



VIGYAN SHREE ODISHA

by Vikashita Odisha Trust

Industry Partner



Strategic Partner



Knowledge Partner



Outreach Partner



Table of contents



1	About us	03
2	Messages by dignitaries	04
3	Engaging Young Minds: GenZ and Gen Alpha in the Biotech Industry	09
4	Making India a Global Leader in Cancer Gene Therapies	12
5	The Development of Small Language Models (SLMs) for Biotechnology and Life Sciences in India: Enabling Cost-Efficient, Locally Adapted Research	14
6	Biologicals in Agriculture: Cultivating a Greener Future for India and the World	18
7	Education At Its Tipping Point ?!	19
8	Compressed Biogas: Promising segment in Biofuels in India	22
9	Ex-situ conservation balancing the commercialization of molecular resources of the Indian Horseshoe Crabs- Fakir Mohan University acts through a convergent approach	24
10	Empowering the Future: The Role of Space Technologies and Education in Societal Advancement	26
11	Role of Botanicals in Plant Nutrition and Pest Control in Indian Agriculture	28
12	Industrial Relevance of Essential Oils: Opportunities and Challenges	31
13	Sponsors	33



About us

Vision

To enhance the quality of life for individuals and communities across Odisha and beyond – empowering people to live healthier, more fulfilled, and dignified lives.

Mission

Vikashita Odisha Trust is committed to enabling holistic well-being through a progressive, sustainable, and all-inclusive approach. Our mission spans across:

- Physical health through accessible healthcare initiatives
- Mental wellness through awareness and support programs
- Financial empowerment through livelihood, entrepreneurship, and skill-building
- Academic and intellectual development via educational interventions and digital literacy
- Social integration by fostering equity, inclusivity, and active community participation

Our work is deeply rooted in Odisha's values, yet guided by modern, future-ready frameworks for sustainable development.

What We Stand For

Inclusivity: Uplifting marginalized communities

Collaboration: Working hand-in-hand with citizens, local bodies, and institutions

Sustainability: Building models that last

Innovation: Driving change with scalable, tech-enabled solutions

Join the Movement

Together, we can create a Vikashita Odisha—an empowered, equitable, and vibrant state where every individual has the opportunity to thrive.

To learn more or partner with us, visit: www.vikashitaodisha.org



SHRI MOHAN CHARAN MAJHI
Honorable Chief Minister, Odisha

MOHAN CHARAN MAJHI
CHIEF MINISTER, ODISHA



LOKASEVA BHAVAN
BHUBANESWAR

MESSAGE

I am glad to know that Vikashita Odisha Trust is organizing the NextGen BioSummit Odisha 2025 and launching the anthology "Vigyan Shree Odisha."

Odisha, rich in biodiversity and resources, is emerging as a global hub for biotechnology-driven by sustainable growth, progressive policies, and the visionary efforts of Viksit Odisha and Viksit Bharat.

The NextGen BioSummit will bring together leading minds from academia, industry, and government to chart a visionary path forward. I welcome all stakeholders to join us in exploring the vast opportunities in Odisha, which offers the realm of science and technology.

I wish the summit and the publication grand success.


(MOHAN CHARAN MAJHI)



SHRI KANAK VARDHAN SINGH DEO
Honorable Deputy Chief Minister, Odisha

ଶ୍ରୀ କନକ ବର୍ଦ୍ଧନ ସିଂହ ଦେଓ

ଉପ ମୁଖ୍ୟମନ୍ତ୍ରୀ

କୃଷି ଓ କୃଷକ ସଶକ୍ତିକରଣ, ଶକ୍ତି



କାର୍ଯ୍ୟାଳୟ : ୦୭୭୪-୨୩୯୦୦୪୧

ପି.ବି.ଏସ୍ ନଂ. :

ମୋବାଇଲ ନଂ. :

ପତ୍ର ସଂଖ୍ୟା...../ଉପମୁଖ୍ୟଙ୍କୁସଶ

ଭୁବନେଶ୍ୱର
ତାରିଖ 30.05.2025

ବାର୍ତ୍ତା

ବିକଶିତ ଓଡ଼ିଶା ଗ୍ରନ୍ଥ, ଭୁବନେଶ୍ୱର ଆନୁକୂଲ୍ୟରେ ଶିଳ୍ପ ଜଗତ ସହିତ ଶିକ୍ଷାବିତ୍, ନୀତି ନିର୍ଦ୍ଧାରକ, ସ୍ୱାର୍ଥାପ୍ତ କ୍ଷେତ୍ରର ବିଶିଷ୍ଟ ବ୍ୟକ୍ତିମାନଙ୍କୁ ନେଇ ‘ନେକ୍ଟରଜେନ୍ ବାୟୋସକ୍ଟର ଓଡ଼ିଶା ୨୦୨୫’ ଆୟୋଜିତ ହେଉଥିବା ଏବଂ ଏହି ଅବସରରେ ‘ବିଜ୍ଞାନ ଶ୍ରୀ ଓଡ଼ିଶା’ ପ୍ରକାଶ ପାଉଥିବା ଜାଣି ଅତ୍ୟନ୍ତ ଆନନ୍ଦିତ ।

ରାଜ୍ୟ ସରକାର ବିକଶିତ ଓଡ଼ିଶାର ଯେଉଁ ଲକ୍ଷ୍ୟ ରଖିଛନ୍ତି, ତାହାର ପରିପୂର୍ଣ୍ଣ ପାଇଁ ଆର୍ଥିକ ସମୃଦ୍ଧି ସହ ପ୍ରଯୁକ୍ତିବିଦ୍ୟାର ବ୍ୟବହାର ଅତ୍ୟନ୍ତ ଗୁରୁତ୍ୱପୂର୍ଣ୍ଣ । ଆର୍ଥିକ ଶକ୍ତି ପ୍ରତିଯୋଗିତାମୂଳକ ହେବା ଆବଶ୍ୟକ ଏବଂ ପ୍ରତିଯୋଗିତା ଜ୍ଞାନ ଶକ୍ତି ଦ୍ୱାରା ପରିଚାଳିତ ହେବା ଆବଶ୍ୟକ । ଜ୍ଞାନ ଶକ୍ତିର ବିକାଶରେ ପ୍ରଯୁକ୍ତିବିଦ୍ୟା ଏବଂ ନବସୃଜନ ଉପରେ ନିର୍ଭରଶୀଳ । ଏହି ବିକଶିତ ଓଡ଼ିଶାର ସ୍ୱପ୍ନକୁ ସାକାର କରିବାକୁ ହେଲେ ଆମକୁ ଉଦ୍ଦିଷ୍ଟତା ପୂର୍ବକ ବିଶେଷତା ବିଦ୍ୟା ଓ ପ୍ରଯୁକ୍ତିବିଦ୍ୟା ଉପରେ ଗୁରୁତ୍ୱ ଦେବାକୁ ହେବ । କୃଷି, ଶିଳ୍ପ, ଶିକ୍ଷା, ସ୍ୱାସ୍ଥ୍ୟସେବା ଆଦି ପ୍ରତ୍ୟେକ କ୍ଷେତ୍ରରେ ଜୈବ-ପ୍ରଯୁକ୍ତିବିଦ୍ୟାର ଗୁରୁତ୍ୱ ବୃଦ୍ଧି ପାଇଛି ଏବଂ ଖୁବ୍ ଶୀଘ୍ର ଏହା ଆମ ଦୈନନ୍ଦିନ ଜୀବନର ଏକ ଅଙ୍ଗ ପାଲଟିବାକୁ ଯାଉଛି । ଏହି ପରିପ୍ରେକ୍ଷୀରେ ଜୈବ-ପ୍ରଯୁକ୍ତିବିଦ୍ୟା କ୍ଷେତ୍ରରେ ସୃଜନଶୀଳ ଯୁବପିଢ଼ିଙ୍କ ଅନୁପାତ ଯେତେ ଅଧିକ ହେବ, ଆର୍ଥିକ ସଫଳତାର ସମ୍ଭାବନା ସେତେ ଅଧିକ ହେବ ଯାହା ବିକଶିତ ଓଡ଼ିଶାର ଦୃଷ୍ଟିକୋଣକୁ ସାକାର କରିବ । ବିକଶିତ ଓଡ଼ିଶା ଗ୍ରନ୍ଥ ପକ୍ଷରୁ ଆୟୋଜିତ ‘ନେକ୍ଟରଜେନ୍ ବାୟୋସକ୍ଟର ଓଡ଼ିଶା ୨୦୨୫’ ଏ ଦିଗରେ ପଥ ପ୍ରଦର୍ଶକ ହେବ ବୋଲି ମୋର ଆଶା ।

ମୁଁ ଆୟୋଜକମାନଙ୍କୁ ଶୁଭେଚ୍ଛା ଜଣାଇବା ସହ ସମସ୍ତ କାର୍ଯ୍ୟକ୍ରମ ଏବଂ ‘ବିଜ୍ଞାନ ଶ୍ରୀ ଓଡ଼ିଶା’ ପ୍ରକାଶନର ସର୍ବସଫଳତା କାମନା କରୁଛି ।

(କନକ ବର୍ଦ୍ଧନ ସିଂହଦେଓ)



SMT PRAVATI PARIDA

Honorable Deputy Chief Minister, Odisha

SMT. PRAVATI PARIDA

DEPUTY CHIEF MINISTER
Women & Child Development,
Mission Shakti, Tourism.



Telephone : 0674-2536642

PBX No. :

Mobile No. :

D.O. No./DCMWCDMST.

BHUBANESWAR

Date 23/05/2025

Message

I am delighted to see Vikashita Odisha Trust take the lead in organizing NextGen BioSummit Odisha-2025 and publishing Vigyan Shree Odisha, a timely celebration of science and innovation.

Biotechnology holds immense promise not only in advancing healthcare and nutrition, particularly for women and children, but also in shaping sustainable, experience-rich tourism rooted in Odisha's unique natural and cultural heritage. Initiatives like *Viksit Odisha* and *Viksit Bharat* reflect our collective vision of a future where technology serves as a catalyst for inclusive growth and community empowerment.

On this momentous occasion, I extend my heartfelt congratulations to all the esteemed members of the Trust and convey my best wishes for the grand success of the summit and the publication.


(Pravati Parida)



SMT SURAMA PADHY

Honorable Speaker of Odisha Legislative Assembly

SURAMA PADHY

SPEAKER

ODISHA LEGISLATIVE ASSEMBLY



Phone : Office : (0674) 2536904
House Chamber : (0674) 2536655
Mobile No. : 9937372328
E-mail : suramapadhyspeaker@gmail.com

No. /Spk.

Date 07/06/2025

MESSAGE

It gives me immense pleasure to know that Vikashita Odisha Trust is going to organize NextGen Bio Summit, Odisha 2025 and a Souvenir Vigyan Shree, Odisha is being brought out in Commemoration.

Odisha's fertile soil and abundant natural wealth make it the perfect Launch pad for Bio Agriculture and Bio Energy Revolutions. With the right blend of Science and Sustainability we can power our fields and fuel our future.

I wish the Summit have its lasting impact and the publication of Souvenir all success.

Surama Padhy
(SURAMA PADHY)



SHRI KRUSHNA CHANDRA PATRA

Hon. Minister Science and Technology and Food Supplies & Consumer Welfare Department

SHRI KRUSHNA CHANDRA PATRA

MINISTER

Food Supplies & Consumer Welfare,
Science & Technology



Phone : (0674) 2536975
EPABX : 2322182
Mobile No. :

D.O. No. /MFSCWS&T.

BHUBANESWAR

Date ..22.01.2025

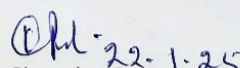
MESSAGE

I am delighted to know that Vikashita Odisha Trust, Bhubaneswar, is organizing the **"NextGen BioSummit Odisha 2025."** This significant event will be accompanied by the release of an anthology, **"Vigyan Shree Odisha,"** which will showcase various facets of science and technology, with a special focus on biotechnology, to commemorate this occasion.

Odisha is a powerhouse of natural resources, with vast biodiversity, abundant freshwater, and a strategic location that drives economic growth. Our vision to harness biotechnology for sustainable socio-economic development and our mission to establish Odisha as a global biotechnology hub have laid a strong foundation for innovation and investment. With a fast-growing economy, world-class infrastructure, and committed government support, we offer an environment ripe for breakthroughs.

NextGen BioSummit Odisha 2025 will serve as a premier platform for the exchange of ideas, bringing together subject experts, academicians, policymakers, and industry leaders to share insights on the latest technological advancements in biotechnology.

I warmly welcome all to come and explore the immense opportunities in Odisha. I extend my congratulations to the Vikashita Odisha Trust for organizing this event and wish the summit and the release of the publication great success.


(Krushna Chandra Patra)



CHELLA PANDIAN PITCHAI

Global Head – Diversity, Equality & Inclusion | Culture & Values |
Talent | Sustainability, Biocon Biologics

Engaging Young Minds: GenZ and Gen Alpha in the Biotech Industry

The biotech industry is on the cusp of a generational shift, with Gen Z and Gen Alpha poised to drive innovation and growth. As digital natives, these young minds are uniquely equipped to leverage technology and shape the future of biotech. With their innate curiosity, creativity, and passion for making a difference, young people are the driving force behind the next wave of biotechnological advancements.

Understanding Gen Z in Biotech

- Diverse and Inclusive: Gen Z values diversity and inclusion, pushing for more diverse hiring practices and leadership development programs. According to a report by Deloitte, 80% of Gen Z respondents believe that diversity and inclusion are essential for business success.
- Socially Conscious: They're driven by a desire for social responsibility and transparency, expecting companies to prioritize sustainability and ethics. A study by Nielsen found that 73% of Gen Z consumers are more likely to buy from companies that prioritize sustainability.
- Digital Fluency: Gen Z is well-versed in digital tools and AI, making them ideal candidates for biotech innovation.
- Digital Skills: Gen Z's proficiency in digital skills such as data analysis, coding, and digital communication can be leveraged to drive innovation in biotech.

Attracting Young Talent

- Authenticity Matters: Gen Z responds to authentic, relatable content, such as "day-in-the-life" stories from employees.
- Hands-on Experiences: Offering lab visits and work experience opportunities can spark interest in biotech careers.
- Social Media Presence: Companies should expand their authentic social media presence to reach young talent.
- DEI Initiatives: Companies that prioritize diversity, equity, and inclusion (DEI) are more likely to attract and retain young talent.



Biotech Industry in India: Statistics and Trends

- The Indian biotech industry is projected to reach \$150 billion by 2025, growing at a CAGR of 16.4% (Source: India Brand Equity Foundation).
- Biotechnology contributes significantly to India's GDP, with the sector expected to create numerous job opportunities in the coming years.
- India is home to several top biotech companies, including Biocon, Serum Institute of India, and Bharat Biotech.

India's Potential in Biotech

To make a significant impact in the biotech industry, India requires a mind shift change, focusing on:

- Innovation-driven entrepreneurship: Encouraging startups and entrepreneurs to develop innovative solutions.
- Collaboration and partnerships: Fostering partnerships between industry, academia, and government to drive innovation.
- Talent development: Investing in education and training programs to develop a skilled workforce.
- ESG Mindset: Companies that prioritize environmental, social, and governance (ESG) factors are more likely to attract young talent and drive sustainable growth.

The Next Best Version (NBV) of Youth in Biotech

The NBV of youth in biotech would involve:

- Embracing emerging technologies: Leveraging AI, blockchain, and other emerging technologies to drive innovation.
- Fostering a culture of innovation: Encouraging experimentation, risk-taking, and creativity.
- Prioritizing sustainability and social responsibility: Developing solutions that address societal needs and prioritize sustainability.
- Values-driven leadership: Leaders who prioritize values such as empathy, integrity, and transparency can inspire and motivate young talent.

Challenges

- Talent Acquisition and Retention: Attracting and retaining top talent in the biotech industry can be challenging due to competition from other sectors.
- Regulatory Framework: Navigating complex regulatory frameworks can be a significant challenge for biotech companies.
- Funding: Securing funding for research and development can be a hurdle for biotech startups.

Opportunities

- Innovation: Biotech companies can leverage innovation to develop new products and services, driving growth and job creation.
- Collaboration: Collaboration between academia, industry, and government can facilitate knowledge sharing and drive innovation.
- Global Market Access: Indian biotech companies can tap into the global market, expanding their reach and customer base.

**Ideas**

- Mentorship Programs: Establishing mentorship programs can help young talent develop skills and gain industry insights.
- Internships and Training: Offering internships and training programs can provide hands-on experience and exposure to biotech careers.
- Industry-Academia Partnerships: Fostering partnerships between industry and academia can facilitate knowledge sharing and drive innovation.

Conclusion

Engaging Gen Z and Gen Alpha in the biotech industry requires a deep understanding of their values, aspirations, and expectations. By embracing diversity, digital innovation, and social responsibility, biotech companies can attract and retain top young talent, driving growth and innovation in the industry.



DR. INDRANEEL GHOSH

Country Manager
Vector BioMed, Inc

Making India a Global Leader in Cancer Gene Therapies

India is a rising hub for cancer gene therapy and the success will be reminiscent of the information technology that we have seen previously. Few years back gene and cell therapy were a dream for India. Given the nurturing ecosystem created by our current government, cutting edge therapies which are available at an exorbitant cost became amenable to our country. The realm of cell and gene therapy of which CAR-T cell therapy is an important part, has progressed in leaps and bounds because of its efficacy and long-term cure. In 2013, Six-year-old, Emily Whitehead was diagnosed with blood cancer with few months to live. She became the first patient to be administered Novartis's CAR-T therapy Kymriah.

Today, she is seventeen years – cured of her cancer. Cell and gene therapy is a cure, not symptom suppression or partial relief. It is the future of mankind and is fast replacing current treatment modalities. Cell and gene therapy global market is more than \$ 100 Billion USD which has led to investment in this sector by all major pharmaceutical companies. Majority of CAR T clinical research focus on haematological cancer (57%), followed by CNS (8%), GI (6%), skin (5%), genitourinary (4%), breast (4%), gynaecologic (4%), respiratory (3%), sarcoma (2%), mesothelioma (2%), and others (5%). Haematological cancer (57%) major areas are Acute Lymphocytic Leukaemia, Diffuse Large B-cell lymphoma, Follicular Lymphoma, Mantle Cell Lymphoma, Multiple Myeloma. Striking success in CAR-T/TCR therapies for blood cancers are three times more likely to receive Phase I approval than average oncology drugs. For drug developers and investors, these findings suggest a strategic pivot towards CGTs that could yield not only transformative health outcomes for patients, but also potentially higher returns. The four approved FDA approved CD19 has on an average 30% CAGR.

CAR-T cell therapy is not amenable to most of the patients, especially in Lower- and Middle-Income Countries. First and foremost, among the barriers is the cost of the therapy. The high cost is due to the fact that human administrable vector license is held by few companies around the world.



The open license vectors can be used to develop product however IP issues arise when companies want to patent their product. Therapeutic vectors are produced in batches. Scalability is a major hurdle which is currently being addressed across the globe. Shortage due to poor scalability, and the availability of a therapeutic vector led to the establishment of Vector Biomed. Vector Biomed is the for-profit sister concern of the non-profit, research and development focussed Caring Cross. Dr. Boro Dropulic, a pioneer in the field of gene therapy is the founder of both the companies. The vision and mission of Vector BioMed includes, but not limited to, establishing centres, in conjunction with local partners, centres of excellence to bring CAR-T cell therapy to the patients of India at an affordable price. In our endeavour we aim to reduce the complex and long Process of vector manufacturing to a simpler process with our proprietary technology.

Approximately half of the therapy cost can be attributed to the vector cost. Keeping in mind the Indian patient populace, majority of whom cannot afford the staggering cost of this therapy Vector Biomed and Caring Cross has joined hands to address the affordability issue by establishing GMP grade therapeutic vector manufacturing facility in India. This will help further reduce the cost of therapy, enabling hospitals to cover a major part of CAR-T cell therapy under Ayushman Bharat Health Insurance benefits. Indian patients are currently not covered by any insurance. A relapse after incurring expenses for CAR-T cell therapy can be devastating both financially and mentally to the patient as well as the family. We have addressed the issues of relapse when using single CD19 CAR-T with our dual and triple CAR-T which we are going to bring to our Indian patients at approximately the same cost of single CD19 CAR-T. We have ensured that our cost of production is almost one third the cost that is currently being charged in the U.S. and European countries.

Next in the horizon of CAR-T cell therapy is targeting solid tumours. Recent clinical trial data conducted by Gilead using intracerebroventricular delivery of bivalent CART-EGFR-IL13Ra2 showed shrinkage of GBM in 8 out of 13 patients for a median period of 1.9 months. This may not be impressive however is an indication of the success of CAR-T cells in solid tumours with improved targeting and delivery process. We at Caring Cross have proprietary targets for GBM which we will bring to India shortly. Platforms like Vikashita Odisha Trust can provide the ecosystem to nurture the influx and successful integration of foreign technology thereby helping India to establish as a global leader in cancer gene therapies.



ABHIK BISWAS

Co-Founder and CTO at Prakat Solutions Inc and
Member of the Forbes Technology Council.

The Development of Small Language Models (SLMs) for Biotechnology and Life Sciences in India: Enabling Cost-Efficient, Locally Adapted Research

Introduction

The rapid advancements in artificial intelligence (AI) and machine learning (ML) have significantly impacted various scientific disciplines, including biotechnology and life sciences. Large Language Models (LLMs) like GPT-4 and PaLM have demonstrated remarkable potential in biomedical research, drug discovery, and genomics. However, these models often require substantial computational resources, making them cost-prohibitive for many research institutions, especially in emerging economies like India.

To address these challenges, the development of Small Language Models (SLMs) tailored for biotechnology and life sciences offers an efficient and cost-effective alternative. These models can be specifically trained on datasets relevant to Indian conditions, making them highly beneficial for researchers in India. This article explores the significance of SLMs, their advantages, and how they can provide a competitive edge to Indian researchers.

The Need for Small Language Models in Biotechnology and Life Sciences

While LLMs have proven useful in various applications, their enormous size leads to high computational and energy costs. Additionally, they are primarily trained on global datasets that may not always be relevant to India's unique biological, environmental, and epidemiological conditions.

SLMs, being more compact, address these issues in several ways:

Cost Efficiency: Running an SLM requires fewer computational resources, making it accessible to academic institutions and smaller research labs with limited budgets.

Domain-Specific Training: These models can be trained on locally relevant biomedical and life science datasets, ensuring better contextual accuracy in predictions and recommendations.



Edge Computing Compatibility: SLMs can be deployed locally on workstations or institutional servers, reducing dependence on expensive cloud-based solutions.

Faster Adaptation: They can be fine-tuned more rapidly with updates and new datasets, enabling researchers to stay up to date with the latest scientific developments.

Leveraging AI to Accelerate Research in Biotechnology and Life Sciences

AI-driven advancements have the potential to significantly accelerate research in biotechnology and life sciences by automating complex processes, enhancing predictive accuracy, and enabling real-time data analysis. Here are some key ways in which AI can enhance research productivity:

Enhanced Drug Discovery and Development: AI-powered models can analyze vast biochemical datasets, predict molecular interactions, and identify promising drug candidates much faster than traditional laboratory-based screening methods.

Faster Genome Sequencing and Analysis: AI can optimize genomic sequencing processes, reducing the time required for analyzing DNA sequences and identifying genetic mutations relevant to diseases.

Precision Medicine and Personalized Treatment: By leveraging AI-driven insights from patient data, researchers can develop customized treatment plans based on an individual's genetic profile and disease history.

Accelerated Clinical Trials: AI can improve the efficiency of clinical trials by optimizing patient selection, monitoring treatment efficacy, and identifying potential side effects early.

Predictive Disease Modelling: AI models trained on epidemiological and genetic data can predict disease outbreaks, assess risk factors, and inform public health strategies.

Automation of Laboratory Processes: AI-driven robotic systems and automated data analysis tools can streamline laboratory workflows, reducing manual errors and increasing research efficiency.

Real-time Insights from National Health Data: By integrating with National Digital Health Mission (NDHM) and other data repositories, AI can provide real-time analytics for disease trends, drug resistance patterns, and healthcare planning.

Training SLMs with Indian Conditions in Mind

One of the major drawbacks of global AI models is their lack of specificity to regional challenges. The following areas highlight why training SLMs with Indian conditions in mind can be particularly advantageous:

Genomic Diversity: India has a highly diverse genetic pool, with unique variations in susceptibility to diseases. SLMs trained on Indian genomic data can aid in precision medicine and personalized treatments.



Epidemiological Relevance: Diseases such as tuberculosis, dengue, and chikungunya are more prevalent in India than in Western countries. AI models trained on local datasets can enhance disease prediction, prevention strategies, and vaccine research.

Agricultural Biotechnology: India's agricultural sector plays a vital role in food security. SLMs tailored for plant genomics and biotechnology can improve crop yield prediction, pest resistance, and sustainable farming practices.

Ayurveda and Traditional Medicine: A large portion of the Indian population relies on Ayurvedic and traditional medicine. Training SLMs on Ayurveda-related biomedical data can facilitate integrative medicine research and alternative treatment validation.

Multilingual Support: Indian researchers often work in diverse linguistic environments. SLMs with multilingual capabilities can enable seamless knowledge dissemination across Hindi, Tamil, Bengali, and other regional languages.

Utilization of National Data Initiatives: India has launched several programs, such as the National Digital Health Mission (NDHM) and National Biotechnology Development Strategy, which provide valuable datasets. SLMs can leverage data from these initiatives to enhance medical research, electronic health records (EHR) analysis, and personalized healthcare solutions.

Running SLMs Locally for Cost Efficiency

Cloud-based AI solutions, while powerful, often come with high operational costs. In contrast, deploying SLMs on local infrastructure can provide the following benefits:

Reduced Cloud Dependency: With on-premise computing, institutions can save on recurring cloud costs while ensuring data security.

Scalability for Smaller Institutions: Universities and biotech startups with limited budgets can leverage local computing resources without investing in expensive GPUs or cloud subscriptions.

Faster Processing and Data Privacy: Local execution of AI models ensures faster response times while maintaining control over sensitive biological and medical data.

Collaboration with Government Initiatives: Indian government programs promoting AI in healthcare and agriculture can integrate locally run SLMs to enhance research output.

Use Cases of SLMs in Biotechnology and Life Sciences

Several use cases demonstrate how SLMs can revolutionize biotechnology and life sciences in India:

Drug Discovery and Repurposing: AI-driven analysis of molecular structures and biochemical interactions can accelerate drug discovery for diseases endemic to India.



Genetic Research: SLMs can assist in analyzing DNA sequences, identifying genetic markers, and predicting hereditary disease risks.

Bioinformatics and Computational Biology: Researchers can utilize AI models for protein structure prediction, gene editing simulations, and biomarker identification.

Clinical Diagnostics: AI-powered diagnostic tools can aid in identifying rare diseases and optimizing treatment plans based on patient data.

Agricultural Biotech Solutions: AI models can help researchers develop climate-resilient crops, improve soil health, and optimize precision farming techniques.

Public Health Monitoring: By integrating with NDHM and other national health data repositories, SLMs can provide real-time insights for epidemic tracking and healthcare policy-making.

Challenges and the Road Ahead

While SLMs offer numerous advantages, several challenges must be addressed to ensure their successful implementation:

Data Availability and Quality: Access to high-quality, well-annotated Indian biomedical datasets remains a challenge.

Computational Infrastructure: While local deployment is cost-effective, institutions still need affordable and efficient computing solutions.

Interdisciplinary Collaboration: Bridging the gap between AI specialists and life science researchers is essential for effective model development.

Regulatory and Ethical Considerations: Ensuring compliance with data privacy laws and ethical AI principles is critical.

Conclusion

The development and deployment of Small Language Models (SLMs) tailored for India's biotechnology and life sciences sector present a transformative opportunity. By addressing cost efficiency, local adaptability, and computational accessibility, these AI models can empower Indian researchers to tackle pressing healthcare and agricultural challenges effectively. With government support, academic collaboration, and investment in AI-driven research, SLMs can help India emerge as a global leader in life sciences innovation.

As AI technology continues to evolve, prioritizing domain-specific, regionally trained models will ensure that scientific advancements are inclusive, impactful, and aligned with the unique needs of Indian researchers and society at large.



DR. MUKESH PATEL

MD and Co-founder,
Agriland Biotech Limited

Biologicals in Agriculture: Cultivating a Greener Future for India and the World

The global agricultural sector is undergoing a quiet revolution—one that is rooted not in synthetic chemistry, but in biology. As awareness grows about the environmental and health consequences of excessive chemical use in farming, biological products derived from beneficial microorganisms—are emerging as powerful, sustainable tools to improve crop productivity and soil health. Biofertilizers, biopesticides, biostimulants, insect sex pheromones, natural farming are emerging field in organic and residue farming for human health.

In India, where agriculture sustains millions of livelihoods and the land has long been nurtured with traditional, nature-aligned practices, the return to biology feels both innovative and familiar. Beneficial microorganisms such as nitrogen-fixing bacteria, mycorrhizal fungi, and biocontrol agents have been quietly supporting crops for centuries. These natural allies promote healthier root systems, enhance nutrient availability, and protect against pests and diseases—often more sustainably than synthetic inputs.

A shining example of this potential lies in Odisha, a state blessed with fertile soils, abundant rainfall, and rich biodiversity. Agriculture plays a central role in Odisha's economy, with a diverse portfolio of crops ranging from rice and pulses to horticultural produce like mangoes and bananas. The state's tribal and rural farming communities have a long-standing tradition of working in harmony with nature, and this heritage is now being strengthened by innovative, sustainable practices. With strong government support and a rising interest in organic and biological inputs, Odisha is well-positioned to lead India's green agriculture movement in both productivity and ecological stewardship.

What's especially encouraging today is the rising awareness among consumers. More people are beginning to understand the connection between how food is grown and the health of our ecosystems. This consciousness is influencing farmers, brands, and policymakers alike to move toward cleaner, greener agricultural practices. As this momentum builds, biologicals are no longer just an alternative; they are becoming an integral part of modern farming systems.

I'm truly heartened to see this shift gaining pace—especially here in India. It gives me hope that we are not only improving our agricultural productivity but also taking meaningful steps to preserve the environment for future generations. A greener world is no longer a distant goal; it is a growing reality, powered by nature and supported by a more informed society.



RAMANAN VAIDYANATHAN

Special Joint Director – Academic Excellence, KREIS
President of RYLA Academy (Rotary International)

Education At Its Tipping Point ?!

With the emerging technologies like AI, ML, Robotics, Drones, 3D Printing, Quantum Computing etc gaining a faster pace of usage across the world, it is now of paramount importance to address the following statements that we have started hearing across Academia, Industry and Parents of aspiring students.

- 1) Computer Science branch is the most preferred choice of study in Engineering whilst most of the Core Engineering branches, including Mechanical branch which is considered the mother of all Engineering, witnessing hardly any takers. Whilst this is the reality at the Universities, our national policy and effort is more towards “Make in India” and “Atma Nirbar (Self- reliance)” that will need a lot more engineers in the core branches.;
- 2) Since last academic year 2024, campus recruitment across all Engineering colleges have drastically reduced with most of the students graduating in Computer science, Information Science etc taking up Sales and Marketing as their careers;
- 3) Mad rush to take up AI related Engineering courses just because there seems to be better career opportunities at the end of the 4-year course. However, most students fail to realise that to be a good AI Engineer, one needs to be very good and passionate in Maths which in reality majority of students have a mental block in advanced Math;
- 4) If a student is passionate in a core engineering like Biotech / Civil / Chemical / Electrical / Mechanical, do they have to do a separate course to learn AI and its impact on the application of core engineering or do they have the emerging technologies also included within the core Engineering branch syllabus itself?
- 5) The entire Nation is focussed on Skill building where as with Machine Learning, more of these skills are being built into the machines itself making it smarter than human beings. In this backdrop, should the major focus continue to be in Skill Building or shift to something else as the primary focus?
- 6) In the core industries, there is more career opportunity for students of ITI & Diploma whilst Engineers end up taking jobs in Swiggy, Zomato, Oyo etc as the salary they can earn is better than their initial salary given by majority of Industries for a fresher;



7) Our education is mostly seen as avenues for earning higher salaries as sustainability of our educational institutions (mainly professional courses) mainly depends on their campus placements record rather than the quality of faculty or the depth of syllabus or access to high end labs / innovation centres / libraries etc

8) Most of the colleges & Universities who had set up an Innovation / Start up centres are struggling to show good progress and enablement;

9) Are our educational institutions merely enabling young minds to simply survive in this fast-changing technological world or is strengthening them to be aspirational to pursue deeper states of purpose that can become an anchor in these highly disruptive global socio-economic scenarios?

10) Finally, students are much faster to know about a topic using google and other AI search engines making lecturers redundant and not much respected.

If you connect with any of the above queries in people's mind, then it will be worth reading further as we go on to look at what should be our approach to enable transform our education system that would effectively address the above concerns.

Based on my over 2 decades of working in the education field across the country and having been a management consultant for large MNCs, following are felt as the transformational policy and focus shift that needs to be brought in to our education system without any further delay:

1) Transform our Schools of Intelligence to become Schools of Wisdom like what we had in our ancient Gurukul system wherein each student was enabled to look deep within and identify their own Self and in the process firm up on their deeper states of purposes in life. This will make India very unique as it once used to be in the days of Nalanda University and the like;

2) Enable IDENTITY BUILDING through Aspirations profiling and management methodologies as the foundation and key focus area of enablement in every student so that the student can chose the skills that they truly wish to pursue and perfect for further application in the real world;

3) Every individual and institution are running behind Success. I am sure you will all agree that:
Success = Ability + Personality + Luck

Question then arises, as to which is more important for success viz., ability / personality (luck is beyond our comprehension and hence not considered). The answer is:

For **Temporary Success, our ability (knowledge + skill) is good enough**; For **Sustainable Success, it is always the Personality that is very essential**.

Hence, there is a need for our education to lay more focus on grooming students by building on their VALUE SYSTEMS as a key performance measure and not merely certify students based on their subject knowledge. There is a dire need today for our universities to build Visionary and Reliable Leaders rather than Insecure and Self-centred leaders that we mostly see in the world today;



4) We place objects whilst human beings are enabled to position themselves. Hence, all our professional colleges should immediately transform their PLACEMENT CENTRE as TRANSFORMATION CENTRE wherein they take the responsibility of developing students as JOB PROVIDERS rather than JOB SEEKERS. Once this is established, it will also make the Innovation / Start-up centres perform to its full potential. Industries will collaborate when they see students not only with capability but also with serious commitment;

5) Professional colleges to engage more “Professor of Practice” that will bring in more real time application-oriented learning to the students;

6) All educational institutions to ensure their Professors and Lecturers are put on more regular frequent training on emerging technologies that will further percolate down to their students and also make their classes more interesting and current. Else, students prefer to skip the classes and pay fine for lack of required attendance;

7) Admission brochures should carry more statistics on how many of their students have become Job Providers each academic year rather than how many students are provided with jobs. It should also mandatorily state on success stories of their Professors, Lecturers and their alumni students.

Are you ready to be part of this transformational journey of our education system which is at its tipping point now?



ABDUL MATEEN

CEO and Co-founder,
Grassroots Energy

Compressed Biogas: Promising segment in Biofuels in India

India has embarked on an ambitious journey to achieve net zero by 2070 and targets serving 50% of its energy needs from non-fossil fuel sources by as early as 2030.

There is a clear need to transition from fossil-based fuels to green alternatives such as Biofuels and Hydrogen.

The government has already taken steps to encourage use of biofuels such as the National Biofuels Policy with ethanol blending target of 20% by 2025. Beyond ethanol, compressed biogas (CBG) is expected to play a critical role in the transition to biofuels. As per projections, CBG has the potential to enable India to achieve up to 20% of emissions reductions from hard-to-abate sectors. In order to drive transition to CBG, government had launched SATAT scheme with a plan to set up 5,000 plants in India.

India generates 62 million tonnes of municipal waste and 500-600 million tonnes of agri waste annually. Transforming this waste has potential to generate 40 million tonnes of CBG annually while reducing the natural gas imports. This has dual benefit of climate objectives: fossil-fuel replacement and reducing waste ending up in landfills or being disposed through polluting processes such as stubble burning.

Fundamentally, for Indian biofuels sector to grow beyond the ethanol success story, CBG project developers need policy, pricing and offtake clarity to be able to underwrite projects with clear path to achieve viable operations.

CBG blending with Natural Gas pipelines

CBG blending mandate for FY26 stands at 1%, 3% by FY27, 4% by FY28 and at 5% for FY29 and covers the CNG (Transportation) and piped gas (Domestic) segments.



Fertilizers

In a significant move toward sustainable agriculture, the Ministry of Agriculture and Farmers Welfare has amended the Fertiliser Control Order of 1985 to include 'Organic Carbon Enhancers' derived from Compressed Bio Gas (CBG) plants as a recognised category of fertilizers.

State level Support expected

Larger plants offer better financial and operations efficiency. Providing incentives per ton of CBG plant, state level taxes, land provision, pockets of the feedstock availability, feedstock processing machinery, land for feedstock warehousing, incentives for the FPOs can help the project developers and investors to de-risk the investments.

As India marches towards net-zero, having clear and forward-looking policy at the central and states will go a long way in driving investments and project developer interest in biofuels.

The article is written by Mateen Abdul, CEO at Grassroots Energy (mateen@grassrootsenergy.co)



BHARAT BHUSAN PATNAIK

Associate Professor and Head, PG Department of Biosciences
and Biotechnology, Fakir Mohan University, Nuapadhi, Balasore

Ex-situ conservation balancing the commercialization of molecular resources of the Indian Horseshoe Crabs- Fakir Mohan University acts through a convergent approach

Horseshoe crabs are ancient marine arthropods that have existed for over 450 million years, surviving mass extinction events and drastic ecological shifts. With a dominant adaptation profile and a rich legacy of evolutionary success, horseshoe crabs remain an interesting spectacle in marine waters. Out of the four species, two species viz., *Tachypileus gigas* and *Carcinoscorpius rotundicauda* are distributed along the eastern coasts of Odisha and West Bengal. While the other two species, *Limulus polyphemus* (distributed in North America along the Atlantic and Gulf coasts) and *Tachypileus tridentatus* (coastal waters of Japan, China, Vietnam, the Phillipines, East Malaysia, and Indonesia) are categorized as 'vulnerable' and 'endangered', respectively, *T. gigas* and *C. rotundicauda* are still considered as 'data deficient' under the IUCN status.

Research focus has been directed on improving the scope of activities towards Indian horseshoe crabs conservation, including cooperative efforts to protect their populations and habitats, advocating public awareness of their importance in the study of evolution, marine coastal ecology, and commercialization of resources for biomedical applications. While fragmented efforts are available on Indian horseshoe crabs (*T. gigas* and *C. rotundicauda*) conservation by noted environmental agencies, trusts, and governmental scientific organizations, a comprehensive strategy towards conservation and resource manipulation for biomedical applications need to be developed. Under the aegis of Fakir Mohan University, the Center for Research and Conservation of Indian Horseshoe Crabs (CRCIHSC) has been established envisioning an act of holistic research on the species in the Balasore and Bhadrak coasts.

The dedicated center is studying the distribution of the species along the coasts, the adaptation genes linked to the evolutionary significance, as an indicator organism of the marine ecosystem and placing under a commercialization bracket, the biomedical significance of blood and the peri-vitelline fluid. This stems from the earlier scientific contributions and achievements at the University level pioneered by Prof. Bisnu Prasad Dash, adjunct faculty and a leading



expert in the field. This includes one research project funded by DBT, Govt. of India on 'Sea-ranching and stock enhancement of the Indian horseshoe crabs', one UGC supported National Conference on Biology and Conservation of Indian horseshoe crabs, 22 research articles in National and International Journals, award of three and seven Ph.D. and M.Phil. degrees, respectively. All the above work are signatories of the fact that Fakir Mohan University has sufficient exposure and expertise in ex-situ conservation of Indian horseshoe crabs, wherein fertilized eggs collected from the wild were incubated in laboratory conditions and approximately 5000 juveniles produced were released into the sea. Further, the antibacterial activity of the peri-vitelline fluid against the pathogenic bacterial strains was validated. With exposure on the research and extension activities on Indian horseshoe crabs, Fakir Mohan University has established recognition within the horseshoe crab specialist groups at the International level, rendering a convergent and consortium-level approach for its conservation and biomedical applications. Recently, the State Wildlife Headquarters have come forward for a healthy participation with the Fakir Mohan University research group for the in situ and ex situ conservation of Indian horseshoe crabs. Further, the State Science and Technology Department is working with the University research group to commercialize the technology of captive breeding and create an infrastructure for commercialization of bioresources such as the recombinant clotting factors, antimicrobial peptides, and other immune molecules.

To summarize, CRCIHSC @ Fakir Mohan University is working towards the sustainable conservation of Indian Horseshoe crabs by

1. Preparing baseline data encompassing breeding and nesting behaviors of the species, human impact assessment, climate change impacts on the population dynamics.
2. Contribution towards devising a molecular atlas strategizing on the availability of genetic markers, adaptation signatures significant in understanding evolutionary success of the species.
3. Exploration of the resourceful properties of blood and peri-vitelline fluid of eggs of the species for research, development and commercialization of biomedical important materials. This would satisfy the 'BioE3-'Biotechnology for Economy, Environment and Employment' policy of Govt. of India and give a boost to the Marine Biotechnology Corridor of Science & Technology Department, Govt. of Odisha

CRCIHSC @ Fakir Mohan University is central towards understanding the responsible management of this keystone species. Already the center supported the horseshoe crabs tagging project with collaboration with Zoological Survey of India and Odisha Forest Department and are interested to partner with the pharmaceutical and the biomedical industry to become a driving force behind the conservation of the species, translational research, and product development.

As an extension, CRCIHSC is creating awareness within STEM students, local youths and eco-tourism economies for setting environmental priorities for nature restoration.



NIKHITHA CHADDE

Co-founder and Director,
Genex Space

Empowering the Future: The Role of Space Technologies and Education in Societal Advancement

Space technologies have become a cornerstone of modern society, driving advancements in communication, navigation, environmental monitoring, and defense. From GPS systems that guide our daily commutes to satellites that provide real-time weather forecasts and disaster management solutions, space technologies have revolutionized the way we live and interact with the world. They contribute significantly to economic growth, agriculture, urban development, enhance national security, and address global challenges such as climate change and resource management.

Despite these contributions, the rapid evolution of space technologies highlights a pressing need for a skilled workforce capable of sustaining and advancing this sector. This is where space education and skill development play a pivotal role. By cultivating a strong foundation in space sciences and technologies, we prepare individuals not just to participate in but to lead the next generation of innovation in this field.

Why Space Education Matters:

Space education fosters curiosity and inspires learners to explore the universe and its mysteries. It serves as a gateway to STEM (Science, Technology, Engineering, and Mathematics) disciplines, equipping students with critical thinking, problem-solving, and analytical skills. By introducing concepts such as satellite technology, applications, rocket science, and space exploration, space education bridges the gap between theoretical knowledge and practical applications, preparing students for real-world challenges.

Moreover, space education encourages collaboration and creativity. Space missions require multidisciplinary teams, comprising engineers, scientists, artists, and communicators, showcasing how diverse skill sets contribute to a common goal. This inclusive approach broadens career prospects and promotes innovation across various sectors.

The Need for Skill Development in Space Technologies:

The global space industry is witnessing exponential growth, with opportunities ranging from satellite development and space applications to space tourism, planetary exploration, and sustainable technology.



To meet the demands of this expanding sector, skill development is essential. Specialised training in areas such as robotics, data analysis, propulsion systems, and space law ensures that the workforce is equipped to tackle the complexities of modern space challenges.

Space Technologies at the Grassroots Level:

Space technology's impact extends far beyond laboratories and satellites in orbit; it directly benefits commoners at the grassroots level. For instance, satellite imagery aids farmers in crop management, helps monitor water resources, and provides early warnings for natural disasters, saving lives and livelihoods. GPS technology enables efficient transportation and delivery systems, while remote sensing supports urban planning and environmental conservation. These practical applications of space technology improve the quality of life and empower communities worldwide.

At Genex Space, our mission is to make space education accessible and impactful, preparing the next generation of space pioneers. By nurturing curiosity and fostering skill development, we aim to empower individuals to leverage space technologies for the betterment of society and inspire a future where space exploration benefits everyone.

Learning space technology equips us to solve some of the most pressing global challenges, such as sustainable resource management, climate adaptation, and disaster resilience. It encourages innovative thinking to address critical issues, making the knowledge and skills gained in this field invaluable.



KOUSHIK CHAKRABORTY

COO,

Sathva Bioactives Pvt Ltd., Bengaluru

Role of Botanicals in Plant Nutrition and Pest Control in Indian Agriculture

Introduction

Traditional agricultural practices in India have long relied on the use of natural plant-based inputs. Indian agriculture has seen a sea change in the past half a century since the introduction of chemical fertilisers followed with chemical pesticides. And, with which came significant challenges for the farmers taking severe proportions in the past few decades, the challenges of soil fertility, environmental pollution, pest resistance, residues, etc.

Plant based or botanicals-based agriculture input products have played a significant role in providing sustainable solutions for plant nutrition and pest management. With increasing concerns about soil health, environmental sustainability, and pesticide resistance, botanical-based solutions are gaining renewed interest as eco-friendly alternatives to chemical or synthetic fertilizers and chemical pesticides.

Botanical Contributions to Plant Nutrition

Products from botanical sources contribute to plant nutrition in multiple ways, primarily by improving soil fertility, acting as bio-stimulants, and enhancing plant growth. Some key aspects include:

1. Organic Manures and Biofertilizers:

- Plant-based manures or cakes such as neem cake, pongamia cake, etc., serve as natural fertilizers, enriching soil organic matter and enhancing microbial activity. These materials decompose slowly, providing a steady release of nutrients, improving soil structure, and increasing water retention capacity.
- Biofertilizers derived from plants, such as Azolla (a nitrogen-fixing aquatic fern - mosquito fern), help improve soil fertility naturally.

2. Green Manuring:

- Crops like Sesbania (अगस्त), sunhemp (सनई), and dhaincha (ढैंचा) are grown and incorporated into the soil to improve nitrogen content and overall soil fertility. Green manuring helps increase organic matter in the soil, enhancing microbial diversity and soil aeration.
- Leguminous plants used in green manuring improve nitrogen fixation, reducing the dependency on synthetic nitrogen fertilizers. Generally practiced as alternate crops in vegetable growing areas.



3. Plant Growth Promoters:

- Botanical formulations from seaweed extracts and moringa leaves act as bio-stimulants, improving root development, enhancing flowering, and increasing resistance to abiotic stress.
- They contain plant growth-promoting hormones such as cytokinins and gibberellins, which improve nutrient uptake and boost crop yield.

Botanicals in Pest and Insect Control

Botanical pesticides are widely used in Indian agriculture due to their broad-spectrum activity, minimal impact on beneficial organisms, and safety for humans and the environment. Some notable examples include:

1. Neem and Pongamia Based Products:

- Neem oil, neem cake, and neem extracts contain azadirachtin, which disrupts insect growth, feeding, and reproduction.
- They are highly effective against various pests such as aphids, whiteflies, and caterpillars, while also acting as natural soil amendments.

2. Plant-Based Fumigants:

- Extracts from turmeric, eucalyptus, and basil are used to control storage pests in grains and pulses.
- They release volatile compounds that repel or kill insects without leaving harmful residues.

3. Essential Oils:

- Oils extracted from citronella, lemongrass, basil, and peppermint serve as natural insect repellents.
- These oils are widely used in organic farming for protecting crops from pests like mosquitoes, thrips, and aphids.

Advantages of Using Botanicals

The use of botanicals in plant nutrition and pest management offers multiple advantages over conventional synthetic alternatives:

- **Eco-Friendly:** Botanicals are biodegradable and do not leave harmful residues in soil or water bodies, making them safer for the environment.
- **Safe for Beneficial Organisms:** Unlike synthetic pesticides, botanical pesticides do not harm pollinators such as bees, butterflies, and earthworms, which are crucial for maintaining ecological balance.
- **Resistance Management:** Continuous use of chemical pesticides leads to pest resistance, which can be minimized by incorporating botanicals into pest management strategies.
- **Cost-Effective:** Many botanicals can be prepared locally at a lower cost compared to synthetic fertilizers and pesticides, reducing the financial burden on farmers.
- **Enhancement of Soil Health:** The use of plant-based biofertilizers and green manure improves soil microbial diversity, enhances nutrient availability, and maintains soil pH balance.
- **Improved Crop Quality:** Crops grown using botanical fertilizers and pesticides have better nutritional content, improved taste, and a longer shelf life compared to those treated with synthetic chemicals.



Challenges and Future Prospects

Despite their numerous benefits, the widespread adoption of botanical solutions faces challenges such as:

- Inconsistent Efficacy: Some botanical pesticides and fertilizers may show variable results depending on climatic conditions, soil type, and pest pressure.
- Lack of Standardization: Variability in composition and concentration of active ingredients affects their effectiveness, necessitating further research and quality control measures.
- Awareness and Training: Farmers need proper training to prepare and use botanical formulations effectively.

Future research should focus on:

- Developing improved formulation techniques to enhance the stability and efficacy of botanical extracts.
- Encouraging Integrated Pest Management (IPM) strategies that combine botanicals with biological control agents and other sustainable farming practices.
- Promoting government policies and incentives to encourage large-scale adoption of botanical-based agricultural inputs.

Conclusion

Botanicals offer a sustainable and eco-friendly approach to plant nutrition and pest control in Indian agriculture. Their integration with modern practices can improve crop productivity while ensuring environmental safety. Awareness will play a crucial role in the future of sustainable agriculture in India. With government support, farmer education, and advancements in biotechnology, botanical-based agriculture can contribute to healthier crops, improved soil fertility, and a safer environment for future generations.



DR. BASUDEBA KAR

Associate professor,
Centre for Biotechnology

Industrial Relevance of Essential Oils: Opportunities and Challenges

Essential oils (EOs) have become increasingly significant across a wide range of industries due to their natural origin and multifunctional biological properties. However, the essential oil industry is also grappling with several key challenges, including quality inconsistencies, adulteration, and market instability, which threaten its long-term growth and credibility. Industrial Applications: Essential oils play a vital role in numerous industries. In cosmetics and personal care, they are incorporated for their fragrance and skin-enhancing effects in perfumes, creams, and hair products.

In pharmaceuticals, essential oils are often used in traditional and modern formulations. The food and beverage sector uses them as natural flavoring agents and preservatives. In aromatherapy, EOs are widely recognized for their calming and therapeutic effects. Market Value and Growth Drivers: The global essential oil market was valued at approximately USD 11.2 billion in 2022 and is projected to reach USD 20–25 billion by 2030, growing at a compound annual growth rate (CAGR) of 8–10%. Key factors driving this growth include increasing consumer awareness about the benefits of natural products, rising popularity of wellness and aromatherapy practices, and growing interest in plant-based alternatives in pharmaceuticals and food preservation.

Market Segmentation: The essential oil market is segmented by type and application. Popular types include citrus oils (lemon, orange), lavender, peppermint, tea tree, and eucalyptus. The essential oils industry serves multiple sectors, with cosmetics and personal care accounting for the largest share at approximately 35%. Pharmaceuticals and aromatherapy follow closely at 30%, while food and beverages comprise around 25%. The remaining 10% includes applications in areas such as cleaning products and agriculture. Industry Challenges: Despite its expanding market, the industry faces significant challenges.

Quality variability: Affected by plant species, climate, soil, and extraction methods. Adulteration: Involves dilution with cheaper oils or synthetic compounds, leading to reduced efficacy and potential health risks. Market instability: Vulnerability to agricultural and geopolitical factors leads to raw material shortages and price volatility.



Regulatory and Institutional Support: Organizations like ISO, European Pharmacopoeia, CIMAP (India), and IFEAT are instrumental in setting quality standards, advancing research, and promoting ethical sourcing. Future scope: Addressing quality, standardization, and supply challenges through stricter regulations, sustainable practices, and industry collaboration will ensure the EO sector continues to grow as a trusted and sustainable global market. With collaborative efforts and sustainable practices, the EO industry can achieve stable, credible, and long-term growth.



Sponsored

MGM Group
Making a positive difference to Odisha

Navigation: About Us, Business Units, Sustainability, CSR, Reports, Media

SNM Group

Navigation: HOME, ABOUT US, RESPONSIBILITY, SUSTAINABILITY, PLACE ENQUIRY

Business Units: AgriTech, Mining, Education, Power & Steel

SNM Group

Mining	S N Mohanty	Steel	Power
Surendra Mining	S N Mohanty	Vishal Metallica	Surendra Power Tech



Sponsored

WCS
World Consultancy Services

ABOUT US ▾ SERVICES ▾ OUR TEAM ▾ CLIENTELE PROJECTS NEWS ▾ CONTACT 🔍

✉ wcs@theworld.co.in 📍 Odisha

f t in

"Efficient & Effective Solutions for Mining Industry"

CSM™

About Us Services Industries Domain Offerings Publications Career 🔍 GL ▾ ☰

CSM Tech at 27

A Legacy of Innovation and a Future Without Limits.

[Learn More](#) ➔

CSM Tech At 27 Emerging Technologies Industry Consultants

27 Years



Sponsored

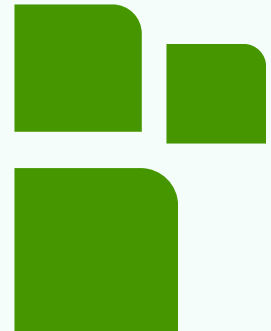


RUNGTA MINES LIMITED





Sponsors





मिट्स जैव प्रौद्योगिकी संस्थान
MITS SCHOOL OF BIOTECHNOLOGY
Estd: 2003
NAAC ACCREDITED | ISO 9001:2015 CERTIFIED | 22 YEARS OF PROUD LEGACY



NAAC
ACCREDITED

Courses Offered

- M.Sc. Biotechnology
- M.Sc. Applied Microbiology
- B.Sc. Biotechnology
- B.Sc. ITM
- BCA
- BBA

Recognition & Affiliation



2(P), INFOCITY, PATIA,
CHANDAKA INDUSTRIAL ESTATE,
BHUBANESWAR-751024

www.msb.ac.in
8599885998





Contact Information

Vikashita Odisha Trust

+91 99964 20012

+91 99374 17679

+91 99382 73623

contact@vikashitaodisha.org

Plot No 20, Lane 1, Jagannath Vihar, Bhubaneswar, Odisha

www.vikashitaodisha.org

Sponsors



RUNGTA MINES LIMITED

