From Natural Wealth to Bioeconomy
How Biodiversity Can Power Indonesia's Economy

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Highlights

- **Indonesia's vast biodiversity represents one of the nation's greatest untapped resources**, offering immense potential for future medicines, food, and sustainable materials. Yet this national asset remains underused, undervalued, and insufficiently protected in the digital age.
- **The convergence of artificial intelligence (AI) and synthetic biology** can transform raw genetic information into high-value applications with unprecedented speed and precision.
- **Biotechnology has become a strategic priority worldwide**. India's bioeconomy has grown to USD 165 billion, while China's exceeds USD 1.3 trillion. Indonesia must act decisively to compete in this expanding global industry.
- **Without a clear national strategy, Indonesia risks a new form of extraction**, where foreign entities exploit local genetic data to create patented innovations, forcing the country to buy back products derived from its own biodiversity.
- **Building a strong bioeconomy requires connecting frontier innovators with established industries**, integrating scientific breakthroughs into national supply chains to create high-value products.
- **Success will depend on several key approaches:** measurable targets, a dynamic innovation ecosystem, and the alignment of talent, investment, and policy under one coordinated national strategy.

Here Comes the "Fifth Element"

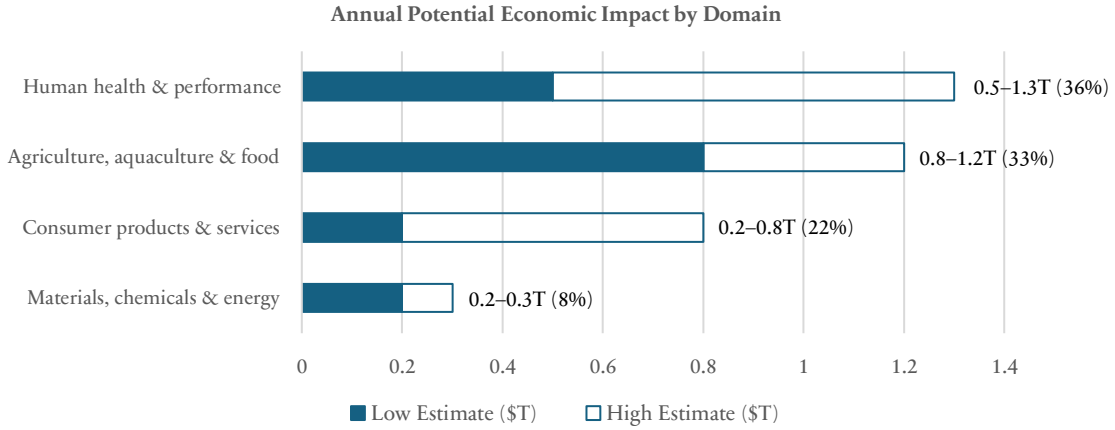
For many years, Indonesia's economy has relied on its natural resources in the form of oil, gas, minerals, and agriculture (e.g. palm oil). These sectors have their parts in providing a strong foundation for national growth and industrial development. As global priorities shift toward sustainability and technological innovation, Indonesia is entering a new phase that builds upon its established strengths. The rise of the carbon economy reflects this transition, where natural assets are managed and valued through environmental stewardship and technological advancement.

But beyond carbon, biodiversity has the potential to emerge as the fifth strategic pillar of Indonesia's nature-based comparative advantage. With the presence of artificial intelligence and synthetic biology, Indonesia's rich biological resources can be transformed into a competitive advantage through high-value products in healthcare, agriculture, and renewable industries. This direction supports sustainable growth and positions Indonesia to lead in the emerging bio-based global economy.

The Five Indonesia's Nature-based Comparative Economic Advantages

1. The Global Economic Potential of Biodiversity

McKinsey (2020) projects that the global bioeconomy could reach USD 3.4 trillion by 2040, with the largest opportunities in human health, agriculture, and food, followed by consumer products, materials, and energy. The total economic impact may exceed current estimates, as many potential applications remain unexplored. Broader and faster adoption across industries, together with indirect effects on other sectors, could further expand its influence. Scientific progress will continue to generate new discoveries and commercial innovations, while value creation will extend through supply chains and into supporting sectors such as logistics and digital services.



Expected Adoption of Bio Innovation Products

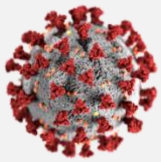
Adoption Domain	Short Term	Long term
Human health and performance	CAR T-cell therapies for liquid tumors Liquid biopsy	CAR T-cell therapies for solid tumors, gene drives to reduce vector-borne diseases, Transplantable organs produced from stem cells, embryo editing for medical purposes (e.g., via CRISPR)
Agriculture, aquaculture, and food	Plant-based proteins Crop microbiome diagnostics and probiotic treatments	Cultured meat Genetically engineered animals and crops (faster growth)
Consumer products and services	Personalized meal services based on genetic and microbiome profile Consumer genetic testing (for personalized insights about health and lifestyle)	Biosensors for monitoring of personal health, nutrition, and fitness based on omics data Gene therapy for skin aging
Materials, chemicals, and energy	Novel biofertilizers (e.g., RNAi pesticides) Improved fermentation processes (e.g. organic acids)	Novel materials and biopolymers (e.g., PLA, PET) Biosolar cells and biobatteries

Source: McKinsey (2020)

The pace at which bio-based innovations move from a laboratory to mass adoption varies. Some applications, such as T-cell therapy for tumors have only recently become commercially viable and are still in the early stages of scaling. Meanwhile, technologies such as genetically engineered plants for carbon capture remain at the research stage; before adoption, they must prove competitive on cost, yield, and practicality compared with existing crops. The bioeconomy will continue to accelerate as technology advances and investment capital shifts toward this sector. Progress in artificial intelligence, automation, and data analytics is shortening research and development cycles, while growing investor interest is expanding the scale of biomanufacturing and commercialization. Together, these forces are setting the stage for exponential growth in bio-based industries over the coming decade.

Box 1. The Impact of Synthetic Biology Combined with AI Innovations on COVID-19

Bio-innovations played a critical role in the COVID-19 response, dramatically reducing drug development timelines at every stage compared to previous pandemics. At the heart of this acceleration was vaccine development, where breakthroughs such as nucleic acid–based platforms (mRNA and DNA) and AI-driven research and design enabled us to move from virus sequencing to human trials in months. These innovations compressed the vaccine development timeline, an achievement considering that developing a Zika vaccine in 2015 took more than a year.



2. The Economic Value of Indonesia's Biodiversity

Being one of the most biodiverse nations in the world, Indonesia holds one of the richest collections of plants, animals, and marine life. Its biodiversity, from genetic traits and bioactive natural compounds to unique organisms, has the potential to strengthen support agriculture, healthcare, and new industrial sectors. These resources can fuel the development of new technologies, create jobs, and generate significant economic impact.

However, Indonesia's bioeconomy remains small compared with peers that have paired natural wealth with strong innovation and manufacturing capacity. Global examples show that countries that have successfully built competitive biotechnology have combined rich biodiversity with clear national strategies, strong R&D and innovation capacity equipped with AI, and investment in biomanufacturing and data infrastructure. What matters is turning biodiversity into knowledge, data, and products that strengthen national capacity and open new paths for industry. Real value emerges when biological resources are transformed into technologies and enterprises that a nation can shape, scale, and claim as its own.

Country	Key Features	Bioeconomy Scale	Current Use Case
China	9.57% of the world's biodiversity, strong gene banks	$1.3T (2025 estimate)	Data control, bioinnovations with AI, strong national gene/bio infrastructure, advanced manufacturing
India	Diverse agroecology, strong ethnobotany knowledge	$165 B (2024 report)	Built scale via talent + startups; example of talent-driven growth from modest biodiversity
Brazil	Amazon rainforest (15–20% of global biodiversity), largest tropical forest, mega-endemism	$100-140 B (2032 projection)	Leveraging biotech, agroindustry, with strong regulatory policies
Indonesia	17,000 islands, 10% of world's flowering plants, 16% reptiles, 2nd richest marine life	$2B (2025 estimate)	Massive **untapped genetic assets**: could be monetized with AI + synthetic biology

Source: China's National Development and Reform Commission (NDRC), India's Ministry of Science and Technology, Brazil's International Chamber of Commerce (ICC), Asian Insiders

Indonesia understood the value of biological innovation as reflected in early efforts in the 1980s. Initiatives such as BIMAS and INMAS, supported by advances in seed and fertilizer technology, helped the nation reach rice self-sufficiency and raise agricultural productivity across the archipelago. These early programs were modest in design but powerful in impact, showing how coordinated action between science, government, and farmers worked.

Now, the new Government's "Biodiversity Strategy and Action Plan 2025–2045" represents a refreshed national attempt to set long-term priorities for biodiversity. However, despite the good intention, its 20 national targets seem to rely on conventional paradigms and seriously overlook how artificial intelligence and biosynthesis could serve as the main leverages for turning biodiversity into a competitive advantage. Indonesia needs a perspective that links biodiversity with the frontiers of science and industry, preparing the ground for breakthroughs that can replicate the mentioned historical successes.

Indonesia's Rich Biodiversity

Indonesia's Rich Species (Source: Indonesia Biodiversity Strategy and Action Plan 2025-2045)

Taxon	Total species	Proportion of total world species (%)	Endemic (unique) species
Mammalia	786	14.51%	421
Fish (Freshwater)	1.246	8.9%	413
Aves (Birds)	1.883	16.97%	577
Amphibia	403	6.26%	161
Reptilia	790	8.7%	236

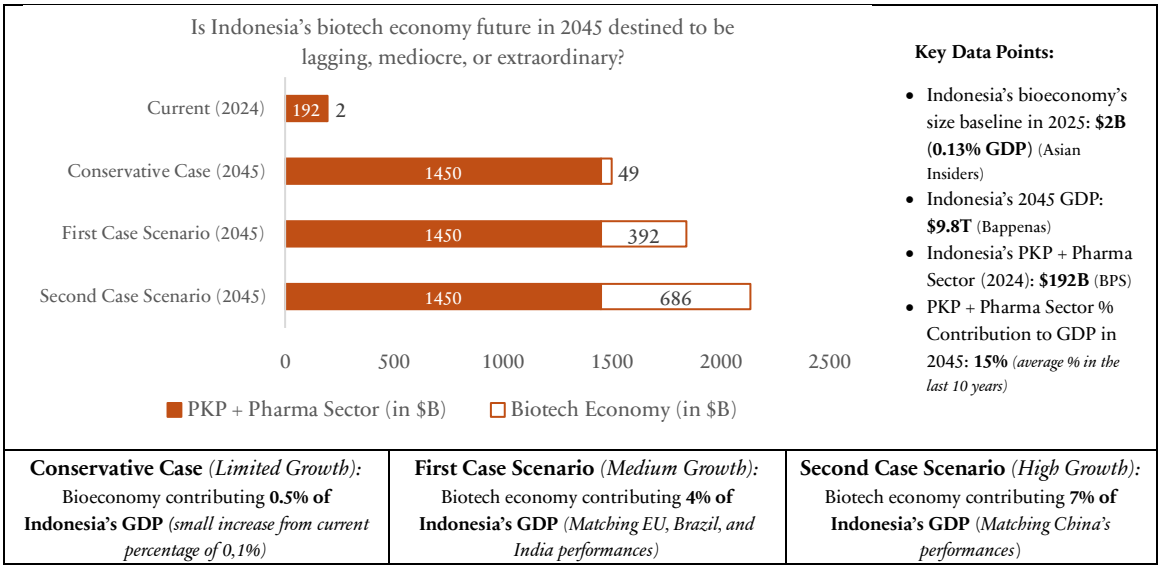
Biodiversity can drive agriculture, medicine, and industrial applications, and where Indonesia holds a distinct global advantage (table below).

Sector	Genetic traits / organism	Product / economic impact	Unique Globally
Crop breeding & food security	Wild and traditional rice diversity; Indonesia is recognized as a center of agrobiodiversity	Traits for drought/pest tolerance to breed resilient staples	Cited as a center for agrobiodiversity and holds 10% of the world's flowering plants (UN CBD)
Drug discovery & biopharma	Soil for actinobacteria/ actinomycetes from tropical and mangrove soils	Leads for antibiotics, anticancer, anti-infectives; agri-biocontrol	Distinctive antimicrobial actinomycetes (e.g., Tuban; South Sulawesi). (*Biodiversitas* Journal)
Traditional & herbal medicine	Thousands of medicinal plant species in use	Jamu/fitofarmaka pipeline; large domestic herbal market	2,000–7,500 medicinal plant used in Indonesia (from the total ~30–40k species) (Bappenas)
Fisheries & marine biodiversity	Coral Triangle epicenter (Bird's Head Peninsula/Raja Ampat)	Fisheries, marine enzymes, high-value marine ingredients (e.g., collagen, omega-3)	76% of the world's coral species occur in the Coral Triangle. (WWF)
Seaweed & blue-bioproducts	High macroalgal diversity; top global producer of farmed seaweed	Hydrocolloids (carrageenan/agar), food, biomaterials	Indonesia among the core producers of global farmed seaweed (World Bank)
Ornamental/ functional plants	High orchid diversity and endemic flora	Horticulture, skincare actives, nutraceuticals	Indonesia harbors very high orchid richness (≈5,000 species)

Source: FAO, WWF, WHO, Bappenas, UN CBD

Currently, Indonesia's agriculture, forestry, and fisheries (PKP) and pharmaceutical sector still contributes a solid 14–16% of GDP, while the biotechnology economy contributes just 0.13%. If Indonesia follows the pathways established by regions such as the European Union, Brazil, or India, the bioeconomy could contribute around 4-5 percent to national GDP. A more ambitious trajectory, comparable to China's current initiatives, could raise this contribution to more than 7 percent.

Projections of Indonesia's biotech economy contribution as % to GDP in 2045 based on three scenarios (0.5% / 4% / 7%)



Conservative Case *(Limited Growth):* Bioeconomy contributing **0.5% of Indonesia's GDP** *(small increase from current percentage of 0,1%)*	**First Case Scenario** *(Medium Growth):* Biotech economy contributing **4% of Indonesia's GDP** *(Matching EU, Brazil, and India performances)*	**Second Case Scenario** *(High Growth):* Biotech economy contributing **7% of Indonesia's GDP** *(Matching China's performances)*

Thus, decisions made in the next decade on policy direction and investment priorities will determine Indonesia's position in the emerging Bio-AI era. Scaling the biotech economy could expand the industry to be worth billions of dollars, diversify Indonesia's economic base, and position the country to compete globally in the high-value bio-based industries.

3. Recommended Key Actions from Here On

First : Understanding the Value and Risks across the Bioeconomy Value Chain

From a genetic resource to a commercial product, this *biodiversity-to-biomanufacturing* value chain has three distinct stages, each requiring different capabilities and presenting different opportunities (or risks). *Upstream*, the abundance of genetic material could anchor new businesses in the field of prospecting, databasing, and sequencing. *Midstream*, the limited availability of local laboratories and weak IP pipelines leaves a space where investors could shape Indonesia's first generation of biotech startups. *Downstream*, consumer demand for biotech products is rising fast while domestic firms have yet to tap into the market.

The challenge is twofold. In the *upstream*, Indonesia must ensure its genetic resources are effectively safeguarded from external exploitation. At the same time, Indonesia must build the capacity to translate this wealth into *downstream* innovations. Thus, Indonesia must plan its bioeconomy through addressing strengths, weaknesses, risks, and opportunities along the value chain.

Now, whoever controls the algorithms will shape the value chain, from advanced crops to new medicines. Without strong capabilities at home, other countries may train their AI systems on Indonesian biodiversity and capture the intellectual property. In that scenario, Indonesia risks remaining a supplier of raw material rather than a creator of cutting-edge industries in the bioeconomy.

Activities	Bioprospecting, specimen collection, DNA sequencing, databasing	Gene editing, synbio design, prototyping, IP generation	Biomanufacturing, scale-up, marketing, distribution
Output	DNA, genomes, & compound libraries, metadata & access agreements	Engineered cell lines, Patents, Process Innovations	Finished consumer bioproducts, scale-up outputs, brands
Needs (Gap)	Metadata/databasing, field digitization, bioinformatics skills	Investment/venture capital in local R&D, regulatory clarity, patent culture, interdisciplinary talent	Scale-up finance, export standards/QA-QC, marketing, branding, go-to-market

Designing a national bioeconomy strategy can draw on lessons from global frontrunners. China is leading ahead but it is just one of several successful paths that Indonesia can learn from. Other nations are developing their bioeconomies by focusing on their unique strengths, with each approach offering valuable lessons for Indonesia.

Box 2. Learning from China's Bioeconomy Development

China's rise in biotechnology has been more than two decades in the making. In the early 2000s, its pharmaceutical sector was dominated by generics with little original drug research. Starting in the 2010s, the government launched major reforms: aligning drug regulations with global standards, investing heavily in advanced research labs, manufacturing facilities, streamlining approvals, opening capital markets for biotech firms, and supporting the use of AI to speed up drug discovery and development. As a result, the market value of China's innovative biopharma companies grew from about $3B in 2016 to over $380B by 2021, positioning China among the world's largest and fastest-growing bioeconomy markets.

Following the success, in 2021 China announce its first comprehensive, high-level 5-year plan with "bioeconomy" as a central theme, aiming for scientific and technological self-reliance which further accelerated innovation, boosted biopharmaceutical production, and increased the economic impact of this industry.

China's Bioeconomy Vision (2021-2025)

Accelerate breakthroughs and achieve scientific and technological self-reliance in four key areas of bioeconomic development, including bio-agriculture and bioenergy.

Strengthen the foundations for innovations
Boost biotechnology research, infrastructure, and the ability to innovate across the bioeconomy.

Protect & fully utilize biological resources
Enhance conservation, sustainable use, and benefit-sharing of biological assets.

Develop key sectors
Empower and scale up biomedicine, agriculture, energy, and environmental industries with advanced biotech.

Build robust biosecurity systems
Improve early warning, emergency response, and regulation for major health and biosecurity risks.

7 Major Projects

1. **Increase innovation capacity -** Support world-class research and tech development in biotech fields.
2. **Deliver biopharmaceutical solutions -** Promote access and innovation in drugs and medical technologies.
3. **Modernize breeding industries** - Use advanced genetics and breeding for livestock and crops.
4. **Showcase bioenergy and environmental protection industries -** Scale up clean bioenergy and sustainable environmental tech.
5. **Merge biotech with information technology -** Advance digital-biological integration (e.g., bioinformatics, health data platforms).
6. **Protect and develop biological resources -** Establish systems for conservation, sustainable use, and genetic data management.
7. **Build bioeconomy pilot zones -** Create demonstration areas for innovative bioindustrial clusters and policy experiments.

Country	Key Policy Levers	Key Initiatives	Lessons for Indonesia
China	Scale and State Strategy	Massive R&D investment ($3B in 2025); 5-year Bioeconomy Plan; pilot zones for clustering; national gene bank and national genomics data centre	Adopt integrated national strategy, invest in create Bio-SEZs, control genomic data domestically to accelerate commercialization and industry scale
Singapore	Regulatory Clarity & Infrastructure	Pro-innovation regulations with $93.9M funding for national synbio program; state-backed labs for industry use.	Streamline biotech regulations and build open-access laboratories to attract investors and global companies.
Brazil	Linking Biodiversity to Industry	National Bioeconomy Strategy (2024); Bioeconomy Secretariat to coordinate ministries; emphasis on benefit-sharing with local communities.	Incentivizing local processing of biodiversity and involving local (*adat*) communities to promote jobs and regional equity.
India	Affordable Scale and Talent	Bio-manufacturing hubs in tier-2 cities; strong BIRAC support for startups and local IP; STEM training, Bio-AI centers	Investing in STEM education and training new bioengineers and computational biologists are key to scale, speed and cost-effective innovation.

Second : Securing Talent

To tap on Indonesia's bio-economy opportunity, the government must help to orchestrate new generation of talent equipped with specific, interdisciplinary skills. The strategic imperative is to build a pipeline capable of managing the entire bio-innovation value chain, from data analysis to product design and commercialization.

Value Chain	Role	Contribution to Bioeconomy	Key Activities	Skillsets/Expertise Needed
Upstream	**Field Biologist / Ecologist**	Generates foundational knowledge and biodiversity data	Sampling, cataloguing, mapping ecosystems	Advanced field techniques, genomic cataloguing
	Molecular & Computational Biologist	Translates raw biodiversity into usable datasets and scientific insights	Sequencing and characterizing genes, decoding biological material	Cellular and molecular biology, genomics and gene editing, bioinformatics
Midstream	**Bioengineer / AI-Specialist**	Converts data into scalable innovations and IP with high market value	Designing biological systems (microbes), creating IP, developing processes for biomanufacturing	Synthetic biology, AI and machine learning, bioprocess engineering
Downstream	**Entrepreneurs**	Bridges the gap between the lab and the market, ensuring that innovations become viable commercial ventures	Builds business and regulatory structures, attracting investment, navigating legal frameworks	Market research, team building and leadership, legal knowledge

Indonesia can build this pipeline fastest by adapting proven schemes from recent practice in Singapore, India, and China. Singapore's SGInnovate runs Deep Tech Talent Central and the Helix Immersion Programme, which place trainees from labs directly inside biotech companies with structured on-the-job training and national co-funding, creating a bridge from education to industry.

India develops talent through both dedicated incubator programs and national science initiatives. BIRAC's BioNEST network now supports more than 70 bio-incubators that mentor young innovators and provide funding to launch startups, while the GenomeIndia project and the Indian Biological Data Centre function as a national-scale research effort that involves hundreds of scientists and data specialists, giving them direct experience with cutting-edge genomic analysis and bioinformatics. China complements these models with the Excellent Young Scientists Fund (overseas), which brings back overseas-trained researchers to lead new labs and startups.

For Indonesia, the actionable move is to create a National BioTalent Accelerator that combines Singapore's structured in-company placements, India's incubators and national research platforms that train specialists, and China's overseas talent incentives, anchored in local universities that already excel in information technology and biotechnology.

Third : Supporting Pioneers and Industry Powerhouses

Several Indonesian pioneering companies are already laying the foundations of a domestic bioeconomy, demonstrating the country's latent capability across the entire value chain, from upstream genomic sequencing to downstream biologics manufacturing, as highlighted in the table below. However, the sector remains young, with limited capital, inadequate access to advanced laboratories, and a small venture capital network focused on biotech. To unlock further growth, government-backed incubators, clearer regulations, and more active venture capital are needed to help these companies grow and attract talent.

Company	Focus Area	Stage in Value Chain	Strategic Relevance
Pandu Biosains	Molecular biology tools, NGS & microarray services	**Upstream** (Discovery & Data enablement)	Builds local capacity for genomic sequencing and data infrastructure, foundation for national biodiversity digitization, partner in national genome science initiatives
Nalagenetics	Pharmacogenomics & precision medicine	**Midstream** (Design & Development)	Develops local IP for personalized medicine, supports Ministry of Health's Biomedical and Genome Science Initiative (BGSi), pivotal in AI-genomics for drug dosing
Nusantics	Microbiome analysis & molecular diagnostics	**Midstream** (Design & Development)	First Indonesian genome-tech startup, pioneer in microbiome R&D and diagnostics (incl. COVID-19 tests); bridges local biodiversity with applied products
KGbio (Kalbe Genexine Biologics)	Biologics & biosimilar therapeutics	**Midstream → Downstream**	Manufactures clinical-stage biologics, biosimilars, and innovative therapies; supports local IP creation and manufacturing, pathway from data to drug applications
Etana Biotechnologies Indonesia	Vaccines & therapeutic biologics	**Downstream** (Manufacturing & Commercialization)	Established ASEAN-leading mRNA and vaccine manufacturing facility, scales up cGMP certified biologics/vaccine production, supports self-reliance in biomanufacturing
Bio Farma	State-owned vaccines & biopharma	**Downstream** (National scale)	Largest biopharma manufacturer; backbone of vaccine security, pandemic preparedness, and large-scale production

Equally important, established companies in pharmaceuticals, agriculture, and healthcare must act as anchor partners in providing capital, market access, and manufacturing capacity. The success of Indonesia's bioeconomy future depends on a partnership between experienced industry leaders and a new generation of agile innovators. Large incumbents have the scale and distribution networks to integrate new biotechnologies and can invest in promising bio-startups to accelerate their growth. By connecting these established players with emerging biotech ventures, Indonesia can turn discoveries into market-ready products faster and more efficiently.

Established Powerhouses	Current Strength	Future Opportunity
Palm Oil & Plantation Agriculture	Largest agricultural export ($24.8B in 2023, global #1 producer), established logistics, 16 million jobs supported	**From Commodity to Biomaterials** Pivot to high-margin products by using biomass as feedstock for bio-refineries to create biofuels, bioplastics, and specialty oleochemicals.
Cosmetics & Personal Care	Deep cultural knowledge, strong local brands, rich supply of botanical ingredients, large and fast-growing domestic beauty market	**Smart, Bio-Based Beauty Products** Use AI and biotech to discover and optimize new active compounds from local plants and marine sources; develop microbiome-based skincare; scale bio-based ingredients for natural, sustainable cosmetics.
Food & Beverage Processing	Huge domestic market; contributed 6.55% of national GDP and grew 4.47% YoY (2023)	**Bio-Based Food Innovation** Become a leader in alternative proteins by applying fermentation tech to local crops. Scale alternative proteins and precision-fermentation ingredients (e.g., dairy proteins, natural flavorings).
Pharmaceuticals & Healthcare	2,000–7,500 medicinal plant species used with strong domestic players (e.g., Sido Muncul and state-owned	**From Traditional to High-Tech Health** Move from traditional remedies and generics to clinically validated, patentable herbal drugs (fitofarmaka) and novel

	Bio Farma as Southeast Asia's largest vaccine producer)	biopharmaceuticals. Leverage biodiversity for drug discovery, while expanding vaccine and biologics manufacturing capacity.
Forestry & Pulp	World's major paper/pulp supplier, large plantation base supplies mills	**Advanced Bio-based Chemicals & Fibers** Convert wood and crop residues into high-value biochemicals, next-generation textiles, and circular bio-based products.
Marine & Fisheries	World's largest archipelago, #2 in seaweed production (~27% of world output)	**Blue Biotechnology on the Rise** Upgrade from raw exports to high-value carrageenan/agar derivatives, bioplastics/bio-packaging, bio-stimulants, and functional foods.

Fourth : Removing Frictions and Accelerate Growth

Indonesia's path to becoming a bio-AI nation begins with strengthening the foundations that make innovation possible. As scientists and engineers transform biodiversity into new discoveries, and the private sector drives commercialization, the government must create the right environment for these innovations to flourish.

At present, significant barriers still limit the translation of Indonesia's natural advantages into economic value. The following three areas outline the government's key responsibilities as an enabler, designed to build domestic capacity, ensure security, and accelerate innovation.

1. **Talent & Education:** Nurturing Human Capital	• **Develop interdisciplinary education** with integrating Bio-AI curricula and fund national scholarships for overseas study in synthetic and computational biology. • **Build continuous, structured upskilling** across AI, genomics, and digital fluency. • **Establish a National BioTalent Accelerator** with in-company immersion programs, bio-incubator network and national research platforms, and return incentives to attract overseas Indonesian talent to lead labs and startups back home.
2. **Partnerships & Infrastructure:** Collaboration for Shared Benefits	• **Joint R&D projects** and manufacturing/commercialization scale-up collaborations between established industry and biotech startups. • **Build an open access**, shared national biotechnology engineering facility and sequencing labs to provide affordable access to advanced research tools. • **Establish Bio-Special Economic Zones** (**Bio-ZES**), similar to China, with incentives and shared facilities to create innovation clusters.
3. **Regulation & Governance:** Setting the Rules of the Road	• **Establish a National Biodiversity Cloud** to secure genetic data and mandate origin disclosure for all related patents. • **Streamline research and regulatory permits** on strategic projects to accelerate innovation. • **Mandate co-ownership of intellectual property** in all research collaborations and benefit-sharing framework for equitable returns. • **Grant targeted tax breaks, lower loan interest rates, and R&D credits incentives** for companies and investors actively engaged in biotechnology innovations.

4. Conclusion: Indonesia's Biodiversity in the Age of AI

Indonesia must translate opportunity into measurable outcomes for its "fifth element" of nature-based comparative advantage: biodiversity. Artificial intelligence and synthetic biology now make it possible to convert biodiversity into new products, from improved crops and advanced medicines to sustainable materials and bio-based energy. The opportunity lies in viewing biodiversity not as a static inheritance, but as a living foundation for innovation and national competitiveness.

The global race toward a Bio-AI future is accelerating. Countries that combine science, technology, and policy within a unified national vision are already leading this transformation. Indonesia's advantage lies in its extraordinary biodiversity and the potential to align it with emerging frontiers in AI and biotechnology. If the country invests in people, data, and infrastructure today, it can turn its natural heritage into a powerful engine of inclusive and sustainable prosperity for generations to come.

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