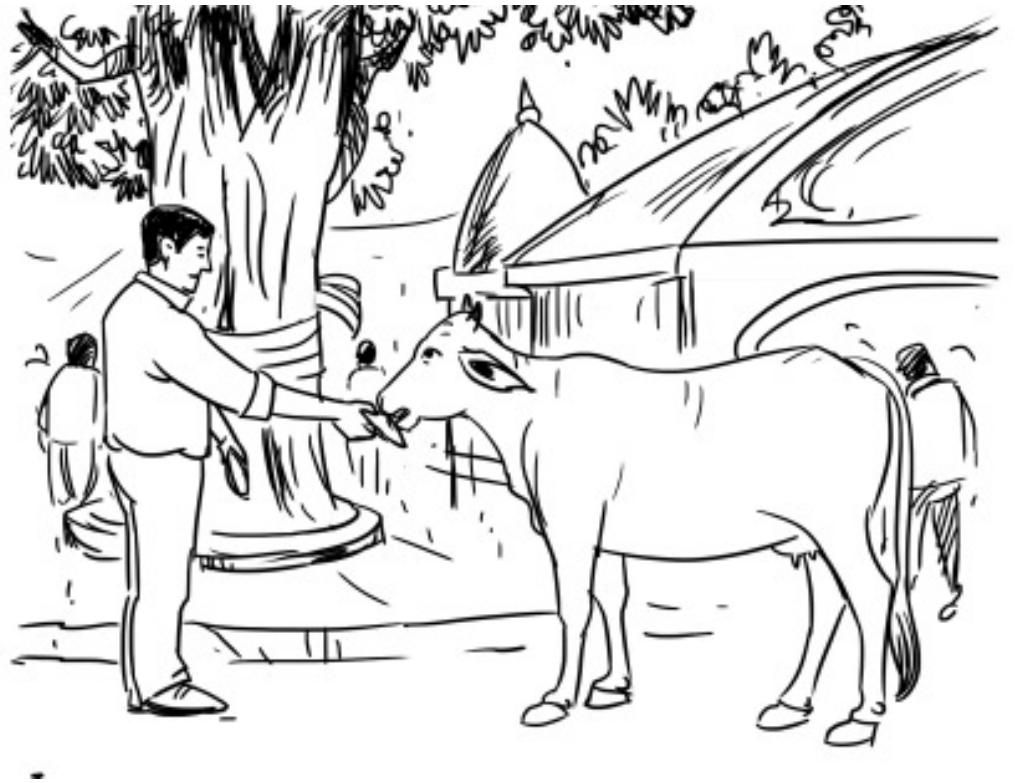
### Expected outcome

- A small change could lead to big savings of energy and economy, thereby saving environment
- With such sensitisation, an initiative of creating awareness among other households would take the message far and wide

### *Project – 2: Our Local Eco-cultural Tradition and Sustainable living*

### Background

Every place has its own unique eco-cultural practices / traditions. With the passage of time, many of these are getting lost. For example, every town has religious places and outside those, one can witness presence of bovines standing and feeding on green grass being offered by the visitors. The owner of the bovine provides grass, grown on his/her own fields, to you for a price; thereby making it a sustainable process. Can there be anything more innovative as an extension to this practice?



## Objectives

1.Come up with an innovative idea for making existing tradition / practice sustainable
2.Work out strategy for the benefactors and beneficiaries
3.Must reinforce three arms of sustainability: environment, economy, and society

## Methodology

Followings are the steps to conduct the study-

1. Identify and understand the eco-cultural tradition prevalent in your locality
2. These could be related to biodiversity / sacred groves, natural resources, water bodies, animal husbandry and the likes
3. Collect detailed information on any one aspect (e.g. feeding grass to bovines outside temples)
4. Assess pros and cons in today's context
5. Normally animals fed outside temples are indigenous breeds producing very less amount of milk
6. Though they yield less mild, these animals are hardy, disease resistant and have different composition of milk
7. Collectively, such animal owners form an unorganized sector
8. This sector can possibly be organized through innovative approach such that each member of the group is economically benefitted (pooling of milk from all the members and supplying locally)
9. Compare the milk composition of these indigenous animals with that of hybrid animals, economics of health-related expenses incurred, and so on.

## Expected outcome

1. In the present example, organising (bringing together) the unorganised sector would make the venture sustainable for every one
2. Quantity vs. quality and cost benefit analysis of the model developed would be a great learning

## *Project – 3: Rainwater Harvesting in our School*

### Background

Rain is an important and the only source of water which plays an active role in hydrological cycle. It is also the medium with which water gets recharged in the ground. In urban communities and towns, water keeps running off from rooftops but does not percolate into the ground. Instead, it reaches the ocean through runoff. Rain water harvesting is a method of collecting and storing the water in natural reservoirs or tanks and recharging the aquifers. Because of underground water getting depleted, there is a continuous scarcity experienced in a region which makes us think on how to collect the water which is otherwise getting wasted as surface run-off. Rainwater harvesting from the rooftops is an excellent method which helps in accumulation and storage of rainwater for reuse.

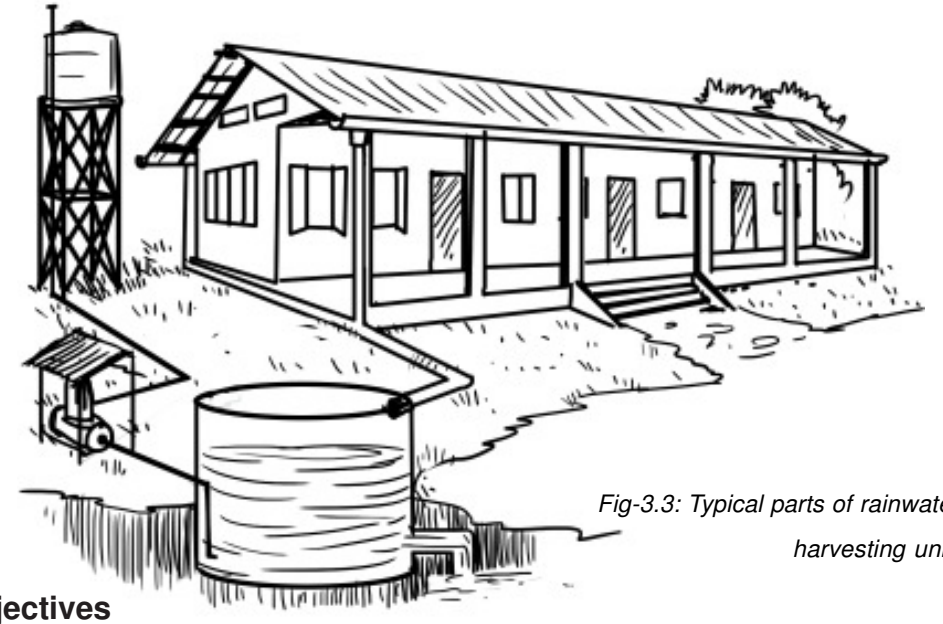


*Fig-3.3: Typical parts of rainwater harvesting unit.*

### Objectives

To practise rainwater harvesting:

1. by understanding the concept and importance of water conservation through collection of rainwater.
2. by understanding the concept of recharging of water
3. developing an approach and methodology to practice it as per the building type.

## Methodology

1. Decide the building or area where rainwater harvesting is to be introduced. The orientation of each building should be such that it maximizes the chances of collection of water. Identify the area where the rainwater can be collected and stored through wells and storage recharge bore-wells.
2. Scientifically water is collected through funnels using infiltration techniques.
   a. Identify the catchment area
   b. Identify where water is going to drains and becoming waste water.
   c. Water from the rainwater pipe from the roof can be collected and passed through the filtration system so that it retains its quality and could be used.
   d. Water from sloping roof is collected through pipe and then it can be passed through different filtration beds and can be collected in tanks/ recharge well for reuse.
   ***Infiltration Channels:*** The channel is utilized to expel suspended particles from water gathered from housetop water. The various sorts of channels for the most part utilized for business design are Charcoal water channel, sand channels, horizontal roughing channel and moderate sand channel. Digging the pit in the form of well and filling it up with rocks, stones, and pebbles from bottom to top for water to percolate down and under
3. Calculation of areas where water gets collected in terms of terrace, backyard.
4. Collect data of regional rainfall.
5. Calculate the water getting collected from these catchments, developing equations.
6. Cleaning of old wells.

## Benefits:

Available water for future.

## Outcome

1.Water does not get wasted and gets collected within the campus. Use of natural resources responsibly.

2.Ultimately, the idea could be replicated for the buildings in the same lane, then to the adjoining areas and in the city to recharge and increase the groundwater table of the area.

### *Project – 4: Formation of a Book-Bank in my Village*

## Background

When we talk of literacy mission and education for all, we also need to understand how and where the resource material, particularly textbooks are coming from. Our society has children of varied socio-economic backgrounds and hence there are a number of children who cannot afford buying text books at a cost. So, can recycling of used text books be introduced which will not only help in solving the above issue but also sensitize others, who can afford buying new text books, by way of developing an attitude of sharing? In the process, children become conscious about preservation and maintenance of text books.

## Objectives

1. Reuse and Recycle of text books by sharing/forming a Book Bank.
2. Learn to preserve and maintain the books in a scientific manner.

## Methodology

1. Carry out need assessment - who are in need and which books are needed
2. Collect used text books from different sources
3. Self-exchange by the students from your school
4. Ensure that after use is over, books are passed on to the next user
5. Assess the quality of the books
6. Wherever required, maintain books as per the need: Putting a cover, labelling, pasting, treatment of the books received for preservation and indexing for record maintenance and other aspects of library science.
7. Eventually form a Book Bank / run a mini-library in the village or locality.

## Expected Outcome

1. Children would learn different methods of preservation of books (including the traditional ones) to make those last long
2. Maintenance of books to last long
3. Learn how to share and to make optimal use of the limited resources
4. Managing and handling of books, indexing, numbering and nomenclature, lending or circulating. Following library science procedure, they will learn to value and respect the books
5. The practice may act as a boon in terms of source of knowledge for the underprivileged,
6. It may contribute towards reduction in the rate of deforestation which would ultimately lead to preserving nature
7. The practice may be scaled up to the formation of Village Library

### *Project – 5: Healthy Food Initiative in My School*

## Background

Food comes to us in different forms; choice lies with us whether to pick up healthy or unhealthy one. School canteens or food stalls at different places often attract the consumers with attractive packaging, ‘added’ taste / flavour, and ultimately take a toll on their health, leading to more cases of obesity. On

the other hand, every home has its own varied combinations of food stuffs for different meals of the day. If the same are introduced in such a manner that can attract the younger generation, it could bring in a revolution.

## Objectives

1. To understand difference between healthy and unhealthy food
2. To identify type of food provided in school canteen
3. To replace unhealthy food stuff with healthy alternatives
4. To assess the impact of introducing a change

## Methodology

1. Gather information about components that make food 'healthy'
2. Evaluate and compare BMI or BMR in children from a school
3. Group them according to their consumption pattern (unhealthy Vs healthy)
4. Create awareness about healthy nutrients in the food
5. Depending on the local varieties or cuisine, try replacing the unhealthy items
6. Record your observation on acceptance of the particular food item

## Expected Outcome

1. Role of fast food / unhealthy food items on BMI or BMR could be understood
2. Healthy ingredients in local cuisine could be appreciated
3. New taste and variety of food items provided in attractive manner could change the consumption pattern among children

## List of project ideas:

| S No | Project titles | Doable features |
|---|---|---|
| 1. | Development of eco-tourism for better understanding and conservation of local ecosystem | • Identify eco-tourism sites around you e.g. river valley, coastal area, hills<br>• Understand and study the ecology of those spots<br>• Promote activities like nature walk, picnics, talks, guided tours |
| 2. | Creation of 'Wall of Charity / Goodwill' for the needy (clothes / shoes) in our town / society | • Identify a suitable place for it in your locality<br>• Initiate the process by placing unused wearable clothes / shoes<br>• Observe the movement (both inward and outward) of these items<br>• Study patterns and human behaviour |
| 3. | Promotion of local art and craft for the empowerment of artisans | • Identify local arts and crafts<br>• Understand what resource materials are being utilized; natural or man-made<br>•Analyse their contribution in preservation / conservation of local ecosystem |
| 4. | Underutilise iron-rich food / feed stuff to produce folic acid supplement for anaemia | • Identify iron-rich food / feed stuff not being used<br>• Biochemical analysis in the laboratory,<br>• Preparation of supplements out of these materials with appropriate procedure |
| 5. | Revival of traditional water harvesting systems in our locality / village / town (abandoned wells / jhalra / baori) | • Identify traditional water harvesting systems locally<br>• Analyse the present status<br>• Understand and apply how those can be revived using technology, engineering |
| 6. | Society-managed emergency healthcare services (human / animal) using mobile apps | • Analyse the status of emergency healthcare services in your locality,<br>•Form an inter-connected group through mobile apps |
| 7. | Reuse / recycle of discarded material e.g. Mobile phones | • Collect information about purchase pattern of new mobiles,<br>• Analyse scientifically the fate of unused ones |
| 8. | Bringing nature to school / Creation of Green Wall in our school | • Locate a suitable place in the school / society / locality,<br>• Initiate steps for creating vertical garden or green wall for a cause (outgoing students' memory / new comers in the society / special occasion)<br>• Understand, learn and promote nurturing of plantations |

| | | |
|---|---|---|
| **9.** | Utilisation of open terrace of our school / home for growing vegetables | • Identify location and vegetables based on available natural resources,<br>• Initiate planting, nurturing and observing the changes on daily basis,<br>• Analyse the economics of the produce |
| **10.** | Minor road repairs to major fuel efficiency, a case study in our locality | • Identify a small stretch of road with potholes,<br>• Analyse the impact on fuel consumption, vehicle maintenance, and on the local residents due to air and sound pollution,<br>• Prove how minor change can bring about major effects. |
| **11.** | Developing products for children / people with disability (physical, vision) | • Identify the beneficiaries,<br>• Understand their simple needs,<br>• Be empathetic and create, design, and develop something useful for them.<br>• Could lead to social entrepreneurship/ vocational skill development |
| **12.** | Promotion of animal products (yak / camel milk and bye products) | • Identify the animals needing attention,• Study and understand their products and bye products,<br>• Analyse their promotional strategies locally, and explore possibilities at national and global levels |
| **13.** | Impact of 'neighbourhood school policy' on our local (urban / rural) environment | • Understand and analyse the distance between school and residence,<br>• Assess impact of modes of conveyance, • What will happen if school comes to your neighbourhood? Will that bring in positive change? |
| **14.** | Developing a mobile app-based alert system to safeguard against natural disaster | • Identify which natural disaster has been striking around your locality. • Understand what type of precautions is being taken.<br>• Can mobile app-based alert system be developed to alert in advance?<br>•Demonstrate to the society |
| **15.** | Innovative designs for value addition/improving efficiency | • List out the applications of devices/items • Identify the issues related to it that need attention,<br>•improvement or changes in the design |

| Required principle for pursuing sustainable living | | |
|---|---|---|
| **Targeted principle need to adopt** | **Focuses** | **Projects** |
| Respect and care for all | There is need to understand how our daily activities are linked to ecosystem where we live in. Accordingly, it is required to design our activities so that every living being in our environment gets what they need for survival and growth. Therefore, there is a need to inculcate a practice to respect all living being. | • Preservation and conservation of sacred groves in our locality,<br>• Solid waste management – an initiative in our school,<br>• Development of eco-tourism for better understanding and conservation of local ecosystem,<br>• Promotion of local art and craft for the empowerment of artisans,<br>• Developing products for children / people with disability (physical, vision) |
| Leading a community life | There is need to shed individualism and adopt collectivism and it should be kept in mind as a member of society. It is required to establish collective initiatives to fulfil our needs and aspiration as well as facilitate our growth; remove the disparity between haves and have nots. | • Assessment of *Swachhta Abhiyan* and its Impact<br>• Creation of 'Wall of Charity / Goodwill' for the needy (clothes / shoes) in our town / society<br>• Underutilized iron rich food / feed stuff to produce folic acid supplement for anaemia<br>• Revival of traditional water harvesting systems in our locality / village / town (abandoned wells / jhalra / baori),<br>• Bringing nature to school / Creation of Green Wall in our school,<br>• Utilisation of open terrace of our school / home for growing vegetables<br>• Promotion of animal products (yak / camel milk and by-products),<br>• Developing a mobile app-based alert system to safeguard against natural disaster |
| Inculcate the habit of saving | Need to inculcate the habit of judicious use by removing the practice of misuse, wastage, exploitation; practice to save Earth's resources, materials, energy; means of welfare and recreation | • Water Audit and assessment of its use, misuse and abuse at school/home/society level.<br>• Minor road repairs to major fuel efficiency - a case study in our locality.<br>• Impact of 'neighbourhood school policy' on our local (urban / rural) environment. |
| Adopt minimalism | Inculcate the approach of minimum input to get maximum output through increasing the efficiency of process involved in production, distribution and consumption. | • Innovative designs for value addition/improving efficiency. |
| Responsible decision-making | Need to remember that everyone is responsible for their own decision. In case, any negative impact arises to environment, life forms, fellow human being they have to rectify their decision and take action to reduce and stop negative impact. | • Events based (birth, birthday, marriage) tree plantation campaign in our locality.<br>• Greening of festivals/ celebrations in our locality.<br>• Craft creation from waste (rubber/plastic) collected from beaches / hill stations.<br>• Society-managed emergency health care services (human / animal) using mobile apps.<br>• Reuse / recycle of discarded materials e.g. mobile phones. |

**Box – 3.2**

**School in Assam Charges Plastic Waste as School Fees**

As the sun rises, scores of children with bags full of books and smiles on their faces walk through the lanes of Pamohi to reach a school situated in the pristine woods in the vicinity of the capital city of Assam. The children, however, do not come to this school only with bags full of books. They bring with them polythene bags full of plastic waste as the only form of fee which this school accepts. The Akshar School in Guwahati has the kind of fee structure where children deposit at least 10 to 20 plastic items per week, with a pledge not to burn plastic.

Parmita Sarma and Mazin Mukhtar founded The Akshar School in June 2016. They wanted to start a free school for children, but were stumbled upon the idea after realizing a larger social and ecological problem brewing in this area. They still remember how their classrooms were filled with toxic fumes every time somebody in the nearby areas burnt plastics. Here it was a norm to burn waste plastic to keep warm. They wanted to change that and thus started encouraging their students to bring their plastic waste as school fees. The school has been giving formal education to more than 100 children belonging to an economically backward category. According to **The North East Now,** the school has designed the curriculum fundamentally for poverty-stricken children. Not only do they teach children lessons on Science, Geography and Mathematics, but also provide vocational skill training so that they can become skilled professionals by the end of the course.

When the establishment of the school Akshar (meaning 'letter' in Hindi) happened in 2016, the foremost challenge which they faced while starting the school was to convince the villagers to send their kids to school as most of them worked in the stone quarries as labourers to earn for their families. So they designed the curriculum in such a way that would fit the child's needs and build a creative

pipeline of employment, post-education. The students earned Rs 150 – Rs 200 per day at the stone quarries. Thus, they could never match that monetarily, so instead they proposed a mentorship peer-to-peer learning model, where the older students teach the younger ones and in return get paid in toy currency with which they can buy snacks, clothes, toys, shoes from the nearby shop. The older students teach younger children every day at Akshar, which serves two purposes – one, it makes them feel valued and important; second, they can have less number of teachers. Unlike other schools, Akshar does not have an age-specific admission system. Rather, students attend the same classes together at Akshar while sitting in open spaces. The levels are decided on the basis of knowledge of the students, tested at the time of admission—the school has tests every Friday. The students will then have to perform well to climb up the levels. This is to ensure that the quality of education is continuously improving.

The Akshar School, which started with just 20 kids in 2016, now has more than 100 children studying in the school. It now has eight bamboo huts to run their classes and two digital classrooms donated by some people. The school curriculum has various vocational courses, including cosmetology, embroidery, singing, dancing, organic farming, gardening, solar panelling, recycling and electronics. Both Mazin and Parmita, the couple now aspires to build 100 such schools across the country in the next five years.

**Educating the community**

With the help of the students, the school also educates the community about the harmful effects of burning plastic. They teach the villagers to recycle the waste and become agents of change. As a result of the school's initiative, more and more families in the village have started participating in the recycling drive and spreading awareness.

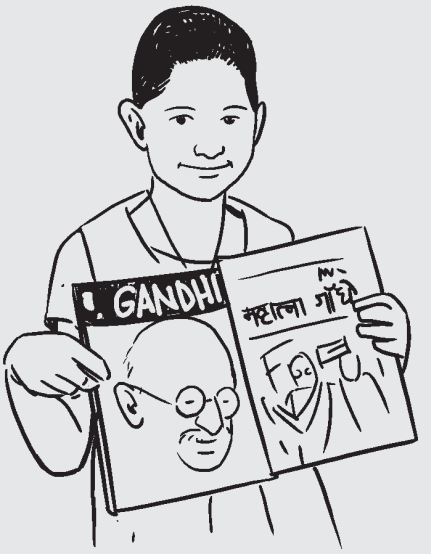
With the help of teachers, the students make numerous construction materials with plastic waste. The students have already created some eco-bricks with the waste material and built some plant guards in the school premises. They also wish to build boundary walls, toilets and some pathways which will help the children go from one place to another when the school campus is waterlogged, with the help of eco-bricks.

**Box – 3.3**

**A 9-Year-Old Girl Opened A Free Street Library In India For Illiterate Children**

Muskaan Arihar, a 9-year-old living in Bhopal, recognised the issue of a large percentage of people being unable to read, and decided that she couldn't sit idly by while her peers suffered through school and life. She opened a library right outside her home that is open to all and called *BalPustakalaya*. The name is fitting because it is for children and run by children, including herself.

She opens her library after school every day and invites a few dozen children to listen to her read aloud. Her library collection has several hundred books from which she chooses to share with her fellow listeners. Muskaan also encourages her peers to check out books from her library so that they can learn from home.




She has many people that are in her corner and very supportive. One organisation called Room to Read has donated over 50 books to her library and are dedicated to partnering with local writers and publishers to translate books into an area's local language.

Her library has also inspired others to start their own libraries, especially because Muskaan is so young. Girls that are a few years older see that if Muskaan can do it by the age of 9, that they can get started on their journey in aiding their peers in furthering their education.

http://www.trueactivist.com/this-9-year-old-girl-opened-a-free-street-library-in-india-for-illiterate-children/

# Sub-Theme – IV

# Design, Development, Modeling and Planning for Sustainable living

## Sub-Theme – 4
# Design, Development, Modeling and Planning for Sustainable living

"***All models are approximation… However, the approximate nature of the model must always be borne in mind***." **– George Box**

We have been consuming natural resources (i.e.materials or substances occurring in nature) since the beginning of industrial development at a faster rate than the planet is capable of regenerating them**.** Even today, in our day-to-day life we areover-using natural resources every year thereby posing threat to our future generation and livelihood. In fact, if natural resources consumption continues at the present rate then by 2030, two Earth-like planets will be required to generate enough resources to cater to our demandsbecause the world population will consume every year two times more resources that the Earth can generate over the same period. So, it is essential to make every stakeholder aware to stop or reduce un-judicious use and unsustainable consumption of our natural wealth; else there will be serious depletion of resources and shrinkage of earth's carrying capacity.

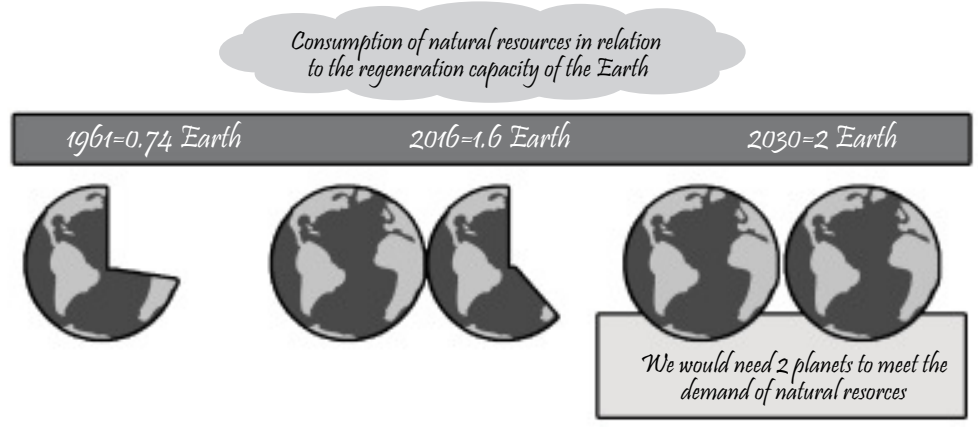



***Fig. 4.1.****Diagram showing Natural Resource Deficit*

In other words, unwise exploitation of materials or substances occurring in nature for economic gain will drastically affect sustainable living of human population on Earth in the long run. Hence, there is a need to understand critically the causes and effects of resource utilisation. Such understanding is a prerequisite for effective and useful planning and management of available natural resources for bringing solutions to the identified problem(s) towards sustainability at local, state, national and global level.

Management of natural resource depends scientifically on reliable projections of future conditions (Modeling) to design, plan and implement desired actions towards sustainable living. Results from empirical studies, coupled with expertise and wisdom of people are essential components that area required for such planning, design and evaluation of management activities.

Modeling and design for planning resources is considered as most essential and need of the day. Virtually, Modeling helps to visualize the future scenario from the historical information/events/data that aid to design and plan the activities for sustainable future. In addition, it also assists to forecast/ predict consequences of our quality of life in case we continue to exploit the natural resources irrationally to meet our demands. This also enables us to evolve sustainable way(s) for resource planning, allocation and management leading towards sustainable lifestyles for all. Moreover, Modeling, design and planning also become useful for conservation and enhancement of natural resource base in its maximum pristine/pollution free levels, which are presently concerned by all globally. Nevertheless, it allows the stakeholders to understand the problem related to various biotic (vegetation, animal, human, etc.) and abiotic (soil, water, air, etc.) resources and their interrelationships. Outcome of these assessments can be applied for design and planning carrying capacity, threshold limits, environmental impacts, natural resource conservation and management and so on and so forth.

However, for better clarity and understanding, all the three aspects (Modeling, design, and planning) have been explained below.

## (A) Modeling

Modeling is a systematic approach and projected representation of a system, phenomenon or situation through equation, graph, map and visuals. Model can help to understand a state or situation or phenomenon, not experienced or visualized at present, but there is possibility of it occurring in future. One of the purposes of any model is to enable an analyst/ user to *predict* the effect of changes in the concerned system or phenomenon. Such predictive Modeling is the process of using previous known results to create a model that can be used to forecast future outcomes. But, a model, on one hand, should be a close approximation to the real system. On the other hand, it should *not* be very complex to understand and unable to do experiment using it. So, *a good model is one that keeps balance between realism and simplicity*. The important issue in Modeling is its validity. Nevertheless, there are various types of models all of which do not come under the ambit of NCSC. Hence, only four types viz. physical, schematic, conceptual, and mathematical models have been described, in nutshell, below.

***Physical model***

It is a smaller or larger physical copy of an object. The object being modelled may be small (e.g., an atom) or large (e.g., Solar System).In other words, the physical models are smaller and simpler representations of the thing being studied (viz., a globe or a map). The structure of the model and the object it represents need be*similar*in the sense that one resembles the other. But in such cases, the *scale*is the most important characteristic to be followed accurately.

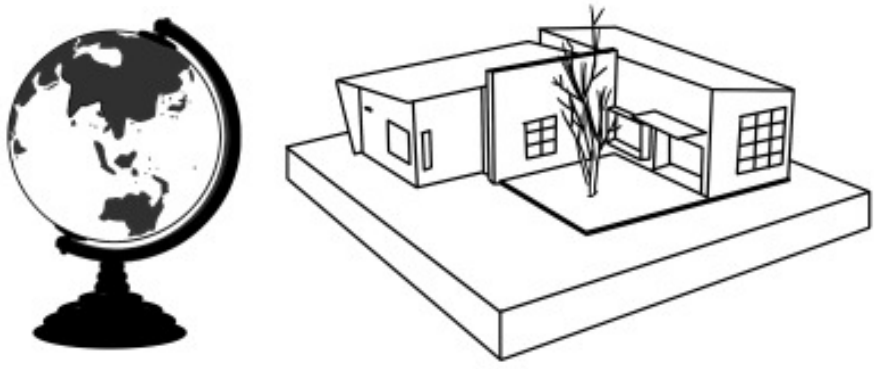
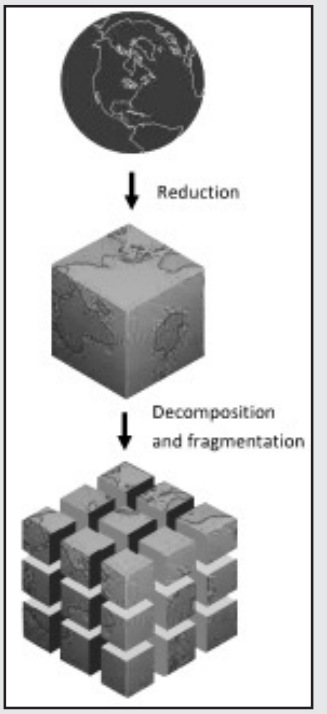


***Fig.-4.2****. Differences Between Model & Prototype*

**Box-4.1**

**Reductionist approach of Modeling:**




The reductionist character of science and scientific Modeling means that however sophisticated a model may be, it is still a simplification of reality. The figure below schematically illustrates how the real world is reduced from a perfect sphere to an 'imperfect' one, i.e. a cube, and this cube is finally sub-divided into individual domains, separated by interfaces. Through reduction and decomposition scientists try to disclose the secrets encountered in their own domain and to understand the 'grammar' according to which the real world behaves. Once this grammar is understood, scientists and engineers are able to create their own alternative world. This process has, in the end, resulted in our modern built environment. In spite of being no more than an approximation of reality, models and the use of them have become the new vehicle to 'manipulate' reality and design a new technology-based society.

***Fig. 4.3.****Schematic model of a typical eukaryotic interphase nucleus*

### *Schematic Model*

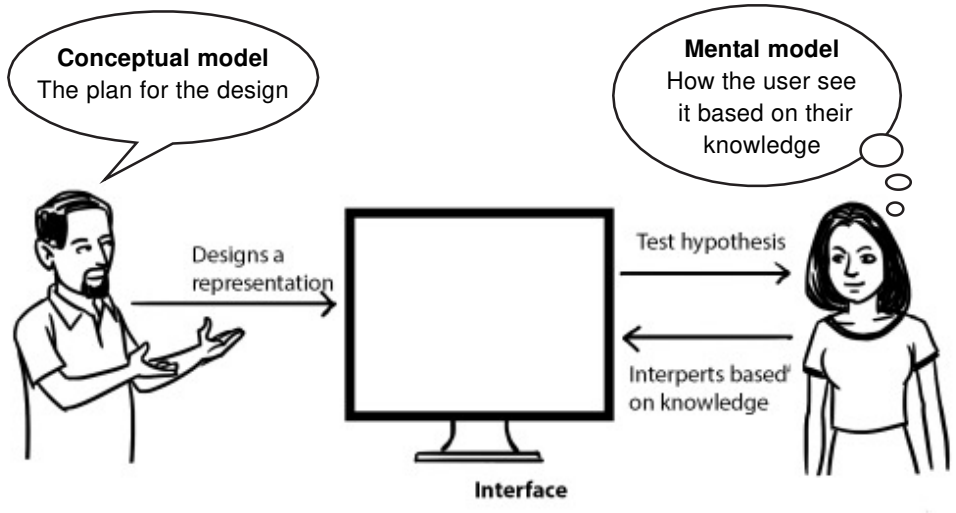
Schematic models are more abstract than physical models. While they do have some visual correspondence with reality, they look much less like the physical reality they represent. Graphs and charts are schematic models that provide pictorial representations of mathematical relationships. Pie charts, bar charts, and histograms are all models of some real situations, but they really bear no physical resemblance to anything. Diagrams, drawings, and blueprints also are versions of schematic model.

**Differences Between Model & Prototype**

| Sl.No. | Physical Model | Prototype |
|---|---|---|
| 1 | Not necessarily functional (don't need to work). | Is fully functional, but not fault-proof. |
| 2 | Can be to any scale (usually smaller but can also be of the original size or bigger). | Is an actual version of the intended product (constructed in scale). |
| 3 | Used for Display or/and visual Demonstration of product. | Used for performance evaluation and further improvement of product. |
| 4 | May consist of only the exterior of the object/product it replicates. | Contains complete interior and exterior. |
| 5 | Relatively cheap to manufacture. | Is relatively expensive to produce. |

***Conceptual models***

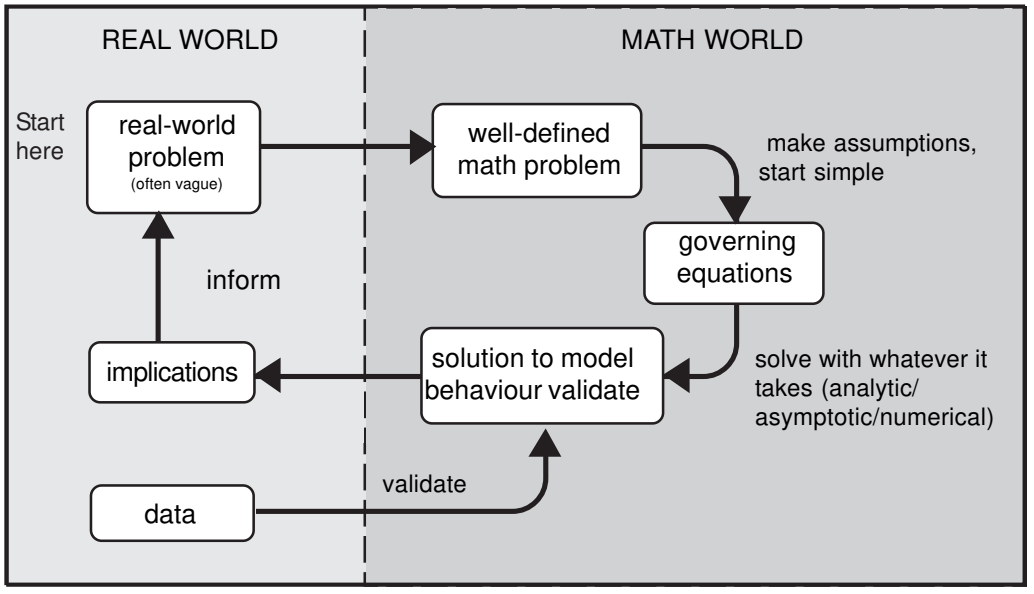
Conceptual models tie together many ideas to explain a phenomenon or event. It is representations of a system, made of the composition of concepts which are used to help people know and understand a subject that the model represents. It is also a set of concepts.A conceptual model's primary objective is to convey the fundamental principles and basic functionality of the system which it represents. A conceptual model, when implemented properly, should satisfy its fundamental objectives. The conceptual model plays an important role in the overall system development life cycle.



***Mathematical Model***

Mathematical models are perhaps the most abstract of the four classifications. These models *do not* look like their real-life counterparts at all. Mathematical models are built using numbers and symbols that can be transformed into functions, equations, and formulas.

It is a description of a system using mathematical concepts and language. The *process* of developing a mathematical model is termed as mathematical Modeling. These are used in the natural sciences (e.g., physics, biology, earth science, chemistry, etc),and engineering disciplines (e.g., computer science, electrical engineering etc.), Health science (Spread of disease, etc.) as well as in social sciences (viz., economics, psychology, sociology, political science, etc.). However, Mathematical Modeling is the process of using various mathematical structures - graphs, equations, diagrams, scatter plots, tree diagrams, etc., to represent real situations. Following is the flow chart usually followed for such Modeling:




MATH MODELING FLOWCHART

A mathematical model can be used for a number of different reasons:

- Developing scientific understanding - through quantitative expression of current knowledge of a system
- Supports in examining the effect of changes in a system
- Aids in decision making

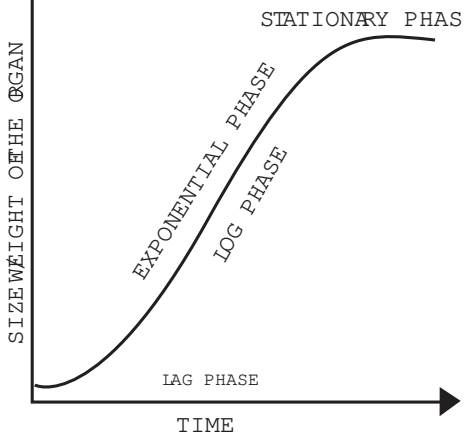


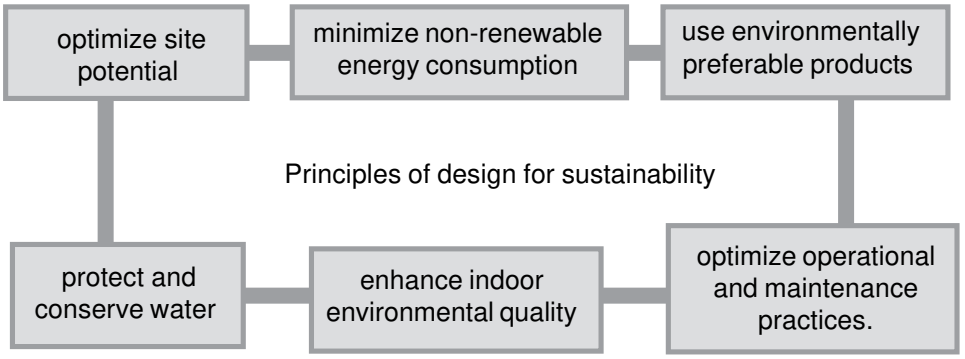

***Fig.- 4.4.*** *Example of mathematical model on Maize plant's 'Grand Period of Growth' (sigmoid curve)*

## (B) Design

Design is an approach to give a shape /structure of an object/tools/gears/ assets to enhance / strengthen its functional efficiency, easy to handle/use/manage, minimize the use of material and energy, labour cost, along with aesthetic values. Different principles of mathematics, physics, chemistry, biology etc., along with elements of art are used for designing any object/article. In context of sustainable living, it is focused on different day-to-day utilities, tools and gears, infrastructures which ultimately based on the principle of minimum input use and maximum output. Use of minimum inputs fromEarth's resources in the form of material and energy, minimization of waste and optimisation of its utility determines efficiency. Sustainable design seeks to reduce negative impacts on the environment, the health and comfort of the

users. At present, the design approaches to address systematically the life cycle of entire product, from the extraction of raw resources to end-of-life of the product, which is usually referred as *Life Cycle Design*, *Eco-design* or *Product Design for environmental sustainability.The* design also looks into the 'nature' as a source of inspiration to address sustainability. Life Cycle Design (LCD) and Cradle to Cradle (C2C) mainly focus on the products' flow of material resources from its raw material collection to its end of life which often overlooks some important environmental aspects (e.g. energy consumption). The design, therefore, must consider the product less than the 'service/result' procured by the product.The basic objectives of sustainability are to reduce consumption of non-renewable resources, minimize waste, and create healthy and productive environments.

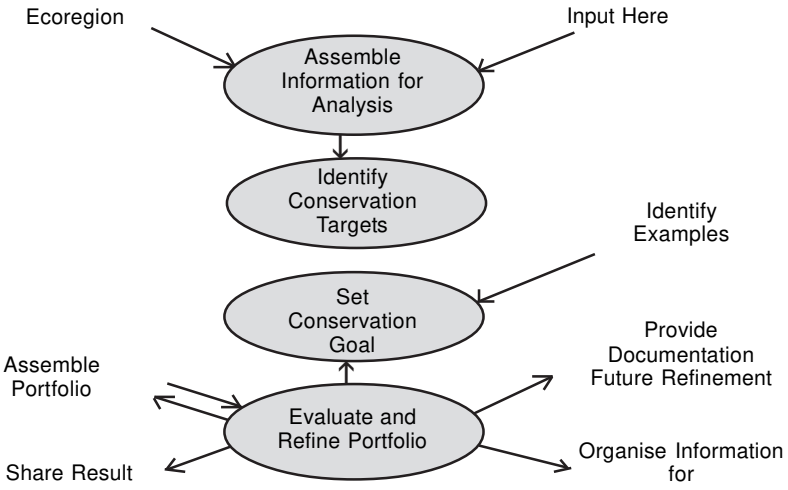
Principles of design for sustainability include the ability to (a) optimize site potential, (b) minimize non-renewable energy consumption, (c) use environmentally preferable products, (d) protect and conserve water, (e) enhance indoor environmental quality and (f) optimize operational and maintenance practices. The steps of design shown through flow chart below:




## (C) Planning

Planning is a systematically organised actions for effective implementation strategy towards achieving a particular goal. It is a system that ensures developmental plan for people's interest, taking into consideration economic, environmental and social benefits (and also drawbacks). Such planning is undertaken using scientific approach with analysis of collected data, developing necessary models and then developing designs. However, it may be done for

multiple levels from local to global, based on the need or demand. In recent past, planners and scientists are concerned over climate change, clean air and water, renewable energy and land use for the greater interest of sustainability and to develop strategies and practices for liveable and self-sustaining communities over long term. The flow chart below shows ecological communities in Eco regional plans.




***Source:*** *Anderson, M, Joseph Comer P, Grossman D, and Weakley S.A. 1999. Guidelines for Representing Ecological Communities in Eco regional Conservation Plans. The Nature Conservancy.*

In fact, environmental and natural resource planning use balanced decision-making that takes into consideration the natural environment. The process combines protection of environmental resources with community goals.Natural resource planning and management deal with managing the way in which people and natural landscapes interact in rational ways. It brings together land use planning, water management, biodiversity conservation, and the future sustainability of industries/ activities like agriculture, mining, tourism, fisheries, forestry and many more.

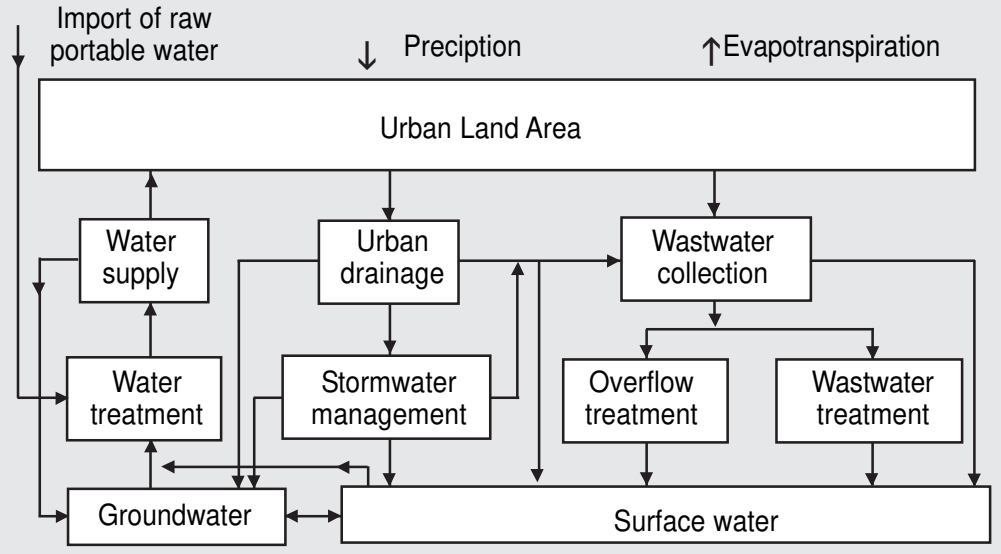



***Fig.-4.6.*** *Urban water cycle: main components and pathways*

Following are few examples of overall plan for sustainable living:

- Carrying Capacity
  - The maximum population that can be sustained by a given environment/ world
- Population Growth rates
  - Family Planning
  - Education
  - Women's Status
- Housing etc.

**Box- 4.1**

**Elements of smart and sustainable housing**

- ***Social sustainability*:**

Safety + security + universal design = social sustainability.

- ***Environmental sustainability*:**

Water efficiency + waste efficiency + energy efficiency = environmental sustainability.

- ***Economic sustainability:***

Cost-efficiency + peace of mind + higher resale value = economic sustainability.

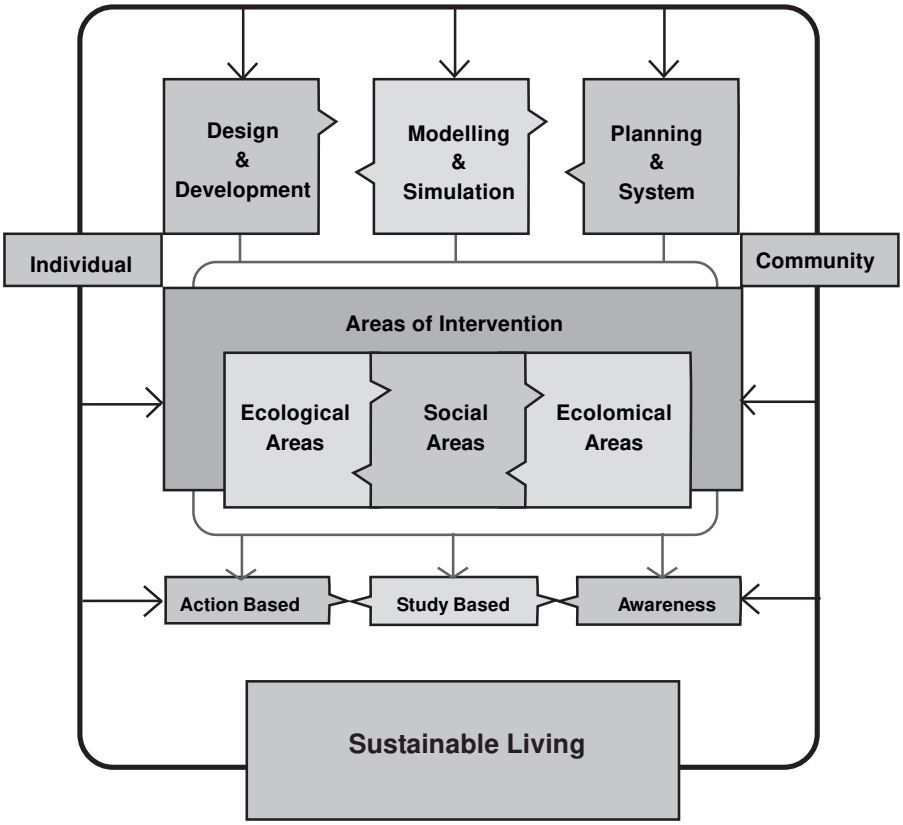



***Fig. 4.7:*** *Summarised flowchart*

## Scope for Doing Project

The sub-theme has scope of undertaking projects in wider areas related to natural resources, water and air, environment, plants, animals (both macro & micro), and human being, etc, and also the interactions. They can easily study the chosen problem using simple mathematical laws of *Algebra, Trigonometry, Geometry, Coordinate Geometry, Solid Geometry, Differential calculus*, etc. However, considering various limitations for the children of different socio-economic and geographic conditions, it is advised to take up small and unique project in any of the areas described above. In table below, the probable focus areas have been shown for convenience of the children. Further the focused areas have been presented in the following table:

**Table-4.7:** Focus Areas

| Approach/Focus | Modeling based | System and planning based | Design and development focussed |
|---|---|---|---|
| **Ecological** | Environment (Land, soil, | Natural Resources | Bio mimicry |
| | water, Air, etc.) | | |
| | Biodiversity | | |
| | Habitat/Ecosystem -Terrestrial - Aquatic | -Land use -Land cover | |
| | Climate and Climate change | | |
| | Disaster mapping | Disaster management | Design for disaster prone areas |
| **Social** | Construction and development Health and Diseases | Habitat planning Energy &Sustainability | Product design Habitat design - - Construction - Structure - Environment |
| | | Human Capacity and Flow | Design for special need |
| **Economic** | Agriculture Fisheries | Production and consumption | |
| | Animal Husbandry | | |
| | | Policy development | |

**Box – 4.2.Few Examples of Design using Biomimicry:**

Humans have always looked to nature for inspiration to solve problems. Leonardo da Vinci applied biomimicry to the study of birds in the hope of enabling human flight. He very closely observed the anatomy and flight of birds, and

made numerous notes and sketches of his observations and countless sketches of proposed “flying machines”. Although he was not successful with his own flying machine, his ideas lived on and were the source of inspiration for the Wright Brothers, who were also inspired by their observations of pigeons in flight. They finally did succeed in creating and flying the first airplane in 1903.Leonardo’s design for a flying machine, c. 1488, inspired by birds in flight. Pigeons also influenced the Wright Brothers’ design for the first airplane.

**Recent developments**

- Photovoltaic systems, which harvest solar energy, are a first step at mimicking the way leaf harvests energy. Research is underway to create solar cells that more closely resemble nature. These cells are water-gel-based—essentially artificial leaves—that couple plant chlorophyll with carbon materials, ultimately resulting in a more flexible and cost-effective solar cell.
- The Thorny Devil, a desert lizard, gathers all the water it needs directly from rain, standing water, or from soil moisture, against gravity without using energy or a pumping device. Water is conveyed to the lizard’s mouth by capillary action through a circulatory system on the surface of its skin. This same concept is trying to be applied to passive collection and distribution systems of naturally distilled water which would reduce the energy consumed in collecting and transporting water by pump action (e.g., to the tops of buildings) and will provide other inexpensive technological solutions such as managing heat through evaporative cooling systems, and protecting structures from fire through on-demand water barriers.

## Model Projects

### *Project – 1: Land use change and its impact on natural and cultural landscape*

### Background

Land use change is a process by which human activities transform the natural landscape, referring to how land has been used, usually the purpose. Land use changes are often nonlinear and sometimes may be causing multi-dimensional impacts to the environment. Therefore, land use changes need assessment, and it is also possible to model future conditions as per assumptions, to ensure sustainable conditions.

### Objectives

1. To assess the land use changes over a time period
2. To conduct field level survey to verify and document land use changes.
3. To quantify changes in land use.

### Methodology

To conduct the study, Step – by-step procedure, as given below, is to be followed.

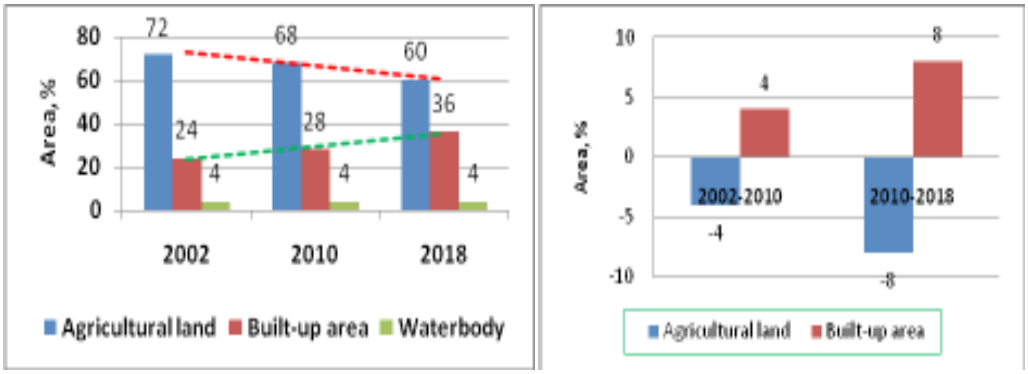
1. Identify the area of study, with a natural or manmade boundary, that can be easily identifiable in the Google Earth image.
2. Save the images of the area from Google Earth for the available years
3. Demarcate land use classes for each year like forest, agricultural land, built up area, water body etc.
4. Find out the area of each classes in every year (using Google Earth; area tool)
5. Tabulate the data and calculate percentages
6. Calculate percentage changes for each category

2002 2010 2018

***Fig.-4.1.1.*** *Satellite images for three different years (from Google map)*

**Table-4.1.1:** Areas under different land uses, calculated from the maps

| Sl. No | Land useClasses | Area, km² | | | Area % | | | Change in area % | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2002 | 2010 | 2018 | 2002 | 2010 | 2018 | 2002-2010 | 2010-2018 | 2002- 2018 |
| 1 | Forest | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | Agricultural land | 18 | 17 | 15 | 72 | 68 | 60 | -4 | -8 | -12 |
| 3 | Built-up area | 6 | 7 | 9 | 24 | 28 | 36 | +4 | +8 | +12 |
| 4 | Waterbody | 1 | 1 | 1 | 4 | 4 | 4 | 0 | 0 | 0 |
| | Total | 25 | 25 | 25 | 100 | 100 | 100 | 0 | 0 | 0 |




(A) (B)

***Fig.4.1.2**: Decadal changes in land areas (in percentage) in two different decades (A) and changes during two decades (B)*

## Expected Results

1. Major land use categories in the area
2. Extent of each land use in different years
3. Changes in land use during these years
4. Decline or increase in respective land use categories with time

## Expected outcomes

1. Use of free satellite image data for local understanding
2. Changes in pattern of land use over time

## *Project- 2: Modeling Alien Invasive Plant Species for Management*

### Background

Many invasive alien plant species which are non-native, spread and interfere in a new ecosystem by posing a serious threat to the native biodiversity, leading to several irreparable losses including economic losses. Invasive species don't allow local species to grow and pose obstruction to wildlife movement. Species like *Lantana*, that grows extensively, leading to degradation and destruction of the biodiversity. Ecological equilibrium of an ecosystem can be maintained only by balancing local floral and faunal population. However, Ecologists are of the view that the removal of the alien species should be in a phased manner with subsequent planting of the native floral/ faunal species in order to improve the biodiversity.

*Lantana*

Since a significant amount of man power and money is required for control and management measures for alien invasive species, it is necessary to define the area of intervention, estimation of populations and prediction of future situations if the process of invasion continues. For the sake of the study let us consider the Parthenium hysterophorusas a plant to study.

### Hypothesis

The alien plant species will grow widely in a few decades that will affect the growth of local plant species.

### Objective

For the purpose, following objectives have been decided:

1. To identify the potential alien invasive species spread in the locality and estimate the frequency of its occurrence in time scale.
2. To develop a mathematical model to predict its over crowdedness in comparison to one of the major native species

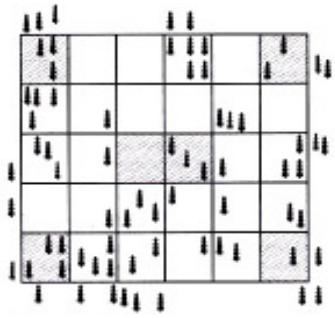
## Methodology

The methodology comprises of three segments- experimentation, development of model, and validation of model. All the three segments have been explained below.

(I) ***Experimentation***

Step – 1: Select an area, big enough to include maximum number of species to be studied in your locality.

Step – 2: Identify the species to be considered for the study. Here, one alien (Species - A) and one native/ local (Species - B) species have been considered.



Step – 3: Using grid methods find out the number of species in each of the grids as shown below-

**Note:** Follow the method given in your text book.

However, prior to beginning, prepare the table shown below in order to record the data in the field. Then, calculate Frequency percentage with the formula given below

**Frequency = [(Number of sampling units in which the species occurs)/ (Total number of sampling units employed for the study)] X 100**

It is expressed in percentage (%) and denoted as 'F'.

**Table – 4.2.1.** Species-wise number of plants in the six grids and their frequencies

| Species | Grids | | | | | | Total Number (N) | Frequency % [(N/6)x100] |
|---|---|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI | | |
| Species - A | 67 | 55 | 62 | 59 | 62 | 44 | 349 | 58.1 |
| Species- B | 38 | 47 | 33 | 40 | 33 | 54 | 245 | 40.8 |

Step – 4: Take out some plant sample and prepare a Herbarium.

Step – 5: Before meeting the villagers, prepare a table as shown below-

| Respondents | Frequency, % | | | | |
|---|---|---|---|---|---|
| | 2018 | 2017 | 2016 | 2015 | 2010* |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| | | | | | |

*Indicates, may be, the year when it was identified first

Step – 6: Select few elderly dwellers of the locality who live on land and ask them pre-designed questions about the plant species chosen for the study. A few sample questions are given in the box below-

Step – 7: Put the information gathered from each individual respondent in the table as shown below. Here some hypothetical data have been considered.

**Table-4.2.2.** Frequency of occurrence of **Species – A,** by year, as gathered from survey

| Respondents | Frequency, % | | | | |
|---|---|---|---|---|---|
| | 2018 | 2017 | 2016 | 2015 | 2010* |
| 1 | 50 | 45 | 40 | 45 | 5 |
| 2 | 55 | 60 | 50 | 40 | 5 |
| 3 | 60 | 50 | 45 | 40 | 10 |
| **Average** | **55.0** | **51.7** | **45.0** | **41.7** | **6.7** |

**Table-4.2.3.** Frequency of occurrence of **Species – B,** by year, as gathered from survey

| Respondents | Frequency, % | | | | |
|---|---|---|---|---|---|
| | 2018 | 2017 | 2016 | 2015 | 2010* |
| 1 | 40 | 45 | 45 | 50 | 80 |
| 2 | 45 | 50 | 55 | 55 | 80 |
| 3 | 45 | 50 | 55 | 55 | 75 |
| **Average** | **43.3** | **48.3** | **51.7** | **53.3** | **78.3** |

**Repeat the process for all the considered species separately for your clarity in understanding.*

**Few sample questions:**

Q1: Are you acquainted with these plants?

Q2: Do you agree that these are affecting growth of local plants?

Q3: If yes, how do you think are they affecting their growth?

Q4: How many years ago these alien species were found?

Q5: Can you say approximately the amount of these species found by years, in percentage? (This will be the information on frequency)

Q7: How do you think we can control the growth of these plants? Do you know any techniques?Q8: Do you know of any other non-invasive species in your locality?

**NB:** showing the calculated values ask question to answer with relation to that to arrive at nearly correct values.

• *These are only samples; but, more question pertinent to your hypothesis may be asked*.

(II) ***Model Development***

**Caution:** Development of such model needs long-term data, usually for 2-3 decades, but for children to understand, a short-term data has been considered. Please remember, more the time span, more will be the precision.

So, in quest of developing a model, simple mathematical relation has been tried. The Step – wise method followed has been described below:

Step – 1: Convert the years of study in number as mentioned below:

Table-3: Assigning number to the corresponding years

| 2010 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| -9 | -4 | -3 | -2 | -1 | 0 |

**[Note:** The current year (2019) of study when the data are recorded in the field to be considered as zero (0) and the years before the year 2019 (i.e. year in which the study has been undertaken in the field) to be considered as negative (-) and the years beyond 2019 as positive (+)].

Step – 2: Put the values from tables- - 4.3.1, 4.3.2 & 4.3.3

**Table-4.2.4.** Year-wise frequency of Species-A

| Plant Species | 2010 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| | -9 | -4 | -3 | -2 | -1 | **0** |
| A | 6.7 | 41.7 | 45.0 | 51.7 | 55.0 | **58.1** |
| B | 78.3 | 53.3 | 51.7 | 48.3 | 43.3 | **40.8** |

Step – 3. Calculate the relationship of frequency with the number of years with Pearson correlation coefficient value (*See the method of calculation in the* Box –I).

Step – 4. Plot the data of Table-4 in a millimetre graph paper with the number of year (T) and frequency (F) in x and y axis respectively. Then draw the best-fitted straight line, as shown below.

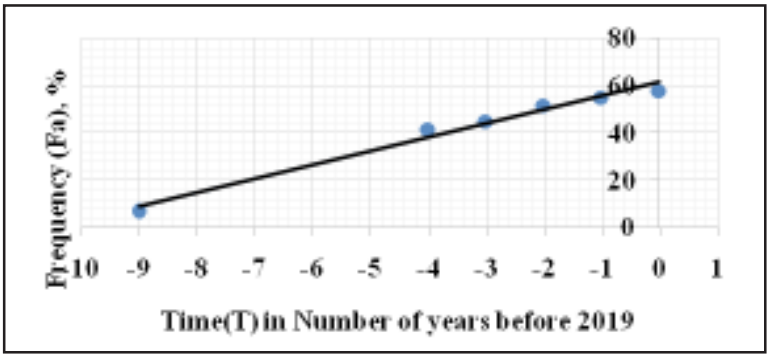



**Fig.-4.3.1.** Relationship between frequency of Species-A with number of years

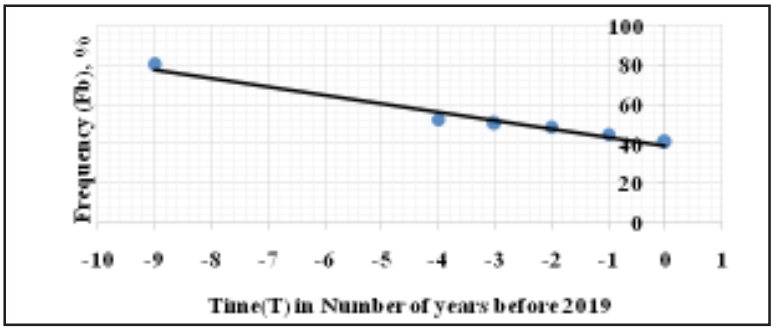



**Fig.-4.3.2.** Relationship between frequency of Species-B with number of years

Step– 5. Using geometric, algebraic or trigonometric method find out the values of 'm' and 'c' of the straight line equation (y = mx + c) from the above graph (Fig.-1).

**Note:** The equation of the line making an intercept c on y-axis and having slope m is given by **y=mx+c.** Note that the value of c will be positive or negative as the intercept is made on the positive or negative side of the y-axis, respectively. *Follow the method that has been taught in the school.*

Step – 6. Note down the values in the table as shown below-

**Table-4.2.5.** Correlation values (between F and T) and intercepts and slopes of the lines

| PlantSpecies | Intercept & Slope of the line | | Correlation value (r) |
|---|---|---|---|
| | c | m | |
| A | 61.54 | 5.85 | 0.98 |
| B | 39.20 | -4.29 | 0.97 |

Step – 7. Explain about nature of relationship as well as strength between the two variables – F & T.

Step – 8. Write down the equations, which are the individual models of two plant species.

$F_a = 5.85\ T_a + 61.54$ ……. (i)

$F_b = -4.29\ T_b + 39.20$ ……. (ii)

Where, F is percentage frequency and T is the time in the number of years. Subscripts 'a' and 'b' indicate the species A and B respectively.

(III) ***Validation of Model***

Every model developed is essentially needed to be validated by projecting the estimated values for the purpose of planning, action and development. Therefore, an attempt has been made here to validate the models calculating estimated frequencies of both the plant species. The steps followed has been explained below-

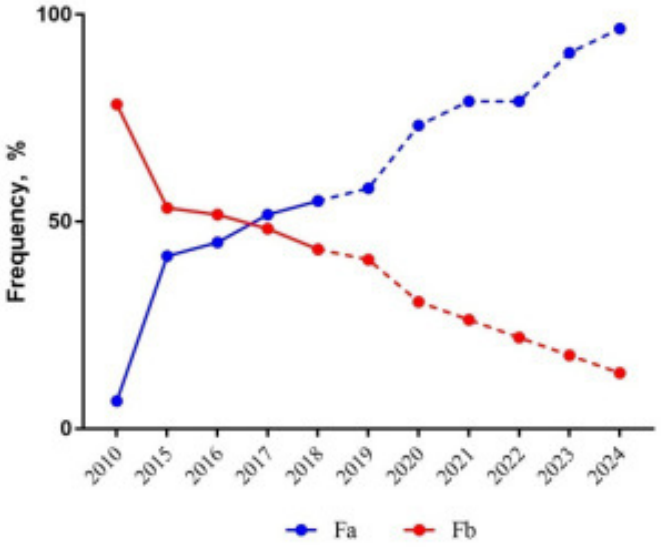
Step – 1: Put the values against $T_a$ and $T_b$ for the years beyond 2019, as shown below, and calculate the predicted values of $F_a$ and $F_b$.

Step – 2: Present the values in the tabular form as has been shown in Table-5.

| Particulars | 2019 | 2020 | 2021 | 2022 | 3023 | 2024 |
|---|---|---|---|---|---|---|
| $F_a$ | 58.1 | 73.24 | 79.09 | 79.09 | 90.79 | 96.64 |
| $F_b$ | 40.8 | 30.62 | 26.33 | 22.04 | 17.75 | 13.46 |

**Table-4.2.6.** Estimated frequencies of the two plant species using linear model
Step – 3: Put the values of $F_a$ and $F_b$ against the years you want to predict (here it is from 2020 – 2025). Draw the curves for both the species. Finally, join every point with the distance bars.

**Fig.-4.2.3.**The predicted population frequencies of boththe plant species, 'A' and 'B'. The dotted lines are the extrapolated data.




## Inference

It appears from the figure- 3 that the distance between the species has been increasing at an alarming rate since 2018 or even prior to that. With the progress of time the population of alien species will supersede the population of the native species under consideration. So, it will deteriorate the biodiversity as well as the ecosystem in the long run. It is not unlikely that the native species will be extinct in next few years.

Hence, hypothesis under consideration is accepted.

## *Project-3: Computing Carrying Capacity and Population Prediction of an Organism Grown Under Resource-Stress Conditions*

### Background

The carrying capacity of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water and other necessities available in the environment. Ecosystems cannot exceed their carrying capacity for a long span of time. In situations where the population density of a given species exceeds the ecosystem's carrying capacity, **the species will deplete its source of food, water or other necessities.** Soon, the population will start dying of. A population can only grow until it reaches the carrying capacity of the environment. At that point, resources will not be sufficient to allow it to continue to grow over the long-term.

For the purpose of the study, the earthworm has been chosen as a test animal.

### Hypothesis

Availability of food and environmental quality influence reproduction and population of earthworm.

### Objectives

1. To examine the influence of different types of feed on population growth
2. To find out carrying capacity
3. To predict population under each types of feed provided

**[*Note:*** Before you begin your project, do a little background research on earthworms, their diet, **biology**, and how to properly prepare and care for them in the bins. Follow the standard procedure in your text book or in other sources.]

### Experimental Procedure

Step – 1. Select three types of feed. It may be-

(i) Finely crushed egg shells

(ii) Fruit pieces with peels

(iii) Vegetable pieces and skins

(iv) Grass clippings and dry leaves
(v) Moist shredded newspaper (avoid coloured pages)
(vi) Cereal and grains
(vii) A mixture of any of the above
(viii) Any other materials of your choice

Step– 2: Decide on the type of food to be added. All the treatments should be given same kind of feed; but the amount will vary treatment-wise. Here let's use the following treatments with 'X' type of feed -
Plot-A: X gm
Plot-B: 2/3rd X
Plot-C: ½ of X

Step – 3: Collect nine plastic or earthen pots of at least of 30 cm diameter, if not more. Of these, make three pots in one batch and thus there will be three batches having three pots in each. Make drainage holes in each pot.

Step – 4: Label the three batches as 'A', 'B' and 'C'. You may go further by labelling each batches as $A_1$, $A_2$, $A_3$…. and like this B & C.

Step – 5: Collect soil from the field

Step – 6: Place soil in each pot to about three-fourths of the way up. Sprinkle the soil with some water so that it is damp, but not soaking wet and pat the soil down into the pot a bit. Add more moist soil, if necessary, to bring the level back up to three-fourths.

Step – 7: Collect locally available earthworm. Worms of similar size and length should be chosen as far as possible.

Step – 8: Divide the worm in nine groups. Count and weigh the groups.

Step – 9: Gently put the worms in each of the cups on the soil of the pot. Add more moist soil on top of the worms so that the soil level reaches about 5 cm (2 inches) from the top edge of the pot.

Step – 10: Cover all the pots with moist newspaper.

Step – 11: Wrap each pot in a dark plastic bag. Be sure to make some small air holes on the top of the bags.

**Note:** *Ensure all pots experience similar conditions like temperature, humidity, etc.*

Step – 12: Place the pots in a cool place,

Step – 13: Weigh and record, in grams, the mass of each type of food before you put it in the pot.

Step – 14: Place a layer of food in the respective pots under the newspaper. Cover the food with the moist newspaper.

Step – 15: Sprinkle some water on top, if needed, to keep the food, soil, and newspaper moist.

Step – 16: Cover the pots with black plastic bags; be sure the air holes are still at the top of the pot.

Step – 17: Measure the acidity (pH), nitrogen (N), phosphorus (P) and potassium (K), of the soil used for potting. This will be the initial data.

Step – 18: Check the pots every 2–3 days, and add food and/or water if needed. Check if most of the food disappeared before adding a new batch of food.

Step – 19: Record the amount of each addition of food and water. Also observe what does the food look like. Are there any changes in the surface or appearance of the soil? Look for deposits of worm casts (a mass of mud thrown up by a worm after it has passed through the worm's body) on the surface.

Step – 20: Prepare a data table, as shown below, for each pot to record what you do and observe. Include: Start date, initial number of worms, group mass of worms etc.

**Table-4.3.1**. Population characteristics before and after the experiment

| Treatments | Initial Population | | Final Population | | Death,% |
|---|---|---|---|---|---|
| | By number | By weight, gm | By number | By Weight, gm | |
| **A** | | | | | |
| B | | | | | |
| C | | | | | |

Step – 20: Measure the acidity (pH), nitrogen (N), phosphorus (P) and potassium (K) of the soil used for potting. This will be the final data. Record the soil analysis results for each pot in your lab notebook. Take average of all the components.

## Results

### (A) Worm Count and Soil Analysis

1. After two months (a longer period may be even better), count and record the number of worms and their group mass in each of the pots. Do this by dumping out the soil from the pot carefully on a large tray or pan that is lined with newspaper. Gently push away the soil to find the worms.
2. Weigh an empty paper cup on the weighing scale and record the cup's mass (W1) in grams. Add the worms to the cup and weigh it (W2) and also count them.
3. Record the number of worms you find in each pot in your table like Table 1.
4. Calculate the group mass of the worms by taking the difference of W2 – W1 and record that in your table.
5. Calculate Carrying Capacity for each of the pots. The calculation has been described below:

### (B) Calculation of Carrying capacity

Earthworm is our test animal. Let, all the treatments are inoculated with 10 numbers of earthworms, which is denoted as $P_0$. So, after 2 months, the period of experiment, the change in population, denoted as $P_1$, will increased by say 6,4 and 2. On the other hand the death rates are 0, 2 and 4.

Table 4.3.2 shows the calculated values for f (fecundity), d (death) and r (intrinsic growth).

**Table-4.3.2**. Change in population, fecundity and death of the worms after two months

| Treatments | $P_0$ | $P_1$ | Change in population ($P_1$ - $P_0$) | Death in number (D) | d- value (D/ $P_0$ = D/10) | Fecundity (f ) | (f - d) | r = (1+f-d) |
|---|---|---|---|---|---|---|---|---|
| A | 10 | 16.1 | 6.1 | 0 | 0 | 0.61 | 0.61 | 1.61 |
| B | 10 | 14.4 | 4.4 | 2.3 | 0.23 | 0.44 | 0.21 | 1.21 |
| C | 10 | 12.6 | 2.6 | 2.8 | 0.28 | 0.26 | 0.02 | 1.02 |

Therefore, intrinsic growth rate (r )will be-

$$r = 1 + (f - d).$$

Further carrying capacity will be calculated with the formula/ relation given below-

$$r - [(P_1 - P_0) / P_1] = (r \times P_1) / K$$

Carrying Capacity will be calculated with the formula/ relation given below -

Here, K is the Carrying Capacity.

When the values for $P_0$, $P_1$ and r are known, the value of K can be calculated out using simple rule of mathematics.

**Table-4.3.3.** The calculated values of Carrying Capacities (K) of three different treatments a, b and c.

| $K_a$ | $K_b$ | $K_c$ |
|---|---|---|
| 21.12 | 19.27 | 15.79 |

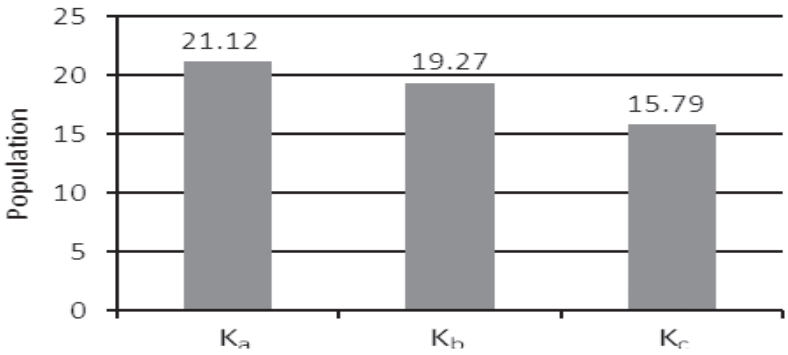



**Fig.–4.3.1.** Difference of Carrying Capacity (K) under three (a, b & c) situations

## Prediction of Population

Using three different K-values, future population has been predicted, using the equation below-

$$P = P + [P*r(1- p/K)]$$

Population of the next generation = P+[P*r(1- P/K)]

Where, P, the population of the previous generation.[ For example, if $p_t$ is the present generation, $P_{t+1}$ will be the 1st generation, $P_{t+2}$ will be the 2nd generation & similarly it will go on like $P_{t+3}$, $P_{t+4}$ …..]

r, the intrinsic growth rate, and K, Carrying Capacity

**Note:** This is possible to perform for any types of organism with respective alterations.

**Table – 4.3.4.** Population at every two months' intervals

| Treatments | Months | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 |
| A | 10 | 16.11 | 22.21 | 20.25 | 21.50 | 20.80 | 21.23 | 20.95 | 21.12 |
| B | 10 | 14.00 | 15.822 | 19.24 | 19.28 | 19.27 | 19.17 | 19.27 | 19.27 |
| C | 10 | 12.60 | 13.74 | 15.56 | 15.79 | 15.79 | 15.79 | 15.79 | 15.79 |

When these values are put in a graph paper and points are joined, it gives a clear picture of carrying capacity as shown in figure-2.

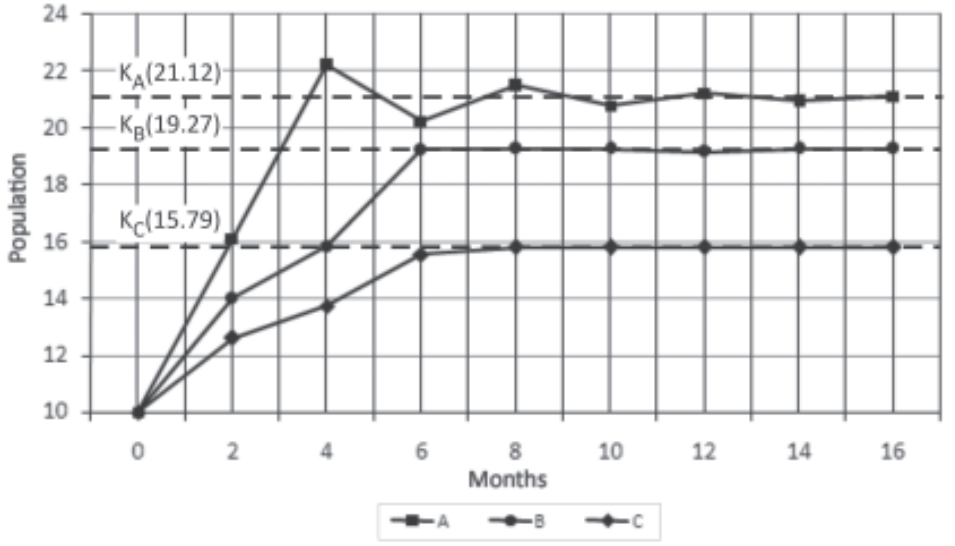



**Fig-4.3.2:** Predicted population with time under three different treatments. The dotted lines show the Carrying Capacities for three different situations.

**Note:** Explain explicitly the findings observed in the graph (Fig.-4.3.2)

## Comparison of Soil Quality

For better explanation, it is essentially required to test the physic-chemical properties of the soil using simple soil testing kit available in the school. Data is to be recorded in the table (as shown in table-5). Observe the changes and try to think critically in the light of resources and environment.

**Table-4.3.5.** Chemical properties of soil before and after the experiment

| Particulars | Initial | Final | Increase/decrease |
|---|---|---|---|
| pH | | | |
| Organic Carbon | | | |
| N | | | |
| P | | | |
| K | | | |

Additionally, show the changes in soil quality drawing bar diagram and explain the changes and their impact on growth and survival of the organism of the study.

## Inference

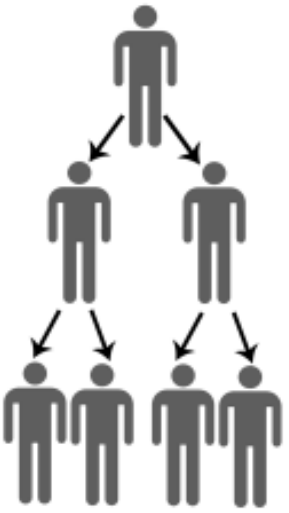
In all the three cases both food availability and environment were responsible for reproduction, growth and development of earthworm was responsible. This is conspicuous in the graph-2. However, the difference in the response due to amount of food availability and environmental quality with progress of time had marked influence on their reproduction, growth and overall population**.**
Hence, hypothesis considered for the study is accepted.

**Note:** Similar activities can be tried with any plants and animals.

### *Project-4: Infectious Disease Modeling*

Throughout history, devastating epidemics of infectious diseases have wiped out large percentage of human population. To name a few are Black Death, plague epidemic, Chicken pox, flue, AIDS etc. and at present COVID-19. Although medical advances have reduced the consequences of some infectious diseases, preventing infections in the first place is preferable to treating them. Question arises, once a vaccine is developed, how should it be used? Should everyone in a society be required to be immunized and many such questions. So, understanding the dynamics of disease transmission is essential to addressing them, and mathematical model can play a role here. Once a model is formulated

that captures the main features of the progression and transmission of a particular disease, it can be used to predict the effects of different strategies for disease eradication or control.



The simplest epidemic model is the SIR model, in which members of the population progress through the three classes in order : Susceptibles remain disease-free or become infected; Infectives pass through an infection period until they are removed permanently from the grip of the disease; and a removed individual is never at risk again. Schematically the model is as –


## Hypothesis

The disease is not an epidemic

## Objectives

1. To find out if the disease will turn into an epidemic in the society
2. To develop model for prediction of studying nature of transmission and progression of the disease with time in the society.

## Methodology

### *Materials*

Collect data on- (i) type of the disease causing organism. (ii) population size of the area, (iii) Date of incidence of the disease, (iv) infective, recovered and death for at least 6-7 consecutive days. (iv) period of incubation of the organism

### Description of SIR model

Mathematically-

$$S + I + R = N \quad \text{at any time (t)}$$

Where, S, susceptible; I, infective; R, Removed (recovered + deceased); N, Population; and t, time

Alike all other mathematical model, this model also consider some assumptions, as mentioned below-

(i) No new births and migration will be taken place and/or will not be considered to avoid complication of the model.

(ii) The population under study mixes *homogeneously*. It means, all members of the population interact (mix ) with one another to the same degree.

Now, to begin formulating our model, at each time t , we divide the population N into 3 (three) classes as described above.

A disease spreads when a susceptible comes in contact with an infected individual and subsequently becomes infected. Mathematically, a reasonable number of encounters between susceptible individuals and infected individuals in an homogeneous mixing condition, is given by the product $S_t I_t$(as per mass action principle).

However, *not all* contacts between healthy and ill individuals result infection. So, we will use a factor termed as ***transmission coefficient*** and it is denoted by **á**. It is a measure of the likelihood that a contact between a susceptible and an infected person will result in a new infection. Because the number of susceptible $S_t$ decreases as susceptible become ill with progress of time. This, in other way may be called as interaction between an susceptible and infective. So mathematically it can be expressed by the following equation -

$$S_{t+1} = S_t - \acute{a} S_t I_t \quad \ldots\ldots\ldots \text{(i)}$$

With time, the infective class grows by the addition of the newly infected.

At the same time, some infective will either recover or die, who are not to be considered further under susceptible class and both the groups will constitute removal class.

The ***removal rate,*** whichisdenoted by **ã** , measuresthe fraction of the infective class that ceases to be infective further, and thus moves into the removed class at time t. Clearly, the removed class increases in size by exactly the same amount

that the infected class decreases. This leads to the additional equations, mentioned below:

$$I_{t+1} = I_t + \acute{a} S_t I_t - \grave{O} I_t \ldots\ldots\ldots \text{(ii)}$$

$$R_{t+1} = R_t + \grave{O} I_t \ldots\ldots\ldots \text{(iii)}$$

Where, S = Susceptible; I = Infective; and R = Recovered individuals; N = Population size; á=transmission coefficient; and ã=removal rate; subscript t is the time span. It is usually advised to use a shorter time step.

Collectively, the three above coupled difference equations form SIR model.

## How to proceed for

Before we proceed forward, there are need some basic information, like-

- What is the causal organism ((bacteria, virus, fungus, etc.)?
- What is the contagious period of the organism? In other words, following infection, how long it takes to manifest (show) the symptoms of the disease on its host.
- What is the most target group of the organism? Is it children of certain age group? Is it male or female and if so of which age group (Ex. COVID-19 infects mostly the persons around 60 year age or above).

## Steps for calculation

If we look at the three equations, the unknown parameters are the two constants á and ã. Value of N is known to us. So, we are to find out these two unknown values.

**Step – 1**. Let us consider equation (i)

$$S_{t+1} = S_t - \acute{a} S_t I_t$$

Or, $S_{t+1} - S_t = - \acute{a} S_t I_t$ [this equation is expressed as: " $S = - \acute{a} S_{t+} \tilde{a} I_t$]

Or, $\acute{a} S_t I_t = - S_{t+1+} S_{t=} S_{t-} S_{t+1}$ (by changing the sides)

Therefore, $\mathbf{\acute{a} = (S_{t-} S_{t+1)} / (S_t I_t)}$ ……. (iv)

Once data on $S_{t\,,}$ $S_{t+1)}$ and $I_t$, are available, using simple rule of mathematics, the value of á can be calculated from equation (iv).

**Step – 2.** During a period of time the infective class grows by the addition of the newly infected. At the same time, some infectives recover or die, and

so progress to the removed stage of the disease. The removal rate (Ò) measures the fraction of the infective class that ceases to be infective, and thus move into removed class. In fact, one can estimate Ò for real disease by observing infected individuals and determining the mean infection period as 1/ Ò. So,

**Ò = 1/ (contagious period) …… (v)**

**Step – 3**. Now it is time to calculate *Basic Reproduction number* (denoted by $\mathbf{R_0}$)indicates characteristics of the disease –whether it is an epidemic or not.

So, $\mathbf{R_0 = ( á/Ò)S_0}$ (here, $S_0$ = N)

**If $R_0$> 1**, then the disease will erupt as epidemic; if **$R_0$= 1**, then a diseased individual produces only one case and no epidemic can occur; when **$R_0$< 1** , the disease dies out.

*So, an epidemic occurs if and only if the Basic Reproduction Number* ($R_0$)>1.

**Note:** The Basic Reproduction Number($R_0$) plays a role in public health decisions, because a disease prevention programme will be effective in preventing outbreaks only when it ensures $R_0$

## The Problem

Let us consider a population of 500 in a small society, being affected by some infectious disease caused by some organism, contagious/ incubation period of which is 10 days and on first day 1 person has been infected.

With the given information, we can calculate using equation (iv)-

á = (500 – 499.5)/(500x1) = 0.001

And using equation (v), **ã =** 1/10) = 0.1

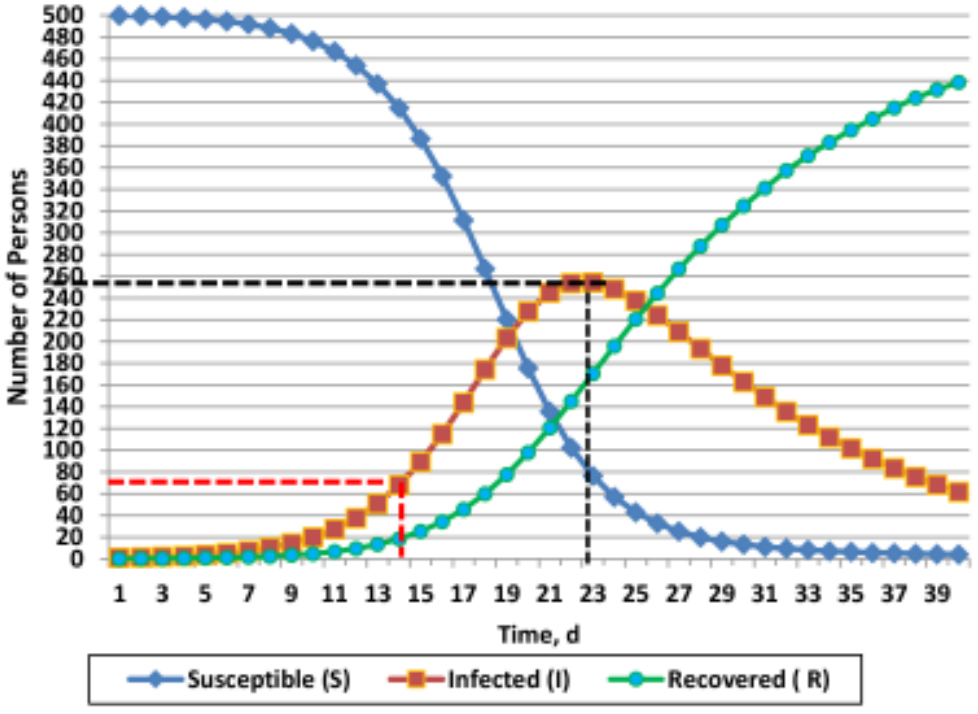
Hence, $\mathbf{R_0}$ =(0.001/0.1)*500 = 5, which is greater than 1 and so the disease is an epidemic.

Once the values of á and ã are known, using all the three equations the following data (Table – 4.4.1) for all the three classes can be calculated out and then the values need to be plotted in the graph paper keeping number of person, the dependent variable, in y-axis and time, the independent variable in the x-axis.

**Table – 4.5.1. Calculated values of three different classes by day**

| Day | Susceptible (S) | Infected (I) | Recovered (R) | Day | Susceptible (S) | Infected (I) | Recovered ( R) |
|---|---|---|---|---|---|---|---|
| 1 | 500.00 | 1.00 | 0.00 | 21 | 135.59 | 244.91 | 120.50 |
| 2 | 499.50 | 1.40 | 0.10 | 22 | 102.38 | 253.62 | 144.99 |
| 3 | 498.80 | 1.96 | 0.24 | 23 | 76.42 | 254.23 | 170.36 |
| 4 | 497.82 | 2.74 | 0.44 | 24 | 56.99 | 248.23 | 195.78 |
| 5 | 496.46 | 3.83 | 0.71 | 25 | 42.84 | 237.55 | 220.60 |
| 6 | 494.56 | 5.35 | 1.09 | 26 | 32.67 | 223.98 | 244.36 |
| 7 | 491.91 | 7.46 | 1.63 | 27 | 25.35 | 208.90 | 266.76 |
| 8 | 488.24 | 10.38 | 2.37 | 28 | 20.05 | 193.30 | 287.65 |
| 9 | 483.17 | 14.42 | 3.41 | 29 | 16.18 | 177.85 | 306.98 |
| 10 | 476.21 | 19.94 | 4.85 | 30 | 13.30 | 162.94 | 324.76 |
| 11 | 466.71 | 27.44 | 6.85 | 31 | 11.13 | 148.81 | 341.05 |
| 12 | 453.90 | 37.50 | 9.59 | 32 | 9.48 | 135.59 | 357.35 |
| 13 | 436.88 | 50.78 | 13.34 | 33 | 8.19 | 123.31 | 370.91 |
| 14 | 414.70 | 67.88 | 18.42 | 34 | 7.18 | 111.99 | 383.24 |
| 15 | 386.54 | 89.25 | 25.21 | 35 | 6.38 | 101.60 | 394.44 |
| 16 | 352.05 | 114.82 | 34.13 | 36 | 5.73 | 92.09 | 404.60 |
| 17 | 311.63 | 143.76 | 45.62 | 37 | 5.20 | 83.40 | 414.76 |
| 18 | 266.83 | 174.18 | 59.99 | 38 | 4.77 | 75.50 | 423.97 |
| 19 | 220.35 | 203.24 | 77.41 | 39 | 4.41 | 68.31 | 431.52 |
| 20 | 175.57 | 227.70 | 97.73 | 40 | 4.11 | 61.78 | 438.35 |

***Fig-4.4.1.*** *Indicates the nature of dynamics of the disease among three classes*



## Conclusion

1.It appears from the figure- 4.4.1, that the infection will be peak by 23rd day from the day of first informed case while around 250 persons or 50% of the population of the area will be infected (shown by black dotted line). So the intervention is essential to bring down the curve towards flattening adopting appropriate measures to prevent the spread the epidemic.

2. But it is better to take the appropriate actions towards prevention at the time as soon as it reaches the inflection point on 12th day affecting 40 numbers i.e. 8% of the population (shown by red dotted line)

**ATTENTION**

1. This model can also be solved by differentiation as well as exponentially.
2. The SIR model is applicable for diseases in the animals other than human being.. Such as Foot and Mouth disease in cow, Ranikhetdisease in poultry and also diseases in fishes.
3. In case of large data, analysis can be done by taking proportionate values with respect to the total population.

## Additional Project Ideas

### (A) Design

1. Design different methods to purify water by using natural materials around you and compare them.
2. Study different systems of water transportation and design an improved product to transport water from source to home.
3. Design an improved product for reducing the burden of headloads of labour workers.
4. Design your own structure for an earthquake-proof house.
5. Design a house for flood prone area based on the challenges faced.
6. Study the design of the tradition housing in your region in relation to the climatic conditions
7. Design a utility-based product from natural waste available in your surroundings. Explore the scientific principles involved in making and application of that product.
8. Find golden ratio in different products around you and explain the science behind using the golden ratio.

9. Find an interesting element in nature around you like leaf, spider web, bird nest, flowers, etc., understand its scientific principle and possibility and design a product being inspired from it.
10. Identify a specific problem or need in your community. Design a product based on participatory design principle addressing that need.
11. Model the energy consumption in your locality and make a comparison based on different housing designs and systems.

**(B) Planning:**

1. Study the Supply Chain of Dabbawala in a city or town supplying home- cooked food. Understand their challenges, propose solution.
2. Map the vulnerability of your school in the context of flood or earthquake.
3. Prepare an evacuation plan for your school in case of a fire incident.
4. Develop ideas for increasing the system efficiency in biomass.
5. Understand the current scenario of Solid Waste Management system in your locality and propose viable better ideas.
6. Map the planning involved for public transport system in your area in relation to the need. Suggest possible ideas for improvement of the system.

**(C) Modeling:**

1. Study on climatic factors of your locality
2. Establish mathematical relation between Body Mass Index (BMI) and Basal Metabolic Rate (BMR)
3. Map the relationship between rainfall and stream flow
4. Comparative study on different plant species using Golden Ratio
5. Map nearby facilities like hospitals, offices, places of interest in 3 km radius of your locality
6. Map ground water level in your village by studying the wells in the area
7. Map the drainage lines in your area and categorise them in natural and man-made understanding its benefits and lacking.
8. Map the changes on the coast line of a specific region of India compared to the natural disasters faced in the region.
9. Map the green cover in your region compared to the land availability and usage.
10. Study on agriculture land use of a village using map as a tool and assess the agricultural self-sufficiency and food security.
11. Model the changes observed in habitats of animals in your surroundings.

## Sub-theme – V

# Traditional Knowledge System (TKS) For Sustainable Living

# Sub-theme – V

# Traditional Knowledge System (TKS) For Sustainable Living

***"If people can't acknowledge the wisdom of indigenous cultures, then that's their loss."*** **– Jay Grffiths**

## Introduction

Traditional knowledge refers to the knowledge, innovations, and practices of local people developed through the experience gained over time and adapted to the local environment and culture. As per the definition given by the United Nations University, "Traditional knowledge or 'local knowledge' is a record of human achievement in comprehending the complexities of life and survival in often unfriendly environments. Traditional knowledge, which may be technical, social, organisational, or cultural, was obtained as part of the great human experiment of survival and development".

Traditional Knowledge System (TKS) is collectively owned and vary with space and time as it is evolved in a different socio-cultural environment. It is society-specific and is dependent on understanding. Further, observational and experimental information about their living environments, along with skill and technology are essential to design a lifestyle in that specific environmental context. TKS is important for sustainable living as a provider of alternative ideas in the present context of global climate change, natural disasters, biodiversity loss, destabilized ecological services, food, and nutritional inequality, problems of sanitation and health.

TKS is mostly traditional knowledge that is propagated orally and/or through practices by the respective practitioners/ performers. Songs and sayings, dances, paintings, carving, chanting and various performances are the most common

ways of transferring the acquired knowledge down through the generations over hundreds of years or even more. Most of the traditional knowledge is mainly of practical in nature as it is seen particularly in the practices like agriculture, fisheries, animal husbandry, health, horticulture, forestry as well as pasture, land and environmental management. It is observed that many examples of traditional practices in the country on natural resource management, agriculture, medicine and health, housing and allied design and construction, have great potential to act as a support and encourage sustainable development. Diverse agro-climatic zones of India support a very high diversity of environmental and cultural practices, which nurture different traditional knowledge-based practices to adjust the way of life of the people to their respective environment. All these practices have some age-old history, progression and empirically tested observation, which essentially need not only documentation but also peer validation, scientific evaluation, and interpretation. Applicability of TKS in the contemporary context is significant to meet and support the requirement for sustainable living. It has been designed and developed by the local communities through their constant observation, trial and modification/customization to match with its appropriateness. Therefore, TKS has the characteristics of local, empirical, time tested dynamisms. By default, TKS or the untapped wisdom of our ancestors are still considered to be useful to promote sustainable living. It operates through the following principles:

**Table – 5.1.** Principle for pursuing sustainable living

| Targeted principle for adoption | Focuses |
|---|---|
| Respect and care for all | Traditional knowledge and its propagation in the society rooted in mutual respect for all including the fellow humans and all life forms around us. |
| Leading a community life | Traditions are evolved to keep up the culture of the society which, in turn, is evolved from their observations and resulted in reflections about nature. |
| Inculcate the habit of saving | By and large, cultural transactions based on traditions were and are rooted in saving and prudent usage of resources with a view of sustainability. |
| Adopt minimalism | Though there are exceptions, traditional practices by default, are designed for increasing the efficiency production, distribution and consumption through minimum input-maximum output formula. |
| Responsible decision making | Traditions are unwritten rules in a society. These necessitate real time operations and decision-making. No one can escape from the responsibility and the resultant outcome which has to promote sustainable living |

From the point of application and associated management approaches, TKS can be categorized as (i) Traditional Ecological Knowledge (TEK), (ii) Traditional Technical Knowledge (TTK) and (iii) Traditional Value and Ethics (TVE). TEK represents knowledge associated with natural resources and environmental management, TTK refers to knowledge associated with tools and appliances used and TVE refers to value, norm, institution, and policy framework evolved with traditional knowledge-based practices.TEK, TTK, and TVE were/are the basis of sustainable living of humanity. However, all these have to be studied in a minimum of three dimensions such as Ecological, Economic, and Sociological angles. Such kind of study can give output with visions.

## BOX- 5.1
## Operational Definitions

**Traditional Ecological Knowledge (TEK)**

TEK refers to the Ecological knowledge of the people on the environment including the relationships between plants, animals, natural phenomena, and the landscape that are used for livelihood and sustenance of life, such as resource gathering through hunting, fishing, agriculture, livestock farming, forestry, agroforestry, etc.

**Traditional Technical Knowledge (TTK)**

TTK represents the knowledge related to the tools, implements, and gears for different applications in the fields related to agriculture, fisheries, preservation and food processing, food preparation, animal husbandry, forestry, handloom, and handicraft, etc. TTK also represents the knowledge and skill about design and construction like housing, water harvesting structure, fishing, roads, and bridges, etc.

**Traditional Value and Ethics (TVE)**

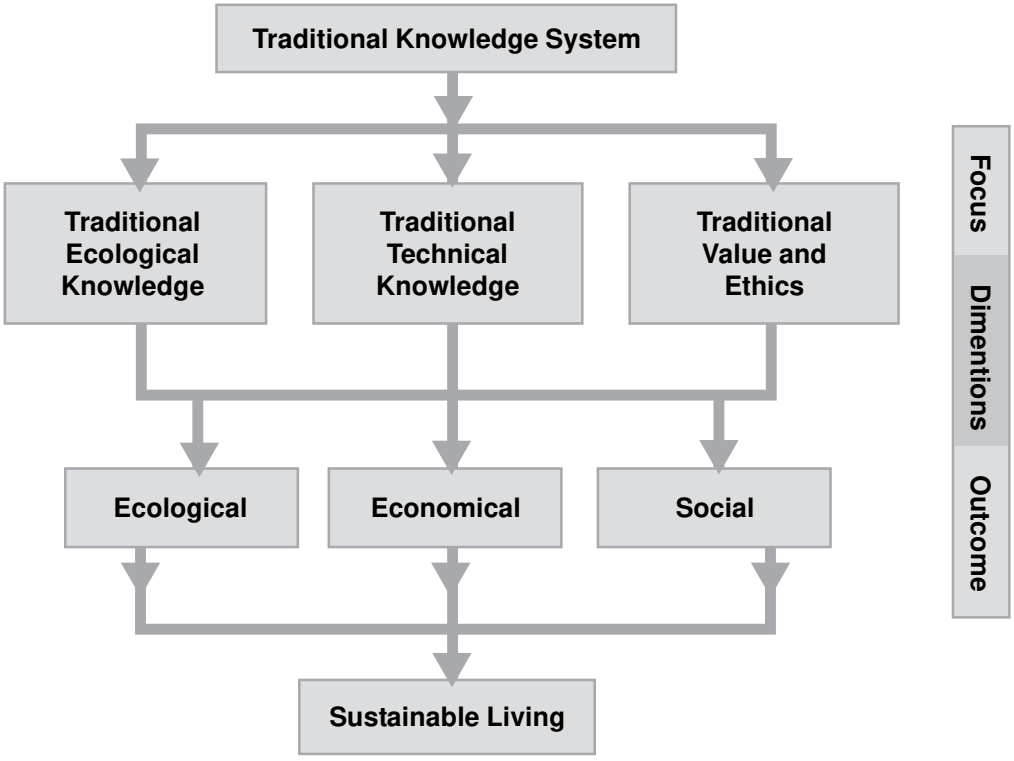
TVE represents traditional cultural practices that prioritize dos and don'ts in the aspects in relation to natural resource harvesting, conservation, and equitable sharing. It evolves the concept of social restrictions, sacred species, space, forests, water bodies, rivers etc. The customary taboos helped humanity to avoid the depletion of natural resources, which is a prerequisite for sustainable living. This will help to identify the prospects for the future adopting lifestyles, habitat management, environment, natural resource management and wildlife protection leading to sustainable living.

*Source : Sarma JK , Tyagi B K (edited) (2014), "Exploring Understanding Traditional Knowledge" Developed and SSEAEP, MG Road, Nagaon-782001, Assam for Vigyan Prasar, New Delhi*

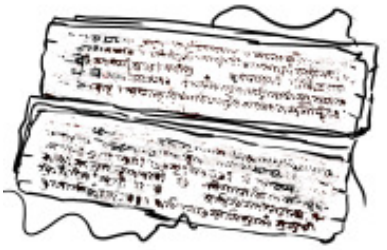
## Core concept

The sub-theme covers studies related with traditional ecological and technological knowledge along with values and ethics related to settlement systems, housing, agricultural, fishing and allied practices, natural resource management, food systems, disaster management, mitigation of human and wildlife conflict, handloom and handicraft, etc. The scope of the studies will be identification and documentation of traditional knowledge practices, its present status and management approach involved in it, along with the scientific validation of the basic principles, techniques, and materials in the context of its objectives. In doing so, one will be able to use secondary information and data with due references of sources to establish the significance of the practices and/or to narrate the trends. However, relevant original primary data derived through survey, field or laboratory experimentation is mandatory to support analysis and interpretation of the study.

## Framework



## Expected area of Coverage



The approach starts with the identification of traditional knowledge-based practice(s) along with its link to natural resources with the aim to support sustainable living. Such practice(s) need to be documented with appropriate answers to the questions like: *"What it is? Where it is? Who does practise it? Why is it in practice? Since when is it being practiced? How does it function?"* and many more.

In the process of documentation, there is a need to adopt the approaches of process documentation (documenting entire process/ all phases). If required one can use flowchart with narratives, maps, photographs, and graphs. However, there is a need to mention what type of TKS (*viz*. TEK, TTK or TVE) this particular study has been focused. It is equally important to validate these with appropriate interpretation in terms of its specific context, as well as in the universal contexts. For example, in the water harvesting system from surface flows, it is required to verify, "Whether watershed perspectives are in existence there? How the slope is considered? What are the catchment area treatment mechanisms followed?" These questions are very much contextual perspectives in nature. On the other hand, verification of the applicability of gravity flow of water is a universal aspect. Sometimes, if such surface flow system is used only for irrigation, one can verify possibilities of harnessing energy from the flowing water, without disturbing the output of irrigation or one can think about the applicability of pedal pumps or hydraulic rams in the system to increase the efficiency of the system without disassociating TKS based practices. Such efforts can be part of alternative, critical and creative thinking to strengthen the system under study.

From context to context, the approach of evaluation may vary. However, it is essential to reflect the evaluation approaches, methods, and tools in a methodological approach of the study. Moreover, entire analysis and interpretation need to portray how these particular TKS based practices help in sustainable living and prudent use of natural resources along with its future prospects.

## How to go about it

Following are the steps of work suggested for the studies:

***(A) Observation and identification of practices and documentation***

Conduct observation in the locality for the current practices of communities' daily life. Out of these, identify and find out some traditional practices which are unique to the area and/or specific to the community. It is always better to note down the observational information in a systematic manner which will help in the identification of specific study, as shown in the table 5.2

***(B) TKS primary data collection Protocol (Examples of some selected indicators)***

***Detailed Documentation:*** After initial observation and compilation of observational information, it is very much essential to document the practices in detail, covering all the aspects as it is mentioned in the above table. Such documentation needs a process interpretation note explaining through the diagram, as given below.

| *Components/Aspects* | *Definitions* | *Indicators* | *Approaches to assess Remarks* |
|---|---|---|---|
| | | | |

## Evaluation of the details

The important aspects of the chosen specific approach practiced by the community need to be validated with the application of the method of science. If it is an approach that nurtures soil health, it requires testing of soil under such practices and validates the impacts. On the other hand, if it is related to weather it requires to be validated with weather conditions and seasonality. Similarly, if it is related to herbal medicine, it is required to identify chemical content in the herbs and its impact on health or if it is water management, it is necessary to find out how such practices help in water conservation, assuring reliable supply system, maintaining perennial supply system, cleanliness of water, etc. It is mentionable that with issues/subject of study the approach of validation will vary. However, without validation it is difficult to establish its appropriate utility; and in absence of that, it may not help us to explore its applicability in future context or to undertake any initiatives for its improvement.

## Table- 5.2.

| Project Idea | Activities | Management principle | Uniqueness, if any | Remarks |
|---|---|---|---|---|
| House building | Design setting, building material selection and uses in construction operation | How it is focused on minimizing material waste, minimizing the cost of time, labour and money, how it helps the marginalized one | Environmentfriendliness, Seismic resistant, the reflection of energy efficiency, any other | At the time of observation visit to all possible sites of the locality, discuss with local practitioners involved with the work |
| Water management | Source identification utilization approaches and purposeend uses | Core management principle adopted for minimization of waste, the safety of the sources, maintaining cleanliness, etc. | If able overcome certain constrains, achieved reliability in terms of quantity and quality | At the time of observation visit to all possible site of the locality, discuss with local practitioners involved with the work |
| Agriculture | Type of crop produced, land preparation for the purpose, seed selection, planting, soil management, water supply weed, and pest management, harvesting & post-harvesting and process | Core management principle adopted for minimization of waste, the safety of crops, maintaining cleanliness, etc | If any constraints overcome, if it is a unique product to the culturally defined food system, if it has a certain weather climate connection, if it has certain value addition potentiality | At the time of observation visit to all possible site of the locality, discuss with local practitioners involved with the work |
| Food and medicine | For what and for whom? Identification and utilization of sourcesHarvesting practices, final product preparation | Core management principle adopted for minimization of waste, the safety of the product, maintaining cleanliness, etc. | If any constraints overcome, if it is a unique product to culturally defined food and health system, if it has a certain weather climate connection, if it has certain value addition potentiality, if it promotes sustainable consumption practices | At the time of observation visit to all possible site of the locality, discuss with local practitioners involved with the work |
| Handloom and handicraft | For what and for whom?Design setting, sources of raw material Harvesting practices of raw material, material processing, end products | Core management principle adopted for minimiazation of waste, the safety of the product, maintaining cleanliness, etc. | If any local opportunities materialized, if it is a unique product to a culturally defined way of life, if it has a certain weather climate connection, if it has certain value addition potentiality, if it promotes sustainable consumption practices | At the time of observation visit to all possible site of the locality, discuss with local practitioners involved with the work |

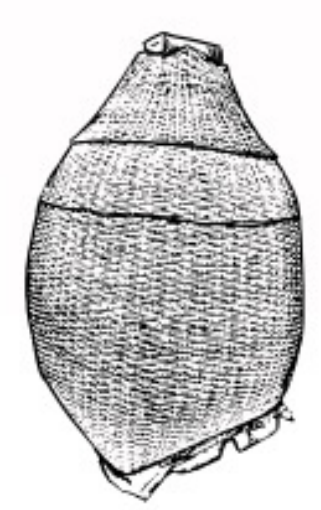
## Inference in relation with the sustainable living

Collected information on TKS should be subjected to peer validation, scientific evaluation and interpretation wherever it is possible. Also, the results need to be inferred and attempted to understand in the context of sustainability goals. Applicability of TKS in the contemporary context in this way is significant to meet and support the requirement for sustainable living.

## Model Projects

### *Project- 1: Understanding the traditional methods of seed storage and its usage in the current scenario*

### Background



The seed is the key component to crop production, food security and human nutritional values. Healthy and high-quality seeds are the utmost need for higher yields in agricultural methods. Post-harvest, seed storage is being done through various preservation techniques for providing protection against weather, insects, pests, rodents, diseases and also thieves. Traditionally, it is being done by many approaches such using insect-repellent materials, using specialised storage devices, locations and so on. India is well-known for its biodiversity and practices associated with it and it applies to agricultural practices as well. In a study conducted in villages of Karnataka, usage of materials such as cow dung slurry, cow urine, common salt, powdered plant extracts, and leaf extracts are reported. There are many traditional methods and customary beliefs related to seed storage techniques. Seed storage can be broadly classified in two ways-making of special structures/granaries and using certain materials to enhance the shelf life of the seeds. Modern ways of seed preservation use various chemical substances in the storage of seeds and grains which cause harmful effects on the consumers. A study of traditional practices used by the farmers to store seeds effectively can be compared with modern practices to understand the value of such practices in the light of the sustainable living.

## Objectives

1. Document the seeds and grains stored in the study area using the traditional methods.
2. Analyse through comparison the traditional methods versus conventional chemicals used in the light of sustainability.
3. Evaluate the attitude of local people regarding the traditional methods of seed storage.
4. To study the differences in the germination potential among the same type seeds stored in different storage methods

## Methodology

1. List the seeds and grains stored using the traditional methods in the study area
2. Document the methods of preservation with details for each crop.
3. Document the storage materials/equipment used in each case.
4. Collect the information about the storage of the same seeds in a modern way.
5. Evaluation of the effectiveness of the method through comparison.
6. Quality analysis of the seeds through the questionnaire method.
7. Sow the same number of seeds stored in different storage methods in similar conditions and calculate the germination percent among them.

## Hints to conduct the study

| Steps | Objectives | Parameters | Proposed tools | Expected outcome |
|---|---|---|---|---|
| **1** | Document the seeds and grains stored in the study area using the traditional methods. | Different types of seeds and grain varieties cultivated in the study area | Observations and discussion with farmers | Documentation of all the seeds and grains in the study area |

| | | | | |
|---|---|---|---|---|
| **2** | Analyse through comparison the traditional methods versus conventional chemicals used in the light of sustainability. | Identification and measurements of the available storage facilities associated parameters such as area, temperature, light, moisture content.Details of pre-storage processing | Scales Thermometer Lux meter Hygrometer | Quantified information about the storage facilities and the pre-storage processing techniques for comparison. |
| **3** | Evaluate the attitude of local people regarding the traditional methods of seed storage. | Type of seeds/ grains Time, location, facilities, pre-storage techniques, and special treatments etc., | Questionnaire Survey | Documentation and comparison of different techniques of seed storage and |
| **4** | Study the differences in the germination potential of seeds. | Number of seeds sown and number of seeds germinated. | Sowing, watering and observation of seedling | Percent germination of the seeds stored by different storage methods. |

### *Project- 2: Understanding functions, mechanisms and improvisation of stream-based water mill*

### Background

In villages in many parts of the country, there are examples of wise use of streamflow for the benefit of the mechanical services required for society. One such example is Chuskur Traditional Watermill practiced in Sagar Village of West Kameng District of Arunachal Pradesh. This is one of the fine examples of traditional knowledge of *Monpa* community to use the water flow for their benefit. In this practice, they wisely direct one hill stream through a narrow channel allowing it to fall on a wheel which will rotate depending on the pressure of the water flow, which turns in proportional to the amount of water fall and its speed. The rotating turbine is then connected with grinding stones and effectively used

for the grinding of grains and many other purposes. This traditional technology of the local people is a topic worth studying for many scientific aspects of TKS.

## Objectives

(1) To understand the water flow dynamics of the selected stream under study.
(2) To explore the multiple energy conversions happening in the watermill.
(3) To come up with innovative design opportunities to improve the efficiency of the mill
(4) To do modelling of the system for maximum and optimal efficiency under various assumptions.

## Methodology

Step-wise procedure to be followed to conduct the study

1. Map / or develop a drawing of the layout of the watermill.
2. Calculate the speed of water in different levels /locations of water flow.
3. Analyze the shape and size of the channel and amount of water flow at different levels.
4. Calculate the amount of water flow to the RPM of the wheel with and without load.
5. Understand the Speed of water/RPM relation.
6. Test effect of water flow on the performance.
7. Develop an optimal model system.

| Steps | Objectives | Proposed tools | Expected outcome |
|---|---|---|---|
| 1 | To understand the water flow dynamics of the selected stream under study | Water flow meters | Calculation of speed of water flow and amount of water delivered in a unit time |
| 2 | To explore the multiple energy conversions happening in the watermill. | Altimeter, Flowmeter Colour tags for calculation of RPM | Calculations of Energy conversions between the stages and relations between them. |
| 3 | To come up with innovative design opportunities better efficiency | Simple calculators | Calculations of turbine speeds for different shapes and length of the canal |
| 4 | Modeling the system for maximum /optimal efficiency | Calculators | Measurements of model watermill to increase the efficiency in different assumed conditions |

### *Project- 3: Study of traditions of sacred groves for biodiversity values, ecosystem services, economic and sociocultural values*

## Background

Sacred groves are isolated forest patches protected and managed by the local people. When seen from distance, they look like a "green island" in the landscape. They are known by many vernacular names such as '*Orans*', '*Banni*', and '*Deovan*'. across India. Generally, a sacred grove is dedicated to some deity. Since hacking down trees is a taboo, very old and huge-sized trees can be seen in such groves. Over time multi-storied forest would have developed in such groves. Being multipurpose areas, these groves are traditionally protected by society. These groves due to the economic, ecological and socio-cultural point of views, have a great value and provide many tangible and intangible benefits to the local society. Hence, in order to get the benefit continuously, they need protection and proper management. A short-term or long-term study on these is required to evaluate the role of these sacred groves as the provider of various goods and services. These ecosystem services given by the sacred groves have to be viewed from the perspective of sustainable living and socio-cultural values. They can also list the conservation related problems of these groves

and suggest some locally doable solutions to perpetuate the flow of benefits.

## Objectives

1) To list and quantify the benefits (tangible and intangible) procured from a selected sacred grove.
2) Document the sharing pattern of the benefits among various sections of the society
3) To understand the trends of benefits (decreasing, increasing or stable). If decreasing, to understand the possible reasons and suggest some solutions.
4) To document the biodiversity present and threats (if any) to its conservation in the selected sacred groves.

## Methodology

The study is to be carried out following step-by-step procedures mentioned below.

1. Identify a sacred grove
2. Prepare the map of that area and procure all the tools needed
3. Have a reconnaissance survey of the grove
4. Conduct linear walks (transect survey) in a crisscross manner or as per some structured manner and list all the flora, fauna and their habitats.
5. Conduct meetings, individual and group interviews to know the status of direct and indirect benefits and verify them with the help of secondary and primary data collection. Primary data should be collected by direct observations and using questionnaires. Data collection protocol is given as annexure TKS-1.

## Hints to conduct the study

| Steps | Objectives | Parameters | Proposed tools | Expected outcome |
|---|---|---|---|---|
| 1 | To list the biodiversity of the selected sacred grove | Listing of flora<br>Listing of fauna | Map of area, Land record, GPS & Camera | A document of biodiversity in the selected sacred grove |
| 2 | To list tangible and intangible benefits and threats | Quantification of materials and services given by the grove; Trends of benefits; Listing threats; Suggestions for better management | Measuring tape,Local flora,Guide books,Questionnaire forSurvey | Document and a plan for management to get benefits perpetually |

## Importance of the study

A good scientific document will enlighten the local community about the social, ecological and economic importance of the grove in their life and it will inspire the people to protect and manage with dedication. It is a good idea that a copy of the document should be given to the local panchayatand the team could explore possibilities to ensure some fund flow through MNREGA to restore the degraded spots of the grove.

### *Project- 4: Study of traditional knowledge of correct harvesting stage of fruits and vegetables.*

## Background

In the past, there was valuable traditional knowledge that existed in understanding the maturity of fruits and vegetables through observation. This knowledge was being largely used by the old generations to harvest the fruits and vegetables before ripening. The key importance of this knowledge is to help to reduce the damage that happens on ripening by a timely harvest. This also helps to consume good and healthy farm goods for sustainable living and good economic returns in contrast to the use of illegal chemical agents used for artificial ripening of fruits.

## Objectives

To study and validate the traditional knowledge on changes in morphology and physiology of fruits and vegetables as correct harvesting stage

## Methodology

Step-wise procedure to be followed to conduct the study

1) Identify plants/fruiting trees that are suitable for the study and study the fruiting seasons, study economics from tree yields etc.

2) Conduct meetings, individual and group interviews to know the knowledge on the correct harvesting stage and verify them with the help of secondary and primary data collection.

3) Primary data to be collected by direct observations and using questionnaires and study the processes, duration of natural ripening processes, shelf- life studies, palatability, marketability, etc. in comparison to chemical-based artificial ripening.

## Hints to conduct the study

| Objectives | Parameters | Proposed tools | Expected outcome |
|---|---|---|---|
| To study and validate the traditional knowledge on changes in morphology and physiology of fruits and vegetables as correct harvesting stage | Colour change, Change in Size,Change in Shape, Change in smell, Behaviour of wild animals present in vicinity | Direct observation Questionnaire surveyField guides to identify the vegetable/fruit plants and animals | Knowing this knowledge will help the agriculture system and economy of our country by consuming healthy vegetables and fruits.Scientific validation of such knowledge will help to understand the physiological changes in fruit and vegetables. |

## *Project- 5: Analysis of traditional food practices in comparison with modern food items*

### Background

Food culture in terms of the food items, preferences, preparations of people changes over time. While a great majority has the tendency to go for new and fashion in food, many stick to their age-old traditions. Food practices are evolved over ages based on what was available in the local ecosystem. It may have a direct positive and negative impact on the health and well-being of the people. It would be interesting to do a comparative study of two food practices. For example, two food items - one traditional and one new/ modern food may be taken for the study.

### Objectives

1. To compare the diversity of plant/animal products involved in the preparation of a selected set of traditional food dishes with another set of modern dishes.
2. To study the loss of traditional skills in people due to the change in food practices.
3. Analysis of nutritional value between the two sets of selected food items.
4. To analyze the energy required for the preparation of the selected food items.

### Methodology

Step-wise procedure to be followed to conduct the study

1. Identify the changing the food practices of the people over time through a questionnaire survey among different sections of people in a given area.
2. List the food items prominently available over the period of 60-80 years with various benchmarks of time.

3. List the ingredients and identify the biodiversity that supported the ingredient of each dish.
4. Get the recipes of all the dishes with the specific cooking techniques including time required and other associated equipment.
5. Qualitative and quantitative analysis of the contents of biodiversity contents of cooking, health benefits, and perceptions of people based on primary data.

| Steps | Objectives | Parameters | Proposed tools |
|---|---|---|---|
| **1** | To compare the diversity of plant/animal products involved in the preparation of a selected set of traditional food dishes with another set of modern dishes. | List the plant species and parts used in the selected dish comparing the recipes.List the animal species used in the selected dish comparing the recipes. | Recipes of different dishes used prepared in the area |
| **2** | To study the loss of traditional skills in people due to the change in food practices. | List of different dishes prepared by people in the area with recipes and specific skills if any. | Questionnaire survey |
| **3** | Analysis of nutritional value between the two sets of selected food items. | Health benefit of different ingredients of food dishes based on the ingredients | Secondary literature and interactions and questionnaires survey with doctors and *vaidya*s |

## Expected Outcome

1. An understanding of the trend of food practices with impact assessment on the health benefits, biodiversity aspects of the traditional and modern food items.
2. The project can create scientific discussions among the students/teachers about the food culture and the ongoing trends of choice of food among people.

## *Project- 6: Analysis of construction technology of houses and other buildings*

### Background

Generally, traditional housings have architectural style and design based on local needs, local availability of construction materials and reflect local traditions. Originally, traditional architecture relied on the design skills and tradition of local builders/ skilled labours. It tends to evolve over time to reflect the environmental, cultural, technological, economic and historical context in which it exists. In the case of environmental factors, major aspects are – geology, land, and soil; weather and climate; availability of the building materials in the locality. On the other hand, family size, family structure (joint or nuclear), food habits, materials, cultural practices, belief system, etc. Based on the building materials used in wall construction it can be categorized as adobe (mud blocks or whole walls), masonry (stone, clay, or concrete blocks), timber, bamboo, etc.Commonly a combination of materials is used. The layout of the building also varies, like the circular plan, rectangular plan and linear plan. Similarly, there may be single-storey or multi-storied buildings. In Indian condition, such traditional housing is very common in the rural context and its design, plan and building material varies with geographical regions. It is important to explore such practices with the objectives to identify merits and demerits of such practices and its usefulness in the context of climate change adaptation, earthquake resistance, environmental sustainability, etc.

## Objectives

1. To observe, identify, list all the buildings with traditional architecture.
2. To understand the simple engineering principles
3. To understand the suitability of the buildings in local conditions

## Methodology

Following are the steps to be followed while carrying out the study.

1. Prepare a list of buildings with traditional architecture in the study area
2. Identify representative building in each category
3. Record the ambient temperature, light, and ventilation inside each of the building
4. Do an energy auditing of the building by calculating the energy consumption for the maintenance of the whole building per month.
5. Analysis of the material used and its sustainability.
6. Analyze the engineering principles, and aesthetic through a questionnaire method.
7. Do a comparative analysis of the all the above parameter between different types of the building including traditional and modern style.

## Hints to conduct the Study

| Steps | Objectives | Parameters | Proposed tools |
|---|---|---|---|
| **1** | To observe, identify, list all the buildings with traditional architecture. | Location of the building Age of the buildingUse and purpose of the building | Enquiry with peopleVisit to the location |
| **2** | To understand the engineering principles | Materials used in constructionArchitectural style such as height, size of door, windows, etc. | Observation Measurements |
| **3** | To understand the suitability of the buildings in local conditions | Light, temperature, attitude of people using the building | Observation, Measurements |

## Expected Outcome

1. Awareness among children and people regarding the importance of traditional architectural buildings.
2. Information on the suitability of the traditional architecture for specific locations.

### *Project -7: Comparison of traditional agricultural techniques with modern farming techniques.*

## Background

Traditional agricultural techniques are still in practice in many areas of the country and considered important. These techniques are followed in the selection of crop varieties, land selection, land preparation, soil fertility management, irrigation, harvesting, post-harvest management, seed preservation, etc. Moreover, there are different tools and implements used for different purposes. For example, there are different shapes and sizes of plough and hoe used for tilling of soil in the country, which vary from region to region based on soil quality, terrain condition and the crop used for cultivation. Not only that, with variations in the crop varieties, the tools used for harvesting also changes. The best example is variations in the different shapes and sizes of sickle used in different areas from time immemorial. Similarly, there are different types of the land cultivar in different regions, which are a potential source for climate change adaptation;

because many of such crop varieties are either drought and/ or flood tolerant. All these changes put together alter the microhabitat of the farming area. Hence the associated flora and fauna of the farmland also show changes.

## Objectives

1. To study the use of different farming equipment and their comparison between farming practices.
2. To study the soil and crop varieties practiced under different farming practices and their comparison.
3. To study the flora and fauna of the farmlands under different farming practices and their comparison.
4. To do a cost-benefit analysis of agriculture among the farmers doing traditional and modern agricultural practices

## Methodology

1. Identify at least one large farm with traditional agricultural practice and a similar large farm with modern agricultural practice.
2. Make a map of the farms with the locations of different crops (if any) and other significant features of cultivation.
3. List different implements used in the farm with the crops for which it is used, time, method and any other specialties.
4. Make a timeline of practices for each of the crops for the year such as land preparation, soil fertility management, irrigation, harvesting, post-harvest management, seed preservation.
5. Observe and list the other flowering plants, birds, butterflies, number of earthworms, insects, frogs and snakes (if any) by spending adequate time in the farmlands.
6. Compare the collected information to infer the answers to the objectives.
7. List the expenditure and income of the farmers for the farming activities for the year.
8. Analysis of all the above-collected information to compare and to find differences and similarities between the agricultural practices.

| Steps | Objectives | Parameters | Proposed tools | Expected outcome |
|---|---|---|---|---|
| 1 | Study the use of different farming equipment and their comparison between farming practices. | Listing of farming equipment for different crops | Observation and enquiry | Knowledge about the traditional equipment used in farming and their changes over time. |
| 2 | Study the soil and crop varieties practiced under different farming practices and their comparison. | Soil parameters such as type and texture of soil, pH, temperature, water-holding capacity etc. | Observation, enquiry, analysis of soil parameters. | Understanding the relation of farming practices on soil water management. |
| 3 | Study the wild flora and fauna of the farmlands under different farming practices and their comparison. | Identification ofwild herbs, birds and butterflies and others. | Field guides | Appreciation about the extent of wild biodiversity in different type of farms. |
| 4 | Do a cost-benefit analysis of agriculture among the farmers doing traditional and modern agricultural practices | Information about the inputs and outputs of two different type of farming practices | Questionnaire survey | Understanding the differences in cost and benefits between traditional and modern farming |

## Expected Outcome

1. Understanding the differences between modern and traditional farming systems and practices in the light of sustainability.
2. Development of skill to do the comparative analysis of the practices and observations among the students.

**Box – 5.2**

**Sample of questionnaire**

Q1. In your opinion density of grove is increasing/decreasing/stable?

Q2. How many people of your family go for morning and evening walk?...

Q3. In your opinion number of bee hives is increasing/decreasing/stable?

Q4. Quantum of fallen wood extracted by your family for fuel purposes?..

Q5. Quantum of fallen leaves extracted by your family for manuring purposes?..

Q6. Quantum of fruits collected by your family for consumption purposes?.... and so on…

## Additional Project Ideas

1. Traditional methods of seed storage and validation.
2. Study of the potential of re-establishing leaf bowls and plates as an alternative to single-use plastics.
3. Evaluation of nutritional values of traditional food.
4. Comparative study of traditional and modern water purifying practices
5. The protocol of traditional tree planting methods.
6. Traditional pollution-free rat control methods.
7. Tradition crop protection practices and its efficacy and evaluation.
8. Study of certain ethno-medicines, their applications, and efficiencies.
9. Traditional insect control methods in agriculture and their efficacies.
10. The tradition of water harvesting techniques and its utility in the modern era.
11. Local and traditional practices of fodder enrichments and its effect on animal husbandry.
12. Minor millets and their pest resistance.
13. Efficacy of traditional honey collection and extraction methods.
14. Traditional termite control methods in agriculture fields and their efficacy
15. Drought hardy traditional crop races and their role in the climate change scenarios.
16. Traditional plant growth promoters
17. Traditional eco-friendly wood curing techniques.
18. Traditional de-ticking or de-worming practices in tribal/rural areas.
19. Traditional food material drying/preservation practices
20. Traditional plant-animal identification methods and vernacular nomenclature.
21. Traditional non-scientific acts and facts – awareness study.
22. Documentation of food processing/food-fermentation techniques and its relation to food quality preservation
23. Study on biodiversity of a particular local community and developing People's Biodiversity Register
24. Different architectural structures and its importance in maintaining the ecosystem (e.g housing, bridges, water distribution canals)

25. Resource conservation methods and its sustainability
26. Various agricultural farming systems and their importance with the future scope
27. Traditional knowledge of various agricultural tools and its applicability in organic farming
28. Traditional knowledge of fisherman and its links to sustainable livelihoods
29. Study on community seed bank and its relation to food security
30. Traditional knowledge of natural fibre and its uses in the modern context
31. Study on traditional knowledge on ecological restoration mechanism its impact on ecosystem management.
32. Traditional crop rotation methods in agriculture
33. Documentation of traditional drinks in an area and comparison with the modern drinks in terms of preparation and health benefits.
34. Traditional calendar of farming activities and in association with weather parameters.
35. Documentation of vernacular names of plants and selected organisms and its comparison to the modern names in conveying the message about the organisms.
36. Documenting the traditional knowledge on the biodiversity use of the study area.

## Relevant Definitions and Terminology

**Alien species**: A species occurring in an area outside of its historically known natural range as a result of intentional or accidental dispersal by human activities. It is also known as exotic and introduced species.

**Anthropocene**: The current geological age, viewed as the period during which human activity has been the dominant influence on climate and the environment.

**Biodiversity**: *Biodiversity* or *Biological Diversity means* the diversity of life in all forms- the diversity of species, of genetic variation within one species and of ecosystem.

**Carrying Capacity**: The maximum number of people or individual of a particular species that a given part of the environment can maintain indefinitely.

**Cluster random sample:** The population is first split into groups. The overall sample consists of every member from some of the groups. The groups are selected at random.

**Ecology**: A branch of science concerned with the interrelationship of organisms and their environment; the study of ecosystem.

**Ecosystem approach**: The ecosystem approach is a strategy for the integrated management of land, water and living resource that promote conservation and sustainable use in an equitable way. The ecosystem approach places human needs at the centre of biodiversity management. It aims to manage the ecosystem, based on the multiple functions that ecosystem performs and the multiple uses that are made of these functions. The ecosystem approach does not aim for short term gains, but aims to optimise the use of an ecosystem without damaging it.

**Ecosystem**: An ecosystem includes all living things in a given area, as well as their interactions with each other and with their non-living environments (weather, earth, sun, soil, climate, atmosphere). Each organism has a role to play and contributes to the health and productivity of the ecosystem as a whole.

**Ecosystem Services**: Ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing. They support directly or indirectly the survival and quality of human life.

**Fauna**: All of the animals found in a given area.

**Flagship species**: A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause.

**Flora**: All of the plants found in a given area.

**Habitat**: A place or type of site where an organism or population naturally occurs.

**Indicator species**: A species whose status provides information on the overall condition of the ecosystem and of other species in that ecosystem.

**Indicator species**: An indicator species is a species or group of species chosen as an indicator of, or proxy for, the state of an ecosystem or of a certain process within that ecosystem.

**Invasive species**: The species which are introduced – intentionally or unintentionally – to an ecosystem in which they do not naturally appear and which threaten habitats, ecosystems or native species.

**Keytone species**: A keystone species is a species that plays an essential role in the structure, functioning or productivity of a habitat or ecosystem at a defined level (habitat, soil, seed dispersal, etc).

**Native species**: Flora and fauna species that occur naturally in a given area or region is known as native or indigenous species.

**Natural Resource Management**: Natural Resource Management (NRM) refers to the sustainable utilisation of major natural resources such as land, water, air, minerals, forests, fisheries, and wild flora and fauna.

**Quadrate method of survey**: Survey of plant or animals in a definite size of square area.

**Sampling**: Sampling is the process of selecting a representative group from the population under study. The target population is the total group of individuals from which the sample might be drawn.

**Simple random sample:** Every member and set of members has an equal chance of being included in the sample.

**Species**: A group of organisms capable of interbreeding freely with each other but not with member of other species.

**Stratified random sample:** The population is first split into groups. The overall sample consists of some members from every group. The members from each group are chosen randomly.

**Sustainable Development Goal:** Sustainable Development Goal (SDGs) are a set of 17 global goals adopted by the United Nations General Assembly in 2015 with a vision of ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity by 2030.

**Sustainable Development**: The development that meets the needs of the present without compromising the ability of future generations to meet their own needs, according to the World Commission on Environment and Development (WCED).

**Sustainable Living:** Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of the earth's natural resources and personal resources. Practitioners of sustainable living often attempt to reduce their carbon footprint by altering methods of transportation, energy consumption, and diet.

**Systematic random sample:** Individuals are selected at regular interval from the sampling frame for ensuring an adequate sampling size.

**Umbrella species**: Species that have either large habitat need or other requirements whose conservation results in many other species being conserved at the ecosystem or landscape level.

**Urban habitat**: Urban habitats are essentially altered or transformed by human use. Land may be predominantly occupied by construction or infrastructure and the ecosystems and species assemblages that occurred there previously, may be completely or almost completely lost.

**Wild species**: Organisms captive or living in the wild that have not been subject to breeding to alter them from their native state.

**BMI:** Body Mass Index

**BMR:** Basal Metabolic Rate

**Empowerment:** The process of becoming stronger and more confident

**Frugal or *Jugaad*:** Economical in use or expenditure

**Hydrological Cycle:** Water Cycle

**ICT:** Information and Communication Technology

**Infiltration:** The process by which water on the ground surface enters the soil

**Kiosks:** Small booth that displays information

**Social Enterprise:** Organisation that applies commercial strategies to maximize social impact alongside profits

**Societal Ideation:** The process of bringing ideas to life by collaborating, commenting, etc.

**Unprecedented:** Never having happened or existed before

**Relevant definition and terminology**

**Appropriate technology**: Technology which is simple, make use of local material and skills, responsive to local needs and contexts, needs little capital, can be used and owned by individuals and small communities.

**Intermediate technology**: It is a kind of technology which is in between complex, large, high-cost technology and small-scale traditional technology.

**Resource-constraint environment**: Situation where lack of access to natural resources, skill and capital can become limiting factors.

**Carbon footprints**: The amount of carbon dioxide released into the atmosphere as a result of activities like use of electricity, transportation, cooking etc. by an individual, organisation or community.

**Water footprint**: Quantity of fresh water used directly or indirectly by a person or community.

**Ecological footprint**: The impact of a person or a community activity on the environment in terms of the area of biologically productive land, water required to produce the goods consumed and to assimilate the waste generated.

**Handprint:** It is an innovative approach to facilitate the measurement, evaluation and communication of the ecological, economic, and social sustainability impacts of products.

**Tradition:** A practice (evolved by the society) of doing something commonly by the various sects of society from the remote past.

**Traditional Knowledge System:** The know-how of the people, gathered through day- to-day walk of life, to overcome the hurdles and tap the potentialities from their immediate neighbourhood.

**Traditional Ecological Knowledge**: The evolving knowledge related to plants, animals and natural phenomena acquired by local people over hundreds or thousands of years through direct contact with the environment.

**Traditional Value and Ethics**: The traditional cultural practices which prioritise dos and don'ts in the aspects in relation to natural resource harvesting, conservation, and equitable sharing.

**Rotation Per Minute (RPM):** Number of rotations a wheel complete within a minute time.

**Intangible benefit**: Invisible gains

**Tangible benefit**: Visible gains

**Indirect benefit**: Invisible gains

**Director benefit**: Visible gains.

**Sacred**: Holly

**Sacred Groves:** A patch of vegetation mostly protected by the society /family due to various faiths and sentiments.

**Water mill:** A mill operated with the help of kinetic energy of flowing water

**Biodiversity**: A sum of all forms of animals and plants confined to a particular habitat or area

**Multi-storied**: Having many storeys

**Empirical**: Verified by observation

**Pasture land:** Area covered with grass or other plants suitable for the grazing of animals.

**Dynamism**: Quality of being characterized by vigorous activity and progress.

**Policy framework**: A document that sets out as a set of procedures on goals, which might be used in negotiation or decision making to guide a more detailed set of policies.

**Vernacular name**: A common name or name of a plant or animal in the common native speech.

**Seismic:** Related to earthquakes, other vibrations of the earth and its crust.

**Catchment area**: The area from which rainfall flows into a river, lake or reservoir

**Ethics**: A set of moral obligations that define right and wrong in our practices and decisions.

**Ethno-medicine**: Medical practices of various ethnic groups.

**Ecological restoration**: Recovery of disturbed or destroyed land or water ecosystems with the aid of supporting practices.

# Annexure

# Annexure- I

## How to calculate Pearson correlation co-efficient

To examine the relationship between two variables, a formula is used which produce a value known as the **co-efficient value** (commonly known as **Correlation Co-efficient**), an unit of less value denoted by 'r'. The co-efficient value ranges between 1 and -1. If the value is negative (-) it means the relationship between the variables is **negatively** correlated, or as one value increases, the other one decreases. But, if the value is positive (+), it means the relationship between the variables is **positively** correlated, or as one value increases/ decreases, the other one also increases/decreases. The Pearson correlation coefficient value is calculated by the following formula.

$$r_{xy} = \frac{N\Sigma XY - \Sigma X.\Sigma Y}{\sqrt{\{N\Sigma X^2 - (\Sigma X)^2\}\ \{N\Sigma Y^2 - (\Sigma Y)^2\}}}$$

$r_{xy}$ = Product moment coefficient of correction between X and Y variables

$\Sigma$ = Symbol of summation

$\Sigma XY$ = Sum of product of X and Y

$\Sigma X$ = Sum of scores of X variables

$\Sigma Y$ = Sum of scores of Y variables

$\Sigma X^2$ = Sum of squre of X

$\Sigma Y^2$ = Sum of squre of Y

**Note:** The sign sigma ($\Sigma$) used in the equation indicates summation or simply addition.

Step- I: Make a chart with your data for two variables, labelling the variables (x) and (y), and add three more columns labelled as ($x^2$), ($y^2$) and (xy).

Step -2: Let us take an example to study the correlation between Age of child and their scores. Here y is the dependent and x is the independent variables.

Step-3: Let's put the above information in the table below-

| Child | Age (x) | Score (y) | (xy) | $(x^2)$ | $(y^2)$ |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |

• *More data would be needed. Here, only three samples have been shown for the purposes of example, but the ideal sample size to calculate a Pearson correlation co-efficient should be more than ten*.

Step - 4: Complete the chart using basic square and multiplication procedures to get the values as depicted in the following table.

| Child | Age (x) | Score (y) | (xy) | $(x^2)$ | $(y^2)$ |
|---|---|---|---|---|---|
| 1 | 20 | 30 | 600 | 400 | 900 |
| 2 | 24 | 20 | 480 | 576 | 400 |
| 3 | 17 | 27 | 459 | 289 | 729 |

Step - 5: After completion of all the values, add all of the columns from top to bottom and put in the table as Total.

| Child | Age (x) | Score (y) | (xy) | $(x^2)$ | $(y^2)$ |
|---|---|---|---|---|---|
| 1 | 20 | 30 | 600 | 400 | 900 |
| 2 | 24 | 20 | 480 | 576 | 400 |
| 3 | 17 | 27 | 459 | 289 | 729 |
| **Total** | **61** | **77** | **1539** | **1265** | **2029** |

Step - 6: put these values in the formula to find the Pearson correlation co-efficient value.

Step - V: Once you complete calculation using the formula above, the result is your co-efficient value. If the value is a negative number, then there is a negative correlation of relationship. If the value is a positive number, then there is a positive relationship between the two variables.

**REMEMBER** Morecloselythe r-value is to ± 1, more is the strength of relationship between the two variables. Of course there are methods to test its strength more accurately. But, for you people, as a rule of thumb, value e" 0.8 may be considered as existing 'very good' strength between the variables.

# Annexure - II

## Proforma for Data Collection Protocol related to Model Project-3 under Traditional Knowledge System

### (A) Biodiversity listings

| Sl. No | Habit/Type | Species | Habitat |
|---|---|---|---|
| 1 | Non - flowering plants | 1. *Spirogyra* sp. (Alga)<br>2. *Volvox* sp. (Alga)<br>3. *Polyporus* sp. (fungus)<br>4. *Marselliaminuta* (fern)<br>5. .....<br>6. ..... | Stream<br>Stream<br>Fallen logs<br>Water pools |
| 2 | Herbs | 1. *Cynodondactylon* (dubgrass)<br>2. *Ocimumcanum* (jungelytulsi)<br>3. .....<br>4. ..... | Moist area<br>Open area |
| 3 | Shrubs | 1. *Woodfordiafruiticosa* (dhawdi)<br>2. .....<br>3. ..... | Rock faces |
| 4 | Climbers | 1.....<br>2..... | |
| 5 | Trees | 1.....<br>2..... | |
| 6 | Non-chordates | 1.....<br>2..... | |
| 7 | Fishes | 1..... 2..... | |
| 8 | Amphibia | 1..... 2..... | |
| 9 | Reptiles | 1..... 2..... | |
| 10 | Birds | 1..... 2..... | |
| 11 | Mammals | 1..... 2..... | |

**Synopsis**

1) Species wise, 2) habitat wise

| Sl. No | Benefits | Method to know status | Present status | Trends | | |
|---|---|---|---|---|---|---|
| 1 | Shade during fair and festivals*(if used) | Interviews | Available | | | ✓ |
| 2 | Morning and evening walk facility** | -do- | -do- | | | ✓ |
| 3 | Suitable fair site | -do- | -do- | | | ✓ |
| 4 | Honey bee hives (pollination service) | Interview and direct observation | Present | ✓ | | |
| 5 | Vulture roosting and nesting site (Scavenging service) | -do- | -do | | ✓ | |
| 6 | Bathing facilities | -do- | Available | | | ✓ |
| 7 | Cattle drinking facilities | -do- | -do- | | | ✓ |
| 8 | Water level in wells present at periphery of the grove | -do- | Record present level | | | ✓ |

**(B). Direct Benefit Evaluation**

**Opportunistic Cost calculation**

*Cost of 1 fair, 20 shops (size 10 x10 ft)

Tent size needed 20 x 10 x10 = 2000 sqft

Cost of tenting 2000 @ Rs 10 P.Sq Ft = Rs. 20000/-

Cost of shade service Rs. 20000/-

**Morning and evening walk costing

50 persons using area twice a day (morning and evening)

Total entry 100

Entry ticket of nearest public garden Rs. 5 per entry

Total cost 100 x 5 x 365 = 182500/-

Similarly quantify and calculate the costs of other services

**(C). Direct Benefits (in the cases it is allowed)**

| Sl. No | Benefit | Quantum extracted | Market rate | Total Value, (Rs) | Trend* | Suggestions/ solutions |
|---|---|---|---|---|---|---|
| 1 | Dry fallen woods used as fuel* | 10 qtls | 500/qtl | 5000 | Decreasing | Plant fuel yielding is species in gaps |
| 2 | Dry fallen leaves collected for manuring | 500 kg | 10/kg | 5000 | Decreasing | Plant species having more foliage |
| 3 | Honey collection | 50 kg | 200/kg | 10000 | Decreasing | Plant flowering tree and bush species |
| 4 | Wax collection | 5 kg | 500/kg | 2500 | Decreasing | -do- |
| 5 | Wild mango fruit collection | 100 kg | 50/kg | 50000 | Stable | Maintain number of mango trees |
| 6 | Wild Jamun collection | 200 kg | 200/kg | 40000 | Stable | -do- |
| 7 | Broom grass collection | 50 kg | | 1000 | Increasing | Protect from fire hazard |
| 8 | | | | | | |
| 9 | | | | | | |
| | Total direct benefits | | | | | |

*Wherever in practice

# Anexure - III

| Recommended Dietary Allowance of Nutrients for adolescents in 24 hours | | | | | | |
|---|---|---|---|---|---|---|
| | Male | | | Female | | |
| | 10-12 Yr | 13-15 Yr | 16-18Yr | 10-12 Yr | 13-15 Yr | 16-18Yr |
| Energy(Kcal) | 2200 | 2500 | 2700 | 2000 | 2100 | 2100 |
| Protein (gms) | 54 | 70 | 78 | 57 | 65 | 63 |
| Calcium (mg) | 600 | 600 | 500 | 600 | 600 | 500 |
| Iron (mg) | 34 | 41 | 50 | 19 | 28 | 30 |

***Source:****https://vikaspedia.in/health/women-health/adolescent-health-1/management-of-adolescent-health/nutritional-needs-of-adolescents-and-anaemia*

# Annexure – IV

## Imperial/Metric unit conversion table

### Linear Measure (Length/Distance)

| Imperial | Metric |
|---|---|
| 1 inch | 25.4 millimeters |
| 1 foot (= 12 inch) | 0.348 meters |
| 1 yard(= 3 feet) | 0.9144 meters |
| 1 (satute) mile(=1760 yards) | 1.6093 kilometers |
| 1 (nautical) mile(=1.150779 miles) | 1.852 kilometers |

### Square Measure (Area)

| Imperial | Metric |
|---|---|
| 1 squre inch | 6.4516 sq. centimeters |
| 1 squre foot (= 144 inch) | 9.29 sq. decimeters |
| 1 squre yard (= 9 squre yard) | 0.8361 sq. meters |
| 1 acre (=4840 squre yard) | 0.40469 hectare |
| 1 squre mile(=640 acre) | 259 hectare |

### Cubic Measure (Volume)

| Imperial | Metric |
|---|---|
| 1 cubic inch | 16.4 cubic centimeters |
| 1 cubicfoot (= 1728inch) | 0.0283 cubic meters |
| 1 cubic yard(= 27feet) | 0.765 cubic meters |

### Capacity Measure (Volume)

| Imperial | Metric |
|---|---|
| 1 (Imperial)fl.oz(=1/20 Imperial pint) | 28.41 ml |
| 1 (US liquid)fl.oz(=1/16 US pint) | 29.57 ml |
| 1 (Imperial)gill(=1/4 Imperial pint) | 142.07 ml |
| 1 (US liquid)gill(=1/4 US pint) | 118.29 ml |
| 1 (Imperial)pint(=20ft Imperial oz) | 568.26 ml |
| 1 (US liquid)pint(=16ft US oz) | 473.18 ml |
| 1 (US dry)pint(=1/2 quarts) | 550.61 ml |
| 1 (Imperial)gallon(=4 quarts) | 4.546 litters |
| 1 (US liquid)gallon(=4 quarts) | 3.785 litters |
| 1 (Imperial)pack(=2 gallons) | 9.092 litters |
| 1 (US dry)pack(=8 quarts) | 8.810 litters |
| 1 (Imperial)bushel(=4packs) | 36.369 litters |
| 1 (US dry)bushel(=4packs) | 35.239 litters |

### Mass (Weight)

| Imperial | Metric |
|---|---|
| 1 grain | 0.065 grams |
| 1 dram | 1.772 grams |
| 1 ounce(=16dram) | 28.35 grams |
| 1 pound(=16ounces=7000grains) | 0.45359237 kilogram |
| 1 stone(=14pounds) | 6.35 kilograms |
| 1 quarter(=2stones) | 12.70 kilograms |
| 1 hundredweight(=4quarter=112lb.) | 50.80 kilograms |
| 1 (long) ton(=2240lbs) | 1.016 tonnes |
| 1 (short) ton(=2000lbs) | 0.907 ton |

**Linear Measure (Length/Distance)**

| Metric | Imperial |
|---|---|
| 1 millimeter | 0.0394 inch |
| 1 centimeter(=10 mm) | 0.3937 inch |
| 1 decimeter(=10 cm) | 3.937 inchs |
| 1 meter(=100 cm) | 1.0936 yards |
| 1 decameters=10 m) | 10.936 yards |
| 1 hectameter(=100 m) | 109.36 yards |
| 1 kilometer(=10 cm) | 0.6214 miles |

**Square Measure (Area)**

| Metric | Imperial |
|---|---|
| 1 squre centimeter | 0.1550 sq. inch |
| 1 squre decimeter(=10000sq. cm) | 1.1960 sq. yards |
| 1 are (=100 sq. meter) | 119.60 sq. yards |
| 1 hectare(=100 ares) | 2.4711acres |
| 1 sq.kilometer | 0.3861 sq.mile |

**Cubic Measure (Volume)**

| Metric | Imperial |
|---|---|
| 1cubic centimeter | 0.0610 cubic inch |
| 1 cubic meter(one million cubic cm) | 1.308 cubic yards |

**Capacity Measure (Volume)**

| Metric | Imperial |
|---|---|
| 1 millilitre | 0.002 (imperial) pint |
| 1 centilitre(=10ml) | 0.018 pint |
| 1 decilitre(=100ml) | 0.0176 pint |
| 1 litre(=1000ml) | 1.76 pints |
| 1 decalitre(=10l) | 2.20(imperial)gallons |
| 1 hectolitre(=100l) | 2.75(imperial)bushels |

**Mass (Weight)**

| Metric | Imperial |
|---|---|
| 1 milligram | 0.015 grain |
| 1 centigram(=10 mg) | 0.154 grain |
| 1 decigram(=100 mg) | 1.543 grain |
| 1 grams(=1000 mg) | 15.43 grains |
| 1 decagram(=10 g) | 5.64 dram |
| 1 hectogram(=100 g) | 3.527 ounces |
| 1 kilograms(=1000g) | 2.205 1 pounds |
| 1 ton(=1000kg) | 0.984 (long)ton |

# A Note on Infectious Diseases with Special Reference to COVID-19

**Year of Awareness on Science and Health (YASH) 2020-2021**

National Council for Science & Technology Communication (NCSTC), Department of Science & Technology launches a programme on health and risk communication "Year of Awareness on Science & Health (YASH)" with Focus on COVID-19.

Important objectives of the YASH programme are:

1. To minimize risks at all levels with help of public communication and outreach activities at large.
2. To promote public understanding of common minimum science for community care and health safety measures like personal sanitation and hygiene, physical distancing, and maintaining desired collective behaviours, etc.
3. To develop and disseminate science communication software, enhance science coverage in mass media including illustrative interpretations especially to reduce the fear of risks and build confidence with a dose of necessary understanding.
4. To assess and rationalize community preparedness and perceptions.
5. To inculcate scientific temper for adopting sustainable healthy lifestyles, and nurturing scientific culture among masses and societies.

At the dawn of the year 2020, a fragile uninvited guest, weighing in attograms, was waiting at global doorstep since previous night. Before we could even realize, this cousin of SARS corona virus of 2013 gained entry into our lives, so deeply, that months-long lock-down is not proving to be enough to evacuate this intruder. Our health, health care system, and preparedness for health emergencies came

under scanner. Being completely unknown, this intruder provided no clue, whatsoever, to counteract. Though not of this scale, but we have suffered from a number of outbreaks, endemics, epidemics, and pandemicsduring last century. The last tragedy of this proportion was recorded almost a century ago. Bottom line is how much have we learnt from our past mistakes. To start afresh, here we are. NCSTC division of DST, GoI has taken an initiative through launching of a program – YASH.

Following insights are expected to give a better understanding and reinforce our preparedness.

**Emerging and re-emerging infectious diseases of public health importance:**

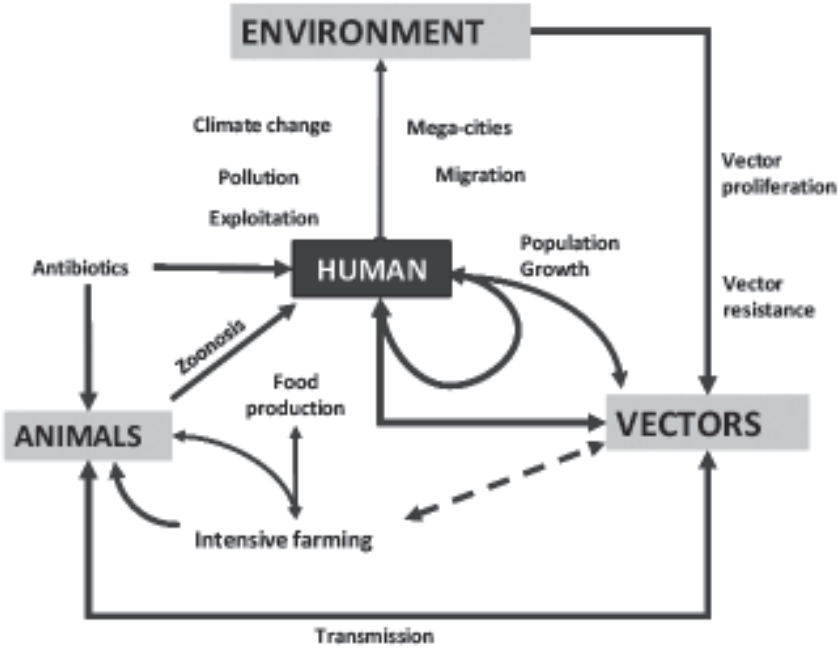
George Santayana pronounced that "those who cannot remember the past are doomed to repeat it" has a biological corollary: The belief that we've vanquished our ancient microbial enemies leaves us alarmingly vulnerable to them.

Infectious diseases dominate public health problems of the 21st Century. Around one-fourth of the fatalities occurring worldwide are caused by microbes and the proportion is significantly higher in the developing countries. Though there has been a remarkable progress in the prevention, control and even eradication of infectious diseases with improved hygiene and development of antimicrobials and vaccines but sadly, with optimism came a false sense of security, which has helped many diseases to spread at alarming rate. India is majorly threatened by emerging and re-emerging zoonotic diseases, food borne and waterborne diseases and diseases caused by multi-resistant organisms.

*"Emerging infectious diseases are those due to newly identified and previously unknown infections which cause public health problems either locally or internationally"*

During last three decades, more than thirty new diseases emerged threatening the health of hundreds of millions of people.

Though causative agents of emerging infectious diseases have mainly been virus (Rota, Parvo, Ebola,Hantaan, Human Immunodeficiency, Hepatitis E, Hepatitis C, Influenza A - H5N1, H1N1, Corona,Nipah), but even bacterial and prion diseases emerged as endemics. The disease in question involves all the major modes of transmission i.e. spread either from person to person, by insects or animals or through contaminated water or food.




To achieve One Health target, we need to understand the interdependent Health Triad

*Source: Annals of Community Health*

"*Re-emerging infectious diseases are those due to the reappearance and increase of infections which are known, but had formerly fallen to levels so low that they were no longer considered a public health problem"*

Re-emerging infectious diseases had often appeared as epidemics. Examples of such diseases include Tuberculosis, Cholera, Chikangunya, Dengue, Malaria, Nipah virus infection.

## Responsible Factors

The factors responsible for emergence and re-emergence of infectious diseases include unplanned and under-planned urbanization, overcrowding and rapid population growth, poor sanitation, inadequate public health infrastructure, resistance to antibiotics, increased exposure of humans to disease vectors and reservoirs of infection in nature, rapid and intense international travel, relaxation in immunization practices, deforestation, failure to control carriers or breakdown in water and sanitation systems, changes in genetic make-up of the pathogen, and high-risk human behaviour and lifestyle

## Challenges

Health perceptions play an important part in ensuring sound health outcomes. To a great extent these notions are culturally determined but also subject to change with economic growth and social development. People intuitively develop capacity to make choices of being treated under the modern or indigenous systems of medicines, keep a balance between good habits traditionally developed for healthy living and modern lifestyles, decide on where to go for chronic and acute care and how to apportion intra-family utilization ofhealthcare resources.

The factors and challenges as mentioned hereinabove surfaced conspicuously during COVID-19 pandemic.

## COVID-19 – in a nutshell

Today, entire humanity is suffering from the **pandemic infectious disease**, **COVID-19**, caused by a newly discovered **corona virus**. Primarily, **spread** of this disease is through droplets of saliva or nasal discharge when an infected person coughs or sneezes.

Since COVID-19 is an **emerging contagious** infection that has no known specific treatment or vaccination, the best way to prevent and slow down transmission is to exercise certain etiquettes while sneezing or coughing (like covering mouth and nose), **washing hands** with soap and water, and / or using alcohol-based sanitizer frequently, and avoid touching the face. **Isolation** or **quarantine** of the patients, as per medical advice, and practicing **social distancing** could also limit the spread of the disease.

In most of the cases, the patients suffer from mild to moderate respiratory illness and recover without requiring special treatment. However, senior citizens, those with underlying medical conditions involving heart related complaints, diabetes, chronic respiratory disease, cancer, and with low **immunity** are more likely to develop serious illness resulting in death. People with fever, dry cough or difficult breathing should immediately seek for medical attention and under any circumstance refrain from **self-medication**.

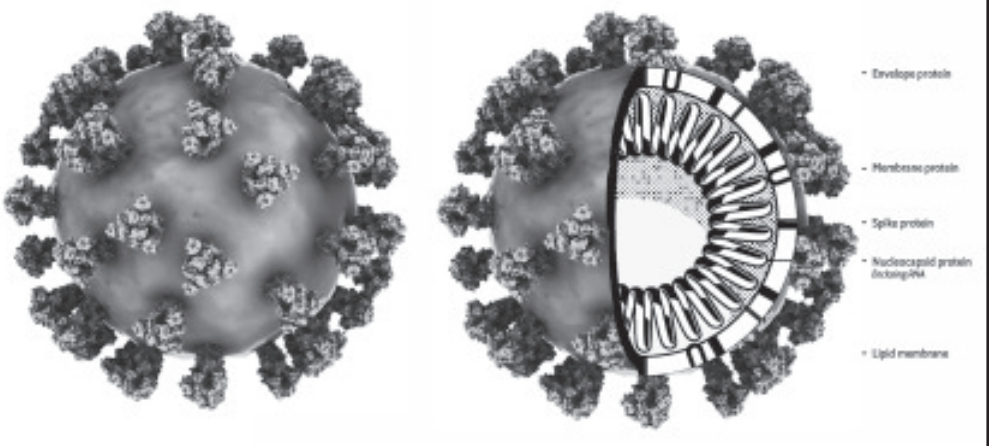



Image and cross-section of typical corona virus for representation

Highlighted terms are being explained (in order of appearance) here under;

### *Pandemic*

Depending on severity of an illness, prevalence, incidence, and the known or unknown disease pathways there are different levels on which a disease event is described. Let us understand these levels one by one;

Sporadic is used to describe infrequent irregular occurrence of any disease, for example outbreaks caused by food borne bacteria like Salmonella or E. coli

When a large number of persons are affected even though the cause is uncertain, for example cancer cases after chemical plant disaster, such an occurrence is referred to as Cluster

A disease is said to be Endemic when it has constant presence and/or usual prevalence in a geographical population. An endemic outbreak occurs at a predictable rate in a certain area or among a set of population. Malaria and chicken-pox are examples of endemic diseases

However, when any disease is persistent and at higher levels in certain population over others, it is referred to as Hyperendemic. For example, HIV is hyperendemic in parts of Africa, where one in every five adults suffer, but endemic in USA, where one in every three hundred are infected

Epidemic is when suddenly a large number of cases are reported, which are more than what is expected from an area. Rapid spread of epidemic among large population takes a fortnight or less, and generally it may be the consequence of natural disasters like storms, earthquakes, floods, or droughts. Examples of epidemic outbreaks include viral diseases like Ebola, Zika, SARS, Chikungunya, Dengue

Though by definition, Outbreak and epidemic are similar but outbreak is more limited geographic event. Initially, when more than expected infected cases are observed in an area, an outbreak is declared. The area could be either a small community or even extended to several countries. Outbreak could be of emerging or re-emerging disease, lasting for a few days to several years, and transmitted through human to human, animal to human and *vice versa*, or from the environment

An epidemic of an emerging infectious disease that spreads over several countries or continents, usually affecting a very large population, is said to a **Pandemic**. Examples of pandemic from yesteryears include cholera, small pox, bubonic plague, influenza and the recent ones like HIV/AIDS, H1N1, H5N1, COVID-19

**Infectious disease**: Any condition that impairs the normal body functions is termed as a disease, and when it is caused by pathogenic (disease causing) microorganisms, such as, bacteria, viruses, parasites, or fungi and that spread directly or indirectly, from human to human or animal to human and vice versa, is said to be an **Infectious disease**. In short, infectious disease is communicable, which can infect anyone

**COVID-19**

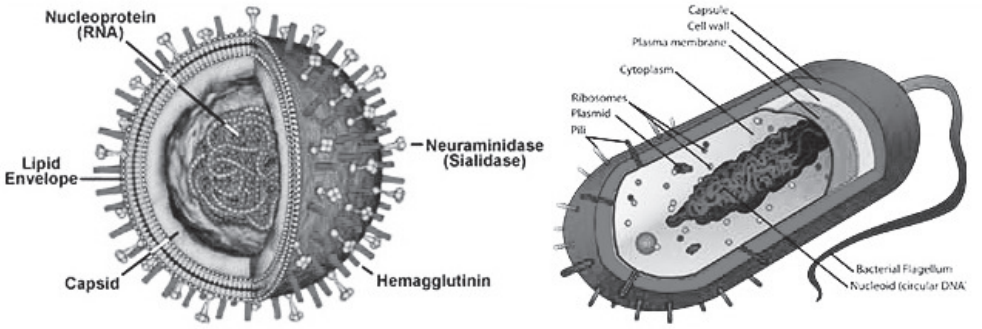
On 11 February 2020, ICTV (International Committee on Taxonomy of Viruses) and WHO (World Health Organization) declared the name of new/novel corona virus disease as **COVID-19**. It is an acronym for **CO**rona**VI**rus**D**isease that appeared during the year 20**19**. COVID-19 is a disease caused by Severe Acute Respiratory Syndrome Corona Virus 2 (SARS-CoV-2)

**Corona virus**: **Corona virus**is an enveloped single-stranded RNA virus that causes disease in vertebrates, particularly in mammals and birds. Corona in Latin means 'crown' or 'wreath'. Electron microscopic images of corona virus show the virus having a fringe of large, bulbous projections on the surface creating an impressionthat of a crown. Virus in Latin means 'poison'. Considered to be in between living and non-living entities, virus is a genetic material of microscopic size (much smaller than the bacteria), acting as an infectious agent, which cannot replicate of their own but only in the truly living cells.

In humans, corona virus affects respiratory system causing common cold, which is typically mild, however the rare forms that result into death, such as SARS (Severe Acute Respiratory Syndrome), MERS (Middle East Respiratory Syndrome), and COVID-19. Symptoms of corona virus vary in other species; in poultry it causes upper respiratory disease, while in cows and swine it causes diarrhea. There are no vaccines or treatment available for prevention or cure of human corona virus infections.

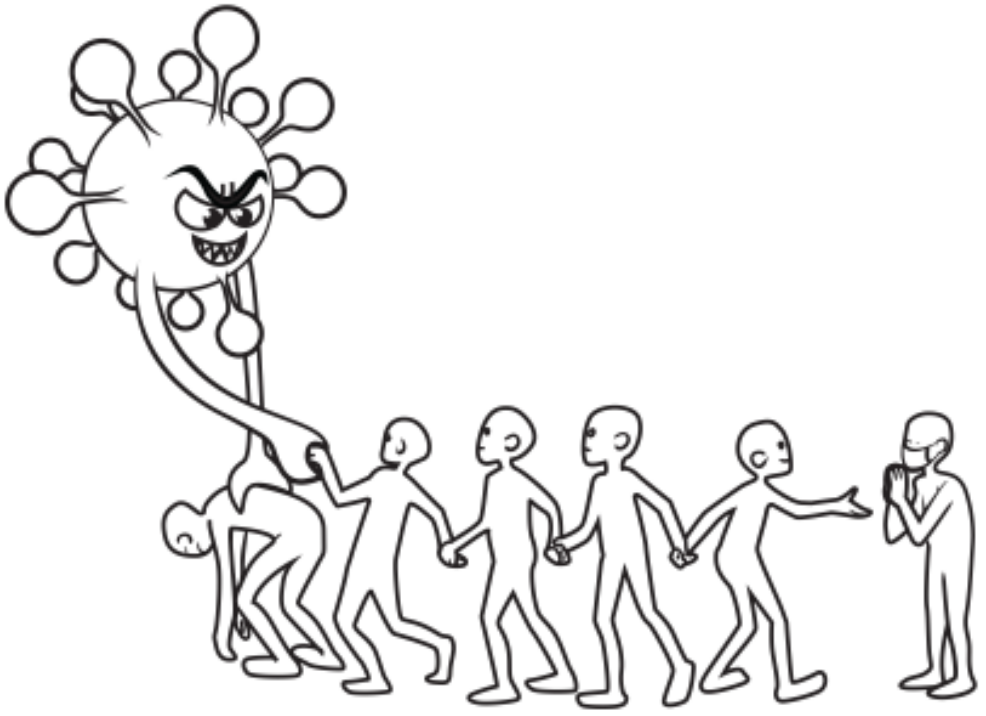
**Difference between a virus and a bacterium (*bacteria is plural*)**

| Characteristics | Virus | Bacterium |
|---|---|---|
| Size | Smaller (20-400 nm) | Larger (1000 nm) |
| Cell Wall | No cell wall, instead a protein coat is present | Made up of Peptidoglycan or Lipopolysaccharide |
| Ribosomes | Absent | Present |
| Number of cells | No cells | One cell (Unicellular) |
| Living/Non-Living | Between living and non-living | Living organisms |
| DNA and RNA | DNA or RNA enclosed inside a coat of protein | DNA and RNA floating freely in the cytoplasm |
| Infection | Systemic | Localized |
| Reproduce | Need a living cell to reproduce | Able to reproduce by itself |
| Reproduction | Invades a host cell and takes over the cell causing it to make copies of the viral DNA / RNA. Destroyed host cell releases new viruses | Asexual reproduction by Fission |
| Duration of illness | Most viral illnesses last 2 to 10 days | A bacterial illness commonly will last longer than 10 days |
| Fever | A viral infection may or may not cause a fever | A bacterial illness notoriously causes a fever |
| Under Microscope | Visible only under Electron Microscope | Visible even under Light Microscope |
| Benefits | Viruses are not beneficial. However, a particular virus may be able to destroy brain tumours. Viruses can be useful in genetic engineering | Some bacteria are beneficial (Normal gut flora) |
| Treatment | Virus does not respond to antibiotics. | Antibiotics |
| Examples | HIV, Hepatitis A virus, Rhino virus, Corona virus | *Staphylococcus aureus*, *Vibriocholerae* |
| Diseases/ Infections | AIDS, common cold, influenza, chickenpox, and others | Food poisoning, gastritis and ulcers, meningitis, pneumonia, and others |




Difference between a virus and a bacterium (*bacteria is plural*);

***Spread:*** Spread or transmission of infectious diseases, particularly, is through direct or indirect contact. Direct contact includes person to person contact, and droplet spread, while indirect transmission could take place through airborne pathogens, touching contaminated objects, consuming contaminated food and water, animal to human contact, vector borne transmission, and environmental reservoirs like contaminated soil.



***Emerging:*** Emerging disease is the one that is caused by a newly identified and previously unknown pathogen affecting public health either locally or internationally. However, when any pathogen known for some time and had reduced to such a low level that these were no more considered as public health concern, have started showing upward trend in incidence or prevalence either globally or have appeared in the areas where these were not found previously cause re-emerging disease.COVID-19 is an example of emerging disease, since it is occurring for the first time.

***Contagious:*** Infectious diseases that spread from person to person are said to be Contagious in nature.

***Washing hands:*** Hand washing is one of the best ways to protect oneself and family from getting sick. Washing hands can keep healthy and prevent the spread of respiratory and diarrhoeal infections from one person to the next. Infectious agents can spread from other people or surfaces by: a) Touching eyes, nose, and mouth with unwashed hands, b) Preparing or eating food and drinks with unwashed hands, c) Touching a contaminated surface or objects, and d) Blowing nose, coughing, or sneezing into hands and then touching other people's hands or common objects.

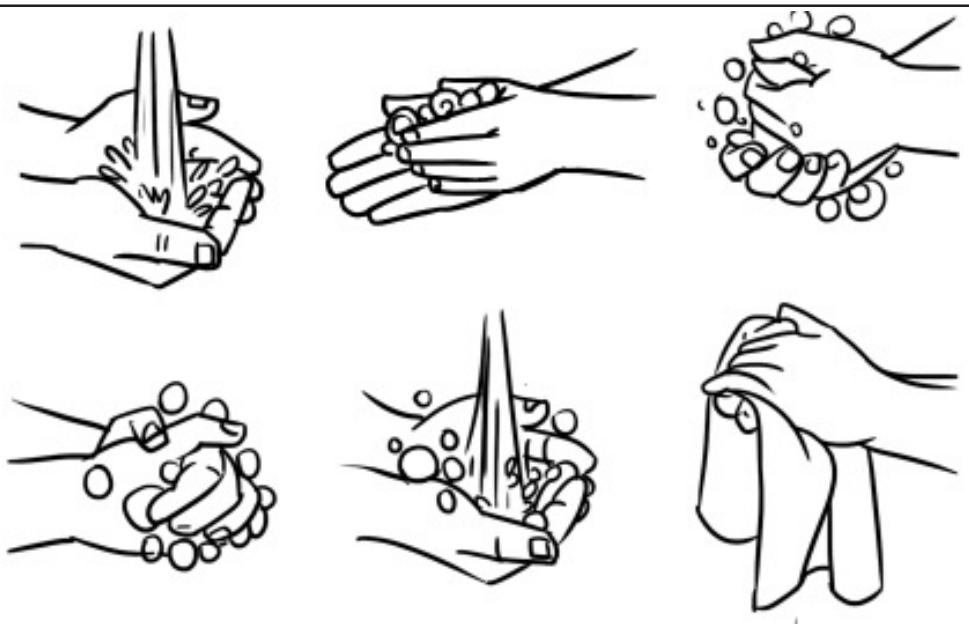
In general, washing hands is warranted; a)Before, during, and after preparing food, b) Before eating food, c) Beforeandaftercaring for someone at home who is sick with vomiting or diarrhoea, d) Beforeandafter treating a cut or wound, e) After using the toilet, f) After blowing nose, coughing, or sneezing, f) After touching an animal, animal feed, or animal waste, g) After handling pet food or pet treats, and h) After touching garbage. In addition, during COVID-19 pandemic situation, hands need to be washed after going in a public place and touching an item or surface that may be frequently touched by other people, such as door handles, tables, gas pumps, shopping carts, or electronic cashier registers/screens, etc, and before touching own eyes, nose, or mouth because that's how microorganisms enter into the body.

Follow these FIVE simple steps while washing hands (technical information sourced from Centres for Disease Control and Prevention website);

i) **Wet**hands with clean, running water (warm or cold), turn off the tap, and apply soap. **Why?** Because hands could become re-contaminated if placed in a basin of standing water that has been contaminated through previous use, clean running water should be used. However, washing with non-potable water when necessary may still improve health. The temperature of the water does not appear to affect microbe removal; however, warmer water may cause more skin irritation and is more environmentally costly. Turning off the faucet after wetting hands saves water, and there are few data to prove whether significant numbers of germs are transferred between hands and the faucet.Using soap to wash hands is more effective than using water alone because the surfactants in soap lift soil and microbes from skin and people tend to scrub hands more thoroughly when using soap, which further removes germs.

ii) **Lather**(or foam) hands by rubbing them together with the soap. Lather the backs of hands, between fingers, and under nails. **Why?** Lathering and scrubbing hands creates friction, which helps lift dirt, grease, and microbes from skin. Microbes are present on all surfaces of the hand, often in particularly high concentration under the nails, so the entire hand should be scrubbed.

iii) **Scrub**(or rub) hands for at least 20 seconds. **Why?** Determining the optimal length of time for hand washing is difficult because few studies about the health impacts of altering hand washing times have been done. Of those that exist, nearly all have measured reductions in overall numbers of microbes, only a small proportion of which can cause illness, and have not measured impacts on health. Solely reducing numbers of microbes on hands is not necessarily linked to better health. The optimal length of time for hand washing is also likely to depend on many factors, including the type and amount of soil on the hands and the setting of the person washing hands. For example, surgeons are likely to come into contact with disease-causing germs and risk spreading serious infections to vulnerable patients, so they may need to wash hands longer than a woman before she prepares her own lunch at home. Nonetheless, evidence suggests that washing



Procedure for washing hands

hands for about 15-30 seconds removes more germs from hands than washing for shorter periods. Accordingly, many countries and global organizations have adopted recommendations to wash hands for about 20 seconds.

**iv) Rinse** hands well under clean, running water. **Why?** Soap and friction help lift dirt, grease, and microbes—including disease-causing germs—from skin so they can then be rinsed off of hands. Rinsing the soap away also minimizes skin irritation. Because hands could become re-contaminated if rinsed in a basin of standing water that has been contaminated through previous use, clean running water should be used. While some recommendations include using a paper towel to turn off the faucet after hands have been rinsed, this practice leads to increased use of water and paper towels, and there are no studies to show that it improves health.

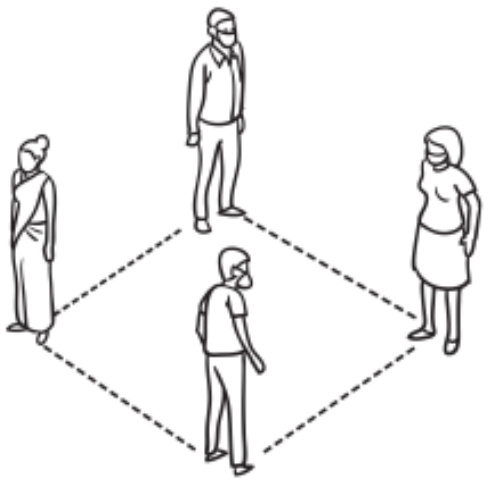
**v) Dry**hands using a clean towel or air dry them. **Why?** Germs can be transferred more easily to and from wet hands; therefore, hands should be dried after washing. However, the best way to dry hands remains unclear

because few studies about hand drying exist, and the results of these studies conflict. Additionally, most of these studies compare overall concentrations of microbes, not just disease-causing germs, on hands following different hand-drying methods. It has not been shown that removing microbes from hands is linked to better health. Nonetheless, studies suggest that using a clean towel or air drying hands are best.

***Isolation** or **quarantine**:* Both the terms, isolation and quarantine, though used interchangeably, actually refer to two different processes that depend on whether the person is actively sick or not.

**Isolation** is a process adopted to separate the infected person from the healthy ones, until they fully recover and are no longer able to spread the disease.

**Quarantine** is a process used to prevent spread of contagious disease by keeping the exposed persons, whoare not yet sick, away from the unexposed ones, under the medical advice of a doctor. It could be both formal, wherein health officials separate individuals from the population and keep them in a special facility, or informal, wherein people are recommended by health care providers to stay at home in 'self-quarantine' to avoid potentially spreading the disease to others. Duration of quarantine depends on the incubation period of the disease, or how long it takes to develop symptoms after coming in contact with the infected person. If individuals develop the symptoms during quarantine, then they are moved to isolation.



***Social distancing*: Social distancing** is a term applied to the measures taken for prevention and control of the spread of highly contagious disease. Closure of educational institutions, working from home, cancellation of events, and avoidance of large gatherings are some of the actions taken during social distancing.

***Immunity:*** **Immunity** is commonly understood as disease resistance or ability of the body to defend against all types of foreign bodies; be it microorganisms, toxic substances and the likes. Lack of immunity in an individual is called as susceptibility.

Mainly there are two types of immunity; innate or natural or non-specific, and acquired or adaptive.

Innate or inborn immunity is inherited from the parents and provide protection right from birth throughout life. For example, humans have inherent immunity against a disease called Distemper, which is a fatal disease of dogs. Being nonspecific immunity, it is provided through a number of barriers at the points of entry into our body; these are physical as skin, physiological as acidic pH in stomach, cellular as WBC, and cytokine barriers.

Acquired or adaptive or specific immunity is acquired by an individual after the birth, which is specific and mediated by antibodies or lymphocytes or both. It not only relieves the infected person from the disease but also prevents from attacks in future. Acquired immunity is of two types; active immunity and passive immunity.

In active immunity cells of an individual produces antibodies in response to an infection or vaccination. The process is slow but long lasting and harmless. Again, active immunity is either natural or artificial. Someone who recovers from an attack of small pox develops natural active immunity, while childhood vaccination provides artificial active immunity.

While in passive immunity ready-made antibodies are directly injected to provide protection against the pathogens. It gives immediate response but is not long lasting. This immunity is also of two types; natural and artificial. Natural passive immunity can be induced by transferring antibodies from mother to fetus through placenta, and feeding colostrum, mother's first milk, which protects the infants up to three months of age. Administration of hyper-immune serum like anti-tetanus serum is an example of artificial passive immunity.

***Self-medication***: **Self-medication** is a global phenomenon in which an individual or a member of the family select and use medicines to treat self-recognized or self-diagnosed condition or symptom. Weighing pros and cons of self-medication, disadvantages score over the benefits. Potential risks of self-medication include; incorrect self-diagnosis, delay in seeking medical attention, probable adverse drug reactions, incorrect dosage, administration, and choice of therapy, along with irrational use of antimicrobials resulting in development of antimicrobial drug resistance.


## Sustainable living for a healthy life

What is one's priority – health or wealth? Someone replied, 'Wealth, till I am healthy, and of course, health, when I'm sick'. Reality strikes when not just an individual but entire humanity suffer. The period of isolation, quarantine or social /physical distancing has allowed almost everyone to redesign their lifestyle. Going back to basics, surviving on the bare necessities, and leaving environment to heal back are the takeaways from the locked down situation.

It is expected that health of all the three components of sustainability must be in pink; the social, economic, and environmental. On social front, the physical (particularly for recovered ones) and mental health should be the priority areas. Psychological duress due to both; traumatic experience of the pandemic period and post-pandemic impact on the livelihood, is likely to take a great toll, unless handled sensitively. Effect on the economic health during or post-pandemic period, would leave a significant mark on lifestyle and livelihood of the future.

For the revival and maintenance of the degraded environment and to uplift the way of living life under changed circumstances, it would be necessary to put in some conscious efforts to change the overall outlook of our lifestyle. It would need dedication and discipline on daily basis to adapt and upgrade the standard of living in sustainable manner.

A second chance, rare of rarest opportunity has been given to the entire mankind, to adopt the changes recommended for sustainable living, in its true spirit. Only then we have a future - a healthy future.