

Genomic Diplomacy: Seed Sovereignty and the New Architecture of Soft Power

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Abstract

This paper introduces the framework of Biotic Realism to analyze the convergence of agricultural biotechnology and international power dynamics. As climate volatility degrades traditional crop yields, the ability to engineer, patent, and distribute resilient germplasm has transitioned from a commercial activity to a primary instrument of statecraft. The study shows that the global system has experienced a profound transformation from competition over traditional natural resources to a struggle centered on genomic resources. We examine the "Technological Lock-in" effect—a mechanism through which client states become biologically dependent on a hegemony's proprietary seed-chemical packages, effectively creating a new form of extraterritoriality and chronic biological dependency. Through a comparative analysis of China's "Green Silicon Valley" and Western "Corporate-Bureaucratic Synergy," the study demonstrates how genomic assets are utilized as a main tool of soft power to secure diplomatic reciprocity and economic rent. The paper further situates this shift within the emergence of a new Biotic Cold War, in which the weaponization of agriculture reshapes global alignments. The paper concludes by identifying "Targeted Genetic Vulnerability" as a burgeoning security risk and proposes a transition toward "Multilateral Genomic Commons" to safeguard global food stability, reduce informational asymmetry, and move beyond the existing Biological Contract that binds states to foreign technological frameworks.

Keywords: Agriculture, Biotic Realism, Food, Genomic Diplomacy, Seed Sovereignty, Soft Power.

Introduction

The modern international system is experiencing a transformation: global powers are shifting their competition from natural resources to genomic resources. The twenty-first century is seeing the emergence of the Bio-hegemon, just as the twentieth century was characterized by the emergence of the Petro-State (1). The power to modify, patent, and transfer the genetic underpinnings of world nutrition is used as a tool of statecraft (2). In this "New Architecture", national security is linked to a nation's ability to build its domestic genetic resistance instead of relying on foreign aid for agricultural development (3). This requires protection of genomic resources by states against the external legal and biological appropriation of their agricultural assets by the bio-hegemons. Within the changing paradigm, Seed Sovereignty is the right of sovereign States and farmer groups to own, save, breed, and exchange their own seeds (4). For conceptualizing this change, the paper presents the Biotic Realism system. In the context of climatic instability, the

principle of agricultural productivity based on land, water, and climate becomes irrelevant (5). Under such a new paradigm, seed sovereignty can no longer be treated as a separate issue, and agricultural biotechnology is no longer a domestic concern but a backbone of international alignment (6). It demands a transition from the classical approach to food security, in which agriculture is treated as a passive victim of crises, to a paradigm of Strategic Agronomy, in which seeds are actively used as instruments of geopolitical power. It is a transformation brought about by the merging of two fields, i.e., agricultural science and international relations. Advanced technologies increasingly engineer crops for improved resilience (7). Concurrently, the deterioration of the rules-based international order has coincided with the emergence of Asymmetric Interdependence, whereby powerful states establish Technological Lock-ins that hold weaker states within proprietary seed- chemical systems (8). These mechanisms create what this paper calls the

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Gene-State Link: a phenomenon in which hegemony controls a client state's ability to respond to drought, salinity, or heat, thus influencing the latter's political stability and foreign policy (9).

Bio-hegemons can achieve various types of strategic advantage by exporting climate-ready seeds. They reap long-term economic rent in the form of intellectual-property royalties under Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreements, and they encourage the creation of payback diplomacy, whereby dependent nations coordinate their votes in multilateral institutions in order to continue to enjoy access to key germplasm in the future (10).

Overall, genetic resource management has been integrated with the exercise of global power. The shift from territorial dominance to genomic dominance is a pivotal redefinition of the nature of soft power in the twenty-first century.

To explain the boundaries of the analysis and epistemological context of Biotic Realism, it is important to differentiate it from five already established paradigms:

(a) Beyond Geopolitical Economy, Dependency

Theory and Neo-Colonialism: Classic dependency theories have been oriented towards physical extraction and the unequal trade of raw agricultural products and primary commodities (11). This dependency is embedded through "Metabolic Bundling", a process that requires client states to accept foreign proprietary chemical catalysts that trigger elite seed characteristics, ensuring geopolitical alignment in a sunk cost dynamic (12).

(b) Re-thinking biopolitics and the "Biological

Contract": This biopolitical perspective is redirected toward the non-human agricultural genome and expanded to international relations in Biotic Realism. With the World Trade Organization TRIPS and UPOV, the legal-biological regime imposes sovereign control at the level of molecular plant DNA, imposing an 'extraterritorial Biological Contract' on client states that puts breeding and seed-saving rights under the control of an outside power.

(c) Materializing Securitization through

Targeted Genetic Vulnerability: Securitization theory (Copenhagen School) is the study of the language and rhetoric of security risks.

Biotic Realism demonstrates the embedding of security threats within agricultural systems through the biochemistry (13). The introduction of huge, genetically homogeneous monocultures created by a foreign hegemony weakens the recipient state's food supply system. The hegemony possesses the genetic blueprint and corresponding biopesticides (the "antidote"), making biological vulnerability a hidden, material geopolitical deterrent.

(d) Integrating Science and Technology Studies (STS) with Realist Statecraft:

STS focuses on the co-production of technology and social order, while Biotic Realism brings STS together with classical realist statecraft. It examines advanced biotechnologies, like CRISPR-Cas9, high throughput phenotypic (HTP) and satellite linked cloud-based databases as technologies of power and informational asymmetry (5).

(e) Distinctive from Food Sovereignty:

Food Sovereignty is an advocacy for community-based food systems, whereas in Biotic Realism, food sovereignty of the state is analyzed from a geopolitical security perspective with a focus on how sovereign control of agricultural genomes is used for diplomatic reciprocity and strategic leverage (6).

Dependency Theory centers on commodity trade rather than molecular, DSI-driven dependencies; Biopolitics governs internal human populations instead of extraterritorial plant genomes; Techno-Nationalism views technology as a domestic economic asset rather than a foreign policy tool; and Food Sovereignty is a normative movement for local farmers rather than a strategic security lens for state survival (6). Therefore, Biotic Realism is theoretically necessary because it bridges molecular agricultural science with structural international security, treating engineered germplasm as a primary currency of modern statecraft.

Existing models provide useful information, but do not provide a sufficiently analytical framework for genomic statecraft. In this sense, the scientific basis of Biotic Realism is theoretically necessary, as it makes it possible to connect agricultural molecular sciences with structural international security, where engineered germ plasm is a central currency of modern statecraft.

Methodology

A qualitative, comparative case study design is adopted in this study to analyze the interaction between agricultural biotechnology and soft power. It is important to notify that this study is a qualitative, text-based international relations analysis utilizing documentary, legal, and institutional sources rather than physical field sampling. We designed our methodology about the following parameters in mind to ensure academic rigor:

(a) Data Collection Processes and Sources of

Evidence: Empirical evidence is gathered from official state planning files (e.g., the Chinese "Green Silicon Valley" plan), corporate reports and patents of major Ag-Tech corporations (Bayer, Corteva, Syngenta), and from international legal frameworks such as the WTO TRIPS, UPOV, and the Nagoya Protocol (12).

(b) Rationale for Case Selection: We conduct a comparative analysis of two contrasting models of genomic influence to show the broader analytical scope of Biotic Realism: The East (China's state-directed centralized model) and the West (Corporate-bureaucratic synergy model) (13).

(c) Temporal Scope: The temporal scope is the time frame of active data collection, in this case from 2023 to 2026, covering the swift growth of digital Ag-Tech platforms and commercial gene-editing deployments (14).

(d) Coding Approach: Deductive thematic coding is used to analyze the textual data, based on four main conceptual indicators of biological dependency, including Metabolic Bundling, Genomic Uniformity, Institutional Isomorphism, and Data-Grafting (15).

(e) Mechanisms of Triangulation: Triangulation is done through the intersection of three sources: diplomatic state rhetoric (e.g., 'Pomegranate Spirit' and 'Health for All'), corporate performance indicators (number of hectares of active cultivation) and legal disputes on plant variety protection (16).

(f) Interpretive Validity: A valid mapping of the causal chain is established from molecular design (genetic modification and trait-activation keys) to legal-biological regimes (TRIPS/UPOV) and ultimately to sovereign geopolitical outcomes (diplomatic voting

alignments and strategic resource negotiations) (17).

(g) Positionality and Ethics: The authors acknowledge that they are international relations security scholars studying agricultural systems from an academic perspective. To counteract interpretive bias, we show both realist pathways of biosecurity and offer explicit normative pathways forward to a "Multilateral Genomic Commons" and "Seed Sovereignty" for ensuring food stability all over the world (18).

This study is aware of the positionality of its authors and of the possibility of using a security lens to analyze agri-food systems, while at the same time maintaining analytical rigor. Framing the issue of seed governance from a Biotic Realism perspective is not a normative policy prescription for more aggressive use of state power in international relations, but a diagnostic tool for identifying structural power imbalances in international relations. An exclusive focus on security can overlook local agroecological agency and indigenous knowledge, but this approach provides a targeted diagnostic lens that reveals the ways in which biological resources function as strategic tools at the macro-geopolitical level. The methodological reflexivity ensures that the vulnerabilities of the socio-biological processes of ecosystems are critically mapped, rather than viewed solely as "security assets".

Analytical Lens: Biotic Realism

The research applies the Biotic Realism framework as its major theoretical basis to examine how states employ genomic resources in creating the phenomena called Technological Lock-ins and Asymmetric Interdependence. According to this framework, traditional natural resources are replaced by genomic resources and the capacity to engineer and package resilient germplasm. It is a key tool of statecraft. In this way, the framework provides a theoretically sound perspective for explaining how biological innovation is converted into a long-term geopolitical bargain in contemporary international relations.

Case Selection: Comparative Analysis

Two different genomic influence models are compared to show how Biotic Realism is applicable universally: the East (China), represented by the state-organized "Green Silicon Valley" and the "Silk Road of Seeds"; and the West (United states and

European Union), represented by the Corporate-Bureaucratic Synergy model, which entails Agricultural Technology (Ag-Tech)-based giant corporations such as Bayer and Corteva.

Technical-political Indicators

These cases are assessed in the research in terms of four definite technical-political indicators that are presented in the literature as the mechanisms of biological dependency: Metabolic Bundling, the linking of transgenic seeds to exclusive chemical catalyst ensuring that particular products are applied to activate high-yield characteristics; Genomic Uniformity, the establishment of vulnerabilities on a global scale by monocultures of a certain scale, which enables the hegemony to possess the antidote in case the pathogen becomes a reality; Institutional Isomorphism, the correspondence between technical expertise, scientific training, and professional regimes of a client state and the proprietary media of a hegemon; and Data-Grafting, the collection of current information on the performance of individual farms by using digital surveillance, Internet of Things (IoT) facilities, and cloud architecture in order to establish informational asymmetry.

Objective

Through a comparison of these models, it is through the methodology that the demonstrative aspect of how Targeted Genetic Vulnerability is used as a tool of present-day statecraft can be brought about. The analysis offers an empirical basis for suggesting the possibility of a shift to Multilateral Genomic Commons to protect global food security and minimize the biological dependency established by the current Biological Contract. Doing so, it will be able to reconcile empirical observations with normative policy prescriptions, to the benefit of the study to both the theory-building and practical governance discussion.

The Science of Influence

The emergence of Genomic Diplomacy is pegged to certain biotechnological attributes which enable strong states to create patterns of chronic biological dependency. To study this new form of influence, it is necessary to explore the scientific processes embedded within these novel geopolitical relationships.

One of the driving factors is the use of CRISPR-Cas9 gene editing which has revolutionized the pace and

responsiveness of agricultural intervention (16). Unlike the years required to develop effective hybrids through conventional breeding, Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) allows Bio-hegemons to create tailor-made genetic solutions to the environmental challenges faced by a client state within one growing season. The hegemony is a Biological First Responder it can rapidly produce traits that respond to sudden outbreaks of pests (e.g., Striga) or severe soil salination. Such immediate intervention, however, unlike traditional forms of financial aid, places the hegemony squarely within the survival system of the client state, creating a process of dependency that cannot easily be broken.

The most powerful instruments of power, though, are the mechanisms underlying the creation of technological bundles designed to generate Technological Lock-in. This is done in several mechanisms that are interlocked:

Genetic Use Restriction Technologies (GURTs) or, in popular usage, Terminator Seeds have the effect of causing plants to produce sterile offspring such that farmers cannot save their seeds and are obliged to buy them every year.

The chemical dependencies create a dependency on the chemical ecosystem of the hegemon, in which the high-yield genomes are altered in such a way that they are unable to function without anything other than proprietary herbicides or fertilizers (6).

An additional layer of proprietary control comes in the form of epigenetic priming whereby the seeds are conditioned to respond to specific environmental cues or even chemical stimuli to achieve performance at an optimum in each climate (9). Since the activation logic of the said traits is a kind of trade secret, the hegemony retains a decisive advantage in determining the final productivity of the crop.

All these mechanisms contribute to the fact that client states cannot simply leave the technological ecosystem at the cost of prohibitive economic and infrastructural expenses.

Another aspect of genomic leverage is based on combining HTP with satellite-linked digital monitoring (19). The latter systems allow Bio-hegemons to receive real-time data on the success of seed exports and in many cases provide them with a higher level of agricultural intelligence

compared to the ministries of the client state (20). Digital agriculture platforms have the potential to give their operators access to high-value information on the agricultural situation, such as soil, climate and crop-performance data, in real time. This can give a comparative advantage in information about some host-state institutions and improve their forecasting capabilities for agriculture. In the light of Biotic Realism, this informational power could be a potential source of strategic influence, especially in the areas of trade and export prohibitions and agricultural aid (21). But the information itself cannot be used directly to put pressure on other nations, and to the best of our knowledge, there is a lack of evidence of that. The combination of fast gene editing, engineering dependency, proprietary logic of activation, and constant data-driven surveillance is working to create a more advanced system of biotechnological statecraft by bio-hegemony (14). These technical processes transform agricultural science into a tool of strategic leverage, which determines the political, economic, and diplomatic paths of the dependent states.

Intellectual Property as Border

The traditional Westphalian sovereignty, based on the territorial boundaries, is being replaced by the new Legal-Biological regime in the new Biotic Realism environment (1). Within this paradigm, international intellectual property (IP) law serves as an extraterritorial control tool, enabling the most powerful states and companies to extend their influence far into the internal land of other countries (2). The territorial demarcation of sovereignty has ceased to be defined at the boundaries of a field and is now located at the very molecular level of DNA.

To a great extent, this transformation is predetermined by the World Trade Organization (WTO) TRIPS framework that requires the member states to maintain the protection of plant varieties and to follow the standards established by the International Union for the Protection of New Varieties of Plants (UPOV) (16). These legal procedures transform the living organisms into personal property. When a farmer plants a patented seed, he or she literally grows something that resides on a foreign legal ground, irrespective of the soil under which it is planted (8). This change erases the line between the law within a

state and outside, forming a novel juridical biopolitics.

This process is enhanced by the emergence of Digital Sequence Information (DSI) that has accelerated the process of dematerialization of biological wealth (10). Since the sequencing of plant genomes and their placement in digital databases see the light of the day, the physical seed takes a back seat to the informational code (22). The biodiversity of the Global South can produce valuable characteristics that can be exploited by states with high computing capabilities and patented by them before the country of origin realizes their strategic value. This relationship results in a Genetic Trade Deficit, in which countries with a high level of biodiversity provide unpaid raw genetic information and rebuke its improved, patented version at a high price (23). The move to DSI platforms of seed banks across the globe in effect constitutes a contemporary enclosure of the biotic commons.

The result of these legal and technological changes is what can be termed a Biological Contract: through the incorporation of a foreign genomic framework, this system commits a country to a new external legal system (7). It is through this dependence that Bio-hegemony can use IP litigation as a geopolitical tool. When a client state acts contrary to the strategic interests of a hegemony, e.g. by voting against the hegemony in a United Nations ballot, the hegemony has the option to react to this by threatening to withdraw planting rights, cut off seed shipments, or institute international legal claims that endanger the agricultural security of the client.

Though there is a strong push for harmonization in global IP structures, there is complementary flexibility in the law, regional differences, and contestation in the practice of TRIPS and UPOV. The sovereignty of developing countries to create sui generis systems as opposed to rigid and uniform protection regimes is guaranteed under TRIPS, Article 27.3(b). Moreover, the status of law enforcement is not uniform around the globe; there are ongoing regional legal adaptations, sovereign reservations and grassroots contestation, including domestic farmer rights laws and regional bio-commons agreements that constantly challenge totalizing IP enforcement. Therefore, Biotic Realism does not see the global IP regime as a smoothly hegemonic system, but

rather as an area of structural friction where the power of institutions interacts with the sovereign legal resistance and contestation of the local (24). Within this field of political-legal practices, sovereignty is no longer determined by the ability to bar foreign populations but rather by the ability to bar foreign genetic code within the food regime. The power over intellectual property has also taken the form of a fundamental instrument of geopolitical leverage, transforming the definition of state autonomy in world where even the genome can be used as a strategic resource.

Results

Analytical Results

The “Lock-In” Mechanism

The transition of the basic agricultural practice to an organized Asymmetric Interdependence arises when the agricultural systems in a recipient state are integrated into the technological ecosystem of a Bio-hegemony (25). The Genetically Modified Food (GMF) seeds, the chemical inputs, the digital platforms, and the training pipelines are operating in this configuration as a massively closely knit architecture designed to make the exit prohibitively expensive in both economic and institutional ways.

Metabolic bundling is one major feature of such architecture: transgenic seeds are programmed to be conditional upon a collection of herbicides, pesticides, or growth regulators that the hegemony solely produces. The hegemony makes sure that the client state is reliant on its products by modifying the metabolic processes of the plants in such a way that high-yield characteristics are only expressed when proprietary chemical catalysts are implemented (5). Any form of switching to a different supplier would necessitate the total redesign of the agricultural equipment, storage facilities, chemical infrastructure, and training of the client--a typical Sunk Cost Trap that strengthens long-term alignment.

Genomic uniformity enhances this dependency, with high-performing monocultures being adopted by states in huge territories. Although this type of uniformity proves efficient in the beginning, it creates vulnerability on a system-wide level: a single pathogen or a single blight can destabilize the whole national food supply. The hegemony in this case has a twofold advantage. Since it has been engineered, the hegemony has the

genetic map of its vulnerability and holds the antidote in the form of resistant strains or matching bio pesticides (16). The ability to produce such options for acceptance or rejection constitutes a reliable, albeit often implicit, deterrent to political betrayal.

Another entrenchment process is Institutional Isomorphism, in which intellectual and technical abilities of the client state are redefined to match the proprietary systems of the hegemony. The agronomists are directed toward structures and systems created by the hegemony through scholarships, university relationships, and specialized training (9). The client state slowly loses its domestic ability to research or move to other technological platforms, as the local experts can only become fluent within that ecosystem.

There are three reinforcing and very specific mechanisms that create this institutional lock-in (7-8):

(a) Specialized Scientific Training: The bio-hegemony funds academic fellowships and university partnerships and trains foreign scientists on its proprietary genome-editing tools, functionally making their local research infrastructure dependent on foreign technical expertise.

(b) Technical Advisory Systems: Expert agronomists from the hegemony are placed in local ministries and make subtle decisions regarding regulation and breeding to conform to the hegemon's crop requirements.

(c) Regulatory Harmonization: Bio-hegemons actively push the national biosafety policies and intellectual property rules of client states to match the hegemony's home policies, promoting the importation of patented seeds without hindering competition.

There is the introduction of the Data-Graft with the advent of digital agronomy. The granular soil, climate, and yield data are fed into servers situated within the territory of the hegemony with the help of IoT sensors, automated machinery, and cloud-based decision platforms. This setup provides the hegemony with real-time agricultural intelligence, which is highly accurate--often more accurate than that of the client state (19, 22). With this information advantage, the hegemony can foresee supply crises, predict developments in food prices, or schedule diplomatic pressure to align with moments of increased vulnerability.

Such a change from a primitive mode of agricultural production to organized Asymmetric Interdependence is evident when the agricultural systems of a recipient state are integrated into the techno-ecosystem of a Bio-hegemony (6). The GMF seeds, chemical inputs, digital platforms and training pipelines of this setup can be considered a highly networked architecture that makes escape an economically and institutionally fortified domain. Metabolic bundling binds transgenic seeds to proprietary catalysts (5), genomic uniformity opens the system-wide vulnerabilities which can only be overcome by the hegemony with proprietary catalysts (8), and institutional isomorphism coordinates the scientific capacity of the client with proprietary systems of the hegemony (9), data-grafting pipes real-time agronomic intelligence to the controlled hegemony servers. Combined with each other, the metabolic bundling, genetic homogeneity, institutional fit, data harvesting and the cycles of increasing cycles form a sustainable system of biological lock-in. The Bio-hegemony not only controls the farming culture of the host state but also influences its economic planning, scientific education, and political decision-making processes, becoming a long-term instrument of geopolitical domination.

Empirical Results

Case Study A – The East: China’s “Green Silicon Valley” and the Silk Road of Seeds

China is now the most active and holistic Biotic Hegemony practitioner, with a strategy that is no longer based solely on domestic food security but on building a global agricultural-technological domain of influence (1). The core of this plan was the Green Silicon Valley project in Sichuan and Meishan. This project, between 2023 and 2026, hastened the establishment of a biotechnology centre, which will compete with Western intellectual property leadership in genomics (13). China has developed plant genes that can survive tough Central Asia conditions--dry climates, salty soil, and high mountains--by investing a lot in advanced technologies like shuttle breeding, CRISPR gene editing, and solar-powered irrigation (7).

This innovation will become the key to the further geopolitical project of China: a Silk Road of Seeds. This is most apparent in the Central Asia Corridor, which serves as a testbed for the model of Business Diplomacy that China exercises (23). China has

been exporting hybrid and genetically edited wheat seeds in Kazakhstan, Uzbekistan, and Kyrgyzstan in the form of agricultural technology parks in coordination with modernized smart irrigation infrastructure. This has led to a big boost in agricultural productivity due to the combination of high-yield genomes and accuracy in water-fertilizer delivery, which led to a 40% increase in agricultural trade between China and the five Central Asian states between 2023 and 2025 (23). Because of this, the countries using these seeds now rely on China's constant genetic updates and farming expertise, making them dependent on China in the long run.

The nationalization of Syngenta in China in 2017 further consolidated the China's dominance. This acquisition provided China with ownership of many Western-based patents, which allowed Beijing to provide cheaper African, Latin American, and Southeast African consumers with Western-quality biotechnology (25). Through the combination of availability of elite genetic features with funding to its infrastructure, China can buy diplomatic goodwill in matters regarding security, regional governance conventions, and multilateral projects.

Another strong narrative structure used in Chinese diplomacy is also a powerful one. The state encourages the "Pomegranate Spirit"--the allegory of ethnic solidarity and self-help--to state its agricultural growth as a non-coercive, cooperative venture. Although this rhetoric focuses on solidarity, it hides the dynamic behind Institutional Isomorphism (8). Chinese programs are used to train thousands of foreign agronomists, scientists, and ministry officials in proprietary software, machinery, and genome platforms. Their professional skill cannot be detached from the technological ecosystem of China over the years, so, though the local institutions may seem independent, they will be run on Chinese lines and standards.

In these interacting processes--namely, technological transfer, proprietary infrastructure, intellectual-property expansion, and strategic capacity building--China has established a sustainable system of Gene-Flow Diplomacy. Thus, the "Silk Road of Seeds" becomes one of the foundations of the China's global strategy, which redefines the way states develop influence by

combining biotechnology with development, trade, and ideological narrative.

Case Study B – The West: Ag-Tech Giants and the Rebranding of “Food for Peace”

As China promotes a state-oriented approach to genomic influence, the Western approach is based on a Corporate-Bureaucratic Synergy, which integrates social policy, individual intellectual property, and the growth of the market (10). The changes in Western Biotic Soft Power in the 2025-2026 timeframe were made through structural reforms of the United States (U.S.) food aid program and the reorganized approach of the key Ag-Tech companies like Bayer and Corteva to the marketplace to turn the strategy into a market-oriented but coordinated mechanism.

The foremost change in such transformation is the America-first rebranding of the ancient Food for Peace program, PL-480. The new structure requires that 100 percent of aid products be of United States origin, effectively deploying humanitarian support to subsidize local agriculture and exposing the world markets to U.S. crops and technologies. The program takes the form of a Market Preparation Tool: having distributed American grains and seeds to aid-dependent countries like Ethiopia or Guatemala, the United States influences taste preferences and technological preferences so that as these countries switch to trade, their agricultural infrastructure would be tuned according to the U.S. exports.

Equivalent to this bureaucratic transformation, Western companies are perfecting more decentralized methods of influence. An example of Corteva's attempts at being Royalty Neutral is its effort to license proprietary traits to local seed firms in the Global South in corn, cotton, and canola. Although this prevents the allegation of biopiracy, the very genetic basis of this is linked to Western intellectual property (16). Local seeds may be presented as domestically bred, though their internal characteristics and functionality rely on the constant supply from Western biotech pipelines--perpetuating dependency on technologies long-term and reducing political hostility. The ‘Health for All, Hunger for None’ program of Bayer is another aspect of Western influence that incorporates the rhetoric of sustainability with market growth. Placing genetically modified seeds, pesticides, and high-tech agricultural machinery as

part of the needs of climate resilience and carbon-intelligent agriculture, Bayer weighs its commercial products in line with international governance systems, including the United Nations (UN) Sustainable Development Goals (SDGs) (2). This alignment causes political trouble for developing states: to turn down Western Ag-Tech is symbolically comparable to refusal to act on climate.

The rise of digital farming means Western power now comes not just from seeds and chemicals, but also from the information systems that run agriculture. Platforms like Cropwise, created by Syngenta, manage over 70 million hectares by 2026, acting like a digital "nervous system" for farms around the world. When farmers send data to the servers controlled by Western countries on soil metrics, chemical applications, yield projections, and satellite-linked images, the United States and its corporate partners gain a degree of predictive intelligence that in most cases goes beyond the knowledge of the agricultural ministries of the client state (22).

Such informational asymmetry can help Western actors to predict economic volatility, time market interventions, and exert their diplomatic pressure with previously unmatched accuracy. This means that data--not just seeds--comes under Western control and becomes a strategic resource.

In this model, Western countries use a mixed form of Biotic Hegemony where markets, algorithms, and intellectual property rules work together. Government policies, corporate planning, and digital monitoring all combine to maintain their global influence in agriculture.

These theoretical lessons are supported by four observable dynamics in the food system:

(a) Seed Reliance in Sub-Saharan Africa: After Syngenta's nationalization in 2017, Beijing has been proactively exporting acquired Syngenta germplasm and agricultural packages to the African countries to gain diplomatic goodwill and cultivate long-term agricultural dependence.

(b) Herbicide-Resistant Monocultures in Latin America: A biophysical lock-in is taking place in Argentina and Brazil, with huge fields of soybeans and maize locked into the use of seed packages that are genetically resistant to glyphosate and dicamba.

(c) Chinese Seed Diplomacy in Southeast Asia

and Central Asia: China's "shuttle breeding" and exporting drought-resistant hybrid wheat seeds through corridors of Central Asia generated a 40% increase in overall agricultural trade in the regions from 2023-2025, putting the recipient states in a perpetual cycle of updates.

(d) Western corporate 'Royalty Neutral' trait-

licensing: Western companies (such as Corteva) license patented traits (corn, cotton, canola) to local breeders in the Global South. Although they may seem to come from the local market, these traits remain bound to Western IP, and companies can choose to enforce legal actions to maintain intellectual property rights.

Discussion

The Global South Paradox-Biodiversity Wealth vs Technological Poverty

This research clearly separates routine commercial integration from structural geopolitical dependency in agricultural markets to achieve conceptual clarity. Proprietary corporate ecosystems—like proprietary seed mtraits, precision digital platforms, and agrochemical bundling—can be a legitimate market phenomenon, supply-chain efficiency, and/or a commercial innovation designed to maximize farm output. But commercial integration can become geopolitical dependence when private corporate dominance is used (or misused) by a State to achieve structural compliance, limit a state's policy space or create systematic vulnerabilities in a target country (26). Biotic Realism does not assume that all commercial networks that are owned are inherently bad or ones that would be used strategically to dominate an economy; it investigates the threshold at which economic market power becomes a tool of statecraft and asymmetric foreign policy.

To make it clear, the sovereign commons establish genetic resources as a state-owned biotic resource, which is tied to the territory and equity-sharing principles. Biodiversity is within the jurisdiction of the law and ecology of a state, and any foreign exploitation, either physical or digital, must be under its sovereignty. It is a conservation system that is aimed at averting the de-territorializing extraction of genetic value.

On the contrary, open access does not consider biodiversity as a research substrate that is

connected to a territory. Genetic materials and digital versions of the same are distributed without much control so that technologically developed states can transform Global South biodiversity into proprietary goods. This model accelerates the outward flow of biological wealth and increases technological dependency.

It is an inherent conflict of modern Biotic Geopolitics that the Global South boasts a huge gene pool, while the Global North holds technological fluency (1). The majority of the most useful genetic resources in the world--those of the Andes, the Ethiopian highlands, and Southeast Asia--are located in countries which lack industrial, bio-informatic, and legal infrastructures to convert this biodiversity into strategic value. This leads to a vicious cycle of the Value-Added Trap: these nations have the biological hardware of world agriculture but do not reap the economic and political fruits of the technological software of world agriculture.

This kind of inequality creates a new form of extraction: countries in the Global South share their raw genetic materials for "scientific cooperation," but then labs in the Global North sequence, modify, and patent those genetics for their own benefit (7). Often the resulting so-called climate-ready or disease-resistant seeds are sold again at a higher price, which is how a cycle of biological wealth moving out and economic dependency moving in is consolidated.

This process is amplified by the upsurge of Biopiracy 2.0, which is led by the spread of DSI. Since genetic data can be uploaded, downloaded, and worked with without physically moving the seeds, powerful states and corporations can steal the biological wealth of a nation via the cloud (10). Using the concept of DSI to present the Nagoya Protocol as open science, several developed states can escape the obligation to share benefits of the Nagoya Protocol. This is a useful strategy of de-territorializing biodiversity, allowing any foreign actor to mine genetic information without having to enter the realm of lawful or ethical action of physical access.

Such inequalities are usually perpetuated by means of Strategic Underdevelopment. The bio-hegemony often provide developing nations with Tier 2 genetic technologies that are superior to conventional varieties, but vastly inferior to the Tier 1 technologies that they use at home or with

strategic allies. This forms a managed Yield Ceiling so that Global South countries are productive to stabilize the region but not competitive enough to threaten Northern dominance in international markets (5).

One of the primary ways of responding to this structural imbalance has been Seed Sovereignty movements. Organizations such as La Via Campesina and the Open-Source Seed Initiative (OSSI) focus on establishing a legal and ecological non-patentable zone to help protect the biotic commons. However, these efforts are often the cause of geopolitical conflict. With the promotion of open-source or farmer-led seed systems, when countries like India or Brazil challenge the WTO patent system, they face the threat of U.S. Special 301 trade sanctions or European Union (EU) retaliation.

This friction shows the analytical distinction between (a) reasonable commercial integration and (b) geopolitical dependence. Seeds from elsewhere and online platforms are the rational economic choice, as part of a standard commercial agriculture trade system to maximize yields and mitigate climate change. From a Biotic Realism perspective, however, this commercial foundation turns into geopolitical dependency, as states actively use these networks as means of leverage and deploy them as strategic tools, such as planting rights, the withdrawal of seed supply, or IP law as a direct tool to manipulate unrelated disputes. Moreover, the IP regime in the world is neither one-dimensional nor undisputed. The developing countries actively challenge these rules and use flexibilities in international law (16):

(a) Article 27.3(b) of the WTO TRIPS framework allows for TRIPS flexibilities, including the refusal to grant patent rights on plants and the use of domestic sui generis systems to safeguard traditional seed-saving practices, which many developing countries have done.

(b) Regional Legal Variation: This involves the creation of model legislation for the protection of farmers rights to save, exchange and sell seeds, such as in the case of the African Union, which is opposed to UPOV 1991, which focuses primarily on the rights of corporate breeders.

(c) To avoid the application of these multilateral flexibilities, the bio-hegemony regularly draft the equivalent of 'TRIPS-plus' clauses in bilateral free

trade agreements, requiring developing countries to forgo their regional legal flexibilities.

While global IP frameworks exert substantial pressure toward harmonization, the operational reality of TRIPS and UPOV implementation is characterized by legal flexibilities, regional variation, and active contestation. Under TRIPS Article 27.3(b), developing nations retain the sovereignty to construct sui generis systems tailored to domestic agricultural priorities, rather than adopting rigid, standardized protection regimes. Furthermore, legal enforcement across the Global South is far from monolithic; regional legal adaptations, sovereign reservations, and grassroots contestation—such as domestic farmer-rights legislations and regional bio-commons agreements—continually challenge totalizing IP enforcement. Therefore, Biotic Realism does not conceptualize global IP governance as a seamlessly hegemonic system, but rather as an arena of structural friction where institutional power projects meet sovereign legal resistance and local contestation.

This is a self-paradoxical war:

- (a) The most biodiverse countries remain the ones that are marginalized in the world bioeconomy because those with the least biodiversity dictate most in terms of commercializing biodiversity.
- (b) The Global South Paradox, based on the dynamics of extractive genomics, IP asymmetries, and techno-political resistance, continues to define the forces of the agricultural order of the twenty-first century.

Security and Conflict – Agriculture as a “Soft Weapon” and Targeted Vulnerability

In examining the relationship between agriculture and biosecurity, a clear distinction needs to be maintained between existing facts and hypothetical/anticipatory situations:

- (a) Realities presently verified: Empirical realities that have been documented are the global dissemination of proprietary seed-chemical packages, bilateral corridors of seed diplomacy under China's seed initiatives in Central Asia, corporate licensing agreements in Latin America, and real-time harvesting of cloud data by platforms covering tens of millions of hectares (27).

- (b) The speculative and anticipatory scenarios presented here represent theoretical scenarios,

including "Targeted Genetic Vulnerability", engineering of latent genetic backdoors, and weaponization of grey-zone pathogens. These concepts are systemic vulnerabilities of genomic centralization as opposed to historically documented operations (28).

According to the Biotic Realism paradigm, the national food supply is no longer perceived merely as a sector of the economy of the country but as a source of strategic security and a possible instrument of coercion (9). This change is encapsulated by the emergence of what is known as Targeted Genetic Vulnerability, as countries embrace high-yield monocultures that are genetically engineered and provided by a single bio-hegemony, they unwittingly align their biological vulnerabilities. Since the hegemony is fully conversant with the genome, including its structural vulnerabilities, it can keep the ability to use such weaknesses at times of geopolitical conflict.

In a grey-zone conflict scenario, the Bio-hegemony may use this asymmetry by empowering or allowing pests or pathogens to spread that take advantage of the known vulnerabilities in the crops of the client state. Even without direct interference, simply withholding new resistant crop traits can create severe agricultural problems (16). These actions are often not done with active military aggression, but through the manipulation of biotic relationships to take diplomatic hostages, remake alliances, or disrupt domestic politics (15). This new ground of war is bolstered by the fact that this is not just a revolution in traditional trade embargoes but also in genomic embargoes the siege of a biological nature. The interruption of proprietary chemical activators, the production of genomic updates, or even dependence on annual imports of seeds can be a more effective method of crippling food production than limiting physical commodities (9). What happened in Eastern Europe in 2024-2025--when fertilizer and seed supplies were disrupted--shows how quickly geopolitical tension can turn weak agricultural supply chains into national security crises.

In response, governments have started treating agriculture as part of national defense. Sovereign seed vaults, strategic reserves of climate-resilient germplasm, and domestic CRISPR breeding centers are now common tools in national security planning (5). At the same time, the emergence of

Genetic Border Control—the rapid sequencing and screening of imported biological material—is intended to prevent the introduction of traits that may undermine domestic IP regimes or introduce terminator traits into native varieties.

Because the Biotic Base--the genetic code that defines how well a nation can handle climate stress--is under their control, hegemonic powers can use food insecurity as an indirect instrument of power. Genomic updates, agricultural intelligence, or manipulation of the availability of inputs can cause food price inflation in target countries, a phenomenon that has long been associated with instability, demonstrations, and political change of power (19). Such pressure in severe cases may lead to the collapse of regimes or force a strategic shift without the deployment of even a single conventional weapon.

Biotechnology cannot be separated from geopolitics in this new security environment. Being able to shape the number of calories, harvests, and vulnerabilities, agricultural systems have become the main stage of twenty-first-century conflict--the place where genomic characteristics, and not territorial borders, determine the borders of influence.

One of the main tools of this security environment is the Strategic Inaction, whereby the Bio-hegemony denies having acted at the time when actions are supposed to take place. Rather than exerting apparent biological pressure, the hegemony merely reserves the emergent traits of resistance, postpones the introduction of vital genomic updates or disregards emergent threats of pathogens which it has the definite ability to mitigate. Since these measures are manifested as technical delays or bureaucratic decisions, they afford the hegemony a diplomatic veneer, even though agricultural pressures, agricultural failure, and market instability proceed naturally in the client state. Strategic Inaction becomes then a kind of silent coercion: a manner of implying geopolitical pressure, restructuring partnerships, or punishing rogue partners without leaving any trace of aggression.

Conclusion

The study conducted in this paper shows that the global system has experienced a profound transformation from competition over traditional natural resources to a struggle focused on genomic

resources. The Biotic Realism approach frames agricultural biotechnology not merely as a domestic commercial interest but as fundamental to international alignment and statecraft. We find that the ownership and command of climate-resilient germplasm have become a main tool of soft power, wherein bio-hegemons have used Technological Lock-ins and informational asymmetry to establish chronic biological dependencies in their client states. Due to the weaponization of agriculture via Targeted Genetic Vulnerability, the old-fashioned "Food for Peace" paradigm has been supplanted by a new Biotic Cold War.

To protect international food security, the global community needs to focus initially on a shift toward Multilateral Genomic Commons. This framework is needed to address the Global South Paradox and prevent the extractive use of genomics and the de-territorialization of biological wealth via Digital Sequence Information. With the creation of a non-patentable zone for the biotic commons, states can leave behind the current Biological Contract, which ties their national security to foreign legal and technological frameworks.

Moreover, states need to immediately delink their agricultural infrastructure from proprietary metabolic bundling to reclaim true seed sovereignty. This will demand a strategic move towards Strategic Agronomy, in which countries invest in national CRISPR breeding facilities and sovereign seed vaults to eliminate the Gene-State Link. States can reduce the threat of Genomic Embargoes and ensure that their agricultural resilience is no longer constrained by foreign genomic technologies by establishing independent control over the genetic resources that determine climate resilience.

Abbreviations

Ag-Tech: Agricultural Technology, CRISPR-Cas9: Clustered Regularly Interspaced Short Palindromic Repeats-associated protein 9, DNA: Deoxyribonucleic acid, DSI: Digital Sequence Information, PL-480: Public Law 480 (Food for Peace program).

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Conflict of Interest

The authors have no conflicts of interest to declare.

Data Availability

All presented data are found in the enlisted verified references.

Declaration of Artificial Intelligence (AI) Assistance

This manuscript was written by the authors without the use of generative AI or AI-assisted technologies. All content is original and has been created by the authors themselves. The authors take full responsibility for the content's originality, interpretation and accuracy.

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