Commentary

Biotechnomy and the Three Zero Theory: A Blueprint for Sustainable Growth

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Integrating biotechnomy with Dr. Muhammad Yunus's Three-Zero Theory offers a sustainable development path for developing countries. Biotechnomy uses local biological resources to create value-added, sustainable products, addressing various sectors. Post-COVID-19, biotechnology's role has expanded, enhancing healthcare, agriculture, and environmental management. The Three-Zero Theory highlights youth involvement, technological innovation, effective governance, and social entrepreneurship. This movement can generate jobs, reduce unemployment, and achieve zero carbon emissions. However, challenges like inadequate infrastructure, investment needs, regulatory hurdles, and ethical concerns must be addressed. To implement these strategies, academics, researchers, scholars, and policymakers must think creatively and advocate for swift government action. A strategic approach is essential to align economic development with environmental sustainability and social equity, fostering growth and prosperity.

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Introduction

Biotechnomy refers to a biobased economy that uses local bioresources to sustainably and profitably produce new value-added products. It is rooted in the development of innovative biotechnologies and encompasses various interrelated aspects, including engineering, environmental and climate change considerations, economic and socio-economic innovations, research and development, as well as human and financial factors[1]. The term 'biotechnomy' was introduced by Juan Enríquez and Rodrigo Martinez during the Genomics Seminar at the 1997 AAAS meeting[2]. This knowledge-based economy

can significantly contribute to the sustainable production of food, healthcare products, textiles, industrial goods, and energy by utilizing biological resources[3].

Biotechnology, which is closely linked to biology, is a fundamental component of the Fourth Industrial Revolution. It encompasses a wide range of innovations, including genetic engineering and bioinformatics, and plays a crucial role in advancing healthcare, agriculture, and environmental management. Countries are developing unique bioeconomy strategies that reflect their specific natural resources and technological strengths, highlighting the significance of national policies in achieving bioeconomy objectives. In the aftermath of the COVID-19 pandemic, the bioeconomy is increasingly recognized as a vital driver for green transformation, as well as for enhancing resilience in public health and the broader economy[4]. As of 2020, nearly 60 countries had established formal strategies to promote their bio-economies. These strategies are essential for fostering innovation and sustainability within the global bioeconomy[5].

While the bioeconomy is essential for efficiently addressing global challenges by promoting a new economic paradigm that thrives on innovative scientific and technological achievements and adapts to evolving socioeconomic and political changes[6], we propose a concept that will revolutionise the bioeconomic growth of the country by synergising biotechnology and the Three Zero Theory.

Harnessing Biotechnomy and the Three-Zero Theory for Sustainable Development: A Multi-Faceted Approach

Is prosperity without bioeconomic growth possible?

The answer lies in the innovative implementation of the Three-Zero Theory within the framework of the biotechnomy revolution. The biotechnomy revolution holds the potential to create jobs, reduce unemployment, generate value-added products to combat poverty, and leverage biotechnological advancements to achieve zero carbon emissions. Achieving the Three-Zero Theory hinges on four key elements: youth, technology, good governance, and social business[7]. Young biotech graduates represent the youthful and technological aspects, while effective governance demands skilled biotech professionals. This holistic approach ensures that economic growth aligns with ecological balance and social equity, paving the way for a green economy and a prosperous future in developing countries like Bangladesh. The Three-Zero Theory provides a framework that can drive the biotechnomy revolution by:

Harnessing the youth energy and creativity: Engaging young people in biotechnological research and innovation can lead to new solutions for sustainable development. Young researchers, starting from the grassroots, are now at the forefront of shaping the Bioeconomy Youth Vision. They emphasize the crucial role of youth involvement in decision-making, the need for inclusive debates, the rethinking of economic models, the importance of responsible resource use, and the thorough assessment of the true burdens and benefits of the bioeconomy[8].

Using the power of technology: Biotechnology advancements offer solutions to environmental and economic challenges, such as genetic engineering for resilient crops and renewable biofuels. Additionally, bioinformatics enhances our understanding of diseases and helps us combat them more effectively. These innovations not only promote sustainable development but also stimulate economic growth by creating new industries and job opportunities. Integrating biotechnology into our strategies is essential for building a resilient and prosperous future.

For instance, AlphaFold, developed by Google's DeepMind, is transforming our understanding of protein folding, leading to improved drug design and better knowledge of diseases. Autonomous therapeutic systems are changing patient care by minimizing human error and reducing medical costs. Furthermore, manipulating the microbiome allows for personalized treatments for conditions

such as obesity and mental health issues, paving the way for enhanced well-being[9]. Quantum machine learning analyses biological data, identifies potential drug targets, and predicts drug interactions swiftly, unlocking new treatments for complex diseases like cancer. Additionally, plastic-eating bacteria can break down plastics much faster than natural processes, revolutionizing waste management and significantly reducing pollution. This showcases how nature-inspired solutions can effectively address global challenges[9].

Transforming business into social business: Encouraging companies to prioritize social impact alongside profit fosters sustainable practices. Notable examples of social enterprises in biotechnology driving the biotechnomy revolution include Grameen Danone Foods Ltd., which produces affordable, nutritious yogurt for children in Bangladesh, addressing malnutrition and supporting local communities. Another example is EcoTech Visions, a social enterprise developing eco-friendly biotechnological solutions for waste management and pollution control, contributing to environmental sustainability and public health. Furthermore, integrating biopharming into family farming enhances sustainability by improving crop yields through genetic modifications. This approach reduces reliance on chemical inputs, increases economic resilience for small-scale farmers, and promotes environmental conservation and food security, ultimately supporting the livelihoods of farming families[10]. These examples demonstrate how social businesses can advance the biotechnomy revolution by emphasizing social impact and sustainability alongside economic goals.

Ensuring good governance: Implementing policies that support and regulate biotechnological advancements is essential for achieving the Three Zero goals: zero poverty, zero unemployment, and zero net carbon emissions. Effective governance frameworks align biotechnological innovations with social, economic, and environmental objectives, ensuring that these advancements contribute positively to society. To foster a supportive environment for sustainable biotechnological growth, it is crucial to establish robust policies, maintain regulatory oversight, and engage in strategic planning. This approach will ultimately drive the biotechnomy revolution in a balanced and equitable manner. Here are some examples:

i. **Responsible Innovation** (RI): This framework highlights the importance of involving various stakeholders in the innovation process to ensure that biotechnological advancements are both socially acceptable and ethically sound. For example, the European Union has incorporated RI

principles into its Horizon 2020 program, which promotes responsible research and innovation in biotechnology[11].

ii. **Dual-Use Biotechnology Governance**: Countries such as China and the United States have created governance models to address the risks linked to dual-use biotechnology, which has the potential for both beneficial and harmful applications. These models incorporate consensus-building, localized actions grounded in broad principles, dynamic consultation mechanisms, and regular evaluation and revision of governance frameworks[12].

iii. **Managing Risks of Biotechnology Innovation**: The Council on Foreign Relations has explored new approaches to global governance aimed at managing the risks associated with biotechnology. These risks include the possibility of biotechnological products escaping containment and causing harm. The discussion emphasizes the importance of international collaboration and the establishment of safety protocols to mitigate these risks effectively[13].

Limitations and Challenges

Implementing biotechnomy and the Three Zero Theory faces several challenges: insufficient technological infrastructure, the need for significant investment, regulatory hurdles, public resistance, balancing innovations with ethical concerns, developing a skilled workforce, integrating new methods into traditional practices, and competing globally (**Table 1**). These obstacles require a strategic approach to ensure sustainable development and successful adoption of biotechnomy in the developing countries.

Limitation/Challenge	Description
Technological Infrastructure	The existing technological infrastructure may not be fully equipped to support advanced biotechnological research and development. Investing in state-of-the-art facilities and training personnel is essential but can be resource-intensive
Funding and Investment	Sustainable biotech advancements require substantial financial investment, making it challenging to secure consistent funding, particularly in a pre-industrial economy
Regulatory Hurdles	Creating and implementing a robust regulatory framework for biotechnological applications is complex and can be hindered by bureaucratic inefficiencies and a lack of expertise
Public Awareness and Acceptance	Resistance to biotechnological innovations often stems from a lack of awareness or misconceptions. Therefore, educating communities and stakeholders is crucial for gaining acceptance
Environmental and Ethical Concerns	Biotechnological interventions can raise ethical and environmental concerns, including potential impacts on biodiversity. Striking a balance between innovation, ethics, and sustainability is a significant challenge
Human Resource Development	Creating a skilled workforce for biotech innovation demands substantial investment in education and training. Retaining talent within the biotech sector is crucial but poses significant challenges
Integration with Existing Practices	Integrating new biotechnological methods into traditional agricultural and industrial practices can be challenging, often necessitating extensive retraining
Global Competition	Competing on a global scale with technologically advanced countries can be daunting. Bangladesh must innovate and produce competitively to attract investment and market its products effectively

Table 1. Limitations and challenges in implementing biotechnomy and the Three Zero Theory in developing countries

Conclusion

Biotechnomy can significantly reduce poverty and unemployment by creating industries and job opportunities in the biotech sector. Integrating biotechnological advancements into healthcare systems, guided by the Three Zero Theory, can establish sustainable, resilient, and equitable healthcare. Environmental biotechnology addresses pollution, waste management, and climate change through bioremediation and bioenergy production. Genetically engineered crops enhance environmental sustainability, improve food security, and support poverty reduction. This holistic strategy ensures that economic activities align with ecological balance and social equity, fostering sustainable development and true prosperity in developing countries.

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Declarations

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