Integrating environmental sustainability concerns in agricultural higher education, research and innovations

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National Agricultural Higher Education Project (NAHEP) is implemented by the Indian Council of Agricultural Research, Government of India and World Bank to strengthen the national agricultural higher education system in India with an overall objective of providing more relevant and high-quality education to agricultural university students. Environment safeguard measures are one of the inbuilt components under the project and are categorized as 'Category B' as per the environmental safeguard policy of the World Bank. Thus, the interventions proposed under the project offer scope for enhancing the positive impacts on the environment through integrating pro-environmental measures. Based on the project proposal, the participating agricultural universities (AUs) prepared 'Environmental sustainability plans' comprising legal compliances and mitigation measures, green initiatives, and education and awareness programmes. The present article studied the impact of green initiatives undertaken by the universities under the categories of energy conservation, water conservation, waste management and enhancing greenery. Data on these activities were collected from project-awarded AUs that introduced environmental pro initiatives. These green initiatives were measured in terms of the reduction of CO_2 emissions (tonnes) annually and presented in the form of the carbon footprint of the university campus.

Keywords: Agricultural universities, carbon footprint, decarbonization, environment safeguard measures, green initiatives, National Agricultural Higher Education Project.

A clean and sustainable university campus provides a healthy and enjoyable environment for its education, research and innovations. The education sector can play a vital part in exploring and concrete efforts to save and restore ecosystems. Therefore, environment-related dialogues are now the priority of academic institutions towards sustainability. This is not a new concept, as even in 1972, the Conference on the Human Environment held in Stockholm put forward the conception of a green academy. Further, in 1994, the United Nations Educational, Scientific and Cultural Organization (UNESCO) launched an action programme called the 'Education for Environment, Population and Sustainable Development'. United Nations (UN) designated 2005–14 as the 'Decade of Education for Sustainable Development' to integrate sustainable development into the teaching and learning processes. In 2015, India committed itself to the UN 2030 agenda for sustainable development. Currently, promotion of environmental education and exploration in our Indian Higher Education Institutions (HEIs) is one of the crucial recommendations of the National Education Policy[1]. According to it, environmental mindfulness, including resource and water conservation, management of biological resources, climate change, waste management and sanitation, conservation of biological diversity, pollution and sustainable development, would be an integral part of the curricula in the coming days. Students will be tutored about making ethical opinions/decisions related to environmental consciousness and doing what is right in favour of global good. NEP-2020 also advocates online education and access to downloadable performances of handbooks and study materials. This green action is in favour of reducing the logistical burden of our educational institutions. Acknowledging the above concerns and the prevalent global trends, the University Grants Commission (UGC), in 2020 proposed a sustainable campus framework to set out the principles for achieving a green and sustainable campus environment for HEIs. It indicates and widely accepts that universities might play an important role in working on major sustainability challenges by educating future generations, undertaking sustainability-related exploration and research projects, and satisfying policymakers

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Table 1. Reduction of carbon emission by replacing incandescent bulbs with LED lights

No. of LED light (8 W)	CO_2 emissions		No. of LED lights (12 W)	CO_2 emissions		Total CO_2 emission by LED lights (kg/year)	Total CO_2 emission by incandescent lights (kg/year)	Reduction of CO_2 emission (kg/year)
	LED lights (kg/year)	Incandescent lights (kg/year)		LED lights (kg/year)	Incandescent light (kg/year)			
6,383	69,006	436,694	7,728	125,423	1,045,197	194,429	1,481,891	1,287,462

to accept the concept of sustainability in the country's development programmes. Not only this, university premises can showcase themselves as an experimental model for sustainability to provide a clean and sustainable loft for a healthy and pleasurable environment for learners.

Thus, it is the utmost duty of Indian universities, which can be the key contributors, to align their activities and educational priorities around applicable sustainable development goals (SDGs) to achieve them fully.

National Agricultural Higher Education Project (NAHEP) is one of such World Bank programmes being implemented by the Agricultural Education Division, ICAR, New Delhi, and is helping in integrating environment sustainability concerns in agricultural education and research in project awarded agricultural universities (AUs) since 2017–18 (ref. 2). Although, overall, the project aims to develop resources and mechanisms for supporting infrastructure, faculty and student advancement, it also considers the management of environmental and social impacts and improves the knowledge and understanding of these issues to integrate environmental sustainability. As part of the project, environmental safeguard policies are mandatory to prevent, mitigate or minimize undue harm to people and their environment in the process of development. During the inception of the project, an environmental assessment study was conducted targeting the faculty and students to understand the safeguard status. Based on the assessment, the environment management framework (EMF) was prepared to ensure the sustainability of the project interventions and to integrate the key environmental concerns in agricultural education, research and innovations. Universities were given the opportunities to integrate curricula of climate resilience, sustainable production systems, and overall reduction of carbon footprint. Accordingly, each university integrated environmental sustainability plan (ESP) as one of the points of its proposal comprising applicable legal compliances, risk and mitigation measures, and green initiatives/environment-friendly activities, including education and awareness.

Green initiatives taken by the project awarded agricultural universities

The project awarded AUs took up certain green initiatives and followed conservation practices in the sectors of energy conservation, water conservation, waste management, enhancing greenery and creating awareness among the students. These initiatives were quantified and presented as carbon footprint to understand better resource utilization and act toward sustainable practices to reduce the carbon footprint. In this process, data from project awarded universities were collected, analysed and quantified using online tools.

Energy conservation

As part of the conservation practices, 23 AUs replaced LED bulbs with high-energy consumption lighting system, converted traditional classrooms into smart classrooms through low-energy consumption teaching aids, etc. Table 1 shows the reduction of 1,287,462 kg of carbon emission in a year by replacing 6383 of 8 W and 7728 of 12 W of LED lights with existing incandescent bulbs. Thus, the total number of LED lights replaced in 23 AUs was 14,111, with the total emission of 194,429 kg of CO_2 in a year against the total carbon emission of 1,481,891 kg/year with the same number of incandescent bulbs.

Thus the total reduction of carbon emission in 23 AUs is about 13% annually due to the replacement of LED lights. Calculation of CO_2 emission was done using an online tool (https://www.thecalculatorsite.com/energy/led-savings-calculator.php) utilizing the information of the number of bulbs, watt of existing bulbs with watt of new LED bulbs, hours used per day, and the number of days used in a week in the university campus.

This project also indirectly enabled 17 AUs to install solar energy systems with the support of their state governments. Table 2 shows the reduction of 16% in carbon emission annually due to the installation of solar photovoltaic (SPV) panels and compares the units consumed by the universities from the state electricity boards with the units consumed through the production of energy due to the installation of SPV panels as an intervention under the project.

CO_2 emissions from solar and thermal energy were calculated using an online tool (https://www.un.org/en/chronicle/article/promise-solar-energy-low-carbon-energy-strategy). According to the tool, carbon emission by SPV ranges from 25 to 30 g/kWh, and emission by thermal energy is 200 g/kWh.

Water conservation

As part of water conservation, 22 AUs conserved a total quantity of 35.87 lakh litres of water through rooftop harvesting (RTH) structure (5%), farm pond (FP) (69.4%), check

Table 2. Reduction of carbon emission by installation of SPV panels

Units consumed from state electricity board in AUs (kWh)	CO_2 emission by electricity (coal based) (g/kWh)	Energy generation and consumption by SPV panels in AUs (kWh)	CO_2 emission by SPV panels (g/kWh)	Reduction in carbon emission (g/kWh)
73,651,642*	14,730,320,400	12,087,165*	362,614,950*	14,367,705,450

*Total solar units multiplied by 30 g/kWh to get CO_2 emission/*Similarly total CO_2 from electricity board multiplied by 200 g/kWh.

Table 3. Quantity of water conservation by various methods

Water conservation methods	No. of AUs adopted	Quantity of water conserved (in litres)	Percentage of contribution
Roof top harvesting (RT)	13	19,321,806	5.3
Farm pond (FP)	20	249,134,925	69.4
Percolation tank (PT)	6	12,525,550	3.49
Check dam (CD)	8	36,750,150	10.2
Waste water treatment plant (WWTP)	7	41,036,622	11.4

Table 4. Reduction of carbon emission by waste conversion into manure

Total waste generated in AUs (kg)	Waste segregated		Percentage of the wet waste (%)	Reduction of CO_2 emission (kg)
	Dry waste (kg)	Wet waste (kg)		
7,817,371	3,523,057	4,294,314	55	6,335,227

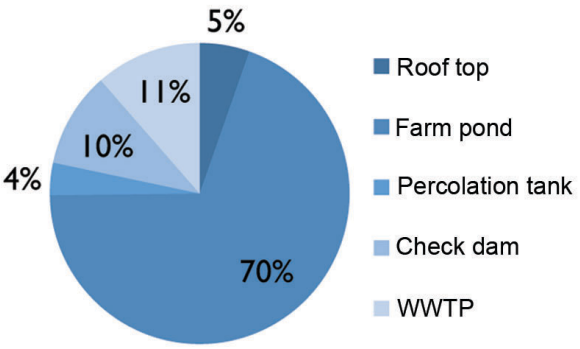

Figure 1. Percentage of water conservation through various methods.

dam (CD) (10%), percolation tank (PT) (4%), and waste water treatment plant (WWTP) (11%) methods (Figure 1).

Though the WWTP method was followed only by 7 AUs, the water conserved through this practice was the second highest quantity as against the FP method, which held the first highest quantity position but was followed by 20 AUs. Each AU followed a minimum of 2–3 methods. Details of the water conservation methods and percentage of contribution of each method are presented in Table 3.

Table 3 shows that each university conserved 1.2 crores (litres) of water following the FP method and 0.5 crore litres following the WWTP method. Other methods were followed based on the local conditions. Following the WWTP method implies that water stress can be reduced in the campus and positively impact water resources. After environmental interventions as part of the ESP, 3 AUs planned for WWTP in their campus in due course of time, which positively impacted the project intervention. State universities under the maximum rainfall category planned for RTH to harvest maximum rainwater, which was also a low-maintenance method compared to the WWTP.

Waste management

The waste segregation process was properly managed in 19 AUs by providing separate dustbins near sources, and these facilities were provided as project intervention. CO_2 emissions were reduced by following different methods, and the carbon emissions reduction is presented in Table 4.

Table 4 shows that the total waste collected by university campuses was about 7,817,371 kg, comprising 4,294,314 kg of wet waste and 3,523,057 kg of dry waste. Wet waste (55%) was converted into manure through various methods such as compost, biogas plant, organic converter, etc., which reduced 6,335,227 kg of carbon emission, and dry waste was handed over to the agencies involved in waste management. In addition to the segregation of waste, 7 AUs declared their universities as plastic-free and took strict measures to implement this initiative by involving student committees, display boards (fine for violation), provision of cloth bags, etc. An average of 3 of months data was considered to calculate the carbon emissions using an online tool (https://watchmywaste.com.au/food-waste-greenhouse-gas-calculator/). The maximum quantity of wet waste has been converted into manure, thus cutting off the major sources

Table 5. Carbon sequestration potential in the AU campuses

Total plants planted by AUs (ha)	No. of species selected	Carbon sequestered by total number of trees after 10 years (kg)
1,117,220 (39.9)	3,262	*27,9305,000

*On an average, a 10 years old tree can sequestrate 250 kg.

of greenhouse gas (GHG) emissions and leaching harmful substances causing air, water and soil pollution.

Enhancing greenery

Under this intervention, massive plantation programmes were carried out in 26 AUs by involving students to improve the green cover in and around the campus (Table 5).

Table 5 shows that 1,117,220 plants were planted by AUs in the last 5 years, covering an area of 39.9 ha with 3262 species under various landscape patterns such as ornamental plantation, compact forest, orchards, biodiversity park or thematic parks, etc. The carbon sequestration of these trees was quantified to understand their potential. A ten-year-old tree can sequestrate an average of 250 kg of CO_2 as per the Eco matcher sequestration tool, and the same was used for calculation in view of an ideal situation (https://www.ecomatcher.com/how-to-calculate-co2-sequestration). Other major initiatives undertaken by the universities were the massive plantation programme concepts like one tree–one student, 4 trees–one student, etc. Linking such activities with academics is one such new beginning for sustainable green campuses and nurturing the students toward sustainable development. One of the AUs established a museum on 'Forestry of non-timber forest products' and also developed organic nutrients from banana pseudo stem.

Education and research awareness

The majority of the AUs under NAHEP were involved in awareness programmes on environmental aspects in the form of rallies, lectures, courses, etc. More than 41% of the awarded AUs conducted courses on conservation, climate change resilience and related topics. Lectures and seminars were made part of the academic programme. In addition, rallies on specific issues like water conservation, waste management, wildlife and forest conservation, lake and beach cleaning campaigns, etc. were also undertaken. Painting, rangoli, poster presentations, etc. were some of the competitions organized by the AUs on world environment and other special days. AUs have also taken up research projects on conservation agriculture, ensuring environmental sustainability, enriching elemental deficiency, carbon storage and enhancing productivity of the soil through biochar, bio floc technology for sustainable effluent management in aqua farming, microbial composition of inland saline water to generate baseline data for environmental sustainability of aqua farming, and to formulate best management practices for the same.

Interventions of introducing green and clean campus award in agricultural universities

The ESP also provides voluntary observance of some global best practices, including green initiatives and clean energy, that are in sync with SDGs 6 and 7. A 'Green and Clean Campus Award' has been constituted under NAHEP for partnering universities with the intention that an ideal educational institution should put in place sustainable environmental management in terms of green cover, solid, liquid, and e-waste management, rainwater harvesting, water and energy conservation, waste reuse, and recycling, to cite a few. Post evaluation of the concept notes, winners of the award were felicitated by the Hon'ble Prime Minister of India, Shri Narendra Modi, along with other dignitaries on 28th September 2021 during VC's and Director's Conference-2021. The award carried a citation with a memento and a cash prize of Rs 10 lakhs, Rs 8 lakhs and Rs 6 lakhs respectively, for the first, second and third positions, besides consolation prizes of Rs 4 lakhs.

Addressing the gaps to integrate environmental sustainability concerns in agricultural higher education, research and innovations

- Though NAHEP created a path towards a sustainable campus, a strategic and more comprehensive plan is required for which detailed environmental assessment studies are needed to develop a university-specific concrete ESP. AUs may also include sustainable procurement practices in delivering activities in other focus areas, including energy and water efficiency, waste and recycling, and buildings and campuses in their ESPs.
- Initial environmental review (IER) may be conducted at the university level in consultation with the architecture of the building, housekeeping in-charges and other people involved in various activities under key environmental domains. It may cover energy, resources, waste (solid and hazardous), ambient/indoor air and landscaping, etc. For this, detailed information may be collected through questionnaires of different aspects within each domain to develop an environmental management plan (EMP).

- SWOT (strengths, weaknesses, opportunities and threat analysis) analysis is needed to show that universities have more potential to be integrated into EMP. The identified weaknesses and strengths can also be taken up through remedial action under EMP for each university by involving the faculty and students. EMP must describe the specific measures to improve the environmental performance of a university with aims to define priorities, set objectives, identify the parameters of importance, and a strategy for achieving goals. Maintenance of the framework should be of utmost priority to ensure the existing features and a road map for achieving sustainability on campus.
- Organizing massive awareness programmes for the students and other stakeholders on workable and lucrative technologies to conserve and wiser use of water with multiple uses with a focus on reducing consumption, water collection and water recycling, etc. Also includes environmental awareness topics like waste management, the role of planting saplings, rainwater harvesting, management of biodegradable waste, use of solar panels, etc.
- Shifting the campus from electric to solar energy systems can provide learning opportunities for students and help them achieve their climate goals.
- Research projects may be taken up by the students and faculty to develop innovative prototypes and next-generation solar panels, etc.
- Educational courses and research on sustainable renewable energy must be included to cover a range of technologies in the transition towards a low-carbon society. Enhance research to develop technologies on environmental management to address the latest topics/issues such as global warming, pollution, deforestation, soil erosion, landfills or depletion of earth's natural resources, etc.
- Initiate research projects on assessing environmental and social impact, effective environmental management in construction and strategies to cope by designing the learning programmes specifically for students with the framework and its application in university education.
- Short term training programmes for the students and faculty focusing on environmental issues related to wind energy, solar energy, crop rotation, water-efficient fixtures, and waste management, including solid and liquid waste management and surveillance, monitoring and reporting, may be taken up by AUs to ensure compliance to environmental safeguards.
- Field visits to different sites will excessively be helpful at the ground-level implementation of such projects as an alternate educational opportunity for the students for hands-on learning and experience and learning from practical demonstrations and face-to-face talks.
- Massive online courses in various languages may be developed by the faculties of AUs on environment safeguarding and sustainable management with solutions to protect our ecosystem, opened to everyone besides students, with or without environmental background.
- Development of information, education and communication (IEC) material in the form of posters on laboratory safety, fire safety measures and use of fire extinguishers, etc. will be highly useful to be aware and follow the precautionary safety measures at laboratories, sites and campuses under safeguard compliances, by the students.
- Ensure all planting schemes must use a minimum of 70% indigenous species with a preference for drought-resistant species.
- Efforts should be made to achieve higher energy and water efficiency by investing in high-efficiency equipment, fittings and new technologies to reduce operating costs and enhance profitability while reducing the negative impacts on the environment due to using high energy.
- Waste is the most visible environmental issue on campus, and tackling single-use disposables, in particular plastics, should be identified as a key priority by all campuses. For this, they may develop and implement a waste management plan, adopt best practices for recycling construction and demolition waste, and try to eliminate single-use plastics wherever feasible and practical.
- Organizing National Environment Awareness Campaign (NEAC) annually at a massive scale at the university level following a decentralized and convergence approach involving NGOs, state departments, Krishi Vigyan Kendra (KVKs) and regional resource agencies. This will create environmental awareness at the National, regional and university levels more efficiently and effectively.

Conflict of interest: The authors declare that they have no conflict of interest.

1. National Education Policy, Ministry of Human Resource Development, Government of India, New Delhi, 2020, p. 38; https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf.
2. Environment Assessment and Environment Management Framework (EMF), NAHEP, PIU, NAHEP, Agricultural Education Division, ICAR, New Delhi, 2019; https://nahep.icar.gov.in/pdf/EMF-NAHEP.pdf.

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