



Green Campus Audit Procedures and Implementation to Educational Institutions and Industries

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ABSTRACT

Nature provides a free lunch, but only if we control our appetites. As we are in the twenty-first century, modernization and industrialization are the two important outputs that have made human life more luxurious and comfortable. Simultaneously, they are responsible for several uses of exploitation of forests, natural resources, and wildlife, polluting the scarce, producing massive solid waste and sacred water resources, and finally making our planet Earth ugly and inhospitable. Today, people are getting more familiar with global issues like global warming, the greenhouse effect, ozone depletion, climate change, etc. Now, it is considered a final call by Mother Earth to walk on the path of sustainable development. The time has come to wake up, unite and combat together for a sustainable environment. The present study focuses on the concept of green audit and its importance with respect to the conservation of nature for future generations. Every organization should have its own green campus and environment policy with respect to nature conservation and environmental protection and should maintain a sizable amount of green cover area after building construction along with natural and planted vegetation. A maximum number of more oxygen-producing and carbon-di-oxide-absorbing plants should be maintained to provide a pure atmosphere to the stakeholders. The installation of a rainwater harvesting system, percolation, ponds, check dam, and drip irrigation system to conserve rainwater and groundwater should be noteworthy on the campus.

INTRODUCTION

Green Audit is a tool of Management system used methodologically for the protection, conservation, and sustenance of the Environment. Green audit procedures are a set of guidelines framed on how to conduct a green audit at educational institutions and industrial sectors as per the checklist of Environment Management Systems and International Standards on ISO 14001:2015 and Indian Green Building Council at 360° views. In addition, it also speaks about an overall idea on green audits groundwork, auditing techniques, audit/non-conformity report preparation, and submission. It will be recording and verify the eco-friendly approaches and practices in educational institutions and industries. The audit process supports the nation as a whole for the noble cause of environmental protection and nature conservation which in turn enhances the quality of life of human beings (Arora 2017). It is a type of assessment to ensure that the Institution and Organization campus is greenish in terms of planting a

large number of trees and lawns on the campus. To ensure that the list of plants and animals/birds available on the campus, biodiversity conservation, water irrigation system, recycling of water, rain harvesting system, site preservation, soil erosion control, and landscape management will be evaluated (Gowri & Harikrishnan 2014). The first concept of Environment Audit was approved in the Earth Summit, Rio-1992. The audit ensures that the campus is greenish in terms of planting a large number of herbs, shrubs, and trees including lawns which in turn reduce environmental pollution, proper water irrigation system, natural topography or vegetation, biodiversity conservation, etc. implemented effectively for the benefit of the stakeholders. Similarly, it will also ensure a green campus, the environmental management system, maintenance of an eco-friendly campus that leads the environment clean and neat, solid-state management, recycling of water, disposal of sewage and waste materials including electronic wastes and biomedical wastes, landscape management, plastic use, etc. in the campus should be implemented effectively for the

benefit for the stakeholders. The Environment Management System is the quantitative and qualitative data to track air, water, and waste, and to gain actionable insights to improve operational performance. It is used to maintain a clean and green environment that leads to the stakeholders. It provides a 360° view of a surrounding campus and makes it easy for Owners/Managers/Environmentalists to collaborate, measure, control, and reduce environmental impacts. Finally, it leads to enhancing the quality of life for human beings, animals, and plants. Green campus initiatives are needed at present across the world due to changes in environmental conditions, global warming, and the increasing human population. It aims to make a sustainable and environmentally friendly campus for the stakeholders.

WHAT IS A GREEN CAMPUS?

A green campus is an area of the organization or the organization as a whole itself that is contributing to having an infrastructure or development that is structured and planned to incur less energy, less water, less or pollution-free, and less or no CO₂ emission. In certain cases, the project zone of the green campus can be self-reliable in terms of energy and water consumption, and with higher ratings of the project zone, they can complement or support national energy and water needs as a part of corporate social responsibility. The green campus capitalization may incur some little investment but the vision of the green campus is to satisfy the organizational needs by its simple initiatives in a bigger vision to prevent the deterioration of environmental resources.

THE GREEN CAMPUS OF AN ORGANIZATION

In the present scenario, with multiple options on the availability of all materials and gadgets with high carbon dioxide emission, the sole responsibility in choosing building materials and less emitting gadgets installed in the projected project area should be considered. In case the organization has to use many of the materials that add up a burden to the environment in terms of anything that disturbs the environmental cycle (in unavoidable circumstances), the organization should have taken proper steps to neutralize or nullify its emission and produce its own needs. A green campus is nothing but environmental-friendly practices and education combined to promote sustainable and eco-friendly practices along with user-friendly technology on the campus. It creates environmental culture, develops sustainable solutions to environmental problems, and provides solutions to various social and economic needs (Wang et al. 2013). It provides the concept of green building and oxygenated building which in turn is useful to provide a healthy atmosphere. Proper strategies and planning budgetary processes for a clean and green

campus also play an important role. Tool kit for members of staff and students for a sustainable green campus can be developed by using tools and resources from case studies and practices, which are intended to inspire, encourage and support educational institutions and industrial sectors to develop and implement their own transformative strategies (Suwartha & Sari 2013). Green campus audit is useful to detect and monitor sources of pollution, nature of vegetation, and topology which emphasizes the management of all types of waste, energy, water, soil, etc. It was implemented in the USA in 1970 for the first time but India is the first to implement environmental audit compulsory in later stages (Arora 2017). It enabled managers, environmentalists, and academicians, to check the compliance with

GREEN CAMPUS AUDIT PROCEDURES

Green campus audit is a structured process of documenting the credentials in terms of measurable, recording, accounting, and investigating of used materials and their impact on the environment and its ecology. Green audit projects the best environmental practices and initiatives taken in the organization at the prescribed site of audit that brings added value to the organization in maintaining the eco-friendly campus. The first step of the audit is ensuring that the organization has a central role in building the green campus, to validate the same.

- Apply application forms of the green audit to any agencies that are Authenticated Professionals for people qualified to investigate and evaluate the campus for validating the best environmental practices.
- Once the application process is over the Professional team of Auditors will have an in-house visit to the mentioned site or organization for its claim.
- On accounting for all the green practices of the organization or the mentioned site or project site a detailed report will be given by the Auditing Professionals and the marks will be awarded to the respective heads.
- The report will be certified and returned to the applicants. If they wish to claim improved marks, they can re-apply with improved structures with a resting period of six months.
- If they wish to claim the neglected marks, they should re-apply within seven days after the receipt of the detailed GAR (Green Audit Report).

OVERVIEW OF THE GREEN AUDIT FLOW

Establishing a Green Campus

Every campus needs to have a vision of self-reliability at the stage of designing itself. As there was no awareness in the

past about green buildings and green practices, the concept of converting the “go green” campus arrived. The campus should have restructured its existing facilities to establish or follow the “go green” campus practices. The “go green” structures and establishments should have a record of minimum documentation of existing records for three months. The Management of the Organization (Auditee) should show their inherent commitment towards making an eco-friendly atmosphere and be ready to encourage all types of green activities (Fig. 1). They should promote all kinds of green activities such as the conduct of environment awareness programs, campus farming, planting trees, maintenance of greenery, irrigation, use of biofertilizers and avoidance of chemical fertilizers and agrochemicals on the campus, etc., before and after the green auditing. The management should formulate ‘Green and Environment Policies’ based on a green auditing report. A clean and healthy environment should enhance an effective teaching and learning process and provide a conducive learning environment to the stakeholders. They should create awareness of the importance of the environment through environmental education among the student members. Green Audit is the most efficient and ecological way to manage environmental problems. In general, the Management should take responsibility to maintain a campus that is completely free from environmental pollution. Green campus audit may be beneficial to the campus in improving the greenery activities which in turn are used to save the planet for the future generation. Since green campus audit is

a kind of professional care and a simple indigenized system about the environment monitoring in terms of planting a large number of trees which is the responsibility of every individual who is part of economic, financial, social, and environmental factors. It is necessary to conduct a green audit frequently at least once in three years on campus because students and staff members should be aware of the green audit and its advantages. ‘Go green concept’ should be adopted to help the institution set environmental examples for the community, and thereby educate the young learners.

Aims and objectives of Green Campus Audit

- To recognize the initiatives taken towards the environment and threats to human health.
- To provide baseline information to assess threat and risk.
- To recognize, diagnose and resolve environmental problems.
- To identify the impact of the Institution on the Environment.
- To identify different pressures on the Institute to improve its environment.
- To ensure proper utilization of resources considering the health and welfare of the community.
- To set a procedure for disposal of all kinds of wastes

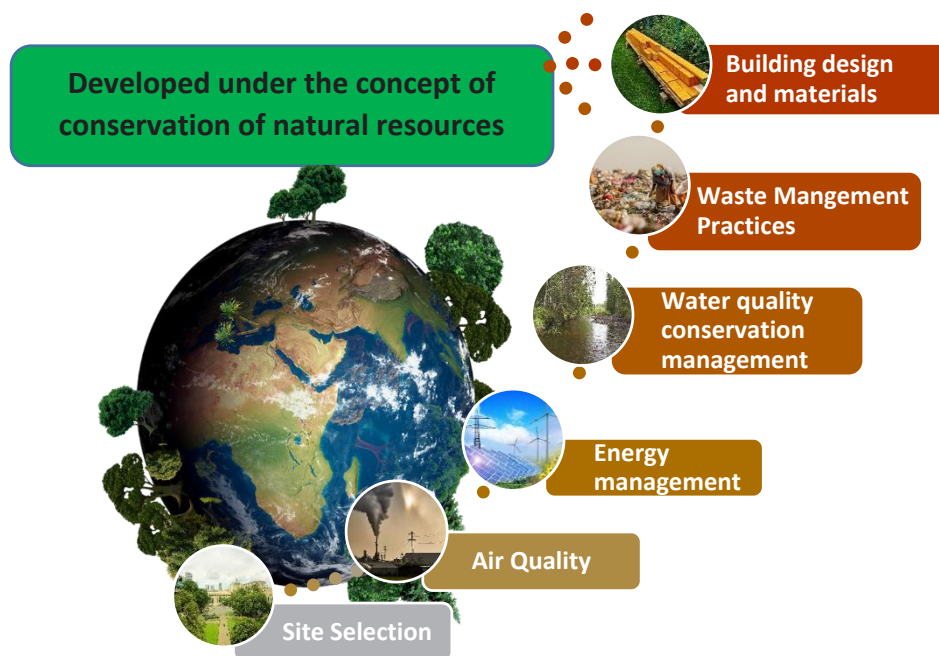


Fig. 1. Key steps for the ‘Go green’ concept at an Organization.

- To ensure the Green cover spread with pollution-free air and that provides working as a carbon sink.

Definition of a Green Campus Audit

Green campus audit is a structured process of documenting the credentials in terms of measurable, recording, accounting, and investigating of used materials and their impact on the environment and its ecology. Green audit projects the best environmental practices and initiatives taken in the organization at the prescribed site of audit that brings added value to the organization in maintaining the eco-friendly campus to the stakeholders. The green campus should have a large number of trees, shrubs, herbs, climbers, twiners, and lianas which will provide an eco-friendly habitat to mammals, birds, flies, moths, earthworms, amphibians, termites, and various beneficial microorganisms in the soil and air. It will lead to giving a pure atmosphere without any environmental pollution and be available to the stakeholders in a sustainable manner (Ounsaneha et al. 2017).

Benefits of the Green Auditing

There are several benefits to the conduct of a green audit by the Organization which may be useful to improve the campus significantly after receiving the report of the audit (Marrone et al. 2018). The green campus audit methodology follows both qualitative and quantitative measurements including physical observation of greeneries in terms of the growth of terrestrial and aquatic plants, animals, and microflora on the campus. The natural and planted vegetation and their maintenance in the organization's campus are also taken into consideration, through topography, landscape management design, and soil erosion control in environmentally sustainable development. The following are the major benefits of green auditing.

- Know the status of development of internal and external Green campus audit procedures and implementation scenarios in the Organization.
- Establishment of Green campus objectives and targets as of today as per the 'Green and Environment Policy', 'Indian Biodiversity Act', and 'Wildlife Protection Act' of the Ministry of Environment, Forests and Climate Change, New Delhi and World & Indian Green Building Council concepts.
- Assigning the roles and responsibilities of Environmental Engineer and Agriculture/Garden Staff to improve green initiatives.
- Development of ownership, personal and social responsibility for the Organization and its environment, and development of an environmental ethic and value systems for young generations.
- Enhancement of the Organization's profile and reaching the global standards in proving the green campus and eco-friendly atmosphere to the stakeholders
- Improving the drinking water / RO water / Bore well water / Open well water / Pond water / Municipal or Corporation water quality through the analysis of the Physico-chemical properties of water.

PROCEDURES FOLLOWED IN GREEN CAMPUS AUDIT

The purpose of the green audit is to ensure that the practices followed on the campus are in accordance with the Green and Environment Policy developed by the Government and private agencies working with environmentally sustainable development adopted by the institution. The first step of the audit is ensuring that the organization has a central role in building the green campus, to validate the same (Adeniji 2008). A green campus is not intended for the self-sustainability of the building alone, it also involves the propagation of the green campus initiatives to be adopted by any individuals and organization at a minimum cost. A green campus audit should be conducted as per the guidelines of MoE. The audit should be conducted by authenticated Professionals who are to investigate and evaluate the campus. Professional team of ISO Environment Management Audit (14001:2015), Indian Green Building Council Accredited Professionals, Experts of Green campus Lead Auditors, and Botanists / Zoologists / Biotechnologists were selected to conduct the Green campus audit process. Labeling of common names and Botanical names of plants were observed. The operation of the water irrigation system, drip and sprinkler irrigation methods, and use of recycled water for irrigation purposes or any other purpose in the campus area was noted. The number of wells bore wells and water reservoir facilities on the campus were also noted as per the Audit Manual of Gnanamangai et al. (2021).

Attempts made for overcoming water scarcity during the summer season regarding the maintenance of plants and frequency of watering for plantations on the campus are noted. Biodiversity conservation education, projects, awareness programs, etc., through the Indian Biodiversity Act and Ministry of Environment, Forests and Climate Change, Government of India, and the conduct of outreach programs for dissemination of the Green campus motto is also recorded (Venkataraman 2009). During the audit process, the best environmental / greenery practices followed and new initiatives undertaken in the organization to reduce the environmental pollution and steps taken for nature conservation that brings added value to the organization in maintaining the eco-friendly campus to the stakeholders are assessed (IGBC 2021, WGBC 2021). The criteria, methods/

procedures, checklists, and recommendations used in the audit were based on the identified risks. The methodology includes: the preparation and filling up of questionnaire along with checklists, physical inspection of the campus, observation, and review of the document, interviewing responsible persons, and data analysis, measurements, and recommendations (Filho et al. 2015). Similarly, the methodology adopted for this audit was a four-step process comprising of data collection, data analysis, best practices followed on the campus, and recommendations and suggestions given to the organization to improve the greeneries practices further (Rajalakshmi et al. 2021).

Pre-Audit Stage Activities

A pre-audit meeting (opening meeting) is conducted with Management and Administrative people along with staff coordinators of the Energy and Environment audit process, wherein, the audit protocol and audit plan are discussed in brief. The purpose of this meeting is to provide an opportunity to reinforce the scope and objectives of the audit and discussions held on the practicalities associated with the audit. Pre-audit stage activities are an important prerequisite for the green audit to meet the auditee and to gather information about the campus and necessary documents are collected directly from the Organization before the initiation of the audit processes. The audit team will be selected by the Audit organizations such as Nature Science Foundation, Coimbatore, as per the checklist comprised of Lead Auditor of ISO (QMS 9001:2015 and EMS 14001:2015), Botanist, Agriculture and Horticulture Scientists from Conventional and Technical Universities across India, Accredited Professionals from Indian Green Building Council, Hyderabad and Associated Chambers of Commerce and Industry of India, New Delhi.

Target Areas of Green Auditing

Any Educational Institution such as colleges, Schools, Universities, Research Institutions, Industries, Service Industries, and Manufacturing Units that operates on a large scale, and cater to many stakeholders must undergo an audit for better environmental management. This will ensure the adequate measure taken to maintain the campus as a sustainable one.

Study Area of Flora and Fauna Diversity

The audit site should be quite clean, and green and has much less pollution than the rest of the places. The campus is important not only from an education and product development point of view but also as a green lung. It is frequently visited by several nature enthusiasts to study the floral and faunal aspects. Biodiversity provides a useful measure of the qual-

ity of the environment and ecological studies are important aspects of the environment, in view of the consideration of environmental quality and protection of natural flora and fauna. Similarly, the topography is also very important with respect to the floral and faunal diversity studies. In the case of topography, altitude, longitude, and latitude are equally important in terms of natural flora and fauna diversity. Similar to that topology, geology, and soil conditions are playing important in green campus establishment. The study area of the audit site should be analyzed for soil type, presence of organic matter, and water holding capacity. Climatic conditions such as maximum and minimum temperature, maximum and minimum relative humidity, average annual rainfall, mean sunshine period, and wind speed during summer and winter periods covering both southwest and northeast monsoon periods are playing a pivotal role.

Accounting on Greenhouse Gas Emission

CO₂ emission details in the campus accounting the direct and indirect sources need to be documented well in terms of usage, period of usage (hour), the number of persons practicing the emission, personnel availability inside the campus, operating time of each equipment in the campus, has to be documented. The carbon footprint data can be calculated based on the usage of electricity, usage of vehicles, usage of GHGs emitting equipment, consumption of fuel for generating electricity, food, and other work occurring. The accounting of green practices related to the neutralization of carbon footprint should be documented periodically. The possible reduction of greenhouse gas emissions can be achieved by enhancing agricultural practices, usage of free energy, usage of equipment with no greenhouse gases (GHGs) emissions, implementation of the vehicle-free zone, no electricity day, and the carbon-free zone should be accounted for and documented well.

Accounting on Energy Conservation and Management

Frequent energy audits or daily energy audits help to maintain the record on their energy consumption. Separate metering for individual blocks helps to identify the energy consumption and leak. The reduction in the consumption of power leads to good green campus development. Documentation on using less power-consuming appliances like higher star-rated refrigerators and air coolers must be used. Usage of CFL (Compact Fluorescent Bulb), LED (Light Emitting Diode) bulbs, and solar lamps should be accounted for properly. Building structures should minimize energy usage and leak proof. Highly ventilated building structures and the usage of fewer energy devices can be documented well. Any practices to reduce energy consumption can be reviewed and documented as well.

Accounting on Water Conservation

Metering water usage and use of fixtures and appliances that consume less water should be documented. Practices like water usage accounting for every need in individual blocks can help to reduce water usage. Rainwater harvesting, watershed management, and storage capacity should be documented. The establishment of the water recycling unit, its capacity, and the need for recycled water along with the quantity should be recorded. Determination of recycled water quality should be documented well to maintain a safe and hygienic atmosphere. Special initiatives like recycled water for enriching the ecology, and water conservation practices should be well documented and practiced effectively. Accounting on 3R water use efficiency, water-efficient plumbing fixtures enabled with dual flow faucet, sensors that prevent leak and overflow tankers, metering devices, rainwater consumption, and purification systems to improve water quality considerably.

Waste Management Practice

Innovative practices related to waste segregation and management must be accounted well for any organization to have a green campus role. Many categories of wastes like hazardous and E-wastes released from the green campus should be as minimum as possible. If the organization pertains to the release of hazardous wastes, it should have a stringent methodology adopted for its management and release to the environment. If the organization is an academic Institution, then the practice related to the usage and disposal of harmful chemicals and harmful wastes should be well documented in their laboratory usage and release. Proper sanitation, management, and disposal methods will be accounted and their function should be transparent to be adopted and practiced effectively. In the case of E-waste management, although reduced usage of electronics and refurbishing activities plays a major role in the green campus audit, the practice of any level of e-waste management and innovative contributions to society as well should be documented and accounted for in terms of the adoption of the practices in their own academic as well as non-academic institutions.

Indoor Environmental Quality

It relates to the well-being of the personnel with respect to the ambiance of the environment. The indoor infrastructure should provide proper light, heat, and ventilation for maintaining a good indoor quality for the stakeholders. The indoor ambiance is accounted for in terms of the breathing zone in the air-conditioned room that relates to indoor humidity and the age of the indoor structure.

Green Building Materials

As of the accounting on the building materials the transportation on the recurring materials must be documented in terms of frequency of storage and the availability of the materials. Green campus auditing also complements the practices of utilizing the resources nearby and requiring materials from a consent which practices the 'go green concept'. Green building materials should be user-friendly without causing any adverse effects to the environment as well as on human beings. Moreover, if the materials are stored for a long time, the material strength, as well as the quality of those materials, should not be lost. During the transportation of green building materials, the materials should not harm the environment and the strength and quality of materials should not be mislaid.

THE PRACTICE OF A GREEN CAMPUS AUDIT

A fresh green campus audit is required for any new (or) old organization to self-evaluate one's needs with respect to environmental objectives and implementation. To have continuous monitoring and implementation of self-sustainable practices, the green audit has to be practiced once a year with updated practices and with consistent improvement in all the mentioned sections of protecting the environmental objectives (Fig. 2). Mere practice and insist on a green campus audit is to create a self-sustainable organization that doesn't affect nature and assists in protecting the natural resources, earth, ecology, and biodiversity (Venkataraman, 2009). The audit helps to assess the strength and weaknesses of any organization on their self-sustainability in the long run in terms of green campus planning and efforts (Aruninta et al. 2017). The Indian Green Building Council (IGBC) is a division of the Confederation of Indian Industry (CII), which was set up in the year 2001. It is coming under the Confederation of Indian Industry (CII) to create and sustain an environment conducive to the development of India as a whole and civil society through advisory and consultative processes. The vision of the Green Building Council is, "To make a sustainable



Fig. 2. Green campus audit practice and benefits

environment for all and facilitate India to be one of the global leaders in the sustainable environment by 2025". IGBC also conducts examinations to qualify accredited professionals for green campus auditing. It also provides membership to individuals to promote sustainability and the environment through green building practices. It looks after and rates the organization starting from the designing of the project site to its implementation. Moreover, IGBC recognizes the initiatives taken toward environmental protection and offers solutions to various environmental problems (IGBC 2021, WGBC 2021).

Role of Plants, Animals and Microorganisms in Green Campus

Ensuring rich biodiversity in the green campus is an important parameter. Plants are indicators for assessing the varying levels of environmental quality. In general, plants improve outdoor air quality with increased oxygen levels and reduced temperature and carbon-di-oxide. The green and varying colors of the flowering plants improve the ambiance of the environment. The record on maintenance of the plant biomass and its management are important with respect to green campus initiatives. The plants in the environment should account for 75% of wild or native plant traits in the green campus. The native plant traits promote the indigenous fauna at the site area. Hence the accountancy of 75% of the wild traits is leveraged for the native animals and birds to a particular region. The existence of such animals and birds in the green campus can be recorded for the rich flora and fauna in the proposed site which is considered a valuable addition to the campus. Similarly, accountability of the total beneficial microbial populations such as nitrogen-fixing, phosphate and potassium solubilizing bacteria, fungi, and actinomycetes are also considered for the rich biodiversity on the campus (Choy & Karudan, 2016).

Natural Topography, Vegetation and Rainwater Harvesting System

Natural topography means the original geographical features of the campus, around 15- 20% of the organization should have natural features like rocks, water resources, slopes, landscape, pathways, etc. and the altered topography can be accounted for if it is facilitated. The vegetation in the land alone is considered as they are part of the natural topography. The vegetation in the artificially created structures is also accounted for audit when it is reported more than 30% of the claimed green campus audit site. The natural topography is well appreciated with wild vegetation than the artificially created topography like pathways and parking areas. Rainwater harvesting is mandatory in green campus audit sites. The main motto of the rainwater harvesting system is to

improve the water level underground which is important to reduce water scarcity (Khanal et al. 2020). For recharging dry bore wells, a pit is excavated around the bore well and a filter medium is filled into the pit (Fig. 3). This has led to self-sufficiency during water stress periods to the maximum extent (Musayev et al. 2015).

Landscape Design and Soil Erosion Control

Landscape management is the care of the land to make sure that landscapes can fulfil the needs and aspirations effectively and sustainably of current and future stakeholders. It is an activity that forms a perspective of sustainable development, and ensures the preservation of a panorama, to help and harmonize changes that are added through social, monetary, and environmental methods. Landscape design is an important feature for any disasters to control especially with respect to soil erosion. In general, soil erosion occurs if the design of the land is not altered to prevent the slope features by strong vegetation and the use of plant buffer zone as safe for the escape of nutrients or fertilizers entering the streams. When the slope features are altered, adequate vegetation can alone be enough to prevent soil erosion. Un-altering the slope design adds value to natural topography, whereas, the vegetation in the same slope topography and plant buffer zone prevents the water from getting polluted.

Establishment of Lawns, Lianas, Trees, Herbs, Shrubs and Climbers on the Campus

Lawns are gazing features of unutilized land made to cover the soil with green grass for the ambiance of the place to have a greenish look. The lawn provides a hollow space among the building structures. The shaded trees in between the grass lawn, pathways, and garden benches are meaningful lineaments to the green campus. In general, the campus should have a large number of trees, herbal plants, shrubs, climbers, lianas, twiners, and lawns that should be growing profusely

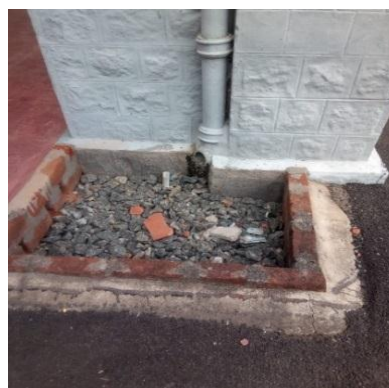


Fig. 3. Rainwater harvesting system

and showing healthier free from pests and diseases attack. The commonly available shrub species are Kakithapoo (*Bougainvillea spectabilis*), Madhanakamaboo (*Cycas revoluta*), Pigeon-berry (*Duranta plumieri*), Nilamulli (*Eranthemum roseum*), Sembaruthi (*Hibiscus rosa-sinensis*), Vetchi (*Ixora coccinea*), Malli (*Jasminum sambac*) and Arali (*Nerium odor*). Similar to that shrubs, the commonly available herbs are Kunukkuth thukki (*Micrococca mercurialis*), Melaanelli (*Phyllanthus maderaspatensis*), Keelanelli (*Phyllanthus niruri*), Otra mullu (*Priva leptostachya*), Adai-otti (*Pupalia lappacea*), Kirantinayan (*Ruellia prostrata*), Pattasukai (*Ruellia tuberosa*), Vettu kayathalai (*Tridax procumbens*) and Kattu paruthi (*Turnera ulmifolia*). The existence of climber, creepers, twiners, and lianas species commonly are Kayathalai (*Allamanda cathartica*), Kovai (*Coccinia indica*), Kattu-kodsi (*Cocculus hirsutus*), Amirtaval (*Tinospora cordifolia*) and Sinthal (*Monstera deliciosa*). The major grasses are Periapullu (*Aristida pinnata*), Chevvarakupul (*Chloris barbata*), Arugam Pillu (*Cynodon dactylon*), Korai Pollu (*Cyperus rotundus*) and Crowfoot grass (*Dactyloctenium aegyptium*). They are the type of herbs and shrubs that are green in color and grow vigorously without any pests and diseases attach which may be coincided with a healthier campus.

Establishment of Different Types of Gardens on the Campus

Different types of gardens such as terrace gardens, vertical garden, kitchen garden, medicinal and herbal garden, ornamental garden and desert garden may be established at educational institutions and industrial sectors for demonstration as well useful purposes to the stakeholders (Fig. 4). Terrace gardens are the best utilization of roof spacing for gardening. They are intended to cultivate some purposeful herbs and shrubs including vegetables and fruits. Very recently the intention of growing trees on the terrace has been raised considerably. Although the initial facilitation is intense, once established the terrace garden yields a good amount of leafy vegetables and other vegetables. The growth of tubers, taproots, and vegetables from shrubs is cultivable in terrace gardens rather than through hydroponics and ver-

tical farming. Terrace gardens are achieved in the provided space by utilizing the grow bags and potteries. This can be grown with fertile and moist soil or coconut coir pith. Kitchen gardens are introduced in every house to utilize the kitchen wastes properly which may serve as the central feature of cultivating vegetables, fruits, ornamental plants, and landscape management.

Kitchen gardens are of two types one that is used to grow plants out of kitchen waste and another one is made to grow plants required for the kitchen like herbs, shrubs, and vegetables with an elevated ground setup. Both types of kitchen gardens add up value to the claim of green campus auditing. Growing many types of herbal plants having medicinal importance on the campus becomes more attractive and useful if concept gardens are maintained. Medicinal plant gardens can contain the locally available medicinal plants, RET (Rare Endangered Threatened) listed plants and those plants are most useful in terms of economic importance. It can also be arranged based on routine uses, herbal formulations, etc. The tree garden/arborea can be planted based on the zodiac signs which would attract the public and students, faculties, staff members, and employees and educate them based on their uses.

Medicinal and herbal plant gardens can be maintained in the backyard of the campus. In the tree gardens, trees as linings all over the campus can act as oxygen corridors. Native trees along with trees like *Azadirachta*, *Pongamia*, and *Ficus* species can be cultivated at the maximum as these plants are used to remove the dust particles and carbon lead from the air and purify the air considerably. Similarly, the ornamental plants with beautiful flowers can be maintained in the frontage gardens of campus for attraction and good ambiance. This will give an overall aesthetic look and also provide fresh air for healthy respiration to the stakeholders.

Labelling of Common as well as Botanical Names of Plants

The calm and serene environment in an educational in-



Fig. 4. Establishment of different types of gardens

stitution and industry is the first and foremost important measure to keep the campus working towards its goal. The contribution of plants in bringing calmness to the minds of people is a well-known fact. Even though there are many restrictions for departments like forestry (Wood yielding trees), agriculture (Crop plants), and Botanical gardens (flowering plants and exotic plant collections) to grow a few types of plants, educational institutions, and industrial sectors do not have such boundaries. Growing plants of different categories are mandatory in educational institutions and industries to maintain the greenery on the campus. Naming the plants in the local language and botanical names (binomial nomenclature) will be an added advantage and also it will contribute to the familiarization of useful plants to the students and visitors (Fig. 5). Labeling the plants with a common name and the botanical name along with the family name (if possible) legibly using tags or hoardings should be done. Otherwise, a complete list of plants available on the campus may be prepared and listed as information for the visitors.

Operation of Water Irrigation System, Drip and Sprinkler Irrigation Methods

Maintaining the green campus and water conservation mechanisms should be applied efficiently on the campus. Well-planned water irrigation systems like sprinklers and drip should be implemented in the entire green area of the campus for an effective water management system. This can be implemented only when the plantations are well planned. The tree growing areas can be connected with drip irrigation and medicinal plants growing areas and flower gardens can be connected with sprinkler irrigation (Fig. 6). The water management system should be well planned and wastage should be minimized as much as possible. Rainwater harvesting should be implemented.



Fig. 5. Labelling of common as well as botanical names of Plants

Importance of Biodiversity Conservation

The campus should be a mini biodiversity conservation area, wherein, more greenery due to native plant species, medicinal plant gardens, concept gardens, and flowering plants that attract bees, birds, beetles, and other animals like squirrels should be monitored. Shade-giving trees in the paths, flowering trees in the avenues, and fruit trees in the back yards also would attract birds, bees, butterflies, and squirrels. Maintaining small ponds/open water sources and reservoirs will attract these small harmless animals to the campus. The Biology / Science departments should maintain a medicinal plant garden, economically important, rare, and endangered plant species or gardens that are the concept centric to the stakeholders. The campus should be free of exotic plants that cause a threat to the natural vegetation. This will aid in adding the necessary nutrients to the soil for the better growth of selected plants. The soil type will also help in choosing the irrigation system with respect to the water holding capacity (Venkataraman 2009). In view of the tremendous increase in human population, over-exploitation of natural resources, environmental pollution, global warming, deforestation, use of forest resources for human consumption, anthropogenic activity, climate change, and natural calamities are the major reasons for the loss of biodiversity (Lauder et al. 2015).

Use of Biofertilizers, Organic Manures, Green Manures and Chemical Fertilizers

Natural or eco-friendly methods should be used to grow plants vigorously on the campus. Use of biofertilizers, organic manures (cow dung, vermicompost, and plant wastes and litters), and green manures to grow healthy plants in the medicinal plant garden, kitchen garden, and terrace garden should be ensured to keep the campus organic. Plant waste such as fallen leaves, stems, fruits, nuts, seeds, and other plant parts should be used to make green manures. A concrete or ground-level green manure production unit and vermicomposting units will help to convert all the plant and animal-based wastes into green/organic manures. This will be a healthy way of solid litter waste management on campus. Minimal use of chemical fertilizers as part of the



Fig. 6. Operation of sprinkler irrigation methods

integrated nutrient management system is acceptable but nil use of chemical fertilizers is highly appreciable and also helps to keep the campus more of an organic ecosystem (Dominguez et al. 2019). Fortnightly the half-degraded plant manure can be removed and used as manure for the garden plants or used as feed for earthworms in the vermicompost pits (Dominguez et al. 2019). A vermicompost unit for decomposing kitchen wastes into vermicompost is considered a good initiative (Fig. 7).

Acoustic Proof in Indoor and Outdoor Stadiums

Any campus of educational institutions as well as industrial sectors should be calm and serene which will bring peace to the stakeholders. At the same time, more enthusiastic expression of joy is also seen in indoor and outdoor stadiums. But this will always create noise above the permissible levels on the campus. Acoustic on-50 steel perforated panels will allow great sound reduction and also be durable. Acoustic baffles will be suitable for reducing reverberation times. So the construction plans or renovation plans should include these acoustical products which will make these indoor and outdoor stadiums (Fig. 8). Some plants absorb ultrasound around the indoor and outdoor stadiums and auditoriums which in turn are useful to reduce sound pollution to some extent. For example, Ferns, Baby's Tears, *Peace Lily*, *Leylandii*, *Aureo*, *Marginata*, *Tamarind*, *Polyalthia*, *Ecuadorian cactus*, *Espostoa frutescens*, etc. These plants are able to absorb ultrasound through cells and metabolized by biochemical methods.

Establishment of Aquarium and Aquatic Plants

Growing fish in small ponds will keep the environment pleasant. In the closed environment like corridors and the front offices, auditoriums and gallery classes placing the fish aquarium as well as plant aquarium will improve the scenic value of the place bringing peace to the people. The fish water waste also can be used as manure for growing potted indoor plants. Growing *Lotus*, *Lilly*, *Hydrilla*, and other water plants will give a pleasant and calm environment and growing fishes like *Guppies* can keep the water clean



Fig. 7. Vermicompost Unit

and neat. The fountains and small ponds can be built in the frontages to give an aesthetic look and also growing water plants in these ponds will help to maintain the aesthetic sense of the environment greenish.

Steps Taken During Hot Seasons to Maintain Plants

Just planting trees on the campus during functions and celebrations will not help in improving the green cover of the Educational Institutions and Industrial sectors. It requires a planned execution of watering them at the right intervals even during the summer vacations is highly important. Applying fertilizers and removing the weeds at the correct intervals should be scheduled and persons who are in charge should be taken care-off. The activities undertaken should be entered in the registers in detail. The Internal monitoring committee should review the activities and examine the results in the field periodically. Well-planned strategies should be implemented to save water and also supply water for the neighbouring residents in summer. Water conservation slogans should be displayed in all water resources, storage areas (water reservoirs), and utilization areas. There should not be any leakages and notices should be addressed immediately so that water wastage may be reduced significantly.

Preservation of natural wells, water reservoirs, and water collection tanks

Preservation of natural wells, water reservoirs, and water collection tanks present on the campus should be well-maintained with high raised walls and removal of plants and shrubs around the wells without any contamination (Fig. 9). Well, restoration procedures are to be adopted and frequent checks on the water levels and water holding capacity, and purity of water should be monitored. Borewells should be made in the required places and instead of digging more bore wells the used and old bore wells can be recharged by connecting to the rainwater harvesting system. The water collected on every terrace of the huge institutions will be enough for recharging the bore wells. The rainwater harvesting unit can also be connected to the small pond, water tanks, and reservoirs to collect and store water to meet the water requirements of the entire campus throughout the year.

An Account of More Oxygen Releasing and Carbon Dioxide Assimilating Plants in the Campus

Some plants are considered highly efficient in oxygen production and carbon dioxide absorption which in turn reflected the quality of the green campus. If more oxygen is made available on campus naturally, the stakeholders may be free from various cardiovascular and pulmonary problems and breathing troubles. The snake plant (*Sansevieria zeylanica*) otherwise known as the mother-in-law's

tongue and Gerbera Daisy (*Gerbera jamesonii*) plant are unique for their night-time oxygen production, and ability to purify air through the removal of various toxic gases in the atmosphere (Tiyarattanachai and Hollmann, 2016). In general, the campus should have a maximum number of more oxygen-producing and CO₂ absorbing plants such as *Areca Palm*, *Money plant*, *Neem*, *Tamarind*, *Ficus*, *Bamboo*, *Arjun*, *Magizhamboo*, *Marudhu*, *Maramalli*, *Nettilingam*, *Manjal*

arali, *Puvarasu*, and *Pongam* trees to give pure atmosphere to the stakeholders (Fig. 10).

CONCLUSION

The green audit is an important key not only for sustainable development and also for a clean environment, at industries level, it detects some environmental problems. The pollution



Fig. 8. Features of indoor plants to absorb ultrasound (Acoustic).



Fig. 9. Water collection and reservoirs tanks.



Fig. 10. Oxygen releasing and carbon dioxide assimilating plants

problems are uprooted by equipping the industries with several maintenance measures. The audit is essential to provide indication management about the performance of the equipment and system of an environmental organization or institute. As a result, the best methods that are practicable can be applied to preserve water, air, soil plants, and animal life from adverse effects. Minimizing waste by developing a recycling system. Higher educational Institutes want to implement the green audit, also referred to as a green audit. One should understand the process of green auditing. It is a cyclic and continuous process. Still, there is a scope for further action, when academic institutes or organizations take part in restoring the environment. The economic development and rapid urbanization at the global, regional and local have led to ecological and environmental crises. In this background, for all the institutes it becomes essential to adopt the system of campus to be green for further development which will lead to sustainable development. NAAC, the National Assessment and Accreditation Council, New Delhi, has made it essential that all higher educational institutions should submit an annual Green Audit Report.

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