

TECHNICAL REPORT OF GREEN CAMPUS AUDIT



Submitted to

**NEHRU ARTS & SCIENCE COLLEGE
COIMBATORE – 641 105, TAMIL NADU, INDIA.**

Date of Audit: 07.08.2021 (Saturday)

Submitted by



NATURE SCIENCE FOUNDATION
*(A Unique Research and Development Centre
for Society Improvement)*



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1. Introduction

Green campus is an area of the Organisation or the Organisation as a whole itself contributing to have an infrastructure or development that is structured/planned to incur less energy, less water, less or no CO₂ emission and less or pollution free environment (Aparajita, 1995). Green Campus Audit is a tool to evaluate environment management system which is systematically executed to protect and preserve the environment. Green campus audit constitutes the environmental friendly practices and education combined to promote sustenance of green environment adopting user-friendly technology within the campus. It creates awareness on environmental ethics, resolves environmental issues and offers solutions to various social and economic needs (APHA, 2017). It strengthen the concept of “Green building” and “Oxygenated building” which in turn provides a healthy atmosphere to the stakeholders.

Green Campus Audit ensures the Organization’s campus should be greenish with large diversity of trees, herbs, shrubs, climbers and lawns to reduce the environmental pollution and soil erosion; it is also useful in relation to biodiversity conservation, landscape management, irrigation/economic water utilisation and maintenance of natural topography and vegetation (Gowri and Harikrishnan, 2014, Aruninta *et al.*, 2017). The maintenance of an eco-friendly campus ensures a neat and clean environment. For the benefit of stakeholders, solid waste management, recycling of water, disposal of sewage and waste materials (electronic and biomedical wastes), ‘zero’ use of plastics, etc. should be followed consistently in the organization campus.

Green Campus Audit procedures includes the definition of green audit, methodology on how to conduct Green audit at Educational Institutions and Industrial sectors as per the checklist of Environment Management Systems and International Standards on ISO 14001:2015, Indian Green Building Council, Swachh Bharath Scheme under Clean India Mission to understand the principles and importance of various audits in the context of the organization and risk assessment at 360° views (Gnanamangai *et al.*, 2021). Green campus audit helps the educational institutions/ industries to maintain eco-friendly environment, assures personal hygiene to various stakeholders and supports the nation; on the whole for the noble cause of environmental protection and nature conservation which in turn enhances the quality of life of all living beings (Arora, 2017).

2. Role of Educational Institutions in India

Educational institutions are playing important role in a nation’s growth and development which starts from maintenance of green campus without harming the environment. A clean and healthy environment in an Organization determine effective learning skills and offers a conducive learning environment to the students. Educational institutions are insisted by both Central and State Governments to offer eco-friendly atmosphere to the stakeholders. In addition, all the Educational institutions are asked to save the environment for future generations and to resolve the environmental problems (accumulating solid wastes and wastewaters/effluents and their careless disposal, enormous utility of plastics, uneconomical consumption of water, irresponsible in water harvesting and storage procedures, etc.) through Environmental Education. Implementing Swachh Bharath Abhiyan Scheme launched by the Indian Government

thro' the Educational institutions plays a major role in terms of giving neat and clean environment to tribal, rural and urban people across the country, besides the regular and conventional activities carried out by NSS, NCC/Student Force, Nature club, Eco club, Science club, Fine Arts club, Flora and Fauna club, Youth Red cross unit, etc. Seminar, Conference, Workshop, training and awareness programmes on Biodiversity conservation education, environmental awareness programmes, etc. may be conducted periodically by the Management and Administrative people of an Organization to the stakeholders.

Green campus auditing is a systematic method whereby an organization's environmental performance is checked against its environmental strategies and compliances of the Government guidelines. This audit process is definitely useful for the Educational institutions to maintain the campus neatly and can give pure atmosphere to the students and staff members including Management people. It is like an official examination of the environmental effects on an organization's campus as per the Government guidelines. The audit report may be useful to improve the organization's campus significantly by following the recommendations and suggestions given in the report. The green campus audit processes are being undertaken by World / Indian Green Building Council (IGBC), Green Building Code and Green Ratings Systems (GBCRS), Green Rating for Integrated Habitat Assessment (GRIHA), Consideration of Indian Industry GreenCo Rating System (CII-GreenCo) and Associated Chambers of Commerce and Industry of India (ASSOCHAM) along with ISO EMS 14001:2015 criteria and the concept of Swachh Bharath Abhiyan under Clean India Mission

3. Green Campus and Environment Policy

Green campus and environment policy aims to provide an education and awareness in a clean and green environment to the stakeholders with regard to environmental compliance. Scope of the policy applies to all employees and students of the Institution/organisation to provide an ecofriendly atmosphere. Green Campus Policy dealt with cleanliness of the campus maintained through proper disposal of wastes and steps to be followed to recycle the biodegradable wastes and utilization of eco-friendly supplies to maintain the campus free from hazardous wastes/pollutants. The concept of eco-friendly culture is disseminated among the students as well as rural community through various awareness programmes. Attempts are made to minimise the energy usage and substitute the non-renewable energy sources with renewable energy sources. Head of the Organization, Departmental Heads and Senior Managers/ Management Representatives are responsible for monitoring the "Go Green" initiatives of the College/University and maintain a clean/green campus while each and every individuals of the organisation should adhere to the policy.

4. Environment Friendly Campus

As stated earlier, Organization is liable to provide an eco-friendly atmosphere along with good drinking water facility to all the stakeholders (students and staff members). Manuring the cultivated plants/grown within the campus may applied with organic manure, cow dung, farmyard manure and vermicompost instead of using chemical fertilizers. All non-compostable and single-use disposable plastic items, plastic utensils, plastic straws and stirrers should be avoided. Demonstration/awareness programme on establishing plastic-free environment and utility of organic alternatives

for all incoming and current students, staff and faculty should be organised. Reduction of use of papers alternated with e-services, e-circulars, etc. and proper disposal of wastes, recycling and suitable waste management system should be considered to establish environment friendly campus.

5. Aims and Objectives of Green Campus Audit

- To recognise the initiatives taken towards establishing the green campus in terms of gardening.
- To grow a large number of oxygen releasing and carbon dioxide assimilating plants in the campus to give a pure atmosphere to the stakeholders.
- To identify and provide baseline information to assess threat and risk to the ecosystem due to Organization development.
- To recognise and resolve different environmental threats of the Organization.
- To ensure proper utilization of resources available in the surrounding areas towards future prosperity of the humanity.
- To fix a couple of norms for disposal of all varieties of wastes and use green cover as a carbon sink for pollution free air.
- To assess the greenish nature of an Organization campus in terms of trees, herbs, shrubs, climbers, twins, lianas, lawns and reflected in reducing the environmental pollution soil erosion, biodiversity conservation, landscape management, natural topography and vegetation.

6. Importance of Green Auditing

The Management of the Organization (Auditee) should be exposed their inherent commitment towards making ecofriendly atmosphere through the green auditing and ready to encourage/follow all types of green activities. They should promote all kinds of green activities such as conduct of environment awareness programmes, in-campus farming, planting trees and maintenance of greening, irrigation, use of biofertilizers and avoidance of chemical fertilizers and agrochemicals, etc., prior to and after the green campus auditing (Suwartha and Sari, 2013). The administrative authorities should formulate 'Green and Environment Policies' based on technical report of green campus auditing. A clean and healthy environment will enhance an effective teaching/learning process and creates a favorable learning green environment to the scholars. They should create the awareness on the importance of greenish initiatives through environmental education among the student members and research scholars. Green Audit is the most effective, ecological approach to manage environmental complications.

Green campus audit may be beneficial to the campus in improving the greenery activities which in turn useful to save the planet for future generation. Green campus audit is a kind of professional care and a simple indigenized system about the environment monitoring in terms of planting a huge number of trees which is a duty of each and every individual who are the part of economical, financial, social, and environmental factors. It is necessary to conduct green audit frequently at least once in three years in campus because students and staff members should aware of the green audit and its beneficial effects in order to save planet by means of 'Go green concept' which in turn support the institution to set environmental models ('icon') for the community. Green audit is a professional and useful measure for an Organization to

determine how and where they are retaining the campus eco-friendly manner. It can also be used to implement the alleviation measures at win-win situation for the stakeholders and the planet. It provides an opportunity to the stakeholders for the development of ownership, personal and social responsibility.

7. Benefits of the Green Auditing

There are several benefits on conduct of green audit by the Organization which may be definitely useful to improve the campus significantly based on the audit report. The green campus audit contained methodology followed and both qualitative and quantitative measurements including physical observation of greeneries in terms of growing of terrestrial and aquatic plants, animals and microflora in the campus. The natural and planted vegetation and their maintenance are also considered in the organization campus through topography, landscape management design and soil erosion control in environment sustainable development. The following are the major benefits of the green auditing.

- Know the status of development of internal and external Green campus audit procedures and implementation scenario in the Organization.
- Establishment of Green campus objectives and targets as on 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 in accordance with prevailing rules issued by the government/local authorities
- Assigning the roles and responsibilities to the Environmental Engineer and Agriculture Staff who are all responsible to improve green initiatives.
- Development of ownership, personal and social responsibility for the Organization and its environment and developing an environmental ethic and value systems to young generations.
- Enhancement of the Organization profile and reach the global standards in proving the green campus and eco-friendly atmosphere to the stakeholders
- Suggested of availability of Biogas plant to the management to restrict the usage of fossil fuel in cooking purposes.
- Implementing status of the rain harvesting system, water reservoirs, percolation pond, etc. in the campus to increase the ground water level.
- Establishment of terrace garden, herbal garden, kitchen, zodiac, ornamental gardens, etc. for enhancing teaching and learning and commercial exploitation.
- Treated water consumption towards plant cultivation, canteen, hostel, machinery cleaning, transport, toilet use and etc. on water consumption and per capita water consumption per day calculation.
- Studying the campus flora by making a complete data on total number of both terrestrial and aquatic plants, herbs, shrubs, climbers, twins and grasses.
- Survey of campus fauna by conducting the number living and visiting animals, insects, flies, moths and worms in the campus.
- Documentation of the number of oxygen releasing and carbon dioxide assimilating plants planted in the campus to give pure atmosphere to the stakeholders.
- Operation of water irrigation, drip and sprinkler irrigation methods to improve the green campus.

- Studying the biodiversity conservation through Life Sciences and Biological Sciences people to conserve economically important, rare and endangered plant and animal species in the campus ecosystem.
- Recommendation in use of biofertilizers, organic and green manures, cow dung manures and farmyard manures for the cultivation of plants to protect the environmental health
- Conduct of outreach programmes for dissemination of Green Campus motto and Green pledge initiatives to rural, tribal and urban people through Eco club, Nature club, Science club, Fine Arts club, Youth Red Cross unit, NCC/Student Force and NSS bodies.
- Academic credentials like major and minor Projects, Dissertations and Thesis work on green campus, environment protection and nature conservation by the students and staff members.
- The plants available in the campus must be tagged with their common name and Botanical name for the stakeholders to impart the knowledge on medicinal and ornamental, economic and food values of plant varieties.
- MoU may be signed with Government and non-Governmental Organizations (NGOs) to utilize the resources for nature conservation and environmental protection.
- Implementation of Government schemes (Swatch Bharath Abhiyan under Clean India Mission) to give pure and safe water to rural people and teach the importance of cleanliness of toilets and restrooms.
- Conduction of awareness programmes and cultural activities on global warming, environmental changes and ecosystem maintenance to the stakeholders.
- Steps taken for organic, inorganic, toxic, e-waste, biomedical, food, sewage waste management, segregation of wastes and reuse methods.
- Public transport, low-emitting vehicles and control of car smokes and exhaust towards carbon accumulation in the campus by carbon footprint studies.
- Implementation of advanced methods for watering plantations (Drip irrigation, Sprinkler irrigation, etc.) and use of metering for water utility, IoT based watering, automation, water device, remote water lines, etc.
- Percentage of Organization's budget for environment sustainability efforts and green campus initiatives planning and efforts.
- Campus facilities for disabled, special needs and/or maternity care including security, safety and health infrastructure facilities for stakeholder's wellbeing.
- High degree of resource management offers the basis for improved sustainable and creation of plastic free campus to evolve health consciousness among the stakeholders.
- Impart of knowledge on environment through systematic management approach and improving environmentally friendly standards by creating a benchmark for environmental protection initiatives
- Best practices followed on green campus initiatives in the Organization listed and disseminated among the stakeholders.
- Recommendations for improving the green initiatives, planning and efforts in the campus after audit report to improve further.

8. About the Organization

8.1. Nehru Arts and Science College

Nehru Arts & Science College has emerged from the galaxy of Nehru Group of Institution with the dictum “Knowledge is wisdom”. The Trust headquarter at Coimbatore, Tamil Nadu, has spread its wings to the neighbouring state Kerala by Establishing Educational Institution of high reputation. The trust was constituted by Late P. K. Das, F.I.E., F.I. Mech. E., M.S. Engg., A. F. R. Ae. S. (London), C. Engg. The College is situated in tranquil environment of sprawling 35 acres campus located in Thirumalayapalayam about 2.5 Km from NH 47(connecting Coimbatore and Palakkad), 15 Km from Kerala Border.

The college was established in 1998 offering 04 programmes with 54 students. It is affiliated to Bharathiar University, recognized by UGC with 2(f) and 12(B), certified with ISO 9001:2008 and ISO 14001: 2004.NAAC was accredited by NAAC with “B” Grade in 2009 and reaccredited with “A” Grade in 2014. Due to the consistent and conscious efforts of the Management and Principal **Dr.B.Anirudhan**, in nurturing the Institution, it has grown in strength and achieved success over the years. The college has got Autonomous status in July 2017. The vision of the college is “to mould the character, shape the career, perfect the behaviour and excel in educating the younger generations of today for tomorrow”. The mission of the college is “to offer innovative and socially relevant job-oriented courses with a view to enhance the employment prospects of the learners. In carrying out educational mission, we endeavour to upgrade the knowledge, skill and behaviour of the students, striving hard towards excellence in all spheres of our activities”. The Quality policy of the college is “to transform our students as knowledgeable individuals, skilled professionals and well-behaved human beings to live as worthy citizens to work for the wellbeing of the society and strive towards building a better India with true spirit of culture, patriotism and nationality to create international brotherhood and global harmony through value based and man making education.”

To this end, they pursue continuous development of infrastructure and enhance state of the art equipment to provide our students a technology up to date and intellectually inspiring environment of learning, research, creativity, innovation, and professional activity, inculcate in them ethical and moral values. The institute is committed to build a better nation through quality education with team spirit. Students are enabled to excel values of life and become good citizens. The system, infrastructure, and services were inspired to satisfy the students, parents, industry, and society.

8.2. About Nature Science Foundation (NSF)

NSF is a Non-Profit ISO 9001:2015 certified Organization and registered with NGO Darpan NITI Aayog and Ministry of Micro, Small and Medium Enterprise, Government of India functioning energetically towards the noble cause of nature conservation and environmental protection. NSF is managed by a board of trustees of NSF Public Charitable Trust under the TN Societies registration Act 1975 (TN Act 27 of 1975) on 29th November, 2017 at Peelamedu, Coimbatore- 641 004, Tamil Nadu, India with Certificate of Registration No. 114 / 2017. In addition, NSF has 12A, 80G and Form 10AC certificates for income tax exemption. The main motto of the NSF is to “Save the Nature to Save the Future” and “Go Green to Save the Planet”. NSF Branch Offices are also functioning effectively at Gorakhpur, Uttar Pradesh and Faridabad,

Haryana, India to adopt the 'Go Green Concept'. NSF family is wide spread across India with over 70 state-wise Lead auditors to conduct Green and Environment Audits.

NSF is functioning strenuously to conduct different awareness programmes and implement various schemes to public and school / college students towards the noble cause of nature protection. Some of the programmes are also being organized for the benefit of tribal communities to create the supply chain for biodiversity conservation studies. The objectives along with vision and mission are illustrated to promote educational and environmental awareness programmes through social activities for enhancing the quality of life and to conserve nature from environmental pollutants using traditional and modern technologies for sustainable land management. NSF is educating the tribal community children through social service and towards the upliftment of tribes as a whole and make them as entrepreneurs.

International Eco Club Student Chapter (IECSC) has been established for Student volunteers and faculty members are encouraged to conduct National and International events, Student Technical Symposium, Distinguished lecture programme, Environment day celebration, Ozone day celebration, Project model exhibition, Awareness programmes on Environmental pollution, Biodiversity and Natural resources conservation and etc. with the financial support of the Foundation. NSF is being released 'Magazine' and 'Newsletter' biannually to share the information about Environmental awareness programmes on biodiversity conservation, seminar on soil conservation, water management and solid waste management, restoration and afforestation programmes in Western Ghats of southern India.

In order to encourage the students, members of faculty, academicians, scientists, entrepreneurs and industrial experts those who are involving in nature protection and biodiversity conservation studies, NSF tributes the deserved meritorious candidates with various awards and honours such as 'Best Faculty Award', 'Best Women Faculty', 'Best Scientist Award', 'Best Student Award', 'Best Research Scholar Award', 'Best Social Worker Award', 'Young Scientist Award', 'Life-Time Achievement Award' and 'Fellow of NSF' will be given.

NSF has introduced various types of Audits such as 'Eco Audit', 'Green Audit', 'Energy Audit' and 'Hygienic Audit' to academic Institutions, R&D Organizations and Industries towards the accreditation process as well as maintaining a hygienic eco-friendly environment to the stakeholders in their campus. All audits will be conducted as per the Checklist prepared by the NSF ISO EMS 14001:2015 criteria and in compliance with Government Law and Environmental Legislations including World / Indian Green Building Council and the concept of Swachh Bharath Abhiyan under Clean India Mission. Green campus and Environment Policy, Purchase Policy, MoU, International Eco Club student Chapter Certificate will be given to get the maximum mark weightage in NAAC. Audit processes are being conducted through the certified Auditors as per the following

Audit	Certified Auditors	Certified Auditors
Green Audit	<ul style="list-style-type: none"> • IGBC - Indian Green Building Council • GBCRS - Green Building Code and Green Ratings Systems • GRIHA – Green Rating for Integrated Habitat Assessment 	<ul style="list-style-type: none"> ➤ Mrs. S. Rajalakshmi ➤ Dr. R. Mary Josephine ➤ Dr. B. Mythili Gnanamangai ➤ Er. Ashutosh Kumar Srivastava ➤ Er. N. Shanmugapriyan
Energy Audit	<ul style="list-style-type: none"> • BEE - Bureau of Energy Efficiency • LEED - Leadership in Energy and Environmental Design • CII-GreenCo – GreenCo Rating System Felicitator 	<ul style="list-style-type: none"> ➤ Er. D. Dinesh kumar ➤ Er. N. Shanmugapriyan ➤ Dr. N. Balasubramaniam ➤ Dr. P. Thirumoorthi ➤ Dr. G. Muruganath
Environment Audit	<ul style="list-style-type: none"> • IGBC - Indian Green Building Council • ASSOCHAM - Associated Chambers of Commerce and Industry of India • FSRS – Fire Safety & Rescue Services 	<ul style="list-style-type: none"> ➤ Mrs. S. Rajalakshmi ➤ Dr. A. Geetha Karthi ➤ Dr. R. Mary Josephine ➤ Dr. B. Mythili Gnanamangai ➤ Er. Ashutosh Kumar Srivastava ➤ Er. N. Shanmugapriyan
Hygiene Audit	<ul style="list-style-type: none"> • FSMS – Food Safety Management System & • Occupational Safety & Health (ISO 22000:2018) • SBICM - Swatch Bharath under India Clean Mission 	<ul style="list-style-type: none"> ➤ Mrs. Gaanaappriya Mohan ➤ Er. Ashutosh Kumar Srivastava ➤ Dr. R. Sudhakaran ➤ Dr. N. Saranya
Waste Management Audits	<ul style="list-style-type: none"> • Water Audit, Soil Audit, Biomedical Waste Audit, Solid Waste Management Audit as per the IGBC, GRIHA and BEE 	<ul style="list-style-type: none"> ➤ Mrs. Gaanaappriya Mohan ➤ Er. Ashutosh Kumar Srivastava ➤ Dr. R. Sudhakaran ➤ Er. N. Shanmugapriyan
Academic & Administrative Audits	<ul style="list-style-type: none"> • Academic & Administrative Audits as per the NAAC Criteria 	<ul style="list-style-type: none"> ➤ Dr. B. Anirudhan ➤ Dr. B. Shreeram

Table 1. The Nehru Arts and Science College Campus facility details

S.No.	Details of Area	Total area
1.	Total Campus area	12 acres
2.	Total Built up area	1,29,598 sq. Ft.
3.	Covered Car parking area	1961.9 Sq.mtr
4.	Air-conditioned area	1961.9 Sq.mtr
5.	Non-Airconditioned area	2678 Sq.mtr
6.	Gross Floor area	7976.62 Sq.mtr
7.	Public area	4009.6 Sq.mtr
8.	Service area	2314 Sq.mtr
9.	Forest vegetation	73.21%
10.	Planted vegetation	24.10%

9. Audit Details

Date / Day of Audit	: 07.08.2021 (Saturday)
Venue of Audit	: Nehru Arts and Science College, Coimbatore 641 105, Tamil Nadu, India.
Audited by	: Nature Science Foundation, Coimbatore - 641 004, Tamil Nadu, India.
Audit type	: Green Campus Audit
Name of ISO EMS Auditor	: Mrs. S. Rajalakshmi, Chairman, ISO QMS & EMS Auditor, NSF.
Name of Subject Expert-I	: Dr. R. Sudhakaran, Board of Director, NSF North Zone, Haryana.
Name of Subject Expert-II	: Dr. M. Ravichandaran, Lead Auditor & Associate Scientist, Bayer Bioscience, Pvt. Ltd. Hyderabad.
Name of IGBC AP Auditor	: Dr. B. Mythili Gnanamangai, IGBC AP, Indian Green Building Council. Ms. Burra Hema Malini IGBC AP, Indian Green Building Council.
Name of ASSOCHAM Auditor	: Er. Ashutosh Kumar Srivastava, Associated Chambers of Commerce and Industry
Name of Eco & Green Officer	: Ms. S. Sowndharya, Eco & Green Council Programme Officer, NSF.

10. Procedures followed in Green Campus Audit

Green campus audit is a structured process of documenting the credentials in terms of number of trees, herbs, shrubs, lawns, climbers and lianas reflected in reducing the environmental pollution and soil erosion and useful for biodiversity conservation, landscape management, natural topography and vegetation. It is a kind of a professional tool for assessing the green campus. Green audit projects the best environmental practices and initiatives taken in the organisation at the prescribed site of audit that brings added value to the organisation in maintaining the eco-friendly campus to the stakeholders. First step of the audit is ensuring that the organisation has a central role in building the green campus, in order to validate the same (Adeniji, 2018).

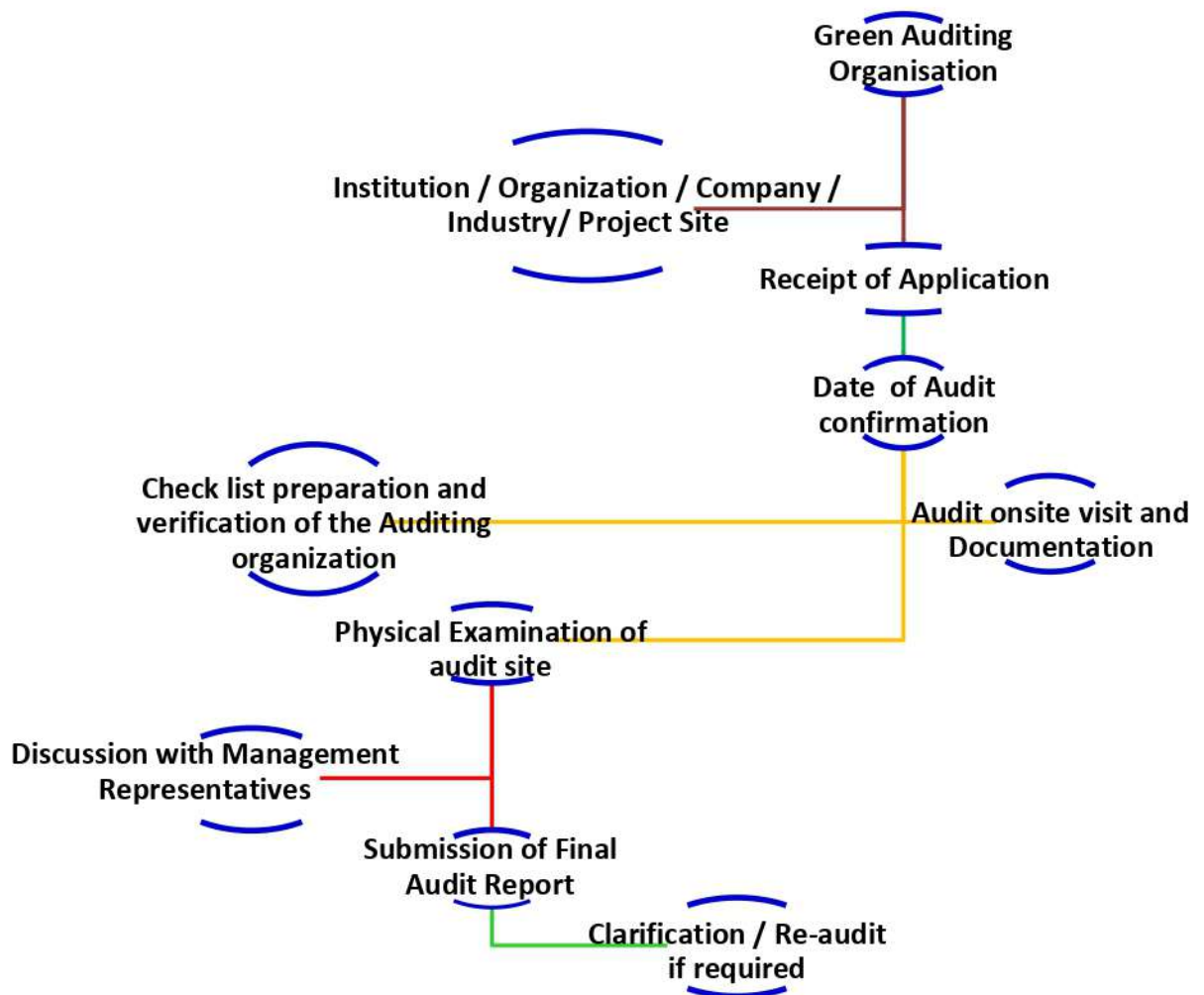
Green campus is not intended for the self-sustainability of the building alone, it also involves in propagation of the green campus initiatives so as to be adopted by any individuals and organization at a minimum cost. Green campus audit has been conducted as per the checklist of Nature Science Foundation, Coimbatore, Tamil Nadu, India (www.nsfonline.org.in) through the authenticated Professionals for people qualified to investigate and evaluate the campus for validating the best environmental practices (Staniskis and Katiliute, 2016, SCSR, 2018). 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.

During the audit, the nature of plants and animals / birds species thriving within the campus were recorded. Establishment of lawns, trees, herbs, shrubs and climbers and establishment of terrace / kitchen / herbal / zodiac / ornamental / medicinal garden / aquarium and aquatic (hydrophytes) plants in the campus were recorded. Labelling 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 purpose or any other purpose in the campus area were noted. The number of water wells, bore wells and water reservoir facilities in the campus were also noted as per the Audit Manual of Gnanamangai *et al.* (2021).

Attempts made for water scarcity during summer season towards the maintenance of plants and frequency of watering for plantations in the campus were noted. Biodiversity conservation education, projects, awareness programmes, etc., through Indian Biodiversity Act and Ministry of Environment, Forests and Climate Change, Government of India and the conduct of outreach programmes for dissemination of Green campus motto were recorded (Venkataraman, 2009). Conduct of outreach programmes for dissemination of Green campus motto to the students and staff members including public domain and signing of MoU with Government and Non-Governmental Organizations to ensure green campus activities for future generation were noted (Lauder *et al.*, 2015; Brindusa *et al.*, 2007). Technology driven solutions initiated by the Green campus organization can also be disseminated and documented successively for propagating the attitude of the Green campus in wider masses.

Projects, Dissertations and Thesis are the academic effort credentials that always fosters the innovative ideas on thinking and implementation of new innovative

approaches towards the green campus. These should be disseminated through presentations and publications in social media, books, magazines and journals so as to spread the innovative ideas and methods to the broad public. These efforts taken by the students and staff were deliberated while conducting the Green campus audit. Green audit processes are taking place as per the following flow-chart starting from the receipt of application forms from the auditee (organization) and ending upon the submission of final report to the concerned organization (Leal Filho *et al.*, 2015). During the audit process, the best environmental / greenery practices followed and new initiatives undertaken in the organisation to reduce the environmental pollution and steps taken for nature conservation that brings added value to the organisation in maintaining the eco-friendly campus were assessed (IGBC, 2021; WGBC, 2021). In addition, supporting activities of the scholars and staff with regard to “Vision and Mission” of the greenery activities of the Organization is also evaluated.



Flow-chart of Green Campus Audit Procedures

10.1. Onsite Green Campus Audit activities

1. Opening meeting is the first step between the audit team and auditee along the Management Representatives where the purpose of the audit, procedures to be adopted for the conduct of the audit, verification of the documents and the time schedules were discussed, in brief.
2. Followed by opening meeting, onsite inspection will be conducted which is the second step in the audit where the Audit team members visited different sites in the Nehru Arts and Science College campus and required photographs were taken then and there for preparing the audit report.
3. During the onsite phase of visit, it is vivid how the various facilities made by the Nehru Arts and Science College Management to the stakeholders without disturbing the landscape, natural topography and vegetation to ensure the green campus.
4. It is observed how the environment is protected in the campus and by what means an eco-friendly atmosphere is being given to the stakeholders. The assessment reveals the strengths and weaknesses of the Auditee's Management controls and risks associated with their failure in creating Green campus facilities.
5. Collecting audit proofs *ie*, data collection and information from the auditee as per the audit protocol were carried out.
6. An exit meeting was conducted to describe the findings of the audit with Management Representatives and staff members along with the audit team in brief.

10.2. Pre-Audit stage activities



Meeting with the Principal and Management Representatives of Nehru College with the Audit Team of the Nature Science Foundation, Coimbatore, Tamil Nadu.

A pre-audit meeting (opening meeting) is conducted with Management and Administrative people along with staff coordinators of Energy and Environment audit process, wherein, audit protocol and audit plan were discussed in brief. The purpose of this meeting is to provide a chance to emphasize the scope and objectives of the audit and discussions held on the feasibilities associated with the audit (Marrone *et al.*, 2018). Pre-audit stage activities are an essential prerequisite for the green audit to meet the auditee and to gather information about the campus and required documents were collected directly from the Organization before the start of the audit processes

(Fachrudin *et al.*, 2019). Audit team was selected by the Nature Science Foundation as per the checklist comprised of Lead Auditor of ISO (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.

Energy and Environment audit activity at the NASC by the NSF Audit Team



10.3. Target Areas of Green Auditing

Green campus audit is nothing but a professional tool to assess the greenery activities in the educational institutions and give a value addition to the campus and considered as a resource management process. Eco-campus concept mainly concentrate on the efficient use of energy and water; minimize waste generation or pollution and also improve the economic efficiency. Green campus audit process may be undertaken at frequent intervals and their results can demonstrate improvement or change over time. Eco-campus focuses on the reduction of carbon emissions, water consumption, wastes to landfill and enhance energy use conservation to integrate environmental considerations into all contracts and services considered to have significant environmental impacts (Choy and Karudan, 2016).

There are several target listed in the Green audit process in which a few are taken into consideration as per the Indian scenario is concerned. They are water use efficiency, energy use efficiency, solid, e-waste biomedical, food, sewage waste

management and reuse methods, planting of oxygen releasing and carbon dioxide assimilating plants, landscape management, topology, vegetation, soil erosion control, carbon footprint due to use of vehicles, electricity and fossil fuels (León-Fernández and Domínguez-Vilches, 2015). drinking water quality supply, Biogas plant, rain harvesting system, water reservoirs, percolation pond, establishment of various herbal, terrace and ornamental, gardens, campus and flora fauna, water irrigation, implementation of Government schemes, conduction of awareness programmes management, public transport, low-emitting vehicles and control of car smokes and exhaust, Organization's budget for greenery activities, campus facilities for disabled, persons needs special attention and or maternity care, security, safety and health infrastructure facilities for stakeholder's wellbeing (Nunes *et al.*, 2018).

10.4. Flora and Fauna diversity of study area

The College is situated in a tranquil environment of sprawling 35 acres campus located in Thirumalayampalayam about 2.5 Km from NH 47 (connecting Coimbatore and Palakkad), 15 Km from Coimbatore City and 14 Km from Kerala border. Its calm, lush green, pollution free surroundings dissolved in the chill breeze makes the climate salubrious and atmosphere conducive for intact and effective learning. It is easily accessible through 60 Institution's buses plying from various parts of Coimbatore, Tirupur, Pollachi and Kerala. The land cover of the campus is >35 acres. The NEHRU ARTS AND SCIENCE COLLEGE is considered as one of the Educational Institution in Coimbatore with overwhelming diversity of flora and fauna. At present, the campus is quite clean, green and with much less pollution when compared to the rest of the city. The campus is frequently visited by several nature enthusiasts to study and document the flora and fauna. Study/documentation of biodiversity provides a useful measure of the quality of the environment and the ecological studies are important aspects of environment, in view of the consideration of environmental quality and natural flora and fauna conservation.

10.4.1. Topography

The NEHRU ARTS AND SCIENCE COLLEGE consists of an environment of dry deciduous type with a mixture of teak, located at 10° 51' N of Latitude and 76° 53' E Longitude.

10.4.2. Geology and Soil condition

The Top soil of the campus is found in the first 5 meters hard rock and above 5 meters hard rock.

10.4.3. Climatic conditions

Climate of the Campus is temperate and from March to June is generally hot. The campus receives maximum rain fall from South-East monsoon and the annual rain fall is 1000mm. April to June are the hottest months, December to January. Temperature start rising towards the end of February.

Table 2. Soil edaphic and environmental parameters of the NASC Campus

S.No	Details of Parameters	Data collected
Soil edaphic parameters		
1.	Soil pH	7.70
2.	Soil types	Red, sandy loam with glacial
3.	Total organic carbon	4.5%
4.	Electrical conductivity	0.14 dSm ⁻¹
5.	Water holding capacity	60.23%
6.	Total Nitrogen	4.5 ppm
7.	Available Phosphorous	6.0 ppm
8.	Exchangeable Potassium	4.5 ppm
Environmental parameters		
1.	Minimum Temperature	16-22°C
2.	Maximum Temperature	25-37°C
3.	Minimum Relative humidity	66-80%
4.	Maximum Relative humidity	7-100%
5.	Annual Average Rainfall	60-70 cm/avg.year
6.	Annual Average Sunshine	3-6 hrs/avg.day
7.	Wind speed	15.2-17.8 km/hr

11. Identification of Plant Species

11.1. Identification of Flowering Plant Species

Various vascular plant species were collected across the NASC campus and subjected to botanical identification (botanical name, family, habitat, and economic importance) and anthropogenic disturbances to the natural vegetation in campus. Plants were freshly collected and their digital photographs were also taken. The collected plant specimens have been identified using taxonomic literatures (Gamble and Fischer, 1972; Matthew, 1983; Nair and Henry, 1983; Henry *et al.*, 1989; Chandrabose and Nair, 1988). Further, their identification was confirmed by matching with authentic specimens in the Madras Herbarium (MH), Botanical Survey of India (BSI), Southern Circle, Coimbatore, Tamil Nadu, India.

11.2. Identification of Non-Flowering Plant Species

11.2.1. Lichen Identification

Lichen specimens were collected from the NASC campus and then identified based on the lichen identification key of Awasthi (2007). Representative lichen specimens were identified based on thalli morphology such as rhizine, cilia and pseudocephellae and reproductive structures (fruiting bodies) such as apothecia, perithecia, soredia, soralia, conidia and isidia embedding on the thalli surface using a stereo microscope (CZM4, Labomed, India). In the present study, Anatomy of the thallus were carried out in order to document micro morphological features such as medulla thickness, upper and lower surface of thallus, lobes, size and shape of spores. Thin section of apothecia and perithecia was made to observe the nature ascus spores and the arrangement of the algal and fungal layers in the thallus; respectively. Spot tests

featured the use of chemical reagents to detect lichen substances by appearances of the characterized colour changes on lichen thallus was noted. The lichen chemistry was analyzed according to Culberson and Kristinson (1970) methods. The colour spot test was done on medulla of lichen thallus using test reagents of potassium hydroxide (K), calcium hypochlorite (C) and paraphenylene di amine (PD). Lichen was identified based on colour spot test using the procedure defined by Orange *et al.* (2001).

To authenticate the identified lichen samples, the representative samples were compared with the voucher specimens at the Lichen Herbarium Centre of National Botanical Research Institute (NBRI), Lucknow, Uttar Pradesh, India and Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu. The lichen species might be confused with other species unless their morphological, biochemical and anatomical features were closely monitored. Therefore, apart from microscopic observation, spot tests, chemical profiling and TLC tests, attempts were made to compare the representative samples with voucher specimens.

11.2.3. Identification of Algae Genera

Algae are the members of a group of predominantly aquatic photosynthetic organisms of the kingdom *Protista* followed by terrestrial algae found in freshwater and slump areas. Algae are non-flowering and lower group of plants which are green in colour because of presence of chlorophyll pigments in the body called thallus. Algae adopt diverse life cycles, and by size, they range from microscopic *Micromonas* to giant kelps that reach 60 metres (200 feet) in length. Their photosynthetic pigments highly varied when compared to that of higher plants; their cells have features not found among plants and animals. In addition to their ecological roles as oxygen producers, they serve as food base for almost all aquatic life; algae are economically important as a source of crude oil and as sources of food and a number of pharmaceutical and industrial products for humans. Algae are defined as eukaryotic (nucleus-bearing) organisms that photosynthesize. They lack specialized multicellular reproductive structures of plants, but they always contain fertile gamete-generating cells surrounded by sterile cells. Algae also lack true roots, stems, and leaves features they share with the avascular lower plants (e.g., mosses, liverworts, and hornworts). Algae identification key consists of couplets of characteristics using algal description of the specimen based on morphological characterization from 58 Genera to species level identification as per the comprehensive key.

12. Identification of Mammals, Birds, Reptiles, Amphibians and Termites

Birds were observed by visual sightings and by calls also the avifaunal data were observed through the Nikon 8 x 40 binoculars and photographs were taken by Canon 600 D camera (55 – 250 mm). The recorded data was noted in the field work note. Later, the birds were identified with the help of field guide- "Birds of Indian subcontinent" by Richard Grimmett, and the IUCN category of the birds were also noted with the same. The point count and transect line methods were used to record the number of bird species in the study area in which regular visits and personal visits were carried out (Ferenc *et al.*, 2014). The surveys were conducted to understand the distribution of bird species in relation to habitats and nesting behaviour of birds in the study area. Based on survey richness and abundance of bird species were calculated using Shannon-weaver

diversity index. Based on available data and species were selected for nest site selection study. Selected species of birds was analysed for its nest site characteristics between the habitats and also plant species preference was enumerated and assessed. The number of breeding bird species and nests found in different habitats as dependent variables such as abiotic and biotic factors as the independent variable (Jayson and Mathew, 2000).

Reptiles and Amphibians are identified based on colouration, markings on the skin, background colour generally brown, Males often have a flecked pattern on back. Occasionally they are in green, leading to mistaken identification as sand lizard, Males have thicker base to tail and brighter, speckled underside. Newborn young are dark in colour, almost black. A rare species, almost entirely confined to heathland sites in Dorset, Hampshire and Surrey, and sand dunes on the Mersey and Welsh Coast. The most common reptile found in a variety of habitats, including gardens. Spends most of its time underground or in vegetation litter. Most likely to be found underneath objects lying on the ground, or in compost heaps. Snakes are identified based on cream, yellow or white collar behind the head, bordered to the rear by black marks. Body colour ranges from bright green to dark olive, but mostly the latter. Darker specimens can appear black from a distance. Truly black grass snakes are rare. Males are predominately brown, females are grey. Dark butterfly shape on top of head may be noted. Pairs of spots, sometimes fused as bars, running along back with black line running through eye are recorded. Males typically grey with a black zigzag stripe, females generally brown with a dark brown zigzag stripe (Beebee and Griffiths, 2000).

13. Green Campus Audit Observations

It covers both qualitative and quantitative measurements including physical observation of greeneries in terms of growing of terrestrial and aquatic plants, animals and microflora in natural and planted vegetation and their maintenance. Topography, landscape management design and soil erosion control are playing important role in environment sustainable development in the campus. An account of a large number of Oxygen releasing and Carbon dioxide assimilating plants planted in the Campus are taken into consideration to give pure atmosphere to the stakeholders. Establishment of different types of gardens in the campus, rainwater harvesting system, operation of water irrigation, drip and sprinkler irrigation methods may be adopted to improve the green campus. Similarly, biodiversity conservation strategies are very essential to conserve a variety of plant and animal species in the campus ecosystem. Biofertilizers, organic and green manures, cow dung manures and farmyard manures may be used for the cultivation of plants which may be protected the environmental health that will not cause any air, water and soil pollution. The various Clubs, Forums, Cells, Associations and Student / Staff Chapters such as Eco club, Nature club, Science club, Fine Arts club, Flora and Fauna club, Youth Red Cross, NCC/Student Force and NSS bodies may be involved in green campus initiatives, planning and efforts among stakeholders. Outreach programmes may be conducted for dissemination of Green Campus motto and Green pledge initiatives to rural, tribal and urban people. Academic credentials like taking up major and minor Projects, Dissertations and Thesis work by the students and staff members may be taken into account towards green campus initiatives, planning and efforts. Best practices followed on green campus initiatives in the Organization and recommendations for greening are illustrated in the audit report as well.

Table 3. Qualitative Measurements of Green Auditing

S.No	Requirements and checklists of the audit	Conformity		
		Yes	No	NA
1.	Have internal Green campus audit procedures been developed and implemented in the Organization?	✓		
2.	Have programmes for the achievement of Green campus objectives and targets been established and implemented as on today?		✓	
3.	Whether Green campus audit and Environment audit are simultaneously carried out or separately carried out?	✓		
4.	Whether Indian Biodiversity Act as per the Ministry of Environment, Forests and Climate Change, New Delhi, Wildlife protection act and World & Indian Green Building Council concepts followed?	✓		
5.	Have responsibilities been assigned for programmes at each appropriate function and level? (Environmental Engineer & Agriculture Staff working for environment monitoring)	✓		
6.	Are the following environmental aspects considered in sufficient detail?			
	a. Drinking water / RO water / Borewell water / Open well water / Pond water / Municipal or Corporation water use and to check quality of water through Physico-chemical properties analysis	✓		
	b. Wastewater treatment facility	✓		
	c. Sufficient number of trees, shrubs, herbs and lawns	✓		
	d. Solid waste management facility	✓		
	e. Availability of Biogas plant	✓		
	f. Rain harvesting system, water reservoirs, etc.	✓		
	f. Aquarium and aquatic (hydrophytes) plants	✓		
	g. Establishment of terrace garden, herbal garden, kitchen, zodiac, ornamental gardens, etc.	✓		
	h. Natural Topography or Forest, Planted vegetation	✓		
	i. Water well, Bore well, lake, water reservoir facility	✓		
	j. Water consumption towards plant cultivation, canteen, hostel, machinery cleaning, transport, toilet use	✓		
	k. Treated water consumption towards plant cultivation, machinery cleaning, transport, toilet use and etc.	✓		
	l. Per capita water consumption per day calculated (45L/P/C/D)	✓		
7.	Whether plants are tagged properly with their common name and Botanical name for stakeholders?		✓	
8.	Signing of MoU with Govt. and NGOs to disseminate Green campus motto and pledge	✓		
9.	Biodiversity conservation of plants, animals and wildlife, genetic resources (Endangered and endemic species) at	✓		

	each appropriate function and level?			
10.	Are any biofertilizers, organic manures, farmyard manures, vermicompost, green manures and chemical fertilizers used for maintaining plants?	✓		
11.	Establishment of herbal garden, zodiac garden, medicinal garden, kitchen garden, terrace garden and ornamental plants garden in the campus	✓		
12.	Implementation of Government schemes (Swatch Bharath Abhiyan under Clean India Mission)	✓		
13.	Functioning of Nature club, Eco club, Cell, Forum, Association, NCC/Student Force, NSS bodies and Social Service League for students and staff members on biodiversity conservation, green campus development, etc.	✓		
14.	Conduction of awareness programmes and cultural activities on global warming, environmental changes and ecosystem maintenance to the stakeholders	✓		
15.	Conduction of outreach programmes for dissemination of green campus initiatives, natural resources, environmental pollution and biodiversity conservation to rural, tribal and urban people	✓		
16.	Implementation of composting pits, vermicompost unit, recycling of kitchen wastes collected from Hostels, Canteens, Cafeteria, Food court and other places	✓		
17.	Maintenance of plantations in the campus and steps taken for water scarcity during summer season to maintain plants	✓		
18.	Steps taken for organic, inorganic, toxic, e-waste, biomedical, food, sewage waste management, segregation of wastes and reuse methods	✓		
19.	Public transport, low-emitting vehicles and control of car smokes and exhaust towards environment monitoring		✓	
20.	Observation on the site preservation, soil erosion control and landscape management	✓		
21.	Projects and Dissertation works and Scholarly publications on environmental science and management carried out by students and staff members	✓		
22.	Implementation of advanced methods for watering plantations (Drip irrigation, Sprinkler irrigation, etc.)	✓		
23.	Use of metering for water utility, IoT based watering, automation, water device, remote water lines, etc.		✓	
24.	Percentage of Organization's budget for environment sustainability efforts	✓		
25.	Campus facilities for disabled, special needs and or maternity care including security, safety and health infrastructure facilities for stakeholder's wellbeing	✓		

Table 4. Quantitative Measurements of Green Auditing

S.No.	Details of Plant and animal species	Numbers / Percentage
1.	Total number of Flowering plant species inside the Campus	112 species belonging to 109 Genera under 51 families
2.	Total number of Non-Flowering plant species inside the Campus	18 species belonging to Lichens, Pteridophytes, Bryophytes and Mycoflora
3.	Total number of living Mammals inside the Campus	10 such as Cats, Mice and Dog
4.	Total number of visiting Mammals inside the Campus	3 species belonging Rabbit, Monitor lizard, Indian grey mongoose
5.	Total number of living Birds inside the Campus	13 species belonging Common Myna, Bank Myna, House Sparrow, King- crow, House Crow, Jungle Babbler, Yellow-billed egret, peacock, Dove and parrot.
6.	Total number of visiting Birds inside the Campus	3 species belonging Greater flameback, Crimson-backed sunbird and Indian black-lored tit.
7.	Total number of Aquarium	Two each of Natural and percolation Ponds
8.	Total number of Aquatic (hydrophytes) plant species	Tow species belonging to <i>Lotus and Water Hyacinth</i> ,
9.	Total number of Grasshopper and Termites	Grasshopper: 4 species Termites: 3 species
10.	Total number of Amphibians and Reptiles	Amphibians: 7 species Reptiles: 7 species
11.	Total number of Butterflies and Mosquitos	Butterflies : 9 species Mosquitos: 02 species
12.	Percentage of Forest Vegetation	73.21%
13.	Percentage of Planted Vegetation	24.10%
14.	Percentage of Water consumption to total human population	-
15.	Percentage of Water consumption to total flora and fauna	-
16.	Per capita water consumption per day	-

13.3. Flora and Fauna diversity in the NASC Campus

13.3.1. Flora diversity in the NASC Campus

13.3.1.1. Flowering plants diversity in the NASC Campus

Ensuring the rich biodiversity in the campus is an important parameter which reflects the real-time ecosystem. Plants are indicators for assessing the varying levels of environmental quality. In general, plants improve the outdoor air quality with increased oxygen levels and reduced temperature and carbon dioxide. The green and

varying colour of the flowering plants improve the ambience of the Organization environment. The record on maintenance of the plant biomass and its management are important with respect to green campus initiatives. The existence of such plants and birds in the green campus may be recorded for the rich flora and fauna which are being considered as a value addition to the campus.

The observations indicated that the NASC campus has more than 75-80 % of wild as well as native plant species and the other 20-25% plant species are ornamental in nature coming under the planted vegetation. Native plant traits promote the indigenous fauna at the site area. Hence, the accountancy of 75% of the wild traits are leveraged for the native animals and birds. The remnants of this past vegetation are found in the campus.

The most plants recorded are *Cocus nucifera*, *Ficus religiosa*, *Azadirachta indica*, *Cycas revoluta*, *Bambusa vulgaris*, *Ravenala madagariensis*, *Delonix regia*, *Roystonea regia*, *Polyalthia longifolia*, *Terminalia catappa*, *Melia azedarach*, *Musa paradisaca*, *Carica Papaya* and *citrus limon* which are dominant trees species characteristic to the vegetation within the campus. Some of the shrub species like *Hibiscus rosa-sinensis*, *Dracaena trifasciata*, *Ixora finlaysoniana*, *Agave americana*, *Acalypha wilkesian*, *Codiaeum variegatum*, *Sesbania punica*, *Catharanthus roseus*, *Chrysanthemum grandiflorum*, *Tecoma capensis*, *Calotropis gigantea*, *Duranta erecta*, *lantana camera*, *Euphoria heterophylla*, *Ricinus communis*, *Ixora chinensis*, *Croton tiglium*, *Amorpha fruticosa*, *Lawsonia inermis*, *Ziziphus oenopolia* and *Ficus macrocarpa* are also rather common in the campus.

Ground flora is comparatively sparse, but fairly rich in undistributed areas. Some of the common weeds like *Cardiospermum Helicabum*, *Sphagneticola trilobata*, *Schefflera actinophylla*, *lantana camera*, *Euphoria heterophylla*, *Ricinus communis* and *Laucaena leucocephala* are found to be predominant. Species such as *Adhatoda vasica*, *Dieffenbachia seguine*, *Alpinia zerumbet*, *Tradescantia spathaceae*, *Ambrosia artemisiifolia*, *Portulaca grandiflora*, *Hydrocotyle verticillata*, *Bryophyllum daigremontianum*, *Sphagneticola trilobata*, *Mentha spicata*, *Mercurialis perennis*, *Crinum asiaticum*, *Agalaonema commutatum*, *Asparagus officinalis*, *Costus spiralis*, *Carex paniculata* and *Maranta arundinacea* are some common herbs in the campus.

Certain common climbers found among the shrubs are *Cardiospermum Helicabum*, *Boungainvillea spectabilis*, *Epipremnum aureum*, *Basella alba* and *Allamanda cathartica*. This campus is rich in grass species like *Aristida adcensionis*, *Heteropogon contortus* and *Themeda trianda* along with *Agave Americana* L., *Asparagus racemosus*. Most of the species found are common in the campus, some of the species *Acacia mangium*, *Ravenala madgacariensis*, *Ixora finlaysoniana*, *Crossandra infundibuliformis* and *Bryophyllum daigremontianum* are some rare species. Number of above species decreased in number and a few face the danger of going extinct due to anthropogenic activities (regular clearing and construction activities). Hence in terms of conserving the available floral biodiversity, it is pertinent to set up a botanical garden within the campus and cultivate them to protect the ones that grow naturally on the grounds upon the vegetation maintenance.

Invasive species

The campus has 42 invasive species of which 6 species were weeds such as *Sphagneticola trilobata*, *Schefflera actinophylla*, *lantana camera*, *Euphoria heterophylla*, *Ricinus communis* and *Laucaena leucocephala*. The presence of invasive weeds is an indication of disturbances to the natural setting in the vegetated areas.

The alien / exotic species viz., *Chrysanthemum grandiflorum*, *Cardiospermum Helicabum* and *Tabernaemontana divaricate* were also found in the campus. The plantation on the campus includes *Allamanda cathartica*, *Hemigraphis alternata*, *Dieffenbachia seguine*, *Alpinia zerumbet*, *Ixora finlaysoniana*, *Agave americana*, *Cuphea hyssopifolia*, *Cycas revoluta*, *Bambusa vulgaris*, *Ravenala madgacariensis*, *Delonix regia*, *Schefflera actinophylla*, *Tradescantia spathaceae*, *Acalypha wilkesian*, *Codiaeum variegatum*, *Sesbania punica*, *Ficus microcarpa*, *Aegle marmelos*, *Roystonea regia*, *Senna siamea*, *Polyscias scutellaria*, *Lagerstroemia speciosa*, *Polyalthia longifolia*, *Catharanthus roseus*, *ficus benamina* and *Dypsis lutescens*

Some of the fruit yielding species such as *Manilkara zapota*, *Mangifera indica*, *Psidium guajava*, *Annona muricata*, *Cocos nucifera* and *Moringa oleifera* were also observed in the campus and some medicinal plants like *Moringa oleifera*, *Adhatoda vasica*, *Ecbolium viride*, *Pongamia pinnata* and *Forsythia viridissima* were also observed in the campus. *Bryophyllum daigremontianum*, a threatened invasive herb belonging to Cassulaceae were also conserved in the campus.

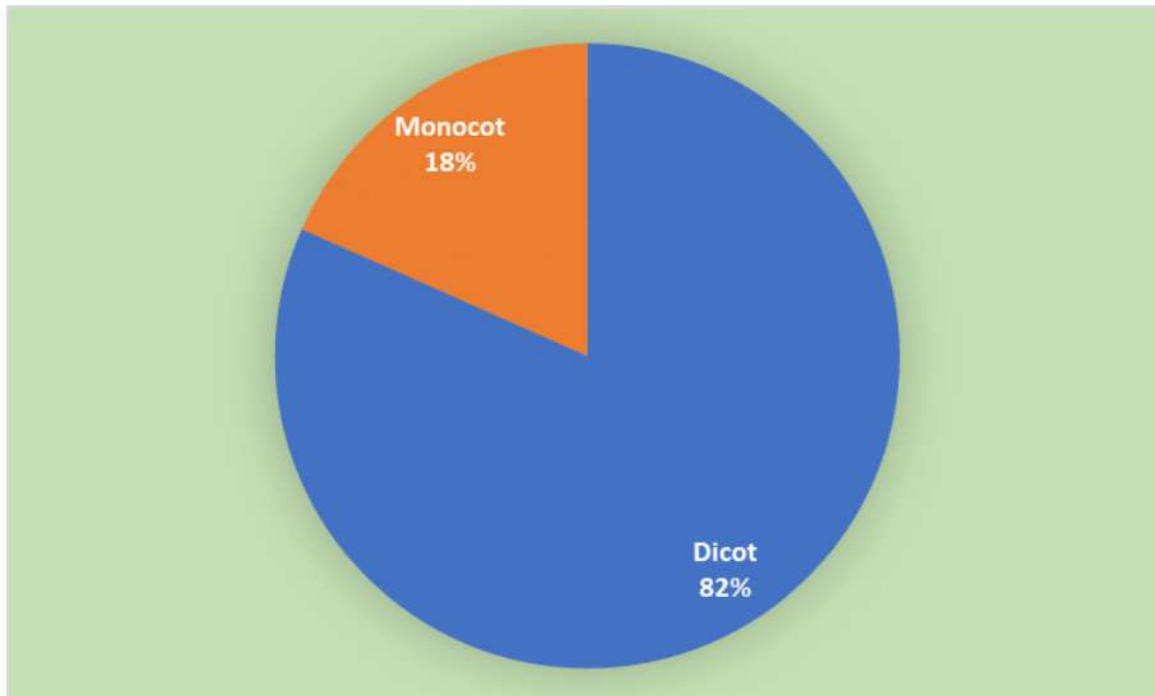


Chart 1. Systematic groups of the plants in the NASC campus

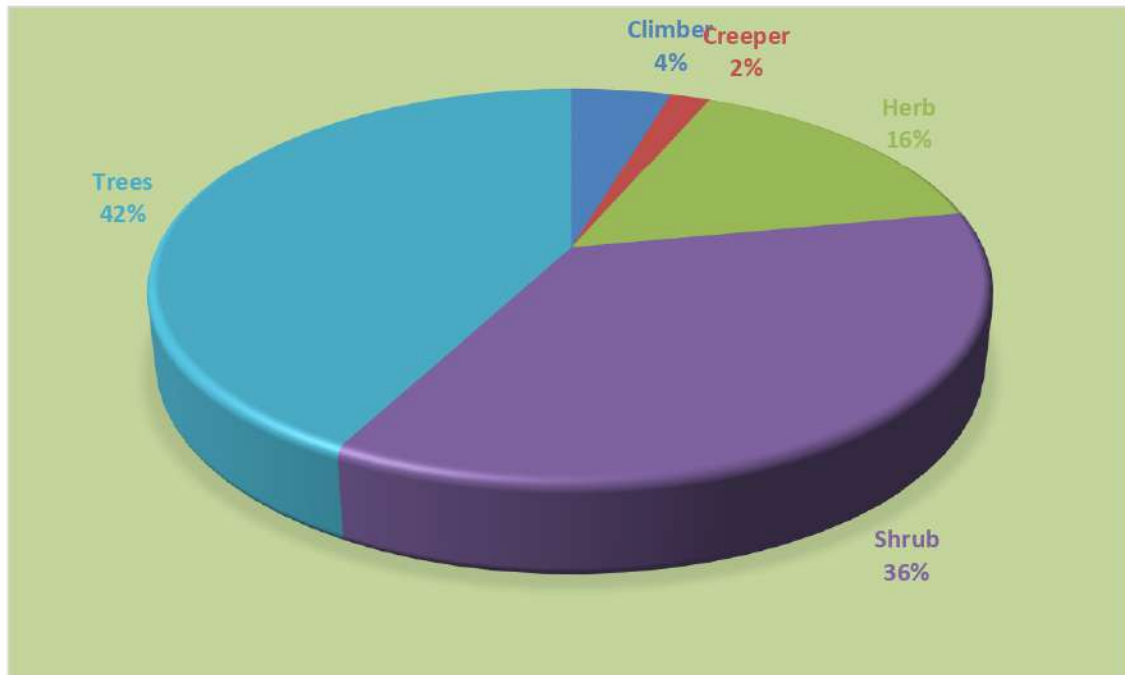


Chart 2. Analysis of habit-wise distribution of plant species in the campus area

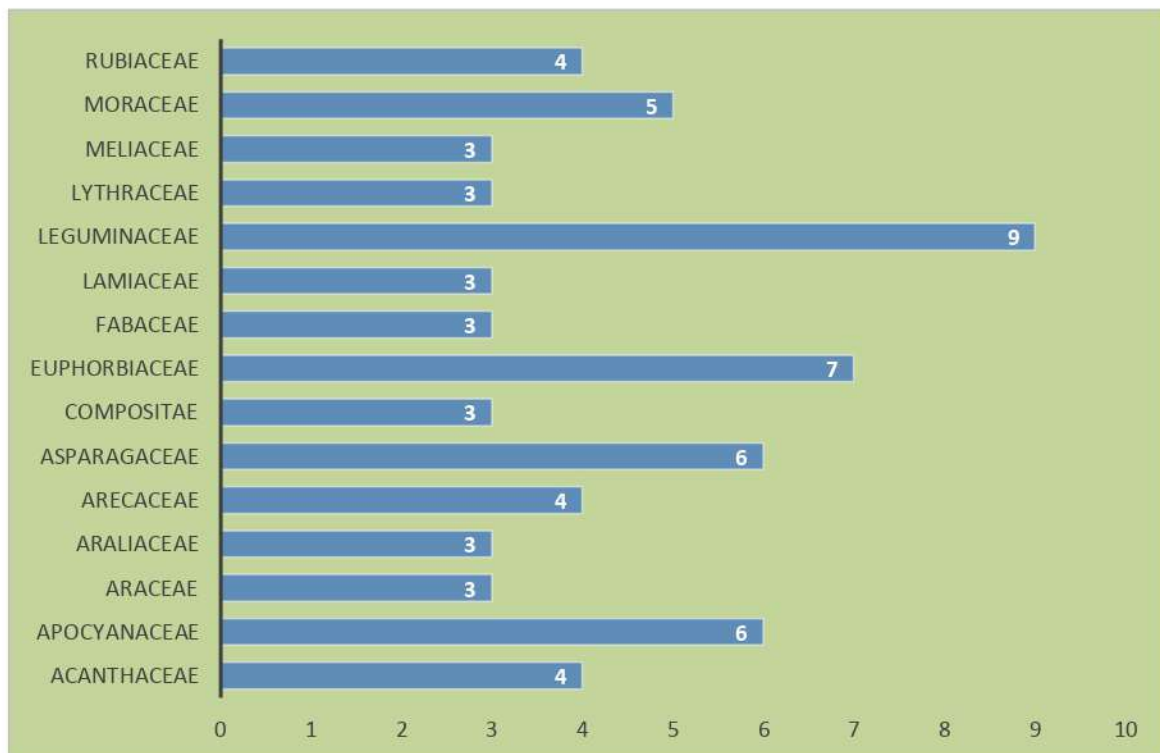


Chart 3. Plant families with higher number of species in the campus area

The biodiversity of NASC Campus comprises a sum of 112 species belonging to 109 genera under 51 families besides the lichens, mycoflora, pteridophytes and bryophytes. Among the documented higher plants, Dicots are dominating with 89 families followed by monocots with 20 families. Over all analysis revealed that trees were dominating flora (42%) followed by Shrubs, Herbs, Climbers and Creepers which accounts 36%, 16%, 4% and 2%, respectively. Among the documented dicots, Polypetalae formed a major proposition with 22 families, 44 genera and 44 species; Gamopetalae with 14 families, 28 genera and 29 species while Monochlamydeae with 6 families, 12 genera and 15 species. In monocots 14 families are spreading over 21 genera and 22 species.

Table 5. List of Flowering plants in the NASC Campus

S. No	Common name	Botanical name	Family
1.	Black wattle	<i>Acacia mangium</i>	Leguminosae
2.	Copper leaf	<i>Acalypha wilkesian</i>	Euphorbiaceae
3.	Bhaikar	<i>Adhatoda vasica</i>	Acanthaceae
4.	Bael tree	<i>Aegle marmelos</i>	Rutaceae
5.	Aglaonema aroid	<i>Agalaonema commutatum</i>	Araceae
6.	Common agapan	<i>Agapanthus praecox</i>	Amaryllidaceae
7.	Agave	<i>Agave americana</i>	Asparagaceae
8.	Garden sisal	<i>Agave vivipara</i>	Asparagaceae
9.	Golden-trumpet	<i>Allamanda cathartica</i>	Apocyanaceae
10.	Shellplant	<i>Alpinia zerumbet</i>	Zingiberaceae
11.	Annual ragweed	<i>Ambrosia artemisiifolia</i>	Compositae
12.	False indigo bush	<i>Amorpha fruticosa</i>	Fabaceae
13.	Soursop	<i>Annona muricata</i>	Annonaceae
14.	Common needle grass	<i>Aristida adensionis</i>	Poaceae
15.	Asparagus	<i>Asparagus officinalis</i>	Asparagaceae
16.	Neem tree	<i>Azadirachta indica</i>	Meliaceae
17.	Common bamboo	<i>Bambusa vulgaris</i>	Poaceae
18.	Indian spinach	<i>Basella alba</i>	Basellaceae
19.	Bauhinia	<i>Bauhinia blakeana</i>	Leguminaceae
20.	Shrubby birch	<i>Betula humilis</i>	Betulaceae
21.	Great Bougainvillea	<i>Boungainvillea spectabilis</i>	Nyctaginaceae
22.	Devil's backbone	<i>Bryophyllum daigremontianum</i>	Cassulaceae
23.	Red powder puff	<i>Calliandra haematocephala</i>	Fabaceae
24.	Giant milkweed	<i>Calotropis gigantea</i>	Apocynaceae
25.	Ballon vine	<i>Cardiospermum Helicabum</i>	Sapindaceae
26.	Greater tussock sedge	<i>Carex paniculata</i>	Cyperaceae

27.	Papaya	<i>Carica Papaya</i>	Caricaceae
28.	Periwinkle	<i>Catharanthus roseus</i>	Apocynaceae
29.	Chondro Mollika	<i>Chrysanthemum grandiflorum</i>	Compositae
30.	Veld grape	<i>Cissus quadrangularis</i>	Vitaceae
31.	Lemon	<i>citrus limon</i>	Rutaceae
32.	Coconut tree	<i>Cocos nucifera</i>	Arecaeae
33.	Variegated Croton	<i>Codiaeum variegatum</i>	Euphorbiaceae
34.	Geiger tree	<i>Cordia sebestena</i>	Boraginaceae
35.	Insulin plant	<i>Costus spiralis</i>	Costaceae
36.	Poison bulb	<i>Crinum asiaticum</i>	Amaryllidaceae
37.	Crossandra white	<i>Crossandra infundibuliformis</i>	Acanthaceae
38.	Purging croton	<i>Croton tiglium</i>	Euphorbiaceae
39.	Mexican Heather	<i>Cuphea hyssopifolia</i>	Lythraceae
40.	King sago	<i>Cycas revoluta</i>	Cycadaceae
41.	Indian rosewood	<i>Dalbergia sissoo</i>	Leguminosae
42.	Gulmohar	<i>Delonix regia</i>	leguminosae
43.	Dumb cane	<i>Dieffenbachia seguine</i>	Araceae
44.	Snake plant	<i>Dracaena trifasciata</i>	Asparagaceae
45.	Golden dewdrops	<i>Duranta erecta</i>	Verbenaceae
46.	Areca palm	<i>Dypsis lutescens</i>	Arecaceae
47.	Blue fox tail	<i>Ecbolium viride</i>	Acanthaceae
48.	Golden pothos	<i>Epipremnum aureum</i>	Araceae
49.	Candelabra cactus	<i>Euphorbia lactea</i>	Euphorbiaceae
50.	Japanese poinsettia	<i>Euphoria heterophylla</i>	Euphorbiaceae
51.	Indian banyan	<i>Ficus benghalensis</i>	Moraceae
52.	Weeping fig	<i>ficus benjamina</i>	Moraceae
53.	Chinese banyan	<i>Ficus microcarpa</i>	Moraceae
54.	Cluster fig	<i>Ficus racemosa</i>	Moraceae
55.	Peepal tree	<i>Ficus religiosa</i>	Moraceae
56.	Greenstem forsythia	<i>Forsythia viridissima</i>	Oleaceae
57.	Malay bush beech	<i>Gmelina arborea</i>	Lamiaceae
58.	Redhead	<i>Hamelia patens</i>	Rubiaceae
59.	Redivy	<i>Hemigraphis alternata</i>	Acanthaceae
60.	Black spear grass	<i>Heteropogon contortus</i>	Poaceae
61.	Hawaiian hibiscus	<i>Hibiscus rosa-sinensis</i>	Malvaceae
62.	Pennywort	<i>Hydrocotyle verticillata</i>	Araliaceae
63.	Chinese ixora	<i>Ixora chinensis</i>	Rubiaceae
64.	White jungle flame	<i>Ixora finlaysoniana</i>	Rubiaceae
65.	Waukegan juniper	<i>Juniperus horizontalis</i>	Cupressaceae
66.	Queen's crape-myrtle	<i>Lagerstroemia speciosa</i>	Lythraceae
67.	Lantana	<i>lantana camera</i>	Verbenaceae
68.	Ipil-ipil	<i>Laucaena leucocephala</i>	Leguminosae
69.	Bay Laurel	<i>Laurus nobilis</i>	Lauraceae
70.	Egyptian privet	<i>Lawsonia inermis</i>	Lythraceae

71.	Winter honeysuckle	<i>Lonicera fragrantissima</i>	Caprifoliaceae
72.	Mango	<i>Mangifera indica</i>	Anacardiaceae
73.	Sapodilla	<i>Manilkara zapota</i>	Sapotaceae
74.	Arrowroot	<i>Maranta arundinacea</i>	Marantaceae
75.	Persian lilac	<i>Melia azedarach</i>	Meliaceae
76.	Spearmint	<i>Mentha spicata</i>	Lamiaceae
77.	Dog mercury	<i>Mercurialis perennis</i>	Euphorbiaceae
78.	Four -o'clock	<i>Mirabilis jalapa</i>	Nyctaginaceae
79.	Moringa	<i>Moringa oleifera</i>	Moringaceae
80.	Banana	<i>Musa paradisaca</i>	Musaceae
81.	Buddha's lamp	<i>Mussaenda philippica</i>	Rubiaceae
82.	Horsebush	<i>Peltophorum dubium</i>	Leguminosae
83.	Frangipani	<i>Plumeria obtusa</i>	Apocynaceae
84.	False asoka tree	<i>Polyalthia longifolia</i>	Annonaceae
85.	Dinnerplate-aralia	<i>Polyscias scutellaria</i>	Araliaceae
86.	Indian Beech	<i>Pongamia pinnata</i>	Leguminosae
87.	Moss-rose	<i>Portulaca grandiflora</i>	Portulacaceae
88.	Common guava	<i>Psidium guajava</i>	Myrtaceae
89.	Common hop tree	<i>Ptelea trifoliata</i>	Rutaceae
90.	Four leaf devil plant	<i>Rauwolfia tetraphylla</i>	Apocynaceae
91.	Travellers palm	<i>Ravenala madgacariensis</i>	Strelitziaceae
92.	Bregu	<i>Rhapis excelsa</i>	Arecaceae
93.	Castor-oil-plant	<i>Ricinus communis</i>	Euphorbiaceae
94.	Cuban royal palm	<i>Roystonea regia</i>	Arecaceae
95.	Ashoka tree	<i>saraca asoca</i>	Leguminosae
96.	Umbrella tree	<i>Schefflera actinophylla</i>	Araliaceae
97.	Ironwood Cassia	<i>Senna siamea</i>	Leguminosae
98.	Scarlet Locust flowering tree	<i>Sesbania punica</i>	Fabaceae
99.	Wedelia	<i>Sphagneticola trilobata</i>	Compositae
100.	Cuban mahogany	<i>Swietenia mahagoni</i>	Meliaceae
101.	Jambolan	<i>Syzygium cumini</i>	Myrtaceae
102.	Pink poui	<i>Tabebuia rosea</i>	Bignoniaceae
103.	Crape jasmine	<i>Tabernaemontana divaricata</i>	Apocynaceae
104.	Cape honeysuckle	<i>Tecoma capensis</i>	Bignoniaceae
105.	Bankok teak	<i>Tectona grandis</i>	Lamiaceae
106.	Tropical almomd	<i>Terminalia catappa</i>	Combretaceae
107.	Beleric myrobalan	<i>Terminalis bellirica</i>	Combretaceae
108.	Kangaroo grass	<i>Themeda trianda</i>	Poaceae
109.	Portia tree	<i>Thespesia populnea</i>	Malvaceae
110.	Boat lily	<i>Tradescantia spathaceae</i>	Commelinaceae
111.	Ramgoat dashalong	<i>Turnera ulmifolia</i>	Passifloraceae
112.	Jharibu	<i>Ziziphus oenopolia</i>	Rhamnaceae



Acacia mangium



Acalypha wilkesiana



Aegle marmelos



Alternanthera Loropetalum



Bougainvillea spectabilis



Carica Papaya



Catharanthus roseus



Citrus hystrix



Cycas revoluta



Delonix regia



Dracaena trifasciata



Dypsis lutescens



Hemigraphis alternata



lantana camera



Manilkara zapota



Forsythia viridissima



Ficus religiosa



Epipremnum aureum



Ravenala madagascariensis



Hydrocotyle verticillata



Lagerstroemia speciosa



Tectona grandis



Sphagneticola trilobata



Rauwolfia tetraphylla,



Musa paradisiaca



Grevillea robusta



Heliconia psittacorum



Ixora finlaysoniana



Melia azedarach



saraca asoca



Dieffenbachia seguine



Carex paniculata



Ricinus communis



Plectranthus amboinicus



Polyscias scutellaria



Ficus benjamina

13.3.1.2. Lichen diversity in the NASC Campus

Lichens are one of the most fascinating symbiotic organisms found worldwide. The lichens species are ubiquitous and common inhabitants of the bark of the tree, rock surface, soil etc. They are a lower group of plants coming under non-flowering plants that live in a variety of substrates under a wide range of environmental conditions with or without causing harm to the hosts. Ecologically, lichen plays important roles in soil formation; re-establishes life on earth; fixes atmospheric nitrogen; plant's health, ecology distribution, and in the formation of organic matter of habitat which in turn benefitting mosses in nutrient availability. A unique synergetic association between a fungal and an algal species results in lichens and occupied in plant kingdom. In this relationship both the organisms are mutually benefited. The algal partner may be cyanobacteria or the blue green algae and this is responsible for the process of photosynthesis. The algae thus provide food or nutrition for the fungi too. The fungal partner in turn provides space and protection for the algae. The lichen is an autotrophic organism in the sense that they can produce their own food by the process of photosynthesis. Even though the lichen is made up of two different organisms, the characteristics of the lichen are entirely different from the original characteristics of the algal and the fungal partner. Lichens are classified as micro lichens and macro lichens in which the microlichens cover the substrate on which they grow in the form of a crust whereas macro lichens grow in the form of a bush or a leaf like structure. The major forms of lichens are a) Foliose lichens exhibit a flat leaf like thallus, b) Fruticose lichens exhibit erect, pendulous and bushy thallus c) Squamulose lichens exhibit thallus with minute, scale like squamules and d) Crustose lichens exhibit flat crust shaped thallus.

Lichen diversity recorded in the NASC campus showed a total of 18 different lichens species representing 14 genera and 10 families. The two families Physciaceae and Parmeliaceae accounted for 23% of total available lichen diversity followed by Pertusariaceae (11%), and the remaining families such as Arthoniaceae, Bacidiaceae, Biatoraceae, Cladoniaceae, Pyrenulaceae, Ramalinaceae and Teloschistaceae were accounted for 5%. The observation on lichen diversity revealed 5 species of Crustose growth forms, 10 species of Foliose growth forms and 2 species of fruticose growth forms.

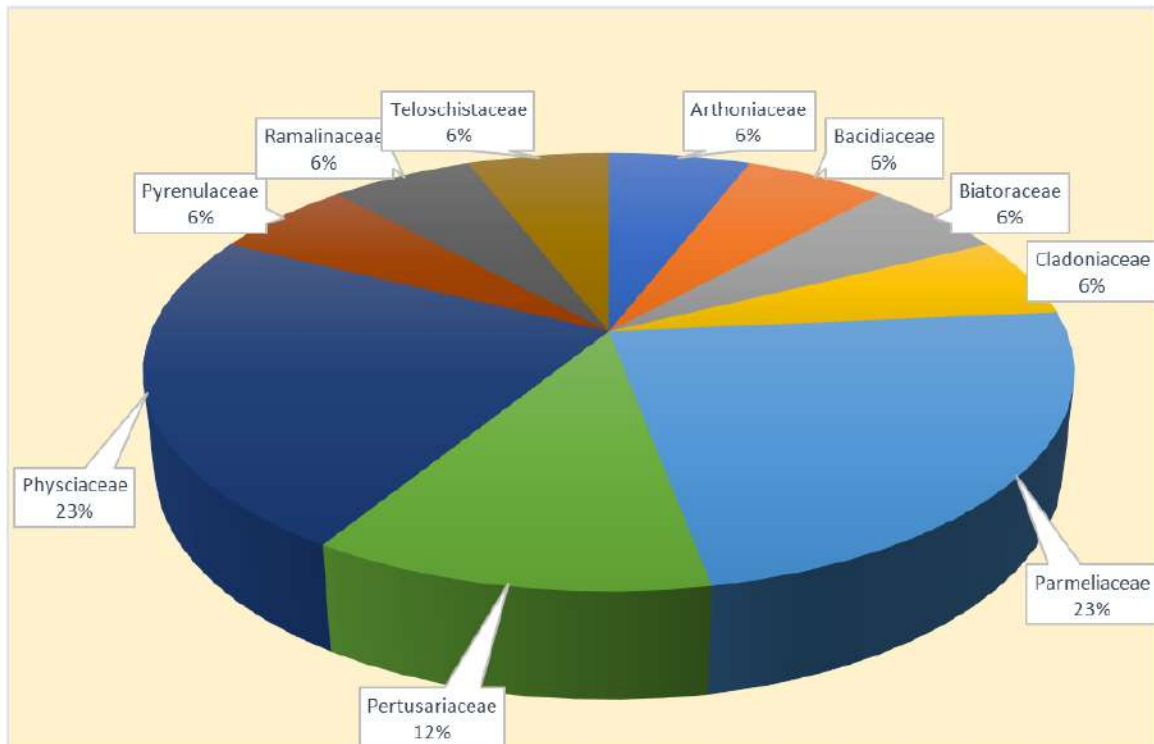


Chart 4. Diversity of Lichen species of NCAS Campus

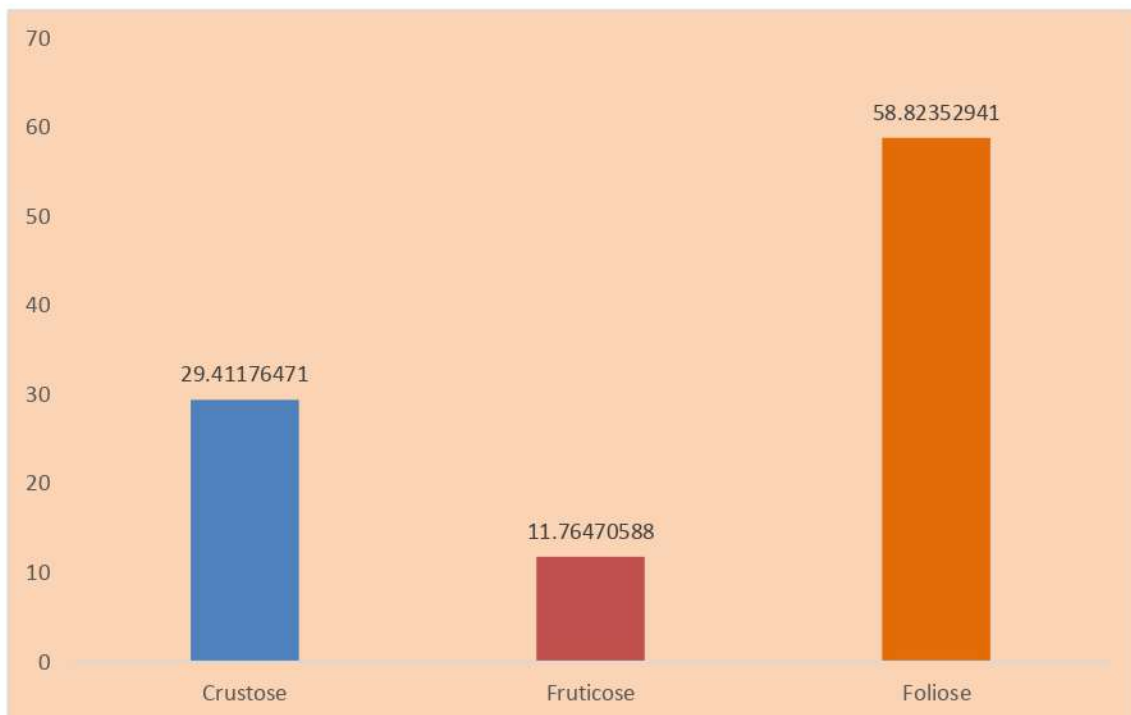


Chart 5. Diversity of Lichen growth forms of NASC Campus

Table 6. Lichen diversity of the NASC campus with respect to family, substratum and growth forms in genus and family wise classification

S.No	Lichen diversity of the NASC campus	Family	Growth forms
1.	<i>Aloplaca sipeana</i>	Teloschistaceae	Crustose
2.	<i>Amalina celsatri</i>	Ramalinaceae	Fruticose
3.	<i>Anthracotheceium assamiense</i>	Pyrenulaceae	Crustose
4.	<i>Arthonia recedens</i>	Arthoniaceae	Crustose
5.	<i>Bacidia fusconigrescens var. oleosa</i>	Bacidiaceae	Crustose
6.	<i>Cercopitheciidae</i>	Parmeliaceae	Foliose
7.	<i>Cladonia macilenta</i>	Cladoniaceae	Fruticose
8.	<i>Diplotoma proximatum</i>	Physciaceae	Foliose
9.	<i>Heterodermia angustiloba</i>	Physciaceae	Foliose
10.	<i>Heterodermia bory</i>	Physciaceae	Foliose
11.	<i>Heterodermia dissecta</i>	Physciaceae	Foliose
12.	<i>Parmotrema crinitum</i>	Parmeliaceae	Foliose
13.	<i>Pertusaria granulata</i>	Pertusariaceae	Foliose
14.	<i>Pertusaria pseudococcodes</i>	Pertusariaceae	Foliose
15.	<i>Phyllopsora corallina</i>	Biatoraceae	Crustose
16.	<i>Rimelia reticulata</i>	Parmeliaceae	Foliose
17.	<i>Usnea stigmatoides</i>	Parmeliaceae	Foliose

13.3.1.3. Algal diversity in the NASC campus

Chlamydomonas, *Scytonema*, *Oscillatoria*, *Oedogonium*, *Spirogyra*, *Volvox*, *Microcystis* and *Cladophora spp.* belonging to the class of Cyanophyceae, Chlorophyceae and Bacillariophyceae are the predominant species found in the campus. The families Chlorellaceae, Closteriaceae, Desmidiaceae, Radiococcaceae, Ulotrichaceae, Uronemataceae and Oedogoniaceae were represented by single genus and species. Chlorophyceae plays an important role in both terrestrial and aquatic ecosystem as most of the members are found to be ecologically important. The highest diversity of Chlorophyceae indicated relatively good health of atmosphere. The presence of these algal species in abundance can be concluded that the NASC Campus ecosystem has high amount of organic nutrients in soil and rock. Generally, occurrence of abundant algal flora at a place indicates the availability of abundant nutrients along with conducive favourable environmental conditions.

13.3.1.4. Mushrooms diversity in the NASC Campus

Mushrooms, edible basidiomycete, represent white rot fungi which contained higher amount of proteins, rich in minerals with medicinal properties. At present three mushroom varieties (white mushroom, the paddy-straw mushroom and the oyster mushroom) are being cultivated in India. These are most popular, economically sound to grow and is extensively cultivated throughout the world. Due to moderate temperature requirement for luxuriant growth, its cultivation are restricted to the cool climatic zones and during winter months in the plains of Telangana region. Mushroom growth yield is influenced by the type of compost, spawn, temperature, percentage of moisture and also affected by the pests and disease-causing agents. There has been extensive discussed in recent years, as far as the production of fungal protein from domestic, agricultural and industrial wastes. Since mushrooms have a very short life

span, it should reach to consumers within a short time or immediately canned. Mushroom growth is determined by means of carbohydrate content in the substrates like paddy straw, sugarcane molasses, saw wood dust and other plant waste materials.

The NASC campus has various mushroom types covering poisonous, edible and medicinal varieties such as white mushroom (*Agaricus bisporus* and *A. laccata*), the paddy-straw mushroom (*Volvariella volvacea*), oyster mushroom (*Pleurotus sajor-caju* and *P. florida*), button mushroom (*Omphalotus olearius*) and other mushroom types such as *Amauroderma conjunctum*, *Amylosporus campbellii*, *Daldinia concentrica*, *Ganoderma applanatum*, *Phallus atrovolvatus*, *Laccaria laccata*, *Termitomyces fuliginosus*, *Pycnoporus cinnabarinus* and *Volvariella bombycina*.

13.3.2. Fauna Diversity in the NASC campus

13.3.2.1. Birds Diversity in the NASC campus

The observations on fauna diversity indicated that the NASC campus has a large number of living as well as visiting animals, birds, reptiles and insects including termites. A total number of 13 birds belonging to the 7 families were recorded. Among the families, highest number of species were recorded under the family Passeriformes (7 genera). Out of 13 bird species recorded 3 species were found to be migrant birds such as Greater flameback, Crimson-backed sunbird and Indian black-lored tit. These birds migrate during winter and summer season in search of favourable environment and availability of food resources.



These birds migrate during winter and summer season in search of favourable environment and availability of food resources.

Table 7. Birds Diversity in the NASC campus

S.No	Common Name	Scientific Name
1.	Greater flameback	<i>Chrysocolaptes guttacristatus</i>
2.	Indian black-lored tit	<i>Machlolophus aplonotus</i>
3.	Indian blackbird	<i>Turdus simillimus</i>
4.	Crimson-backed sunbird	<i>Crimson-backed sunbird</i>
5.	Indian peafowl	<i>Pavo cristatus</i>
6.	Indian robin	<i>Copsychus fulicatus</i>
7.	Zitting cisticola	<i>Cisticola juncidis</i>
8.	Greater coucal	<i>Greater coucal</i>
9.	House crow	<i>Corvus splendens</i>
10.	Rock dove	<i>Columba livia</i>
11.	Black drongo	<i>Dicrurus macrocercus</i>
12.	Common kingfisher	<i>Alcedo atthis</i>
13	Rose-ringed parakeet	<i>Psittacula krameri</i>

Table 8. Total number of visiting birds in the NASC campus

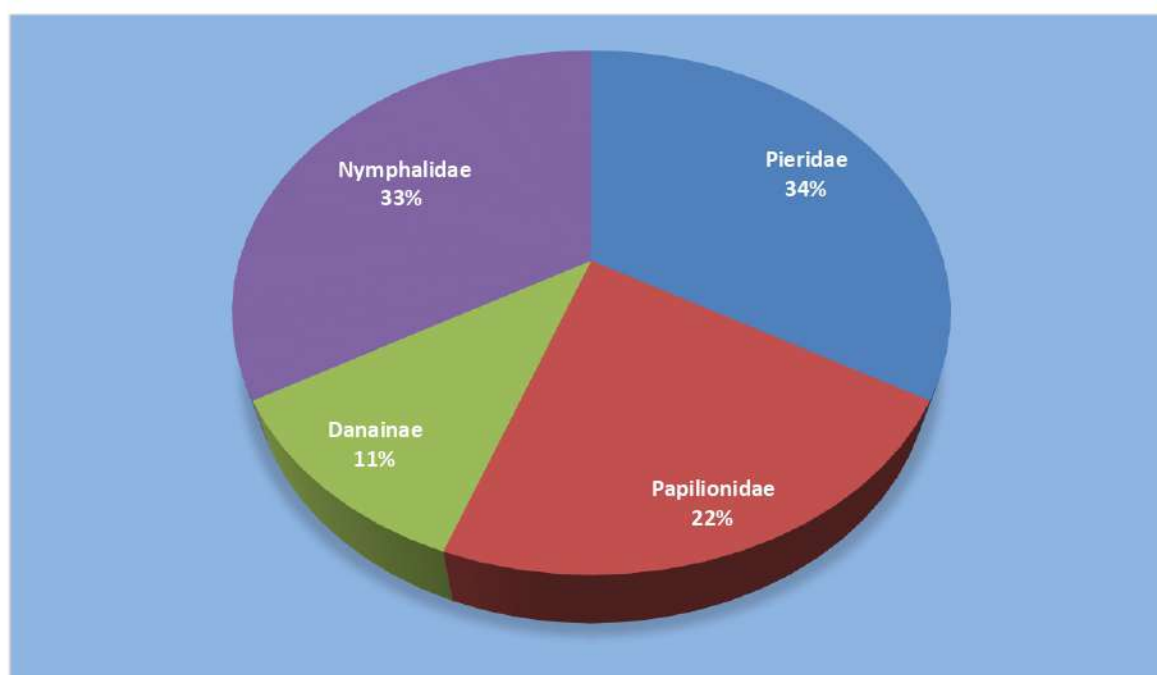
S.No	Common Name	Scientific Name
1.	Greater flameback	<i>Chrysocolaptes guttacristatus</i>
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3.	Indian black-lored tit	<i>Machlolophus aplonotus</i>

13.3.2.2. Butterflies diversity in the NASC campus

The NASC campus has 4 family level diversities such as Papilionidae, Pieridae, Nymphalidae and Danainae in which butterflies such as *Cepora nerissa*, *Catopsilia pyranthe*, *Belenois aurota*, *Papilio polytes*, *Graphium sarpedon*, *Danaus genutia*, *Charaxes solon*, *Junonia hierta* and *Ypthima baldus* are commonly found.

Table 9. List of Butterflies recorded in the NASC campus

S.No.	Common Name	Scientific Name	Family
1.	Common gull	<i>Cepora nerissa</i>	Pieridae
2.	Mottled emigrant	<i>Catopsilia pyranthe</i>	Pieridae
3.	Pioneer	<i>Belenois aurota</i>	Pieridae
4.	Common mormon	<i>Papilio polytes</i>	Papilionidae
5.	Common bluebottle	<i>Graphium sarpedon</i>	Papilionidae
6.	Striped tiger	<i>Danaus genutia</i>	Danainae
7.	Black raja	<i>Charaxes solon</i>	Nymphalidae
8.	Yellow pansy	<i>Junonia hierta</i>	Nymphalidae
9.	Common five ring	<i>Ypthima baldus</i>	Nymphalidae

Chart 6. Butterfly Diversity in the NASC campus

13.3.2. 3. Mammals diversity in the NASC campus

Mammals, a group of vertebrate animals (class: Mammalia), characterized by the presence of mammary glands (where females produce milk for feeding/nursing their young), a neocortex (a region of brain), fur or hair and three middle ear bones. These characteristic features differentiate them from reptiles and birds. Observation on diversity of mammals in the NASC campus indicated that around 10 Mammal species are commonly distributed. The commonly found mammals are Indian Long Tailed Field Mouse, Dog, Goat, Three striped Palm squirrel, Malabar Giant squirrel, Cows, Buffalo Monkeys, Cats and Horses.

Table 10. List of Mammals diversity in the NASC campus

S.No.	Common Name	Scientific Name
1.	Indian Long Tailed Field Mouse	<i>Apodemus sylvaticus</i>
2.	Dog	<i>Canis familiaris</i>
3.	Goat	<i>Capra hircus</i>
4.	Three striped Palm squirrel	<i>Funambulus palmarum</i>
5.	Malabar Giant squirrel	<i>Ratufa indica</i>
6.	cows	<i>Bos tarus</i>
7.	Buffalo	<i>Bubalus bubalis</i>
8.	monkeys	<i>Cercopithecidae</i>
9.	cats	<i>Felis catus</i>
10.	Horses	<i>Equus caballus</i>

13.3.2.4. Amphibians diversity in the NASC campus

Amphibians (class: Amphibia) are ectothermic, tetrapod vertebrates. All living amphibians represent the group Lissamphibia and they inhabit a wide variety of habitats. Most of them living within terrestrial, fossorial, arboreal or freshwater aquatic ecosystems. Amphibians naturally start out as larvae living in water, but some species bypass this by developed behavioural adaptations. Observation made on diversity of Amphibians in the NASC indicated that around 7 species are Amphibians are commonly distributed. The commonly found amphibians are listed.

Generally amphibians undergo metamorphosis from larva with gills to air-breathing adult with lungs. Skin of the Amphibians served as a secondary respiratory organ while very few terrestrial salamanders and frogs lack lungs and they rely entirely on their skin for respiration. With their complex reproductive needs and permeable skins, amphibians are often ecological indicators. In recent decades, there has been a drastic decline in populations of many amphibian species around the globe.

Historically, amphibians evolved in the Devonian period from sarcopterygian fish with lungs and bony-limbed fins, which were helpful them to adapt to dry land conditions. Their spread was higher and predominant during Carboniferous and Permian periods and they were later displaced by reptiles and other vertebrates. Over a period, amphibians shrank in size and their diversity decreased drastically, leaving only the modern subclass Lissamphibia. Modern amphibian orders include Anura (the frogs), Urodela (the salamanders) and Apoda (the caecilians). Number of known amphibian species is nearly 90% are frogs. Observation made in the NASC Campus on diversity

of Amphibians revealed that around 7 species of Amphibians are commonly disseminated. The commonly found amphibians are listed hereunder.

13.3.2.5. Grasshopper diversity in the NASC Campus

Grasshoppers, a group of insects belonging to the suborder Caelifera and they are probably most ancient living group of chewing herbivorous insects. They are typically ground-dwelling insects with powerful hind legs which allow them to escape from threats by leaping dynamically. As a hemimetabolous insects, they do not undergo complete cycle of metamorphosis. In other word, they hatch from an egg into a nymph or "hopper" which undergoes five moults, to become identical to that of an adult. Grasshoppers hear through the tympanal organ which can be found in the first segment of the abdomen attached to the thorax; its sense of vision is compound eyes. Under certain environmental conditions, some grasshopper species at high population densities can change colour and behaviour besides form swarms. Grasshoppers are plant-eaters; few species at times become as a serious pests of cereals, vegetables and pasture, especially when they swarm to destroy the crops over huge contiguous areas. Surveillance audit at NASC on diversity of Grasshoppers demonstrated that 6 species are Amphibians are commonly distributed which includes *Eyprepocnemis alacris*, *Cyrtacanthacris tartarica*, *Crucinotacris decisa*, *Aulacobothrus luteipes*, *Acrotylus humbertianus* and *Sathrophyllia rugosa*

13.3.2.6. Termites Diversity in the NASC Campus

Termites are most successful groups of insects on earth, colonising most landmasses. Their colonies range in size from a few hundred individuals to enormous societies with several million individuals. Eusocial insects, commonly Termites, are taxonomically ranking as infraorder. Isoptera, or alternatively as epifamily Termitoidae, within the order Blattodea (along with cockroaches). Although Termites are habitually known as "white ants", they are not ants and they are not closely related with them. Earlier, Termites were classified as a separate order from cockroaches. Recent phylogenetic studies revealed that they evolved from cockroaches, as they are deeply nested within the group and the sister group found to wood eating cockroaches of the genus *Cryptocercus*. More recent estimates suggest that they have originated during the Late Jurassic period evidenced with the first fossil records in the Early Cretaceous. Termites mostly nourish on cellulose based dead plant material (wood, leaf litter), soil and animal dung. Three species of Termites (*Odontotermes anamallensis*, *Trivitermes fletcheri* and *Nasutitermes indicola*) recorded during on-site Green Campus audit at NASC Campus and they are belonging to the Genera *Odontotermes*, *Trivitermes* and *Nasutitermes*.

13.4. An account of more Oxygen releasing and Carbon dioxide assimilating plants in the NASC Campus

There are some plants which are being considered highly efficient in oxygen releasing and carbon dioxide assimilating (Carbon sinks) which in turn reflected the quality of the green campus. If more oxygen is made available in the campus naturally, the stakeholders may be free from various cardiovascular and pulmonary problems and breathing troubles. *Sansevieria zeylanica* (commonly known as snake plant or the mother-in-law's tongue plant) and Gerbera Daisy (*Gerbera jamesonii*) plants are unique for oxygen release during night time and they are able to purify the atmospheric air in

terms of removal of toxic gases. Although options are available to enhance the level of oxygen by reducing CO₂ with the aid of oxygenators and air purifiers, there are certain alternatives to improve the air quality which is beneficial for both body and mind. Green campus audit at NASC campus revealed that the campus is well distributed with more oxygen releasing and CO₂ assimilating plants such as *Hibiscus rosa-sinensis* and *Polyalthia longifolia* trees. There are 25 plant species which are able to create an eco-friendly atmosphere in terms of reducing erosion, moderating the climate, improving air quality and supporting wildlife besides they are economically important and valued for different medicinal aspects.

The oxygen releasing plants such as *Azadirachta indica*, *Dracaena trifasciata*, *Dyopsis lutescens*, *Ficus benghalensis*, *Ptelea trifoliata*, *Saraca asoca*, *Syzygium cumini* and *Tectona grandis* were observed from NASC Campus. The ornamental plants such as *Catharanthus roseus*, *Dyopsis lutescens*, *Polyalthia longifolia*, *Ficus benjamina* and *Saraca asoca* are made available. In addition, medicinal plants such as *Adhatoda vasica*, *Ecbolium viride*, *Forsythia viridissima* and *Moringa oleifera* are available in the campus.

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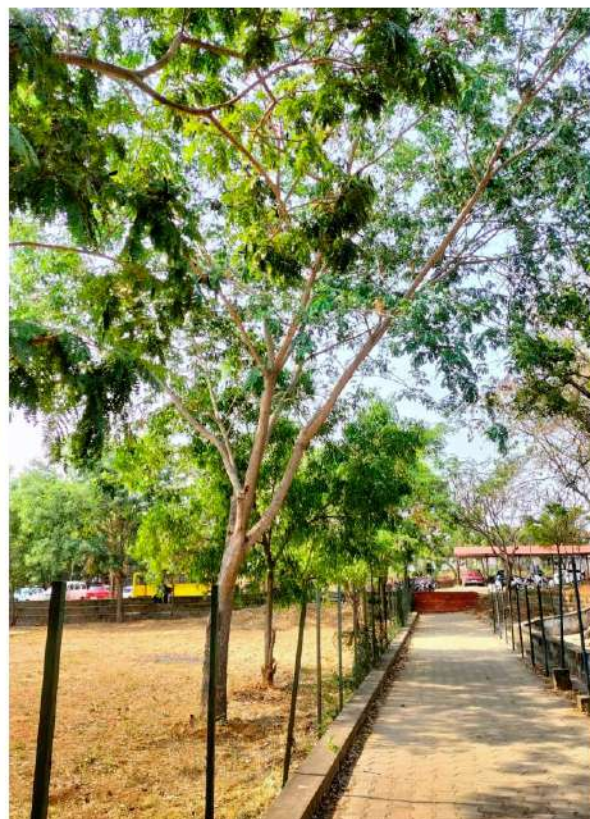
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Oxygen releasing and Carbon dioxide assimilating plants in the NASC Campus

Table 12. List of Oxygen releasing and Carbon dioxide assimilating, Ornamental / Medicinal plants in the NASC Campus

S. No	Plant Name (English)	Scientific Name	Grouping / Nature	Characteristic Features of the plant
1.	Black wattle	<i>Acacia mangium</i>	Dicot	Pulp and Paper
2.	Bhaikar	<i>Adhatoda vasica</i>	Dicot	Medicinal
3.	soursop	<i>Annona muricata</i>	Dicot	Fruit yielding
4.	Neem tree	<i>Azadirachta indica</i>	Dicot	O2 releasing
5.	Periwinkle	<i>Catharanthus roseus</i>	Dicot	Ornamental/Medicinal
6.	coconut tree	<i>Cocos nucifera</i>	Monocot	Fruit yielding
7.	Snake plant	<i>Dracaena trifasciata</i>	Monocot	O2 releasing
8.	Areca palm	<i>Dypsis lutescens</i>	Monocot	Ornamental/O2 releasing
9.	Blue fox tail	<i>Ecbolium viride</i>	Dicot	Medicinal
10.	Indian banyan	<i>Ficus benghalensis</i>	Dicot	O2 releasing
11.	Weeping fig	<i>ficus benjamina</i>	Dicot	Ornamental/O2 releasing
12.	Peepal tree	<i>Ficus religiosa</i>	Dicot	O2 releasing
13.	Greenstem forsythia	<i>Forsythia viridissima</i>	Dicot	Medicinal
14.	Hawaiian hibiscus	<i>Hibiscus rosa-sinensis</i>	Dicot	CO2 assimilation
15.	Mango	<i>Mangifera indica</i>	Dicot	Fruit yielding
16.	Sapodilla	<i>Manilkara zapota</i>	Dicot	Fruit yielding
17.	Moringa	<i>Moringa oleifera</i>	Dicot	Medicinal
18.	False asoka tree	<i>Polyalthia longifolia</i>	Dicot	Ornamental/ CO2 assimilation
19.	Indian Beech	<i>Pongamia pinnata</i>	Dicot	Medicinal
20.	Common guava	<i>Psidium guajava</i>	Dicot	Fruit yielding
21.	Common hop tree	<i>Ptelea trifoliata</i>	Dicot	O2 releasing
22.	Four leaf devil plant	<i>Rauwolfia tetraphylla</i>	Dicot	Endangered
23.	Ashoka tree	<i>saraca asoca</i>	Dicot	O2 releasing Ornamental/Medicinal
24.	Jambolan	<i>Syzygium cumini</i>	Dicot	O2 releasing
25.	Bankok teak	<i>Tectona grandis</i>	Dicot	O2 releasing

13.5. Lawns, Trees, Herbs, Shrubs, Climbers and Lianas in the NASC Campus



Lawns are gazing features of unutilized land made to cover the soil with green grass for the ambience of the place to have a greenish look. 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.

The advantage of lawn is that it prevents the unintended weeds growth in the unutilized landscape areas. Trees that are native to land with medicinal value, ethnicity and environmental value add an advantage to green building. Purpose of trees is to provide shade, atmospheric CO₂ sequestration and supply of oxygen that serves the purpose of a green campus. Herbs are small plants with medicinal values and shrubs are small plants with thick stems and can hold soil to some extent than the herbs and serve the purpose of soil erosion. Climbers can grow with the support of wall structures and the climbers can enhance the wall value with greeneries.

The NASC campus has a huge number of trees, herbal plants, bushes, climbers, lianas, twiners and lawns. It is further observed that all the plants are growing profusely and showing healthier free from pests and diseases attack.

13.6. Establishment of different Gardens in the NASC Campus

S. No.	Common Name	Scientific Name	Uses
1	Aashoo	<i>Melastoma indiarum</i>	For asthma, bronchitis, piles
2	Badam	<i>Prunus dulcis</i>	To lower blood sugar levels, blood pressure
3	Banana	<i>Musa sapientum</i>	For Anemia, blood pressure, nerve problem
4	Chitrak	<i>Cymbopogon nardus</i>	As a mild laxative, in anemias
5	Okra/Badi	<i>Solanum melongena</i>	Antibioactive effects, reduce blood pressure
6	Pharali	<i>Zingiber officinale</i>	As a stimulant, anti-nausea
7	Erukani Chedi	<i>Calotropis gigantea</i>	For leucoderma, warts, psoriasis, asthma
8	Guaia	<i>Pavonia latifolia</i>	For headaches, anti-dermatitis
9	Henna	<i>Lawsonia inermis</i>	For leg, eye, skin diseases, Arthritis, Hair disorders
10	Karpooorvali	<i>Abrothamnus ambovatus</i>	Prevention from cold, nasal congestion
11	Kantrajal	<i>Dalium sanctum</i>	Antimal, reduces cholesterol
12	Kantrajal	<i>Murraya koenigii</i>	In herb oil, anti-diabetic
13	Kantrajal	<i>Aloe vera</i>	For menstrual disorders, skin diseases
14	Kanchanani	<i>Abrus precatorius</i>	Promote hair growth, for fever
15	Lemon Grass	<i>Cymbopogon citratus</i>	Anti oxidant, anti fungal
16	Mango	<i>Mangifera indica</i>	For brain activation, to cure coronary heart diseases
17	Mariji	<i>Eclipta prostrata</i>	In herb oil, for nervous disorders
18	Naraj	<i>Syzygium cumini</i>	Antianginal, blood purifier
19	Neem	<i>Azadirachta indica</i>	Antibiotic, insecticide, Pesticide
20	Nellikai	<i>Physalis peruviana</i>	For asthma, strengthen heart
21	Nihakalyani	<i>Coprahantus rostrata</i>	For Cancer, Leukemia
22	Papaya	<i>Carica papaya</i>	Anticancer, bone health
23	Pharali	<i>Cassia siamea</i>	For osteoporosis, gastric ulcers
24	Sengul Poo	<i>Clitoria ternatea</i>	Anticancer, ornamental
25	Veniver	<i>Vanilla zizanioides</i>	Deacidification, gastritis, skin diseases
26	Vilvam	<i>Acylo nardus</i>	Antianginal, Anti-nervous, Anti-diabetic



Growing many types of herbal plants having medicinal importance in 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. The tree garden / arborea can be planted based on the zodiac signs which would attract the public and students, faculties, staff members, employees and educate them based on their uses. 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 purifies the air considerably. Similarly, the ornamental plants with beautiful flowers can be maintained in the frontage gardens of campus for attraction and good ambience. This will give an overall aesthetic look and also provide fresh air for healthy respiration to the stakeholders.

In NASC, they are planted ornamental plants for the display of appealing characteristic features including: varying types of leaves and their texture, flowers and their fragrance, fruit, stem and bark. In some places, plants of unusual features also planted to be of interest, such as the prominent thorns of cactus and snake cactus. There are 27 varieties of ornamentals plants we are maintaining surrounding of our college campus. In front of principal's room, cafeteria, college grounds and many places planted ornamentals plants. These plants are making the college campus pleasantly and decoratively. Every year they try to plant new varieties with help of Environmental department. Once in three months the unwanted barks of the plants are cut it down, to make the beautification of their campus. No plant is cut unless it becomes dead. Not only can visitors enjoy seeing the ornamentals plants and also humming birds, butterflies shelter in that. This environment makes campus greenish and pleasant.

13.7. Natural Topography and Vegetation



Natural topography means the original geographical features of the campus, around 25-30% of the organization should have the natural features like rocks, water resources, slopes, landscape, pathways, etc. and the altered topography can be accounted for, 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 are also accounted for when it is reported more than 25% of the claimed green campus audit site. Vegetation is the cultivation of a bunch of plants irrespective of the plant *taxa* for the covering of the area or ground topography. Natural topography is better appreciated with wild vegetation than the artificially created

topography like pathways and parking areas. The observation at the NASC campus indicated that more than 25% natural topography and vegetation have been maintained properly. Further, there was no anthropogenic activity in some of the interior side of the campus.

13.8. Rainwater Harvesting System and Percolation Pond

Rainwater harvesting system is a traditional old practice not only in drought prone areas and also in areas having seasonal rainfall. The Indian traditional rainwater harvesting is being practiced in various parts of the country to improve the ground water status. Now the threatening features of the lower ground level of water has created a revamp of newly featured rainwater



harvesting systems. Indian traditional rainwater harvesting systems are constructed based on three modes either direct pumped, indirect pumped or by gravity alone in the campus. In addition, lakes, bonds, water channels and any other water reservoir methods are considered as the rainwater harvesting system. The green campus should have adopted any of the above said modes of rainwater harvesting or any new methods that has the benefit of conserving the water resource as well. A small square shaped pit containing gravels and sands constructed near the building for rainwater harvesting and connected with pipes from the roof of the building to pit. During the audit, there are two well developed rain harvesting systems such as 1) Pond, 2) square shaped pit containing gravels and sands and 3) water channels connected with a square shaped pit observed with the NASC campus. Rainwater harvesting structures and recharge wells have been commissioned in the campus at different locations.

13.9. Landscape design and Soil Erosion control

Landscape management is the maintenance of land to make sure that backgrounds can fulfil the needs and objectives in an effective and sustainable manner for current and future members. It is an action that forms a perception of viable expansion, to ensure the preservation of a panorama, in order to help and harmonize alterations which are supplemented through social, monetary and environmental methods. Landscape design is an important feature for any disasters to control especially with respect to the soil erosion. In general, soil erosion occurs if the design of the land is not altered so as to prevent the slope features by strong vegetation and use of a plant buffer zone as safe for escape of nutrients or fertilizers entering the streams. When the slope features are altered, adequate vegetation can alone be enough to prevent soil erosion. The observation revealed that the NASC campus has very good landscape design without disturbing the natural vegetation. Contour ploughing is being done at right angles to the slope wherever possible and ridges and furrows are properly maintained to break the flow of water down to the empty land. These activities are widely adopted to control soil erosion in the campus.

13.10. Operation of Water irrigation, Drip and Sprinkler Irrigation methods

Maintaining the green campus and water conservation mechanisms should be applied efficiently in 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. The NASC campus has taken sufficient efforts to maintain the plants greenish and frequency of watering to the plants. A register is maintained to note down the timing of watering the plants and quantity of water poured every time. Internal auditing of time of plantation, number of times the plants are watered and growth parameters of the plants in the campus is being carried out.

13.11. Importance of Biodiversity Conservation

The campus should be a mini biodiversity conservation area, wherein, more greenery due to native plant species, medicinal plant garden, concept gardens, flowering plants that attract bees, birds, beetles and other animals like squirrels should be monitored as ecosystems. Shade giving trees in the paths, flowering trees in the avenues and fruit trees at the back yards also would attract birds, bees, butterflies and squirrels. The NASC campus is free of exotic plants that cause threat to the natural vegetation. It is like a mini bio-reserve rich in native species and endemic plants. A complete data on the soil type, water holding capacity and soil nutrition in the campus is being thoroughly studied internally or with the Government agriculture departments. It is useful for cultivation of various native and wild plant species and also helps in choosing the proper irrigation system.

13.12. Pedestrian Path facility at the NASC campus

The concept of pedestrian path is to give safe space to walk freely by the pedestrian. It is very important in the green campus in terms of freely walk pedestrians or people going on foot without any obstacles. The pedestrian path is otherwise called as zebra crossing by the combination of black and white stripes remained to characterize the zebra. This path is specially designed space to the stakeholders to walk freely without any disturbance. It is useful for cross walk and easy to recognize to walk by means of wide black and white colour combination of lines and authorize to walk while crossing and walking on the foot. In addition, pedestrian path are created in



the green campus along with road side which meant for walking only using special cement bricks and stones. The pedestrian path aims to end circulation not only cars, buses, vans, trucks and other vehicles but also giving safe space to the pedestrians, where cross and pass through blocks and also forcing vehicles to comply with it. The NASC campus is having very good facility in creating pedestrian path for stakeholders.

13.13. Use of Biofertilizers, Organic and Green manures

Natural or eco-friendly methods should be used to grow plants vigorously in the campus which could reduce the environmental pollution. 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. The 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 in the campus. Minimal use of chemical fertilizers as part of 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. The soil, air, water and sunlight are the four major natural resources any campus gets. Proper use and conservation of these resources are mandatory in green campus audit sites. The available resources and their

utilization should be accounted for from time to time. Management of the right way of utilization of these resources with the vision of sustainability should be carried out by framing a committee led by the Head of the Institution concerned. Biofertilizers such as Nitrogen fixing bacteria, Potassium and Phosphorus



solubilizing bacteria, Potassium mobilizing fungi (VAM), farm yard manure, dried cow dung manure, vermicompost manures and biofungicides and biopesticides are extensively used in the Nehru Arts and Science College to cultivate plants. Agrochemicals, chemical fertilizers (urea, murate of potash, sulphate of potash, rock phosphate, etc.), pesticides and fungicides are not used. These practices are very well appreciated because air, water and soil pollution due to use of agrochemicals is eradicated which in turn to improve the soil health significantly.

13.14. Conduct of Outreach programmes for dissemination of Green Campus motto and Green pledge initiatives by Eco club, Nature club, Associations, Cells, Forums, NCC/Student Force and NSS bodies in Green Campus initiatives

Professional implementation of all the Eco plans in the campus should be done through the Eco clubs, Nature clubs, Science clubs, Youth Red cross units, Fine Arts clubs, Women cell, Associations, Forums, SSL, NCC (National Cadet Corps) and NSS (National Service Scheme). All the students, members of staff and employers should be

mandatory members of the club and should do tree planting and maintenance of greenery in the campus periodically. Conducting frequent seminars, conferences, workshops, awareness rallies, etc. on topics relevant to the environment is necessary to educate and create awareness among the students and staff members. In addition, student's associations, cells, clubs and forums should be the first hand receivers of all the new plans proposed by the Government such as Swachh Bharath Abhiyan and Jal Shakti Abhiyan under Clean India Mission and implement the same in the campus. The NASC

Campus has well developed NCC/Student Force, NSS, Swachh Bharath Abhiyan under Clean India Mission. These bodies are actively involved in Swachh Bharat Summer internship programme (SBSI 2.0) with an awareness rally in front of the railway station followed by cleaning tracks inside the station and in Nachipalayam Village. The students planted more than 100 saplings in the village. Awareness programme on Afforestation, Rainwater Harvesting and Avoid plastics to the school students of the village. The NASC Campus is conducting a large number of activities to conserve the nature and to teach about the importance of environment to rural, tribal and urban people.



Awareness programmes on the green campus initiatives and dissemination of green motto and pledges are accounted in a sustainable manner. Its benefits and self-sustainability are being projected for wider centric on earth and Ecology conservation. Innovative practices that add up credentials in implementing the green campus which needs to be promoted in the awareness programme to the students and staff members including public domain. Technology driven solutions initiated by the green campus organization are periodically disseminated and documented successively for propagating the attitude of the green campus in wider masses. The NASC Campus has taken sufficient attempts to disseminate the green campus motto and green pledge such as ‘Don’t cut trees’, ‘Don’t use plastic bags’, ‘Don’t waste waters’, ‘Plastic Free Zones’ and ‘Preserve the Natural Resources’ and etc. among the students and staff members in the campus.

The NASC Campus is implemented the Government schemes (Swatch Bharath Abhiyan under Clean India Mission) to give pure and safe water to rural people and teach the importance of cleanliness of toilets and restrooms to people living in Hyderabad city. These activities are very important in view of the instantaneous vicinity to undertake progressive programmes and conducted Participatory rural appraisal programmes. It is involving the socioeconomic position of the inhabitants, natural resources, traditional knowledge systems, cropping patterns, etc. of the rural and tribal people. The NASC Campus is also focusing on the development of women through Nehru Centre for Women Excellence. Other women related committees such as Sexual Harassment, Women Empowerment and Grievance Redressal are functioning in the college under the able guidance of Nehru centre for Women Excellence. Nehru Centre of Women Excellence Trust had organised a special programme on “Installation of Kavalan SOS App” for the Girls students and lady faculties of the college.



The NASC Campus helps to develop social commitment and to expose the students to get sensitized to social realities and to build a link between the student community and the wider community. It enhances the social interaction, inter-personal communication skills and develop emotional maturity of students. It also helps students in total and integrated personality development. The centre for Rural Development, National Service Scheme of Nehru Arts and Science College organised a vaccination camp for the needy at Ganga Hospital.



The NASC Campus facilitates to prepare the students for future life, by developing qualities such as cooperation, team spirit, leadership, discipline and development of creative talents including to boost the self-confidence of students.

13.15. Establishment of Aquarium and Aquatic plants

Growing fishes in the 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 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 in greenish. The NASC Campus has a good aquatic site in which aquatic plants and birds are living generously.

13.16. Academic credentials: Projects, Dissertations and Thesis work

Project, Dissertation and Thesis works are academic effort credentials that always fosters the innovative ideas on thinking and implementation of new innovative approaches. Applied research work of the faculties, staff and student members should be implemented within the campus owing to the credential of the research. Those works indicating the significance of empowering the green campus can be implemented or adopted in other organizations. If the innovation is capable of developing into entrepreneurship, then it is highly appreciable. The Report of projects and dissertations

which are productive in methodologies should be disseminated through presentation and publication in social media, books, magazines and journals so as to spread the innovative ideas and methods to the broad public. The NASC Campus faculty members and students from various subject domains are doing extensive project work related to nature conservation, environmental pollution, soil and water analysis.

14. Best practices followed on Green Campus initiatives in the Organization

1. It is observed that the NASC Campus is maintaining more than 51.5% of the green cover area after building construction as per the guidelines of World Green Building Council and Indian Green Building Council to provide a healthy environment and ecofriendly atmosphere to the stakeholders. It is calculated that the natural vegetation was 82% and planted vegetation was 27%.
2. The NASC Campus is established at Kuniyamuttur of Coimbatore District which provide pure atmosphere to the stakeholders under natural environment, topology, landscape and soil erosion. The campus is established without disturbing the natural vegetation along with the artificially created topography like pathways and parking areas.
3. The NASC Campus has created 'Medicinal garden' for establishing a massive reforestation / afforestation planting programme in which a large number of trees and shrubs species were planted together with a minimum distance covering fruits, nuts and timber yielding plants are planted. It was established by following the method of 'Miyawaki Concept' that helps build dense, native forests and to restore the natural potential vegetation, landscape management and control soil erosion.
4. In view of floral biodiversity in the NASC Campus, a sum 112 species belonging to 109 Genera under 51 families covering trees, herbs, shrubs, climbers, lianas, twiners and lawns and 18 species belonging to Lichens, Pteridophytes, Bryophytes and Mycoflora like Mushrooms were recorded. It is observed that all the plants are growing profusely and showing healthier free from pests and diseases.
5. In view of faunal biodiversity in the NASC Campus, a total of 10 living Mammals representing 10 different Genera, 13 species of birds, 4 species of Grasshopper, 3 species of Termites, 6 species of Amphibians, 7 species of Reptiles, 9 species of Butterflies and two species Mosquitos were recorded and documented.
6. The NASC Campus has established rainwater harvesting models, percolation pond to recharge the borewells by collecting rainwaters from the building roofs, open areas and playgrounds including unexplored areas which are channelized to flow of rainwaters to increase the ground water level.
7. The NASC Campus adopted a well developed Automatic water irrigation systems like drip and sprinkler irrigation methods in the entire green area of the campus which in turn are useful to reduce the operation costs under energy conservation policy.

8. The campus has a maximum number of more oxygen releasing and carbon dioxide assimilating plants such as *Areca* Palm, Banyan tree, Money plant, Neem tree, *Arjun* tree and *Pongam* trees including some of the shrub and herbal plants.
9. The NASC Campus, Departments of Biotechnology and Microbiology are offering various courses in Regulation 2021 related to Environment Studies, Natural Disaster Management and Waste Management to the students and research scholars.
10. The matured trees may be subjected to do white wash upto 3 feet height with limestone and neem oil mix to prevent the pests and diseases attack

15. Recommendations for Greening

- The name board may be kept in each plant species in which the common name along with binomial name may be mentioned. The year of planting and economic importance with medicinal values if any may be mentioned in some plants so that the oldest as well as useful herbal plants may be identified in the campus.
- Honey Bee hives may be kept in the campus which is free from student's mobilization. Honeybees are natural pollinators help to increase the yield potential of plants (flowers, fruits and vegetables) upto 33%.
- A complete data on the soil parameters such as pH, electrical conductivity (EC), water holding capacity (WHC), total organic carbon, available nitrogen, exchangeable potassium, available phosphorus in the campus may be studied which may be useful for the cultivation of various native and wild type plant species.
- A complete data on the water quality parameters such as pH, TSS, BOD, COD, dissolved oxygen and dissolved carbon dioxide and macro and micro elements like iron, nickel, chromium, ferric and ferrous ion concentrations may be studied for which bore well, open well, corporations, municipal RO, Aquaquad, Millipore. Distilled water rain water and may be used. It may be analysed which may be useful for the plant growth as well as to the stakeholders.
- It is recommended to develop 'Green Campus Policy', 'Energy and Environment Policy' and 'Purchase Policy' for not allowing the non-degradable plastic covers during the paking of goods with respect to nature conservation and environmental protection.
- NASC Campus Management has to take smart initiatives towards creating a Green Campus in the areas of green computing and waste management. The desktop infrastructure is virtualized through VMW virtualization technology.

16. Conclusion

After the establishment of NASC Campus, Thirumalayampalayam, in the past three decades, it has made significant progressive contributions with respect to teaching learning, research and consultancy, innovation and transfer of technology, community service and value education, *in toto*. The NASC Campus is a well-established self supporting Institution in Tamilnadu which imparts quality education to rural, tribal and urban people across the Nation. This Organization is excellent in terms of academic activities and providing an eco-friendly atmosphere to the stakeholders. The Organization has taken enormous efforts to maintain green campus to the students, research scholars, staff members and parents in a sustainable manner which reflects the importance of the environment and stakeholders. It is conducting a large number of activities for the benefit of rural and tribal community people without disturbing the natural environment, topology, landscape management and vegetation. The NASC Campus is maintaining more than 51.5% of the green cover area after building construction along with 35.6% of natural vegetation and 3.11% planted vegetation.

The natural topography and very good landscape design without disturbing the natural vegetation are being maintained by the NASC Campus. A maximum number of more oxygen releasing and carbon dioxide assimilating plants are being maintained to provide pure atmosphere to the stakeholders. The installation of a rainwater harvesting system and drip irrigation system to conserve rainwater and ground water are noteworthy in the campus. The Organization has created medicinal plants gardens and campus is also following the method of 'Miyawaki Concept' that helps build dense, native forests and to restore the natural potential vegetation, landscape management and control soil erosion.

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