IARE
INSTITUTE OF AERONAUTICAL ENGINEERING

Technology Innovation & Product Support (TIPS) URS - Urban and Rural Sustainability

INSTITUTE OF AERONAUTICAL ENGINEERING
25 YEARS

Appreciate IARE students who are showing interest in the Urban and Rural Sustainability (URS) Product Project Program at the Institute of Aeronautical Engineering!

URS Project team members work as part of a research group of students, research scholars, and faculty members to tackle novel problems around a theme.

URS program encourages students to identify real-world challenges and develop product-based solutions that are sustainable, cost-effective, and scalable. It provides an interdisciplinary platform for students to work collaboratively on projects that integrate technical knowledge with social relevance, focusing on domains such as clean energy, smart agriculture, waste management, water conservation, health care, affordable housing, and urban infrastructure.

The Goal of URS projects are:

The Urban and Rural Sustainability (URS) Product Project Program aims to empower students to develop innovative, sustainable, and technology-driven solutions that address real-world challenges faced by urban and rural communities. The program seeks to:

- Foster a culture of social responsibility and environmental stewardship among students.
- Promote interdisciplinary collaboration for the development of impactful product-based solutions.
- Encourage problem-solving through design thinking and innovation aligned with the United Nations Sustainable Development Goals (UN-SDGs).
- Bridge the gap between academic learning and societal needs by translating classroom knowledge into practical, scalable solutions.
- Prepare students to become change-makers and future leaders in sustainable development through hands-on experience, community engagement, and entrepreneurial thinking.

The research theme of this URS project also focuses on the challenges presented by the Sustainable Development Goals (SDGs).

IARE Sustainability Development Goals (SDGs) highlighted with Blue Colour Font	
SDG #1	End poverty in all its forms everywhere
SDG #2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
SDG #3	Ensure healthy lives and promote well-being for all at all ages
SDG #4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
SDG #5	Achieve gender equality and empower all women and girls

SDG #6	Ensure availability and sustainable management of water and sanitation for all
SDG #7	Ensure access to affordable, reliable, sustainable and modern energy for all
SDG #8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
SDG #9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
SDG #10	Reduce inequality within and among countries
SDG #11	Make cities and human settlements inclusive, safe, resilient and sustainable
SDG #12	Ensure sustainable consumption and production patterns
SDG #13	Take urgent action to combat climate change and its impacts
SDG #14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
SDG #15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
SDG #16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
SDG #17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

The following research domains are recommended for URS Projects, and selected students should find the research gap and frame the problem statements from any one of the themes below.

S.No.	Name of the Theme	SDGs
1	Zero Hunger	SDG 2
2	Clean Water and Sanitation	SDG 6
3	Industry, Innovation, and Infrastructure	SDG 9
4	Sustainable Cities and Communities	SDG 11

In order to participate in URS Projects, you must formally apply and be accepted by the project coordinator. To proceed, please mail to the project coordinator, Dr. shikha.kumaripandey@iare.ac.in, Assistant professor, chemistry. This will bring up all available open positions tagged as URS projects. When submitting a project document and an updated résumé, include a statement regarding why you are interested in working with the team to which you are applying.

Please note that participation by the URS project team requires registration for the accompanying research statement from any of the specified domains. More information will be provided to all selected URS project applicants who have been offered a

position. If you have any questions about a particular team, please contact the team's faculty mentor(s).

We encourage you to contemplate this fascinating new opportunity. We look forward to receiving your application submission!

Sustainable Agriculture & Food Security

Dr. Shikha Kumari Pandey, Asst Professor & TIIC Division
Faculty Mentor

Goal:

The primary goal of this project is to develop and implement innovative agricultural practices that ensure long-term food security while preserving environmental resources. This involves increasing crop productivity, reducing resource wastage, and promoting eco-friendly farming methods. The focus is on creating a balance between agricultural output, environmental conservation, and socio-economic well-being of farmers. The project also aims to integrate technology-driven solutions to make agriculture more resilient to climate change, resource scarcity, and market fluctuations.

Methods & Technologies:

- Precision Agriculture – Using IoT sensors, drones, and satellite imagery to monitor crop health, soil moisture, and nutrient levels for optimized input usage.
- Smart Irrigation Systems – Automated drip and sprinkler systems controlled by soil moisture data to reduce water wastage.
- Organic & Natural Farming -Avoiding harmful chemicals by using biofertilizers, biopesticides, and integrated pest management (IPM).
- Climate-Smart Agriculture – Selecting climate-resilient crop varieties and adjusting planting cycles based on weather forecasting models.
- Post-Harvest Technology – Solar dryers, cold storage units, and blockchain-based supply chain tracking to reduce food loss.
- Vertical Farming & Hydroponics – Urban agriculture models that save space, conserve water, and increase yield.

RESEARCH, DESIGN, & TECHNICAL ISSUES

For the Sustainable Agriculture & Food Security theme, the research focus would revolve around soil fertility mapping, nutrient management strategies, and precision agriculture approaches to optimize inputs while minimizing environmental impact. Studies would explore the use of low-cost remote sensing and IoT-based monitoring systems tailored for small and marginal farmers, as well as evaluating crop yields under various climate adaptation techniques, including drought-resistant varieties, intercropping, and agroforestry. Design considerations would emphasize scalability for different farm sizes, modular technology components for phased adoption, and seamless integration with existing farming practices to ensure farmer acceptance. From a technical perspective, challenges include the high initial investment required for smart farming technologies, unreliable rural connectivity affecting IoT devices, limited technical skills among farmers to operate advanced systems, and the need for

robust, weather-resilient equipment. Addressing these issues requires user-friendly interfaces, capacity-building programs, and affordable financing models to make sustainable agricultural innovations both practical and accessible.

MAJORS & AREAS OF INTEREST

The majors and areas of interest for Sustainable Agriculture & Food Security span across multiple disciplines to ensure a holistic and impactful approach. In Environmental Science, the focus lies on sustainable land and water use, enhancing climate resilience, and preserving ecosystem services. From an Economics and Rural Development perspective, efforts are directed toward building strong policy frameworks, improving market linkages, and ensuring consistent income generation for farmers. Renewable Energy Engineering integrates solar, wind, and biomass-based applications into agriculture to reduce reliance on non-renewable resources.

MENTOR CONTACT INFORMATION
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PARTNERS & SPONSORS- None

Urban Green Spaces & Biodiversity

Goal

The primary goal of the Urban Green Spaces & Biodiversity initiative is to enhance the ecological health, liability, and climate resilience of urban areas by integrating nature-based solutions into city planning and development. This project aims to create, restore, and preserve green spaces such as parks, community gardens, green roofs, urban forests, and biodiversity corridors that support native flora and fauna. By increasing urban vegetation cover, the initiative seeks to mitigate the urban heat island effect, improve air quality, and promote groundwater recharge. It also aims to provide inclusive recreational spaces that improve physical and mental well-being for residents, fostering stronger community engagement with environmental stewardship

Methods & Technologies

Combine native species planting, green corridors, pocket parks, green roofs and vertical gardens with GIS-based site selection, remote-sensing for canopy monitoring, soil health sensors, low-energy irrigation (drip + moisture sensors) and citizen-science mobile apps for biodiversity recording. Use permeable pavements and bioswales for stormwater infiltration and microhabitat creation.

Research, Design & Technical Issues

- Baseline biodiversity assessment & mapping using remote sensing and field surveys to identify priority corridors and habitat gaps.
- Design for ecosystem services: selecting species mixes for pollination, air purification and thermal comfort while avoiding invasives.
- Monitoring protocols: developing low-cost sensor networks and citizen-data validation for canopy cover, soil moisture, pollinator counts.
- Technical constraints: soil volume limits (esp. green roofs), maintenance budgets, irrigation water sourcing, human–wildlife interface in peri-urban zones, air/noise pollution stress on flora.

Majors & Areas of Interest

Urban green spaces and biodiversity conservation are multidisciplinary in nature, involving collaboration across environmental science, urban planning, engineering, and social sciences. Environmental science and ecology play a crucial role in assessing urban biodiversity, restoring degraded ecosystems, and conserving native species. Geospatial science and remote sensing enable accurate mapping and monitoring of vegetation cover, habitat connectivity, and land-use changes, which support data-driven planning. Sociology and community development promote citizen engagement in greening projects, ensuring long-term sustainability.

Affordable & Sustainable Housing Solutions

Goal

The primary goal of Affordable & Sustainable Housing Solutions is to develop housing models that are both economically accessible and environmentally responsible, ensuring decent living conditions for all sections of society without compromising future generations' needs. This initiative aims to address the dual challenge of rapid urbanization and environmental degradation by integrating sustainable design principles, renewable energy systems, and resource-efficient construction techniques.

A key objective is to reduce the environmental footprint of housing through the use of eco-friendly materials, energy-efficient appliances, passive solar design, and water conservation measures such as rainwater harvesting and greywater recycling. The project also focuses on improving resilience to climate change impacts, such as extreme heat, flooding, and resource scarcity, by incorporating adaptable and disaster-resistant structures.

Ultimately, the aim is to align with multiple Sustainable Development Goals (SDGs), including No Poverty, Sustainable Cities and Communities, and Climate Action, creating housing solutions that are affordable, scalable, and environmentally sustainable.

Methods & Technologies

Passive design (orientation, daylighting, natural ventilation), insulated and modular prefabricated components, low-embodied-carbon materials (stabilized compressed earth blocks, recycled plastic–aggregate composites), rooftop rainwater harvesting, greywater recycling, solar PV for basic electrification, and standardized modular floorplans for rapid replication.

Research, Design & Technical Issues

- Performance testing: thermal comfort, energy demand, water balance, indoor air quality for prototype units in different climates.
- Material R&D: assessing local materials' structural and durability properties and developing low-cost recycling pathways for construction waste.
- Scalability & finance models: affordable finance mechanisms, microloans, community-build coop models.
- Technical constraints: structural safety standards, fire and moisture control for alternative materials, supply-chain readiness for prefabrication, regulatory approvals and local building codes.

Majors & Areas of Interest

This theme integrates Civil and Structural Engineering for eco-friendly and disaster-resilient construction, Architecture & Urban Planning for sustainable layouts and passive design, and Environmental Science for resource efficiency and climate adaptation. Renewable Energy

Engineering contributes solar, wind, and biomass integration for self-sustaining homes, while Material Science focuses on low-carbon, recyclable, and locally sourced construction materials. Economics & Policy Studies address affordability models, financing mechanisms, and housing policy frameworks. Social Sciences explore community engagement and inclusivity, ensuring designs meet diverse needs. Together, these areas drive innovation in creating housing solutions that are affordable, scalable, and environmentally responsible.

Circular Economy in Urban- Rural Context

Goal

The primary goal of the Circular Economy in Urban–Rural Context project is to establish a closed-loop system that minimizes waste, optimizes resource use, and promotes sustainable economic growth across interconnected urban and rural communities. This involves transforming traditional linear "take–make–dispose" models into regenerative systems where materials, products, and resources are reused, repaired, refurbished, and recycled to their fullest potential.

The project aims to bridge the resource flow between cities and villages - where urban areas can channel recyclable waste, technology, and investment into rural production systems, while rural areas can supply sustainable raw materials, renewable energy, and eco-friendly products to cities. It also seeks to promote decentralized waste processing, local entrepreneurship, and green jobs to strengthen both environmental and economic resilience.

Methods & Technologies

Material flow mapping and lifecycle analysis to identify high-value loops; decentralized composting and bio-digesters for organic waste; plastic-to-fuel/aggregate recycling units; modular material recovery facilities (MRFs) with manual sorting + mechanized separation; blockchain-enabled traceability for recycled materials; business models for industrial symbiosis (waste heat, byproduct exchange).

Research, Design & Technical Issues

- Circular value-chain design: mapping inputs/outputs of urban waste and rural byproducts to identify symbiotic exchanges (e.g., urban organic waste → rural compost; rural agro-waste → urban bioenergy feedstock).
- Tech incubations: piloting low-cost recycling and upcycling technologies and evaluating environmental and economic viability.
- Policy & behaviours research: incentives, producer responsibility mechanisms, and community adoption barriers.
- Technical constraints: contamination of waste streams, economies of scale vs. decentralization trade-offs, logistics (collection/transport), quality standards for recycled outputs, and regulatory compliance.

Majors & Areas of Interest

The Circular Economy in the Urban–Rural context draws from multiple disciplines to create closed-loop systems that minimize waste and maximize resource efficiency. Environmental Science focuses on waste reduction, resource recovery, and life cycle analysis. Industrial Engineering contributes through process optimization and product redesign for reuse. Computer Science and IT enable IoT-based resource tracking, blockchain for transparent supply chains, and AI-driven waste sorting. Economics and Rural Development explore

sustainable business models and rural entrepreneurship. Agricultural and Environmental Engineering promote composting, bioenergy, and sustainable agro-processing. Urban Planning integrates waste-resource systems, while Renewable Energy Engineering supports energy recovery from organic and industrial waste. Environmental Engineering, Chemical & Process Engineering, Industrial Ecology, Supply Chain Management, Economics (circular business models), Agricultural Engineering (agro-waste valorization), Computer Science (traceability platforms), Social Entrepreneurship.

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PARTNERS & SPONSORS- None