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सीएसआईआर
CSIR
भारत का नवाचार इंजन
The Innovation Engine of India

CSIR TechConnect

Volume 1, Issue 2

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Designer Rice: Low GI, High-Protein

POMbranes: Solving Big Industrial Problems

Science of "Green" Asphalt

Turning Faecal Sludge into Sustainable Solutions

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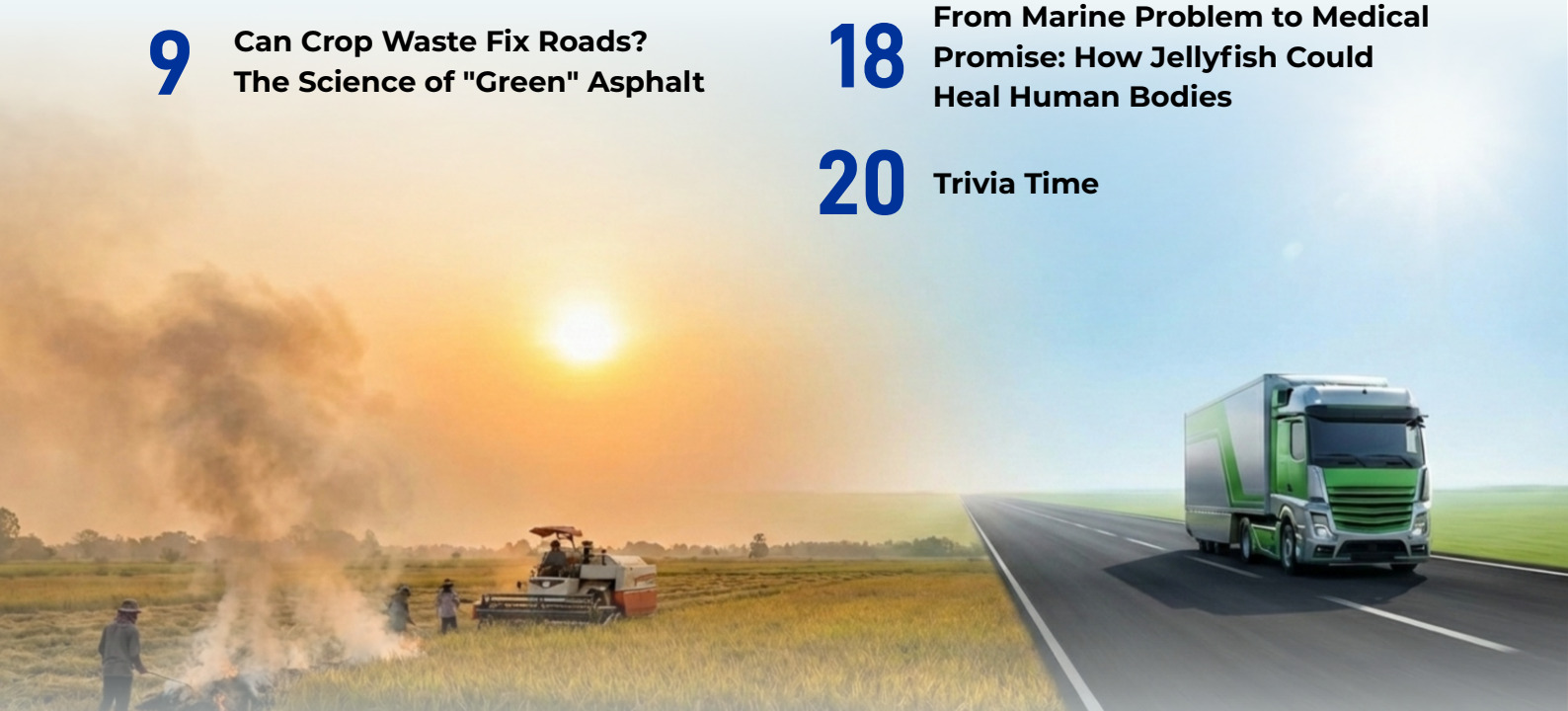

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Editorial

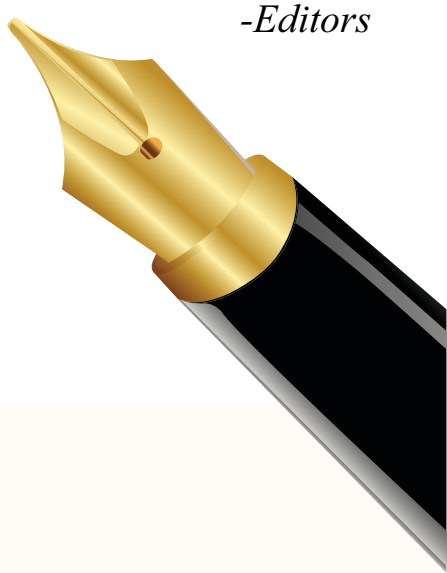
This issue of CSIR TechConnect brings together a diverse range of innovations that demonstrate how CSIR is actively addressing some of today's most pressing challenges—across urban living, sustainable infrastructure, healthcare, and advanced materials. From green noise barriers and climate-responsive buildings to 3D concrete printing and smart construction tools, the stories reflect a future where technology is reshaping how we design, build, and live.

A defining theme of this edition is the idea of turning challenges into opportunities. Breakthroughs such as converting industrial waste into eco-friendly bricks, transforming crop residue into green roads, and managing faecal sludge as a resource highlight the growing momentum toward a circular and sustainable economy. At the same time, innovations like high-protein designer rice, rapid diagnostic kits, and next-generation biomaterials underscore a strong focus on improving quality of life through accessible and impactful science.

What stands out across these stories is their practical relevance and scalability. Many of these technologies are not just conceptual advances but are ready for real-world deployment, offering solutions that are efficient, affordable, and tailored to India's unique needs. They also reinforce the spirit of Atmanirbhar Bharat, showcasing the strength of indigenous research and development.

For further information on any of the technologies featured in this issue, readers are encouraged to reach out to us at ask.scdd@csir.res.in —we would be glad to connect and assist.

-Editors



CSIR TechConnect is a quarterly bulletin published by the Science Communication and Dissemination Directorate (SCDD), Council of Scientific & Industrial Research (CSIR), New Delhi

Quiet by Design: Compact Green Noise Barrier for Healthier Urban Soundscapes

In cities where noise has become an unseen health hazard, CSIR-NEERI offers a solution that softens sound, space, and environmental impact—quietly and sustainably.

As Indian cities grow denser and transport networks expand, noise pollution has emerged as an invisible but serious public health challenge. Prolonged exposure to high noise levels from highways, flyovers, construction sites, and industrial zones is linked to stress, sleep disorders, cardiovascular risks, and reduced quality of life. Addressing this escalating concern, CSIR-National Environmental Engineering Research Institute(CSIR-NEERI) scientists have developed a Compact Green Noise Barrier (C-NoBar): a portable, modular, and environmentally sustainable solution designed to control urban noise without compromising space, mobility, or aesthetics.

How the Compact Green Noise Barrier Works

C-NoBar is engineered as a compact, stationary or mobile noise mitigation system that combines acoustic science with green infrastructure. Unlike conventional concrete or metal noise barriers that rely mainly on reflection, C-NoBar employs dual-face noise attenuation, absorbing sound energy from both sides to reduce overall noise levels in complex urban environments.

The system features multiple slots that can house different acoustic panel materials, allowing it to be customised for varied noise sources and frequency ranges. Movable noise caps further enhance attenuation by redirecting and suppressing sound propagation in multiple directions, making the barrier effective in open, dynamic settings such as highways, flyovers, and construction corridors.

Turning Industrial Waste into High-Performance Acoustic Panels

At the core of C-NoBar is Aco-Pan, an innovative acoustic panel developed using industrial waste materials, specifically waste tyre rubber granules and fly ash. These materials are converted into value-added acoustic panels through an environmentally safe, non-chemical process that does not require pre-treatment of the waste.

Aco-Pan panels demonstrate efficient sound absorption across a wide frequency spectrum, making them suitable for both outdoor and indoor noise control applications. By utilising industrial by-products at scale, the technology addresses two urban challenges simultaneously, noise pollution and waste management, while aligning with circular economy principles.

Green Infrastructure for Smarter Noise Control

A defining feature of C-NoBar is its integrated vegetation cover, supported

Picture Credit: Parkly

by a soil box and drip irrigation system. The vegetation layer plays a functional role by minimising sound reflection and diffusing residual noise, while also contributing to improved microclimate, dust control, and visual appeal.

This green-acoustic hybrid design marks a shift away from purely structural noise barriers toward nature-integrated urban infrastructure, better suited to space-constrained and environmentally sensitive locations.

Designed for Real-World Urban Applications

C-NoBar is designed with mobility, modularity, and scalability in mind. Its symmetrical configuration allows flexible deployment, whether as a temporary noise shield during construction activities or as a semi-permanent installation along traffic corridors. Identified applications include flyovers, highways, indoor facilities, barriers, walls, and enclosures, where conventional noise mitigation solutions are often bulky or impractical.

The system's compact footprint makes it particularly suitable for dense urban settings where land availability and installation time are critical constraints.

Indigenous Innovation with Protected Intellectual Property

The Compact Green Noise Barrier and its associated acoustic panel technologies are backed by Indian intellectual property, including patents, design registrations, and trademarks.

This strong IPR foundation underscores the system's technological maturity and readiness for wider deployment and commercial adoption.

Shaping Quieter, Healthier Cities

C-NoBar represents more than a noise control device; it reflects a shift toward human-centric, sustainable urban design. By combining waste-derived acoustic materials, green infrastructure, and modular engineering, CSIR's Compact Green Noise Barrier offers cities a practical tool to reclaim acoustic comfort without adding environmental burden.

As India moves toward smarter, healthier, and more liveable cities, innovations like C-NoBar demonstrate how science-driven solutions can transform everyday urban challenges into opportunities for sustainable progress.

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Scan to know more

Clear, Light, and Battle-Ready: Glass-Ceramic Bulletproof Breakthrough

Glass developed by CSIR-CGCRI

CSIR-CGCRI's breakthrough proves that the next leap in bulletproof technology isn't thicker glass—but smarter material science.

A sheet of transparent armour that is thinner, lighter, and strong may sound futuristic, but it is already taking shape at the CSIR–Central Glass and Ceramic Research Institute (CSIR-CGCRI) in Jadavpur, Kolkata. At a time when India is rapidly strengthening its defence capabilities, CSIR-CGCRI scientists are reimagining the very material that protects soldiers, vehicles, aircraft, and sensitive installations. Their new glass-ceramic panel blends glass with nanometre-sized crystals to produce a transparent shield that is significantly lighter and tougher than current standards. While conventional bulletproof glass relies on heavy, thick layers that strain engines and obstruct visibility, CSIR-CGCRI's innovation offers a modern, efficient alternative

How the New Glass-Ceramic Armour Works

The material developed at CSIR-CGCRI is created through nanocrystallisation, a process in which extremely small crystals, just 20 to 30 nanometres in size, are uniformly embedded within a specially engineered glass matrix. This transforms the material into a glass-ceramic that behaves very differently from ordinary glass. It becomes harder, tougher, and far more capable of absorbing ballistic impact while maintaining excellent transparency. In initial tests conducted with DRDO Chandigarh, the material successfully stopped AK-47 bullets fired from a distance of ten metres. Future tests will involve multiple shots fired in quick succession to validate full ballistic performance. Because the material derives its resilience from this internal nanostructure rather than sheer bulk, it achieves high ballistic ratings at a fraction of the thickness required by conventional laminates. This structural efficiency is the key engineering breakthrough that distinguishes it from ordinary glass.

Built for India's Defence Needs

The development is being carried out in close collaboration with the Defence Research and Development Organisation (DRDO), with active participation from its establishments in Chandigarh and the Naval Materials Research Laboratory (NMRL) in Maharashtra. Together, scientists are refining the material to meet the rigorous operational standards of the Army, Air Force, and Navy. Moving beyond the laboratory, the project has already garnered significant commercial attention; the institute has signed Memoranda of Understanding with five multinational companies in the presence of NITI Aayog and CSIR leadership. These agreements indicate strong industry interest and pave the way for rapid, commercial-scale production to meet national security demands.

A Homegrown Solution to a Global Challenge

Transparent armour made from glass-ceramics is known in advanced defence ecosystems such as the United States, Israel, and parts of Europe. These systems, however, are extremely expensive, highly specialised, and usually tailored to their own military standards. India has traditionally relied on importing these solutions, often at high cost and without flexibility for local climatic conditions or threat environments. CSIR-CGCRI's glass-ceramic panel stands apart because it is designed and developed entirely within India, using indigenous nanocrystallisation techniques and customised for Indian ballistic requirements.

A Turning Point for India's Protective Materials

The implications of CSIR-CGCRI's innovation extend across the defence ecosystem. By shedding significant dead weight, armoured vehicles gain critical improvements in speed, payload capacity, and manoeuvrability. Drivers and pilots benefit from distortion-free situational awareness, while the streamlined profile reduces engine strain and fuel consumption. These operational gains make the material ideal for weight-sensitive platforms like light helicopters, naval fast-attack craft, and high-mobility reconnaissance vehicles. Beyond the battlefield, the same technology can enhance protection in banks, ATMs, sensitive public buildings, and critical infrastructure. By replacing costly imported solutions with a scientifically advanced, fully indigenous material, CSIR-CGCRI is helping shape a future where India's protective equipment is not only Made in India but engineered for India's unique conditions.

Shaping the Future of Transparent Armour

CSIR-CGCRI's multilayer glass-ceramic bulletproof panel represents more than a materials breakthrough, it reflects a national transition from dependence to capability. By combining advanced glass science, nanotechnology, and defence collaboration, the institute has delivered a transparent armour system that is clearer, lighter, stronger, and entirely homegrown. It is a quiet but powerful leap forward, offering a new protective shield for those who protect the nation and marking a significant milestone in India's journey toward self-reliance in advanced defence materials.

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India's First 3D printed house in Roorkee, Uttarakhand

Building the Future Layer by Layer: Gantry Robot for 3D Concrete Printing

A new construction approach is taking shape—one designed for speed, precision, and rural realities.

Imagine a construction site where walls rise without scaffolding, where shapes once considered too complex for manual labour appear effortlessly, and where homes are printed directly from digital blueprints. This futuristic vision is becoming a reality through the work of scientists at the CSIR–Central Building Research Institute (CSIR-CBRI). Their latest innovation, a Gantry Robot designed specifically for 3D concrete printing, promises to transform India's construction landscape by introducing automation, precision, and speed on a scale never seen before in the sector.

How 3D Concrete Printing Works

At its core, 3D concrete printing works very much like a large industrial version of a desktop 3D printer. But instead of plastic filament, the system extrudes a specially engineered concrete mix, and instead of printing small prototypes, it prints structural walls, modular building parts, emergency shelters, and even entire housing units. The gantry robot developed by CSIR-CBRI provides the strong, stable frame required for this process, guiding the print head across three axes with high accuracy so that each concrete layer is placed exactly where the digital design demands. This ensures uniform walls, precise curves, and complex geometries with remarkable consistency.

Inside the Gantry Robot System

The machine itself is built as a rigid portal-like structure, capable of spanning large construction footprints. Mounted on the gantry is the printer head, fed by a high-performance concrete mix developed in-house to ensure workability, rapid setting, and structural integrity. As the gantry moves, the nozzle deposits concrete in continuous ribbons, building the structure layer by layer. Because the process eliminates the need for formwork and reduces manual involvement, the robot can print complex shapes and hollow walls at a speed far beyond traditional construction methods. CSIR-CBRI has tested this system for printing housing elements, disaster-resilient modules, and transportable units that can be installed on-site, demonstrating its suitability for rapid and large-scale construction.

Why India Needs This Technology

Traditional construction remains slow, labour-intensive, and heavily dependent on formwork, curing cycles, and favourable weather conditions. With India facing massive demand for affordable housing and climate-resilient infrastructure, modernising construction processes is essential. 3D concrete printing addresses these challenges by offering faster construction schedules, higher precision, reduced material usage, and greater design freedom. It also improves safety by reducing the amount of manual work at heights or near heavy equipment. The result is a construction method that is faster, safer, and more sustainable, perfectly aligned with the needs of a rapidly urbanising nation.

Global Context: New but Growing Technology

Globally, 3D concrete printing is an emerging field, with research groups and specialised companies in Europe, the United States, and China demonstrating printed houses, bridges, and modular buildings. While the technology is not entirely new on the world stage, it remains complex, expensive, and often difficult to adapt to local construction materials. This makes CSIR-CBRI's achievement particularly significant. Their gantry robot, along with the printable concrete mix, is fully indigenous and tailored specifically for Indian climatic conditions, domestic cement types, and cost considerations. It fills a critical gap by offering a locally designed, affordable, and scalable alternative to imported systems, which were previously the only option available.

An Indigenous Milestone for India

In India, this marks one of the earliest and most complete demonstrations of a homegrown 3D concrete printing system developed by a national R&D institution. CSIR-CBRI's gantry robot represents a breakthrough: an Indian-built machine powered by Indian materials, capable of addressing Indian construction challenges. It positions the country not just as a user of advanced construction technologies, but as a developer and future exporter of them.

Impact Across Sectors

The potential impact of this innovation extends far beyond the laboratory. With state governments, defence establishments, and housing boards looking for rapid and cost-effective construction solutions, the gantry robot can accelerate the building of affordable homes, emergency shelters for disaster-struck regions, sanitation units for rural areas, and modular structures for defence outposts. In a practical demonstration of its capabilities, CSIR-CBRI has developed a 32 sqm 3D Concrete Printed Pradhan Mantri Awaas Yojana-Gramin (PMAY-G) rural house that integrates multiple advanced features. Notably, the house was constructed at an approximate cost of ₹1.80 lakh and, after printing, was assembled and finished on-site within just five days, demonstrating remarkable speed and cost-effectiveness. It also strengthens India's manufacturing base by encouraging the domestic production of gantry systems, motion-control components, pumping equipment, and specialised concrete mixes.

Printing the Buildings of Tomorrow

In many ways, CSIR-CBRI's 3D concrete printing gantry robot is more than a technological achievement, it is a preview of how India will build in the future. It shows that construction can be cleaner, faster, more affordable, and more creative. By blending digital design with robotic automation and material science, the institute has laid the foundation for a new era in Indian infrastructure. This is not just a machine; it is a quiet revolution rising layer by layer, turning construction sites into factories of the future and helping India literally print the buildings of tomorrow.

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Cool in Summer, Warm in Winter: Solar AC-cum-Heater and the Future of Climate-Resilient Buildings

A unique solar air conditioner and water heater developed by CSIR-CBRI Roorkee for high-altitude regions has been transferred to a Pune company for large-scale deployment. This affordable, sustainable system offers heating and cooling with up to 70% energy savings, proving effective even in extreme temperatures.

As India grapples with rising temperatures, extreme weather events, and growing energy demand, the role of buildings in addressing the climate challenge has become increasingly critical. Ensuring indoor comfort while reducing energy consumption and enhancing resilience is no longer optional, it is essential. Responding to this need, scientists at the CSIR–Central Building Research Institute (CSIR-CBRI), Roorkee, are developing integrated solutions that combine renewable energy systems with climate-resilient building design. Among these innovations, the Solar AC-cum-Heater stands out as a technology that redefines how buildings can intelligently adapt to their environment.

Solar-Powered Thermal Comfort, Year-Round

The Solar AC-cum-Heater developed by CSIR-CBRI is designed to provide both cooling during summer and heating during winter using solar energy as the primary source. By integrating solar thermal and solar photovoltaic technologies with efficient heat exchange and thermal management mechanisms, the system delivers year-round comfort while significantly reducing dependence on grid electricity.

Unlike conventional air-conditioning and heating systems that consume large amounts of power, particularly during peak seasons, this hybrid system optimises energy use by harnessing renewable solar resources. Its modular and scalable design makes it suitable for residential buildings, offices, institutional campuses, and even remote or off-grid locations, demonstrating how clean energy solutions can be seamlessly embedded into everyday infrastructure.

Strengthening Buildings Against Climate Extremes

CSIR-CBRI's work extends beyond individual appliances to the broader goal of creating climate-resilient buildings capable of withstanding environmental stresses such as heatwaves, floods, high winds, and seismic activity. The institute integrates energy-efficient materials, passive cooling strategies, climate-responsive architectural design, and disaster-resistant construction techniques to enhance both structural integrity and occupant safety.

By reducing heat gain, minimising energy demand, and improving overall durability, these resilient building systems help mitigate the impacts of climate variability. When combined with renewable energy technologies like the Solar AC-cum-Heater, they offer a holistic approach to sustainable and safe habitation.

Tailored for India's Diverse Climatic Conditions

India's wide range of climatic zones, from arid and semi-arid regions to cold mountainous areas and humid coastal belts, demands adaptable building technologies. CSIR-CBRI's innovations are developed with this diversity in mind. The Solar AC-cum-Heater is engineered to perform efficiently across varying temperature and humidity conditions, ensuring reliable operation in both hot and cold environments.

By lowering reliance on energy-intensive cooling and heating systems, these solutions also help ease stress on the power grid during peak demand periods. At the building level, the integration of renewable energy contributes to reduced carbon emissions, improved energy security, and more sustainable urban and rural development.

Translating Research into Real-World Solutions

CSIR-CBRI is actively collaborating with government agencies, urban planners, and industry partners to move these innovations from the laboratory to the field. Pilot installations and demonstration projects are validating the technical performance, reliability, and economic viability of the Solar AC-cum-Heater and associated resilient building technologies.

These efforts align closely with national priorities such as Mission LiFE, India's Net-Zero commitments, the Smart Cities Mission, and disaster-resilient infrastructure planning. By offering scalable and indigenous solutions, CSIR-CBRI is supporting wider adoption of climate-responsive technologies across the country.

Building for a Sustainable and Resilient Future

The Solar AC-cum-Heater and climate-resilient building systems developed by CSIR-CBRI represent a strategic shift in the way buildings are designed and operated. By integrating renewable energy, smart thermal management, and robust construction practices, these innovations enable structures that are energy-efficient, climate-adaptive, and resilient by design.

As India moves toward a more sustainable and climate-ready future, CSIR-CBRI's work demonstrates how science-driven innovation can transform buildings from passive energy consumers into active contributors to environmental resilience, turning climate challenges into opportunities for long-term progress.

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Molecular Donuts: The Tiny Sieves Solving Big Industrial Problems

Researchers at CSIR-CSMCRI and IIT-Gandhinagar have developed "POMbranes"—revolutionary synthetic filters made from crown-shaped molecular clusters. By utilizing rigid, one-nanometer "donuts," these membranes achieve ten times the precision of current technology. This breakthrough offers a sustainable, energy-efficient solution for purifying medicines, capturing carbon, and recycling industrial wastewater.

Imagine trying to separate a bucket of fine beach sand from a pile of pebbles using nothing but a large-mesh fishing net. It sounds like a fool's errand; the holes are too big, too uneven, and the sand and pebbles would likely just tumble through together.

In the world of industrial chemistry, scientists face a similar, albeit microscopic, version of this headache. They often need to separate molecules that are nearly identical in size to purify life-saving medicines or clean toxic dyes from textile wastewater. For decades, we have relied on plastic-like polymer filters, but these have a flaw: their pores are flexible and irregular, like a net that stretches and sags, letting the wrong molecules slip through.

Now, a team from CSIR-Central Salt and Marine Chemical Research Institute (CSIR-CSMCRI), in collaboration with IIT-Gandhinagar and international partners, has engineered a solution inspired by the "gatekeepers" of biology. They have built a sieve not out of messy, tangled plastics, but out of precise, microscopic "donuts."

The Magic of the Molecular Donut
The secret ingredient is a cluster called a polyoxometalate, or POM. Specifically, the team used a cluster known as P8, which naturally forms a rigid, crown-like structure.

Think of these P8 clusters as tiny, indestructible donuts. Unlike a rubber band that can be pulled out of shape, the hole in the center of this "donut" is a fixed, permanent 1 nanometer (nm) wide. In the world of the ultra-small, 1 nm is a magic number—thousands of times thinner than a human hair, yet just the right size to act as a definitive boundary for many industrial chemicals.

Finding the Perfect "Tail"
On their own, these POM donuts are like a pile of loose Cheerios; they form brittle crystals that are impossible to use as a flexible filter. To turn them into a usable "membrane"—a thin, fabric-like sheet—the researchers had to get creative with molecular "tails."

The team attached chemical chains (called alkyl chains) to the donuts. These tails act as both glue and shock absorbers, allowing the donuts to self-assemble into a thin film called a POMbrane. However, the length of these tails changed everything:

- The Short Tail (Q4): These tails were too short to fill the gaps between the donuts. Water could flow through the donut holes and the messy spaces between them. It was fast, but leaky and imprecise.
- The Long Tail (Q7 & Q10): These longer chains packed together tightly, completely plugging the gaps between the donuts. This forced every single drop of liquid to pass through the 1-nm holes in the center of the P8 clusters.

Why Precision Matters
By forcing liquids through these uniform "donut holes," the researchers achieved what they call sub-nanometer precision. In tests, the Q7 and Q10 versions could distinguish between molecules based on a weight difference of just 100–200 daltons. To put that in perspective, these POMbranes are roughly ten times more precise than the standard membranes used in industry today.

This isn't just a win for the lab; it's a potential lifesaver for the planet. Currently, industrial separations—like purifying chemicals or processing food—consume nearly 40% to 50% of all global industrial energy because they rely on heat-heavy methods like boiling (distillation).

"These membranes are flexible, stable across different acidity levels, and can be manufactured in large sheets," explains Dr. Ketan Patel, a principal scientist at CSIR-CSMCRI. "This combination is essential if the membranes are to be adopted widely in industry."

A Greener Future
From the textile factories of India, where water recycling is a dire necessity, to pharmaceutical labs where drug purity is paramount, these "molecular donuts" offer a path forward. By mimicking the way nature uses perfectly sized pores to move water through cells, we are moving toward a future where we can filter our most precious resources with the turn of a microscopic key.

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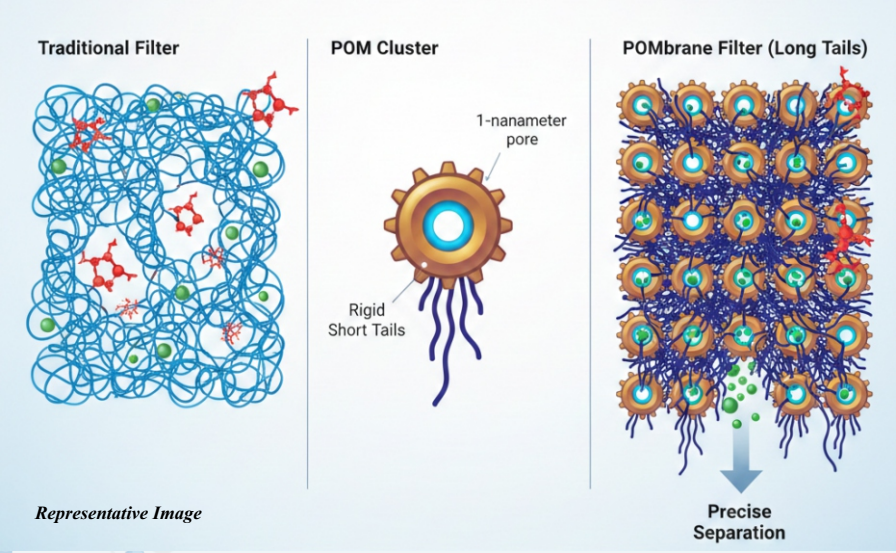

Representative Image

Green Bricks from Gritty Waste: CSIR's New Recipe for Sustainable Cities

India's massive foundry industry generates millions of tonnes of hazardous waste sand annually, threatening soil and water safety. Now, a breakthrough by CSIR-NIIST transforms this toxic industrial by-product into eco-friendly, high-strength building bricks. This "Waste to Wealth" innovation preserves natural resources while providing a green, cost-effective solution for the nation's booming construction sector.

Every time a car engine is cast or a heavy machine part is forged, a silent pile of grit grows in the backyard of India's industrial hubs. This is foundry sand, a high-quality silica sand originally used to create the intricate molds required to hold molten metal. India is the world's second-largest foundry hub, a powerhouse of 5,000 units producing 12 million tonnes of metal castings annually. But this industrial prowess comes with a gritty hangover: roughly three million tonnes of this waste sand are generated every year, enough to bury several city blocks. For decades, this has been a major environmental headache, particularly for small-scale foundries that lack the resources for expensive waste treatment. Now, scientists at the CSIR - National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) have found a way to stop the waste at its source, turning a hazardous burden into a building block—literally.

The Science of "Waste to Wealth"

The challenge with spent foundry sand is its chemistry; once exposed to extreme heat and binders, it loses the structural integrity needed for industrial reuse. Traditionally, making bricks requires natural clay, which is often sourced by stripping fertile topsoil. To break this cycle, the CSIR-NIIST team, under the CSIR "Waste to Wealth" program, systematically studied how this sand reacts with alternative binders like cement, lime, and gypsum. The

result is a cement-bonded compression moulding technique. Unlike traditional clay bricks that must be fired in massive, coal-burning kilns, releasing huge amounts of carbon dioxide and soot, these eco-friendly bricks are "cured" through pressure and chemical bonding. This means the process is not only recycling waste but also significantly reducing the carbon footprint of the building industry.

Better for the Earth, Better for the Builder

These aren't just "filler" bricks. They are engineered to meet the IS - 1077 standards, the gold standard for common building bricks in India. The technology utilizes over 55% foundry sand, meaning every house built with these materials is effectively "locking away" industrial waste that would otherwise pollute the environment.

The advantages are multifaceted:

- Preservation of Nature: It completely avoids the use of natural clay, fertile topsoil, and river gravel—resources that are currently being depleted at an alarming rate to feed the construction boom.
- Zero Firing Emissions: Because the bricks aren't kiln-fired, the process produces virtually no CO^2, aligning with India's green energy goals.
- High Performance: With a compressive strength of over 5 MPa and a density of 1.8 to 2.1 kg/cm³, these bricks are incredibly sturdy, durable, and exhibit low water absorption.
- Versatility: Beyond standard bricks, the CSIR-NIIST technology can be adapted to produce paving tiles, hard aggregates, and interlocks in aesthetically appealing colors for modern architectural interior designs.

A National Blueprint for Green Growth

The scale of the problem is vast, with foundry clusters spread across the country. In North India, the industry is concentrated in Ludhiana, Batala, and Jalandhar in Punjab, and Faridabad and Kaithal in Haryana. In the East, Howrah remains a historic hub. By deploying this technology locally, these clusters can transform their environmental liability into a profitable local economy.

This isn't just a lab experiment; it is a market-ready solution. CSIR-NIIST has already partnered with private industry players and public sector units like Autokast Ltd in Kerala. A new manufacturing unit is designed to consume 30 tonnes of waste sand daily to produce 5,000 high-strength bricks. This collaborative model ensures that the "know-how" moves from the scientist's bench to the factory floor, providing technical assistance for machinery procurement and plant design.

Building the Future

This "Green Initiative" is poised to fuel massive government projects, such as the 'House for All' mission and Kerala's Life-Mission Project, which aims to provide homes for 1.6 lakh families. By substituting expensive, scarce natural materials with recycled industrial by-products, the cost of construction drops, making sustainable housing a reality for the masses.

As we look toward a future of rapid urbanization, the "Waste to Wealth" program offers a glimpse of a circular economy in action. By turning the "grit" of our industrial past into the "granite" of our future homes, we are not just cleaning up our backyard, we are building a more resilient, eco-friendly nation. The message from the labs of CSIR-NIIST is clear: the future of our cities isn't just built on new ground; it's built on the clever, scientific reuse of what we once threw away.

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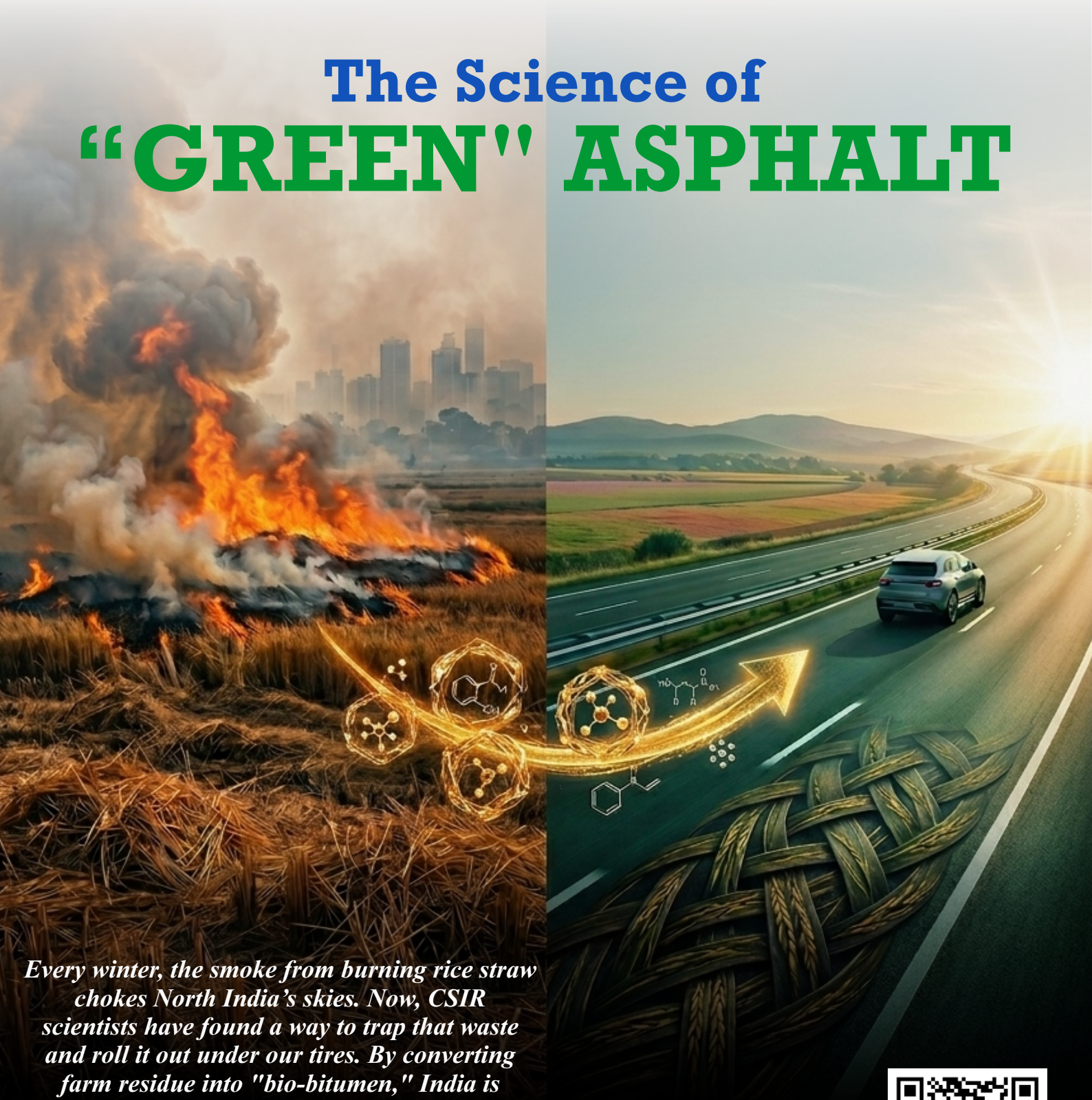
Bricks from Foundry Silica Sand

Can Crop Waste Fix Roads?

The Science of "GREEN" ASPHALT



Every winter, the smoke from burning rice straw chokes North India's skies. Now, CSIR scientists have found a way to trap that waste and roll it out under our tires. By converting farm residue into "bio-bitumen," India is cutting pollution, saving billions in imports, and building a greener future—one kilometer at a time.

Scan to know more

Every winter, a familiar, gray shroud descends upon Delhi. It is the season of "the smog," a period when the air thickens with the remnants of millions of tons of rice straw being burned in nearby fields. For years, this agricultural waste—or stubble—has been framed as a seasonal villain.

For a long time, this practice has remained a primary source of air pollution with no significant solution in sight—a crisis that desperately needed a scientific breakthrough to turn a recurring disaster into an opportunity. What if the smoke that chokes the sky could be trapped, transformed, and rolled out under our tires instead? Scientists at CSIR-Central Road Research Institute (CSIR-CRRI) have developed a "bio-bitumen" technology that turns crop residue into the sturdy binder that holds our roads together.

In 2021, CSIR-CRRI scientists Dr. G. Bharath and Dr. Ambika Behl asked a bold question: Could the very stubble causing the pollution crisis replace some of this expensive petroleum? Working alongside the CSIR-Indian Institute of Petroleum (CSIR-IIP), the team spent three years refining a way to turn biological waste into industrial infrastructure.

The Alchemy of Pyrolysis

How exactly do you turn brittle yellow straw into a viscous black liquid? The team uses a process called pyrolysis. To a scientist, pyrolysis is the thermal decomposition of materials at high temperatures in an inert atmosphere. To the rest of us, it's a bit like "baking" the straw without letting it catch fire.

The process is ingenious yet simple. First, the rice straw is collected from farms and compressed into small, dense pellets. These pellets are then heated in a chamber where oxygen has been removed. Because there is no oxygen, the straw cannot burn. Instead, the heat breaks the straw down into three things: a gas, a charcoal-like substance (bio-char), and a dark, sticky liquid called bio-oil.

It is this bio-oil that holds the magic. It possesses natural adhesive properties remarkably similar to petroleum bitumen. By blending this bio-oil with traditional bitumen—typically replacing about 15% to 30% of the fossil-fuel product—the scientists created a "green" asphalt mix that meets rigorous national standards.

From the Lab to the Rain-Soaked Highway

But does a road made of plants actually last? The results from the field suggest it might even be better than the original. In 2024, the team laid a trial stretch of road on the Jorabat–Shillong Expressway in Meghalaya—a region famous for its relentless, punishing rains.

After two full monsoons, the road hasn't just survived; it has maintained high-speed highway quality. The scientists found that bio-bitumen is remarkably resilient; it resists "rutting" (the grooves made by heavy tires), prevents moisture damage, and can even withstand the blistering heat of a Delhi summer better than conventional asphalt.

A Multi-Billion Rupee Windfall

"This day will go down in history as India enters into an era of 'Clean, Green Highways'," stated Dr. Jitendra Singh, Hon'ble Union Minister for S&T, during a recent technology transfer ceremony in New Delhi. He described the initiative as a "Whole-of-Nation" approach, transitioning India's highways from fossil-fuel dependency to bio-driven, regenerative solutions.

The economic implications are as massive as the environmental ones. Dr. Singh highlighted that India currently imports nearly 50% of its bitumen. This indigenous innovation holds the potential to replace imported bitumen worth ₹25,000–30,000 crore annually. Beyond the savings, roads built with this technology require a smaller budget and offer a more sustainable lifespan, all while being free from the hazard of environmental pollution.

The benefits are twofold

Environmentally, it provides a "circular economy" solution—giving farmers a reason to sell their stubble rather than burn it, which clears the winter skies. Economically, the impact is even larger. Hon'ble Union Minister Shri Nitin Gadkari noted that with just 15% blending, India could save nearly ₹4,500 crore in foreign exchange.

Paving the Path Forward

Within the next few months, the CSIR-CRRI plans to pilot bio-bitumen on the key arterial roads of Delhi. The beauty of this innovation is its compatibility; it works with the machinery and contractors we already have. It doesn't need to reinvent the wheel to lay a bio-bitumen road.

It is a poetic solution to a modern crisis. The very material that once darkened the skies and clouded the vision of drivers may soon be the very thing providing them with a smoother, more sustainable path forward. In the quest for a "Viksit Bharat" (Developed India), the road to the future is quite literally being paved with the waste of the past.

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A Staple Reimagined: The High-Protein, Low Glycemic Index Rice Set to Transform Indian Kitchens

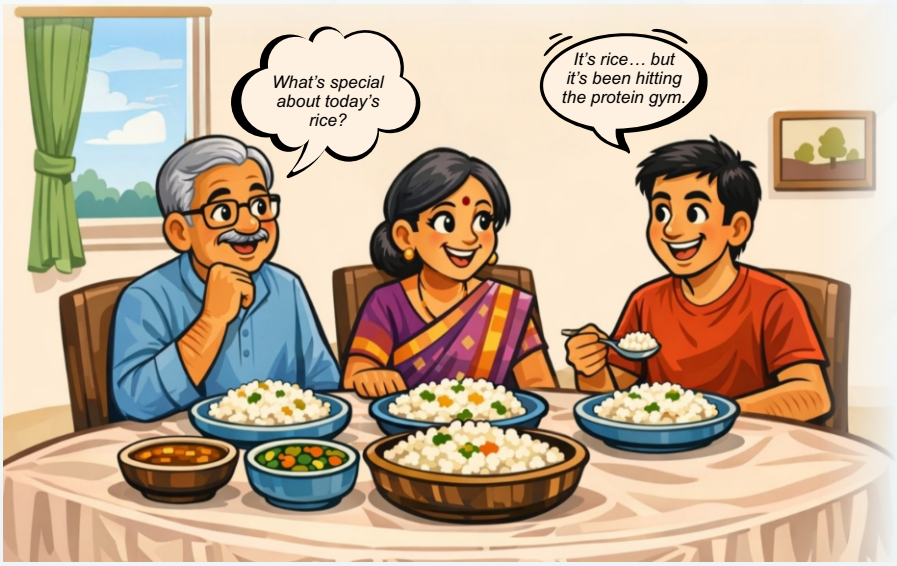
India's favorite staple is getting a high-tech makeover. Scientists at CSIR-NIIST have developed a "designer rice" that packs three times the protein of normal grains while maintaining a low glycemic index to help manage diabetes. By transforming broken rice into a nutrient-dense powerhouse, this innovation aims to nourish millions and tackle malnutrition one plate at a time.

For generations, the rhythmic sound of a pressure cooker's whistle has been the heartbeat of the Indian kitchen. Inside, more often than not, is white rice—the fuel for over half the global population. But for all its comforting warmth, polished white rice carries a silent burden: it is mostly starch, which the body quickly turns into sugar, contributing to a rising tide of Type 2 diabetes.

What if the grain that anchors our daily diet could become a targeted tool for managing our most pressing health challenges? At the CSIR-National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) in Thiruvananthapuram, researchers have moved beyond simple fortification to develop "Designer Rice." This is not a grain with vitamins and minerals merely sprayed onto its surface; it is a fundamental re-architecture of our most basic staple. By deconstructing the rice grain into its primary components—starch, protein, and fiber—and then precisely reassembling them, scientists have created a nutrient-dense food that functions as a proactive, structural solution for metabolic health. This process allows the rice to retain its familiar taste and cooking properties while delivering a superior nutritional profile.

The Architecture of a Grain

"Think of it as food architecture," explains Dr. C. Anandharamakrishnan, Director of CSIR-NIIST and the visionary behind the project. To understand this, imagine a building. If traditional rice is a house made mostly of "sugar bricks" (starch), the CSIR-NIIST team took that house apart. They



removed a significant portion of the starch and replaced it with "protein beams."

By using food-processing technology rather than genetic modification, the team took broken rice, the bits usually sold at a discount—ground them into flour, and blended them with protein and micronutrients like iron, folic acid, and Vitamin B12. They then "reformed" this mixture into grains that look, feel, and taste exactly like the rice we know.

Solving the "Hidden Hunger"

India faces a paradoxical health crisis. On one hand, we are the "diabetes capital of the world," where the high Glycaemic Index (GI) of white rice causes blood sugar to spike dangerously fast after a meal. On the other hand, millions suffer from "hidden hunger"—deficiencies in protein and minerals despite eating enough calories.

The designer rice hits both targets at once:

- Low GI (Below 55): It releases energy slowly, preventing the sugar spikes that plague diabetics.
- Protein Powerhouse: While normal rice has about 6–8% protein, this version boasts over 20%.
- Fortified Defense: It bridges the gap for anaemia by embedding iron, folic acid and Vitamin B12 directly into the grain's structure.

Beyond the Lab

The most brilliant science is useless if it stays in a test tube. To bridge the "valley of death" between a lab prototype and your local grocery store, CSIR-NIIST has officially transferred this technology to industry giants like Tata Consumer Products Limited.

"It tastes even better than normal rice because of the increased protein," says Dr. Anandharamakrishnan. Most importantly, it doesn't require people to change their culture. You don't have to switch to expensive quinoa or salads; you just keep eating the rice you love, but with three times the nutrition.

As we look toward a future of sustainable living, this innovation also champions a "circular economy." By using broken rice grains—a byproduct of the milling process—scientists are creating an opportunity for farmers to add value to a resource that was previously underutilized. From the lab in Kerala to the plates of millions, the humble rice grain has officially been upgraded. It's no longer just a side dish; it's a prescription for a healthier nation.

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Scan to know more

Beyond the Sewer: A Sustainable Solution for India's Growing Septic Challenges

With over half of India's urban households operating outside the central sewer network, managing faecal sludge has become a pressing environmental challenge. Innovative indigenous technology from CSIR-NEERI is now transforming this waste into nutrient-rich, pathogen-free organic manure. By combining mechanical dewatering with rapid drying, these new plants offer a scalable, circular solution for sustainable urban sanitation.

Flush, and forget. For most of us, that's where the story ends. For about a third of urban India, the "out of sight, out of mind" rule of the flush holds true, waste travels through a labyrinth of sewers to a distant treatment plant. But for the majority, roughly 53% of urban households, the story is more localized. Their waste settles into septic tanks and pits, slowly accumulating into a thick, nutrient-rich, but contagious material called faecal sludge.

As we expand sanitation coverage under the Swachh Bharat Mission, we are successfully moving away from open defecation. But this success creates a new challenge: what do we do with the mountains of digested sludge left behind in these tanks? For years, this "non-sewered" waste was a logistical headache, often dumped illegally or clogging up systems not meant to handle it. However, CSIR – National Environmental Engineering Research Institute (CSIR-NEERI) has developed a way to stop seeing this sludge as a burden and start seeing it as a bridge to sustainable agriculture.

The Science of the "Big Squeeze"
The solution lies in a specialized process called the Mechanical Dewatering & Drying System (MDDS). It sounds complex, but it essentially works like a high-tech solids-liquid separation and oven drying.

The first step is a bit of chemistry: Lime and poly-electrolyte addition. By adding a 10% lime and 0.1% solution, the scientists stabilize the sludge. This does two vital things: it kills the sharp, unpleasant odor and alters the physical structure of the sludge to make it easier to filter.

Next comes the mechanical lifting. The sludge is fed into a Rotary Drum Screen and Screw Press Compactor. Here, the material is squeezed with immense pressure, separating the liquid from the solids. The liquid moves toward treatment, while the remaining "cake" of solids is transported via a belt conveyor to an LPG-fired dryer.

In the dryer, high temperatures (90 – 95oC) perform the ultimate safety check. They destroy pathogens, the bacteria and viruses that cause disease and drive off any remaining moisture. What emerges at the end is no longer waste; it is a dry, stable, and nutrient-dense product.

From Hazard to Harvest
The brilliance of the MDDS technology is its output. The resulting material isn't just "safe"; it is organic manure that meets the strict Indian Standards (Fertiliser Control Order 2013) set by the Ministry of Agriculture. It is rich in nitrogen and phosphorus, the very ingredients farmers buy in chemical form to enrich their soil.

In Chandrapur, Maharashtra, a new plant with a capacity of 25,000 liters every eight hours is now in operation. It can process roughly 20 truckloads of sludge daily, turning a potential environmental hazard into 100 kg of high-quality fertilizer.
Compact Solutions for Local Needs

While the Chandrapur plant handles heavy urban loads, CSIR-NEERI has also pioneered a smaller, "nature-based" version for decentralized use: the Compact Faecal Sludge/Septage Separation and Treatment (CFSST) plant. Recently demonstrated at Ramtek, this system uses an Upflow Anaerobic Baffled Reactor (UABR) and constructed wetlands to treat waste. It's a low-energy solution where the treated water is clean enough for gardening or floriculture, and the solids become soil-enriching manure.

A Cleaner Future
By implementing these indigenous technologies, India is addressing two Sustainable Development Goals at once: Clean Water and Sanitation (SDG 6) and Sustainable Cities (SDG 11). These plants prevent the pollution of our groundwater and provide farmers with an affordable, eco-friendly alternative to chemical fertilizers. As these models are replicated across other urban local bodies, the "unseen journey" of our waste will increasingly end not in a landfill, but in a field, helping to grow the food of tomorrow.

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Sal Seed Butter: How a Forest Seed is Shaping New Livelihoods

Sal seed butter, derived from the seeds of the sal tree, is emerging as a sustainable, plant-based resource with wide industrial potential. A CSIR–Central Mechanical Engineering Research Institute (CSIR-CMERI) initiative is transforming this overlooked forest produce into a science-led livelihood opportunity for tribal communities in Junglemahal. The story highlights how technology, tradition and community participation are shaping a new rural value chain.

Every summer, the sal forests of eastern India carpet the forest floor with millions of seeds shed by the sal tree (Shorea robusta). Small, brown and rich in oil, these sal seeds represent a largely underutilised forest resource. From them is derived sal butter—a non-traditional yet valuable vegetable fat that naturally solidifies at room temperature after oil extraction. Known for its excellent moisturising, healing and emollient properties, sal butter has been used for centuries in traditional Indian practices, particularly for skin care and wound healing.

Today, this age-old knowledge is being revitalised through modern science. In Molandighi, on the forest fringes of West Bengal's Junglemahal region, a science-led initiative of the CSIR–Central Mechanical Engineering Research Institute (CSIR-CMERI), Durgapur, is transforming this overlooked forest produce into a sustainable livelihood resource. By integrating mechanical innovation with community participation, the initiative is enabling tribal families to convert fallen sal seeds into value-added products, linking forest bioresources with inclusive rural development.

From Forest Seed to Valuable Butter

What makes a forest seed "butter"? Scientifically, sal seeds are a non-traditional but potent source of vegetable fat. The magic lies in their chemical composition. Sal butter is primarily composed of stearic acid and oleic acid accompanied by smaller proportions of palmitic acid and linoleic acid. These fatty acids are the building blocks that give the butter its unique physical properties. Stearic acid provides firmness and a high melting point, while oleic acid adds moisturizing qualities. This combination makes sal butter an ideal "cocoa-butter substitute"—a high-demand ingredient in the chocolate industry—as well as a stable base for soaps and high-end cosmetics.

A Scientific Solution to a Seasonal Challenge

Despite its potential, sal butter production has long been constrained by the seasonal nature of sal flowers. They bloom only between May and June and are highly perishable, making long-term storage difficult. Sal flowers are particularly susceptible to fungal infestation, and the use of pesticides during storage can affect oil quality, making immediate processing essential, Dr. Pranab Samanta, Senior Principal Scientist, CSIR-CMERI, pointed out.

Recognising this bottleneck, CSIR-CMERI focused on immediate, decentralised processing. The institute developed a machine that performs simultaneous shelling and grading of sal flowers, producing clean seeds suitable for extraction. The seeds are then sun-roasted or heated and processed using an expeller machine. When the extracted oil is left at room temperature, it naturally solidifies into sal butter—without requiring complex downstream processing. The team found that combining shelling and grading into a single operation significantly improves efficiency and makes the technology suitable for rural deployment.

When Technology Meets the Community

In villages such as Chuha, near Molandighi, around 30 tribal families are now part of this emerging value chain. Their role begins with collecting fallen sal seeds during the season and supplying them for processing.

To support this transition, CSIR-CMERI conducted training-cum-workshop programmes, introducing villagers to seed handling, machinery operation and basic quality standards. An NGO has been involved from the outset as a mediator, helping bridge scientific intervention with community participation and early commercial engagement.

One of the major challenges in remote areas is the lack of access to machinery and technical knowledge, which is why training and awareness are as important as the technology itself, Dr. Samanta emphasised.

Unlocking a National Opportunity

Sal forests, concentrated across eastern and central India, generate nearly 1.5 million tonnes of sal seeds annually, with the potential to produce about 1.8 lakh tonnes of sal fat. Yet, due to limited processing and organised value chains, only around 9,000 tonnes are currently utilised.

Although the sal tree is region-specific, sal butter represents a national opportunity—as its processing, value addition, and use in food, cosmetics, and wellness products can be scaled across India. With rising global demand for sustainable, plant-based ingredients, sal butter offers a promising forest-based bioeconomy pathway linking tribal regions to national and international markets.

The Road Ahead

Over the next five years, CSIR-CMERI aims to expand the initiative to more tribal villages, establish decentralised processing units, and strengthen skill development and capacity-building programmes. "Our vision for the next five years is to expand this model to more tribal villages, introduce decentralised processing units and build a strong rural value chain that makes sal butter a commercially viable product," added Dr. Samanta. The larger goal is to position sal seed butter as an environmentally responsible product in national and global markets, while securing dignified livelihoods for forest-dependent communities.

Once overlooked and underfoot, sal seeds are now at the centre of a quiet transformation proving that when science works closely with people and nature, even the smallest forest seed can shape a larger future.

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Sal seeds collected from forest floors

Scan to know more

U-AST kit: pink signals resistant bacteria and no color change confirms an effective antibiotic match

The Pink Signal: A ₹15 Shield Against a Widespread Silent Threat

A silent UTI epidemic claims thousands in India, fueled by delayed, costly diagnosis. Scientists at CSIR-CSMCRI unveil a ₹15, nine-hour "pink" test that reveals infection and the right antibiotic at a glance. By replacing guesswork with speed and simplicity, this tiny kit could transform rural healthcare and fight antibiotic resistance.

In 2019, while the world's attention was beginning to pivot toward a global pandemic, a quieter crisis was already claiming lives. That year, over 400 million people worldwide suffered from Urinary Tract Infections (UTIs), resulting in nearly 236,000 deaths. India felt the weight of this crisis more than most, seeing 10 crore cases and more than 55,000 deaths.

For most, a UTI is seen as a painful nuisance—a burning sensation or a frequent urge to go. But for many in rural India, where clean water is scarce and diagnostic labs are miles away, a simple infection can spiral into kidney failure or life-threatening sepsis. The barrier to safety isn't just distance; it is time and money.

Now, a team of scientists at the CSIR–Central Salt & Marine Chemicals Research Institute (CSIR-CSMCRI) in Bhavnagar has developed a tool that could turn the tide. It is a rapid, low-cost test kit that does in nine hours what currently takes three days, and it costs less than a cup of tea to produce.

The Bottleneck of the "Gold Standard"

To treat a UTI effectively, doctors need to know two things: is there an infection, and which antibiotic will kill it?

The current "gold standard" involves sending a sample to a lab for microscopy and culture testing. This process is slow, often taking 48 to 72 hours as technicians wait for bacteria to grow in Petri dishes. It is also expensive, costing between ₹1,000 and ₹3,000. In many semi-urban and rural areas, these labs simply don't exist. Patients are often forced to travel to distant cities just for a report.

While they wait, many are given "empirical" treatment—essentially, a doctor's best guess at an antibiotic. If the guess is wrong, the bacteria keep multiplying, and the patient gets sicker. Even worse, this guesswork fuels Antimicrobial Resistance (AMR), where bacteria evolve to "outsmart" our best medicines because they were used incorrectly.

Simplicity by Design

The new solution, called the U-AST (Urinary Antibiotic Susceptibility Test) kit, aims to eliminate the guesswork. Developed by a team led by Dr. Soumya Haldar, Chief Scientist, CSIR-CSMCRI and Maheshwari J. Behere, Research Scholar, CSIR-CSMCRI the kit replaces high-end machinery with elegant chemistry. The kit uses a colorimetric format. In the world of science, "colorimetric" is just a fancy way of saying it changes color

Dr. Soumya Haldar and his research team

to tell if there is any infection. The kit consists of a small tube and a membrane. “The membrane used is made of PVDF of size 1 cm2, it is coated with glucose, graphene oxide, double strength nutrient broth and tetrazolium dye. The membrane is simply kept in tube” explained Dr. Haldar to Science Communication and Dissemination Directorate (SCDD), CSIR-HQ.

When a urine sample is added, the membrane interacts with any bacteria present. If the urine sample turns pink, the patient is considered to have an infection. The pink colour is because of bacterial metabolism. If the color remains unchanged, it means the bacteria have been eliminated by the antibiotic being tested. It is a visual "yes or no" that can be read by the naked eye, requiring no specialized training or expensive laboratory equipment. Dr. Haldar explained the logic behind the color change: “If there is change in color to pink that means the bacterial community present in that urine sample is resistant for that particular antibiotic, if there is no change in color that means the bacterial community present in that urine sample is susceptible for that particular antibiotic.”

A Game-Changer for Rural Healthcare

The most transformative feature of the U-AST kit is its cost. While a standard lab test can drain a month’s savings for a low-income family, the manufacturing cost of this kit is roughly ₹15. Even when mass-produced and marketed, it is expected to cost only a fraction of traditional tests.

Furthermore, the kit requires no cold-chain logistics—the expensive refrigerated transport systems usually needed for medical supplies. This makes it perfect for primary health centers in remote corners of India.

According to Dr. Haldar, the kit allows health workers to detect infection and antibiotic sensitivity within a single working day. This means a patient can provide a sample in the morning and begin the correct treatment by evening.

Beyond Detection

The U-AST kit does more than just spot an infection; it provides a roadmap for recovery. “Our aim is to test antibiotic resistance profile of infecting bacterial community as early as possible so that doctors can prescribe proper and targeted antibiotics to the patient to give fast relief and cure,” Dr. Haldar explained. By ensuring that only the necessary medicines are used, the kit acts as a frontline soldier in the global fight against AMR. “It gives an idea about the overall infection and antibiotic resistance profile” added Dr. Halder.

The research, recently published in a journal of the Royal Society of Chemistry (DOI: 10.1039/d4ay00632a), has already been validated using samples from clinical laboratories. Now, the CSIR-CSMCRI team is in talks with pharmaceutical companies to bring this innovation to the masses. For the team, true success is measured by the impact on public health. Widespread adoption would be defined by reduced use of broad-spectrum antibiotics, higher first-line treatment success, and fewer treatment recurrences. Ultimately, this leads to lower healthcare costs and stronger antibiotic stewardship in the rural settings that need it most.

By shrinking a three-day ordeal into a nine-hour wait, and a ₹3,000 bill into a pocket-change expense, these scientists aren't just localizing healthcare—they are democratizing it. In the battle against microscopic invaders, the most powerful weapon might just be a small tube that turns pink.

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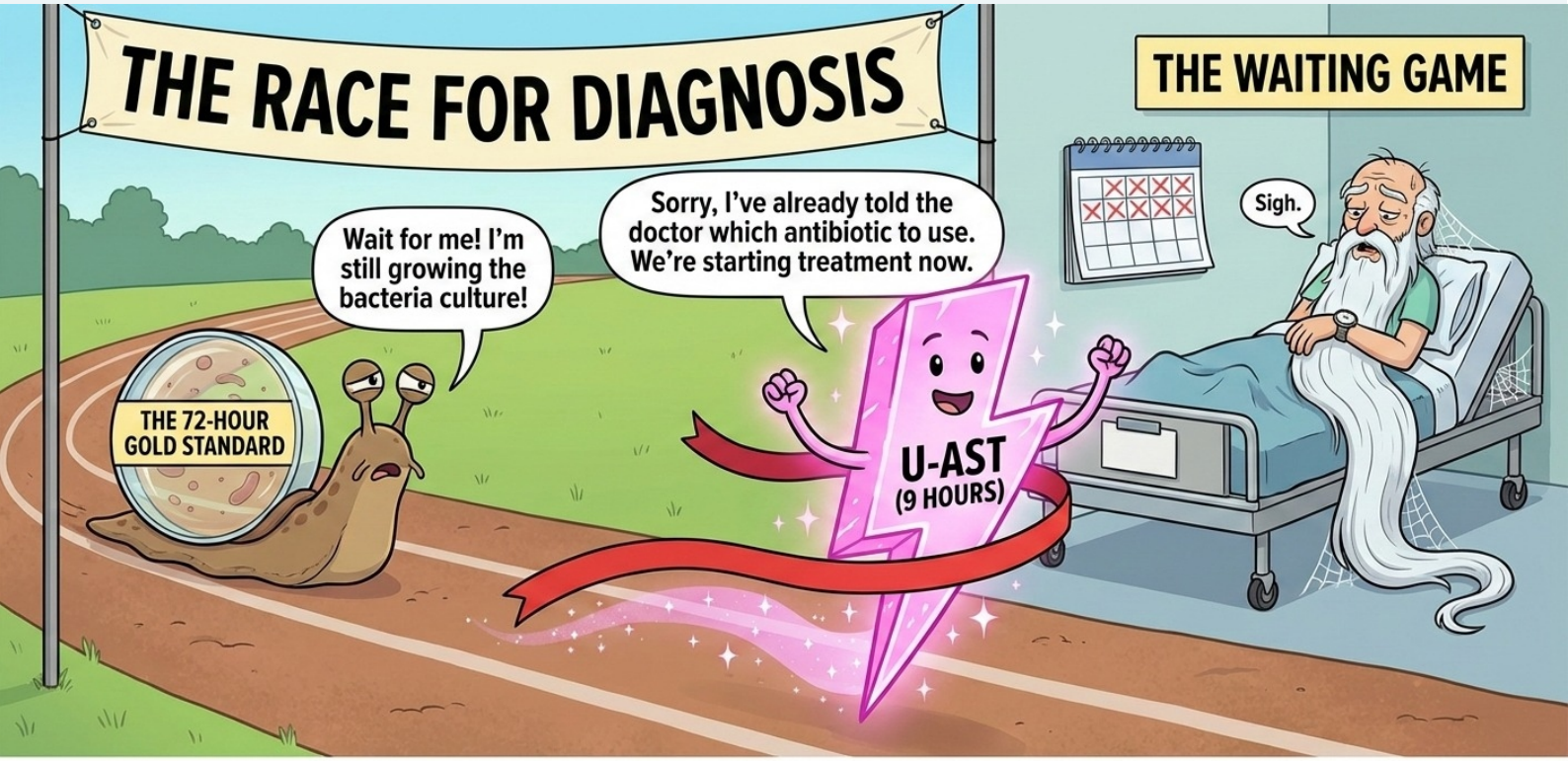


Shrinking days into hours. Saving lives in real-time

Healing with Silk: A Next-Gen Collagen Gel for Faster Recovery

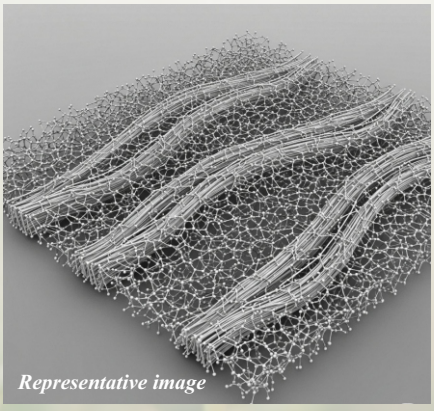
Silk steps beyond fabric into healing, as scientists reimagine it for faster skin repair. At CSIR-Central Leather Research Institute, a photo-activated silk–collagen gel is engineered to gently accelerate tissue regeneration. Stable, patient-friendly, and powerful, this next-gen hydrogel could redefine wound care for chronic and fragile skin.

Silk has always been known for its uses in premium quality cloths and prized for how it feels on the skin. But scientists in Chennai are now giving silk an interesting purpose, helping the skin heal itself. At the CSIR-Central Leather Research Institute (CSIR-CLRI), researchers have engineered a cutting-edge wound-healing gel by blending silk fibroin with a synthetic collagen-like protein. They call it Photo-activated Silk fibroin and Collagen-like Protein Hydrogel (PASCH), a promising new material designed to accelerate tissue repair while avoiding many of the limitations of traditional treatments.

Silk and Collagen

Silk fibroin, a natural protein extracted from silkworm cocoons, is already known for being gentle on the body. Its biocompatibility and strength make it attractive for biomedical innovations, from sutures to scaffolds. But on its own, silk fibroin has a drawback, it doesn't provide an ideal environment for cells to grow, multiply, or migrate, all of which are essential during wound healing.

Collagen is the structural protein that holds our skin and connective tissues together. Collagen-based dressings are already used widely because they support cell adhesion and repair. But natural collagen can cause allergic reactions, degrade too quickly, or carry risks associated with animal-derived products.



Representative image

To overcome these issues, the CSIR-CLRI team, led by scientist Dr. Niraikulam Ayyadurai, used a lab-engineered collagen-like protein (CLP-BS) instead. This synthetic version mimics the architecture and function of collagen without the biological instability, unpredictability, or immune risks of natural sources.

How PASCH Comes Together

A key innovation lies in how the two proteins, silk fibroin and CLP-BS, are combined. Instead of relying on harsh chemicals or ultraviolet radiation, the researchers used safe blue visible light along with riboflavin (vitamin B2). When exposed to this light, riboflavin activates the formation of dityrosine crosslinks, strong chemical bonds that "lock" the proteins together into a stable, flexible gel.

This photo-activation method is gentle, quick, and avoids any potentially toxic by-products. It also gives more control over the gel's structure, making it easier to fine-tune for medical use.

Among the different ratios tested, a 7:3 blend of silk fibroin to collagen-like protein turned out to be the most effective. This formulation created a porous network, almost like a microscopic sponge, that allowed skin cells to attach, spread, and migrate easily. Such porosity is essential for oxygen flow, nutrient exchange, and the movement of repair cells into the wound bed.

Designed for Real-World Wounds

One of PASCH's standout strengths is its practicality. The hydrogel can be spread directly on a wound and stays in place without the need for frequent dressing changes. Its texture helps maintain a cool, moist environment, conditions known to promote faster healing and reduce patient discomfort.

Importantly, PASCH is stable at room temperature, even around 27°C, and does not require special storage. This could make the gel especially valuable in rural clinics, emergency kits, and home care settings where refrigeration is limited.

Researchers point out that the hydrogel's properties make it particularly suitable for diabetic ulcers, burns, and chronic wounds that require long-term management. As the gel slowly biodegrades, it absorbs excess fluid and supports tissue rebuilding without irritating surrounding skin.

"The hydrogel would benefit elderly patients the most. Their skin is fragile, and frequent dressing is difficult. A self-managing gel that maintains hydration and supports healing without extra help is ideal," says Ayyadurai.

A Step Toward Next-Generation Wound Care

With the initial studies showing strong potential, the team is now preparing for clinical trials. These will evaluate PASCH's safety and performance in real patients, including those with chronic wounds, burns, and age-related skin fragility.

The researchers are also exploring other hybrid materials that pair natural and synthetic proteins to create smarter, more responsive wound dressings. Their goal is to engineer treatments that not only close wounds faster but also improve the quality of the healed tissue. PASCH could mark a major leap forward in wound care blending the elegance of silk, the strength of collagen, and the precision of modern bioengineering into a single, patient-friendly gel.

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Scan to know more

Revolution in Wall Plastering: A Smart Innovation

From labour-intensive drudgery to precision-driven efficiency, this indigenous innovation is set to transform how walls are built in India.

Over the years, construction sites across India have evolved from purely manual, labour-intensive work to the use of modern machinery for various activities. Small, low-rise structures have given way to high-rise buildings and skyscrapers with increasingly tight deadlines. Yet, one age-old task has largely remained untouched by modernisation—wall plastering.

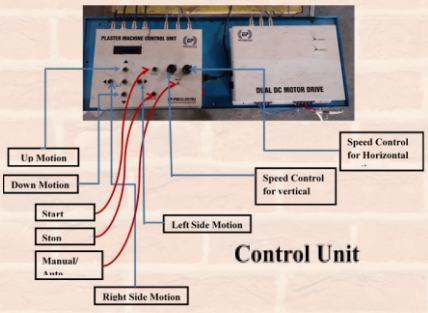
With India's urban boom accelerating under initiatives such as Housing for All, the demand for faster, efficient, and consistent construction methods has never been greater. What if a machine could transform the tedious and physically demanding task of plastering into a precise, semi-automated operation?

Scientists at CSIR-Central Building Research Institute (CSIR-CBRI), Roorkee, have done exactly that by developing a Semi-Automatic Wall Plastering Machine—a smart solution that speeds up construction while ensuring uniform and high-quality finishes.

The "Smart Innovation": Wall Plastering Machine

The team led by Dr. S. K. Panigrahi at CSIR-CBRI worked on a simple yet powerful idea—not to replace the mason, but to upgrade the mason. The outcome is a semi-automatic wall plastering machine designed specifically for Indian construction site conditions.

The machine is lightweight, portable, and robust enough to handle uneven brickwork commonly found on sites.



Control Unit

Most importantly, it enhances human effort rather than eliminating it—making skilled work less tiring, faster, and more consistent.

Challenges of Traditional Plastering

Plastering plays a critical role in a building's aesthetics, durability, and thermal performance. However, conventional manual plastering continues to face several persistent challenges. The process is heavily dependent on the availability of skilled labour, making quality inconsistent across sites. Variations in plaster thickness and surface finish are common, often leading to rework and compromised aesthetics. Manual methods also result in significant material wastage and slow execution, which can delay project timelines. Additionally, the physically demanding nature of plastering exposes workers to fatigue, musculoskeletal strain, and safety risks.

Three-Step Process to a Smooth Wall

The plastering machine simplifies the entire operation through a structured three-step process. In the first stage, a motor powered by a Variable Frequency Drive (VFD) spreads the mortar evenly across the wall surface. This significantly reduces the physical effort required from workers while ensuring uniform mortar application.

In the second stage, levelling or screeding is carried out using a thread-mounted mechanism that precisely controls plaster thickness. The system allows easy adjustment of coating thickness, enabling both thin skim coats and thicker plaster layers to be applied as per site requirements.

The final stage focuses on finishing, where a power trowel moves smoothly over the plastered surface. This ensures a uniform, smooth, and paint-ready finish, eliminating the inconsistencies often seen in manual plastering.

Proven Performance in Field Trials

Field trials conducted by CSIR-CBRI demonstrated the strong performance of the machine under real construction site conditions. The trials showed that plastering could be completed two to three times faster compared to traditional manual methods. The machine consistently produced uniform thickness and superior surface finish while significantly reducing material wastage. Workers experienced lower fatigue levels due to reduced physical strain, leading to improved ergonomics and enhanced overall site safety.

Building the Future

As India moves rapidly towards modern infrastructure, urban housing, and commercial development, the construction sector must evolve beyond traditional practices. The CSIR-CBRI Wall Plastering Machine stands as a strong example of how indigenous research and development can smartly enhance existing workflows. By reducing labour stress, improving productivity, and accelerating project timelines, this innovation aligns perfectly with the nation's construction needs.

In the journey towards a Viksit Bharat, this breakthrough reflects how hard-working hands, empowered by modern engineering, can truly build the walls of the future.

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Plastering Machine in Working


Sprayed mortar on wall


Finished Plastered Wall

From Marine Problem to Medical Promise: How Jellyfish Could Heal Human Bodies

What once clogged fishermen's nets may soon power the next generation of biomedical materials.

Every year, large swarms of jellyfish drift across India's coastal waters. For fishermen, they clog nets and disrupt fishing operations. For coastal industries, they can interfere with intake systems and marine activities. For decades, these gelatinous creatures have largely been viewed as a nuisance—an inevitable consequence of changing marine ecosystems.

But what if this marine challenge could be transformed into a biomedical opportunity?

Scientists at the CSIR–National Institute of Oceanography (CSIR-NIO), Goa, are exploring exactly that possibility by extracting high-value marine collagen from jellyfish, a sustainable biomaterial with promising applications in healthcare, nutraceutical, cosmetics and regenerative medicine.

Why Collagen Matters

Collagen is the most abundant structural protein in the human body. It forms the basic framework of skin, bones, cartilage, connective tissues and blood vessels, helping maintain strength, elasticity and structural integrity.

Because of these properties, collagen plays an important role in several biomedical and industrial applications. It is widely used in wound-healing materials, tissue engineering scaffolds, drug delivery systems and cosmetic formulations designed to support skin repair and anti-ageing treatments.

Traditionally, commercial collagen is obtained from bovine (cow) and porcine (pig) sources. However, these conventional sources raise several concerns, including the risk of disease transmission, religious and cultural restrictions in certain communities, and the environmental footprint associated with livestock production.

These limitations have encouraged scientists to explore alternative and safer sources of collagen, and the ocean has emerged as a promising frontier.

The Jellyfish Advantage

Jellyfish offer a surprisingly attractive alternative. Research indicates that collagen derived from jellyfish shows high compatibility with human tissues and carries a lower risk of immune reactions. It is also naturally biodegradable and free from the zoonotic disease concerns sometimes associated with mammalian sources.

Recognising this potential, researchers at CSIR-NIO began studying India's abundant jellyfish populations—particularly species that are often discarded as by-catch or treated as marine waste. By examining these underutilised organisms, scientists identified an opportunity to transform a marine problem into a valuable biomedical resource.

From Marine Biomass to Biomedical Material

Extracting collagen from jellyfish is scientifically challenging. Jellyfish bodies consist of nearly ninety-five percent water, making them fragile and technically difficult to process.

To address this challenge, CSIR-NIO researchers developed optimised extraction and purification techniques that preserve the natural structure of collagen while ensuring the level of purity required for biomedical applications. The process has been designed to support scalable production while minimising the use of chemicals and energy.

The result is a high-quality Type-II marine collagen that can serve as a versatile biomaterial for healthcare and biotechnology applications.

Applications Beneath the Surface

Jellyfish-derived collagen has the potential to support a wide range of emerging technologies in medicine and biotechnology. It can be used in advanced wound dressings and burn-care materials where rapid healing and tissue regeneration are essential. It may also serve as a scaffold material in tissue engineering, helping support the growth and regeneration of human tissues.

Beyond medical applications, marine collagen can be incorporated into cosmeceutical formulations aimed at skin repair and anti-ageing treatments. It may also find use in specialised drug delivery systems, biomedical coatings and hydrogels used in modern therapeutic technologies.

Early studies suggest that this marine biomaterial can promote tissue repair while reducing inflammation—key characteristics for next-generation biomedical materials.

Jellyfsh-derived Type-II collagen is unique in its amino acid composition featuring cysteine, tryptophan and

Type-II collagen

methionine which are not found in commercially available collagen and is essential for nutraceutical purposes. Its anti-oxidant and UV protective properties of the collagen peptide align with the increasing consumer demands for the natural, non-toxic, and functional skincare products, potentially reducing reliance on synthetic chemicals. CSIR-NIO in collaboration with CSIR-CFTRI, Mysore has developed different formulations for the nutraceutical application especially in skin care.

Turning a Marine Challenge into Opportunity

In many parts of the world, jellyfish blooms are increasing due to climate change, nutrient pollution and overfishing. What was once considered an ecological disturbance can now be viewed as a potential bioresource.

The work carried out by CSIR-NIO demonstrates a circular blue-economy approach, where naturally abundant marine biomass is converted into high-value biomedical materials through scientific innovation. Such technologies can reduce dependence on imported collagen while creating opportunities for value addition within India.

Science that Flows from the Sea

The story of jellyfish collagen is ultimately a story of perspective.

What drifts silently through the ocean—often unnoticed or unwelcome—may hold the key to healing human bodies. Through careful scientific research and sustainable thinking, CSIR-NIO is transforming a marine phenomenon into a material of medical promise.

In the journey towards a Viksit Bharat, innovation does not always emerge only from factories or laboratories. Sometimes, it rises quietly from the depths of the sea.

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Picture Credit: Pinterest

TRIVIA TIME

Q1. What level of precision do POMbranes achieve compared to conventional membranes?
A). Same precision
B). Twice as precise
C). Ten times more precise
D). Hundred times more precise

Q2. What is a key environmental advantage of bricks made from foundry sand?
A). Faster drying
B). Zero kiln emissions
C). Lower weight
D). Better color

Q3. What process is used to convert crop waste into bio-bitumen?
A). Distillation
B). Combustion
C). Pyrolysis
D). Fermentation

Q4. Which nutrients are added to designer rice?
A). Calcium and zinc
B). Iron, folic acid, Vitamin B12
C). Vitamin C and D
D). Magnesium and potassium

Q5. Which CSIR lab developed the sludge treatment technology?
A). CSIR-NIIST
B). CSIR-NEERI
C). CSIR-CBRI
D). CSIR-IIP

Q6. What is sal seed butter derived from?
A). Leaves of sal tree
B). Bark of sal tree
C). Seeds of sal tree
D). Flowers of sal tree

Q7. What disease is targeted by the U-AST kit?
A). Urinary Tract Infection (UTI)
B). Tuberculosis
C). Malaria
D). Dengue

Q8. Silk fibroin is obtained from:
A). Plants
B). Synthetic polymers
C). Marine organisms
D). Silkworm cocoons

Q9. What major issue does C-NoBar address?
A). Noise pollution
B). Water scarcity
C). Air pollution
D). Soil erosion

Q 10.Which CSIR lab developed the glass-ceramic bulletproof material?
A). CSIR-NEERI
B). CSIR-CGCRI
C). CSIR-CLRI
D). CSIR-CMERI

Q 11.What material is used in 3D concrete printing?
A). Plastic filament
B). Metal rods
C). Clay
D). Specially engineered concrete mix

Q 12. Which technologies are combined in the Solar AC-cum-Heater?
A). Wind and hydro
B). Solar thermal and photovoltaic
C). Nuclear and solar
D). Biomass and coal

Q 13. What is a major advantage of jellyfish-derived collagen?
A). Higher cost
B). Lower biodegradability
C). Lower risk of immune reactions
D). Limited availability

Q 14. How much faster is the machine compared to manual plastering?
A). 2–3 times faster
B). 1.5 times faster
C). Same speed
D). 5 times faster

Q 15. What blending level of DME with LPG is approved for domestic use?
A). 5%
B). 10%
C). 20%
D). 50%

Answers
1) C 2) B 3) C 4) B 5) B 6) C 7) A 8) D 9) A 10) B 11) D 12) B 13) C 14) A 15) C

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