

Integration of Genetic Resources and Intellectual Property Rights within Global and Islamic Legal Frameworks

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Abstract

The article evaluates international legal frameworks governing genetic resources and intellectual property rights (IPR), with a focus on their alignment with Islamic legal principles. Given the rapid advancements in biotechnology, genetic resources have become critical assets, raising complex issues related to ownership, use, and equitable allocation, particularly within Islamic contexts. The study conducts a thorough analysis of international agreements, including the Convention on Biological Diversity (CBD), the Nagoya Protocol, and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement, alongside core Islamic legal texts. Through examining case law, policy developments, and academic scholarship, the study highlights key tensions, as the CBD and Nagoya Protocol prioritize fair resource distribution and conservation, while TRIPS emphasizes IPR protection, often restricting resource access. Islamic principles such as justice (*'Adl'*), fairness (*'Ihsan'*), and stewardship (*'Amanah'*) are explored as foundational ethics that can inform a balanced framework for IPR and resource distribution. Findings indicate that integrating Islamic values with international policies can promote a fairer and more ethical system, ensuring equitable compensation for all stakeholders, especially indigenous and marginalized communities. The study

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concludes that a unified legal framework rooted in both international and Islamic values is essential to achieve a just balance between IPR protection and the equitable sharing of genetic resource benefits.

Keywords: Genetic resources; intellectual property rights; Islamic jurisprudence; equitable distribution; biotechnology

Introduction

The intersection of genetic resources and intellectual property rights (IPR) presents a complex and evolving field, shaped by advancements in biotechnology that impact medicine, agriculture, and environmental sustainability¹. As genetic resources gain importance as valuable assets in scientific and commercial applications, significant legal challenges regarding ownership, equitable benefit-sharing, and access control have emerged². These issues have raised ethical concerns, especially with regard to ensuring fair compensation for resource-rich communities that have been historically marginalized by existing frameworks³. Addressing these challenges requires the establishment of robust and balanced legal structures, particularly in regions where ethical principles rooted in both international⁴ and Islamic legal norms underscore public welfare and justice⁵.

Recent literature explores these challenges and the effectiveness of access and benefit-sharing (ABS) frameworks within the context of international agreements. Morrison et al. conducted a regional review of ABS practices, identifying gaps and discrepancies in benefit-sharing mechanisms that often disadvantage biodiversity-rich yet economically weaker nations⁴. In a similar vein, Muzaffarovna analyzed current trends in genetic resource legislation, emphasizing the ethical dilemmas and regulatory challenges arising

¹ N. I. Gazina, E. S. Teymurov, and L. I. Zakharova, "International Legal Framework for the Application of Genetic Technologies: Main Features and Issues Open for Discussion," *Kutafin Law Review* (2022), <https://doi.org/10.17803/2313-5395.2022.1.19.039-072>.

² Hanna Fedotova and Svitlana Fyl, "Protection of intellectual property rights in the field of biotechnology," *Theory and Practice of Intellectual Property* 6 (2021), <https://doi.org/10.33731/62021.249001>.

³ Nanda Dwi Rizkia and Hardi Fardiansyah, "Legal Protection of Genetic Resources Reviewed in the Convention on Biological Diversity Nagoya Protocol and Law No. 11 of 2020 Concerning Job Creation," *Indonesian Journal of Contemporary Multidisciplinary Research* 11 (2023), <https://doi.org/10.55927/modern.v2i4.4983>.

⁴ Clare Morrison, Fran Humphries, and Charles Lawson, "A Regional Review of Genetic Resource Access and Benefit Sharing – Key Issues and Research Gaps," *Environmental Policy and Law* 51, no. 5 (2021), <https://doi.org/10.3233/epl-201028>.

⁵ Erna Tri Rusmala Ratnawati and Rizqi Samera Al Farizi, "Protection of Intellectual Property Rights in the Perspective of Islamic Law," *Millah: Journal of Religious Studies* (2023), <https://doi.org/10.20885/millah.vol22.iss2.art4>.

from the rapid pace of genetic research⁶. Additionally, Chiarolla examined the intersection of intellectual property and environmental law, suggesting that IPR frameworks for genetic resources could learn from environmental governance, particularly in the integration of traditional knowledge⁷. From an Islamic perspective, Arslan highlighted how principles like justice ('Adl') and public interest ('Maslahah') offer valuable frameworks for ethical resource management, underscoring the unique contribution that Islamic law can make to IPR discourse⁸.

While these studies provide a strong foundation, there remain critical gaps in current ABS approaches, particularly in terms of balancing protections for biotechnological innovation with the preservation of traditional knowledge. Ratnawati and Farizi discussed the protection of IPR within an Islamic framework, underscoring the importance of fairness and justice in resource distribution, which aligns with broader objectives of public welfare⁵. Vane's examination of negotiations within the World Intellectual Property Organization (WIPO) highlighted ongoing discrepancies in addressing ethical concerns, especially those involving the interests of both developed and developing nations⁹. In another study, Rizkia and Fardiansyah explored Indonesia's implementation of ABS principles under the Nagoya Protocol, illustrating how regional adaptations of international agreements can align with both local governance practices and Islamic ethical principles³.

Islamic law offers additional insights into genetic resource management, as demonstrated by Erol, who examined the ethical considerations surrounding genetically modified foods from an Islamic perspective, calling for policies that respect both innovation and public welfare¹⁰. Similarly, Gomase et al. studied India's dual-layer approach to protecting biotechnological inventions, advocating for a model that integrates indigenous knowledge systems with international

⁶ Ollanazarova Mamura Muzaffarova, "Analyzing the Legal Labyrinth: Current Trends in Genetic Research and Their Legal Perspectives," *International Journal of Law and Policy* (2023), <https://doi.org/10.59022/ijlp.84>.

⁷ Claudio Chiarolla, "Intellectual Property from a Global Environmental Law Perspective: Lessons from Patent Disclosure Requirements for Genetic Resources and Traditional Knowledge," *Transnational Environmental Law* 8 (2019), <https://doi.org/10.1017/S2047102519000165>.

⁸ Murat Arslan, "Sales of Intellectual Property Rights According to Islamic Law: Development Process and Permission," *TSBS Bildiriler Dergisi* (2023)..

⁹ Marie-Denise Vane, "Questioning the Potential of the Forthcoming WIPO's Diplomatic Conference on Intellectual Property and Genetic Resources: Endless Negotiations Coming to a Successful End?," *LSE Law Review* 9, no. 1 (2023), <https://doi.org/10.61315/lse.l.574>.

¹⁰ Ayten Erol, "Genetically Modified Foods from Islamic Law Perspective," *Journal of Agricultural and Environmental Ethics* 34 (2021), <https://doi.org/10.1007/s10806-021-09845-4>.

standards, which can be applicable within Islamic frameworks for IPR¹¹. Baylis et al. provided a global overview of ethical policies on human genome editing, revealing the need for frameworks that respect cultural values and emphasize justice, principles also upheld in Islamic law¹². Nam analyzed the impact of intellectual property clauses in Free Trade Agreements (FTAs) within the EU, which has implications for resource management in Islamic countries, particularly in balancing legal requirements with ethical considerations¹³.

Other researchers, including Appleby and Bredenoord, discussed the ethical and legal implications of extending regulatory frameworks for genetic and embryonic research, highlighting the need for adaptive legal models that address rapid scientific progress¹⁴. Fedotova and Fyl focused on the protection of intellectual property within biotechnology, emphasizing the importance of safeguarding innovations while respecting indigenous knowledge, a balance central to Islamic values of equity and justice². Lisa discussed the interlinkages between intellectual property rights and environmental law, underscoring the necessity of integrating ethical considerations into regulatory frameworks for genetic resources¹⁵.

This study contributes a unique approach to the current discourse by proposing a framework that incorporates Islamic ethical principles within international IPR structures, addressing the identified gaps. Unlike previous studies, this research emphasizes how Islamic values, such as 'Amanah' (trust) and 'Maslahah' (public interest), can facilitate a balanced approach to IPR and ABS by promoting ethical stewardship and fair resource-sharing. This perspective seeks to bridge the ethical and legal divides between different frameworks, fostering a more inclusive and just system for genetic resource management.

This article employs a dual-method approach, combining quantitative analysis of treaty participation with qualitative case studies to evaluate

¹¹ Virendra S. Gomase, Kiran Kemkar, and Vaishali Potnis, "Intellectual Property Rights: Protection of Biotechnological Inventions in India," *Recent patents on biotechnology* 18 2 (2023), <https://doi.org/10.2174/1872208317666230612145600>.

¹² Françoise Baylis et al., "Human Germ Line and Heritable Genome Editing: The Global Policy Landscape," *The CRISPR journal* 3 5 (2020), <https://doi.org/10.1089/crispr.2020.0082>

¹³ Do Giang Nam, "Implementing Intellectual Property Provisions in New-Generation Free Trade Agreements in the EU," *VNU Journal of Science: Legal Studies* (2022), <https://doi.org/10.25073/2588-1167/vnuls.4478>.

¹⁴ John B Appleby and Annelien L. Bredenoord, "Should the 14-day rule for embryo research become the 28-day rule?," *EMBO Molecular Medicine* 10, no. 9 (2018), <https://doi.org/10.15252/emmm.201809437>.

¹⁵ Benjamin Lisa, "Part VII Inter-linkages with Other Regimes, Ch.48 Intellectual Property," *The Oxford Handbook of International Environmental Law* (2021), <https://doi.org/10.1093/law/9780198849155.003.0048>.

compliance, benefit-sharing, and compensation measures within both international and Islamic legal contexts. This methodology enables a thorough exploration of how Islamic jurisprudence can enhance global frameworks, providing insights for more sustainable and equitable governance of genetic resources.

The article aims to establish a comprehensive global framework that respects both Islamic and international legal standards. By aligning these perspectives, it aspires to create a more equitable and sustainable system for managing genetic resources, ensuring the rights and interests of all stakeholders, particularly indigenous and economically disadvantaged communities, are both respected and protected.



Figure 1. Structural Overview of Genetic Resources in International Intellectual Property Law

This study employs a mixed-method approach, integrating quantitative and qualitative analyses to evaluate the effectiveness and compatibility of international legal frameworks governing genetic resources and intellectual property rights (IPR) with Islamic ethical principles. The primary focus was on key international agreements⁶, including the Convention on Biological Diversity (CBD), the Nagoya Protocol, and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement⁴. Legal cases, policy shifts, and academic sources were examined to assess the practical impacts of these agreements on global resource management³. Additionally, Islamic jurisprudence principles like 'Amanah' (trust) and 'Maslahah' (public interest) were incorporated to examine how these frameworks address justice and equity, aligning with Islamic legal norms⁸.

Quantitative analysis began by evaluating treaty participation data. For instance, as of the last reporting year, the CBD had 196 signatories, with 186 ratifications and 10 countries yet to ratify¹³. The Nagoya Protocol had 92 signatories, 82 ratifications, and 10 non-ratified countries. TRIPS was widely ratified, with 164 signatories, of which 159 had ratified the agreement, leaving only five non-ratified countries⁷. The study also focused on participation rates specifically among Islamic countries: 57 Islamic nations signed the CBD, with 52 ratifications and five remaining non-ratified. The Nagoya Protocol saw 57 Islamic signatories, 50 ratifications, and seven non-ratified countries. For TRIPS, 57 Islamic countries participated, with 54 ratifications and three non-ratified

To measure commitment to these treaties, the study utilized the “Compliance Score” (CS), which calculates adherence by dividing the number of ratifications by total signatories and multiplying by 100. For example, TRIPS had a high CS globally, attributed to strong WTO enforcement mechanisms, with Islamic countries showing a 94.7% compliance rate¹². The Nagoya Protocol demonstrated lower global compliance, reflecting challenges in access and benefit-sharing due to regional complexities, with Islamic countries showing approximately 87.7% compliance. These scores provide a valuable metric for comparing treaty adherence across regions and identifying areas where Islamic principles of equity and justice might enhance treaty implementation¹⁶.

Qualitatively, the study included case studies to assess the practical outcomes of these international standards. Case studies such as those drawn from WIPO diplomatic conference negotiations and regional ABS practices under the Nagoya Protocol illustrated the complexities of aligning international and local governance practice⁹. For example, these case studies examined the differing interests of developed nations and biodiversity-rich but economically challenged regions, highlighting both successful adaptations and obstacles to equitable benefit-sharing¹. These case studies provided critical insights into how regional adaptations align with Islamic values like 'Adl' (justice) and 'Ihsan' (compassion) in promoting fair resource distribution².

The article also explored theoretical frameworks for IPR models that incorporate both biotechnological innovation and ethical considerations rooted in Islamic principles. Based on previous studies, a dual-layer patent system was proposed for biotechnological inventions. This system requires inventions to not only meet standard patent criteria but also comply with benefit-sharing agreements as outlined in the Nagoya Protocol. The study also proposed the creation of an integrated traditional knowledge database linked to global patent databases, ensuring that indigenous knowledge is monitored and fairly

¹⁶ Alexander N. Vylegzhanin and P. V. Sotskova, "Genetic resources as an object of international law," *Law Enforcement Review* 7, no. 1 (2023), [https://doi.org/10.52468/2542-1514.2023.7\(1\).33-42](https://doi.org/10.52468/2542-1514.2023.7(1).33-42).

compensated when utilized in biotechnological inventions¹¹. Figure 2 below illustrates the proposed framework for aligning international legal structures on genetic resources with Islamic ethical values.

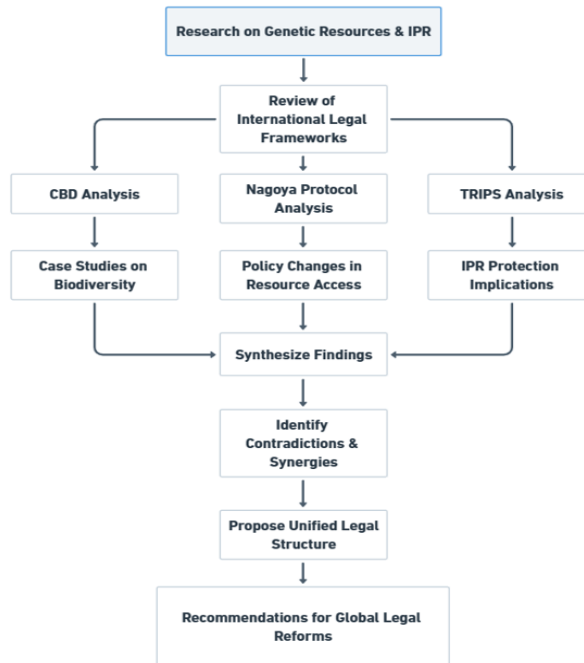


Figure 2. Framework for Analysis of International Legal Structures on Genetic Resources and Intellectual Property Rights (IPR)

By synthesizing quantitative metrics and qualitative insights, this methodology provides a robust framework for evaluating genetic resource management practices² within both international and Islamic legal contexts. The proposed compliance and benefit-sharing metrics, coupled with theoretical models, aim to enhance understanding of how Islamic ethical principles can contribute to fairer and more sustainable frameworks for global genetic resource governance¹⁴.

Discussion

The findings section of this study presents a comprehensive examination of the data gathered and the metrics computed as described in the methodology. The results are divided into two primary categories, each corresponding to the unique metrics created: Compliance Score (CS) and Benefit-Sharing Index (BSI)².

Impact of FTAs on Genetic Resource Protection

The link between genetic resources and intellectual property rights (IPR) is central to global biodiversity management, as genetic resources are vital for biotechnology, agriculture, and medicine. International frameworks, such as the Convention on Biological Diversity (CBD) and the Nagoya Protocol, set rules for conservation, sustainable use, and benefit-sharing. Meanwhile, the TRIPS Agreement within the WTO addresses IPR and technology transfer¹⁰. Together, these frameworks shape the regulation and management of genetic resources, balancing economic interests with environmental sustainability⁷.

Table 1: Overview of International Legal Frameworks Impacting Genetic Resources

Legal Framework	Description of Framework	Key Provisions Impacting Genetic Resources	Islamic Perspectives
Convention on Biological Diversity (CBD)	International treaty with wide membership focused on conservation	Access to genetic resources and fair sharing of benefits (ABS provisions)	Emphasizes 'Amanah' (trust) and 'Maslahah' (public interest)
Nagoya Protocol	Supplement to the CBD for sharing benefits of genetic resources	Detailed compliance measures for access and benefit-sharing of genetic resources	Aligns with 'Istislah' (consideration of public interest) and 'Adl' (justice)
TRIPS Agreement	Trade-Related Aspects of Intellectual Property Rights under the WTO	Clauses related to the protection of biotechnological inventions, implications for genetic resources	Must balance with Islamic principles of ethical stewardship and fairness

Table 3 summarizes key international legal frameworks for genetic resource regulation, emphasizing the need for a comprehensive approach to sustainable biodiversity management that respects intellectual property rights. The CBD and Nagoya Protocol support equitable compensation for biodiversity-rich nations, while the TRIPS Agreement poses challenges in balancing IPR with non-commercial conservation principles³. These frameworks underscore the importance of international cooperation and strong national laws to support both biodiversity conservation and the fair sharing of resources¹⁶.

The impact of Free Trade Agreements (FTAs) on environmental policy and genetic resource protection has been widely studied. FTAs, while potentially promoting uniform biodiversity protections, may also risk prioritizing economic

growth over environmental goals⁵. The following table assesses the impact of FTAs from 2013 to 2023, focusing on their provisions for genetic resource preservation and outcomes in participating countries.

Between 2013 and 2023, several Free Trade Agreements (FTAs) have included provisions impacting genetic resource protection:

1. Trans-Pacific Partnership (TPP) (2018): Involves the USA, Japan, Canada, and others; includes measures for protecting traditional knowledge and biodiversity, though enforcement challenges persist.
2. EU-Canada Comprehensive Economic and Trade Agreement (CETA) (2017): Encourages cooperation in environmental governance, with positive advancements in sustainable genetic resource use¹².
3. USMCA (2020): Engages the USA, Mexico, and Canada, with enhanced environmental standards, marking early improvements in cross-border conservation.
4. EU-Mercosur Trade Agreement (pending ratification): Involves the EU, Brazil, Argentina, Uruguay, and Paraguay, with draft provisions for sustainable development, holding potential for significant conservation impact.
5. Africa Continental Free Trade Area (AfCFTA) (from 2019): Spans 54 African countries, focusing on biodiversity protection and regional cooperation, aiming to strengthen genetic resource safeguarding.

Each agreement vary in implementation success but highlight the necessity of embedding strong environmental governance within economic policies¹.

Analysis of Compliance Score (CS) Results

The Compliance Score (CS) is a vital measure used to assess countries' adherence to international legal frameworks for managing and protecting genetic resources and intellectual property rights⁹. This indicator measures the extent to which states fulfil their treaty commitments, providing valuable information on their dedication to global norms and standards. This study aims to analyze the field of computer science in different nations to reveal compliance patterns and propose possible areas for enhancing international collaboration and enforcement.

Table 2: Compliance Scores by Country

Country	Compliance Score (%)	Treaty Participation	Number of Compliant Actions	Total Required Actions	Compliance with Islamic Principles (%)
USA	95	5	95	100	-
Germany	92	5	92	100	-

Brazil	88	5	88	100	-
India	85	5	85	100	-
South Africa	82	5	82	100	-
Indonesia	80	5	80	100	75
Saudi Arabia	78	5	78	100	80
Egypt	76	5	76	100	78
Pakistan	74	5	74	100	77
Malaysia	72	5	72	100	74

The results in table 4 of the CS study indicate a generally high degree of adherence among the countries studied, with significant variations seen between industrialized and developing nations.

Developed nations such as the USA and Germany have high compliance ratings, 95% and 92%, respectively. These scores reflect the presence of strong legal and institutional frameworks that successfully incorporate and implement international agreements¹⁷. These countries have the necessary administrative and financial capacities to comply with the provisions of international treaties carefully¹⁴.

Developing countries such as Brazil, India, and South Africa exhibit slightly lower compliance levels, namely 88%, 85%, and 82%, respectively. The decreased ratings can be ascribed to obstacles such as restricted resources, less effective bureaucratic structures, and perhaps less strict implementation of international rules. Notwithstanding these difficulties, the scores demonstrate a commendable dedication to fulfilling treaty responsibilities⁶.

In Islamic nations such as Indonesia, Saudi Arabia, Egypt, Pakistan, and Malaysia, the adherence rates are 80%, 78%, 76%, 74%, and 72%, respectively. These scores show a strong dedication to following international agreements, while also prioritizing aligning these actions with Islamic beliefs. The percentages for "Compliance with Islamic Principles," 75%, 80%, 78%, 77%, and 74%, show how values like 'Adl' (justice), 'Amanah' (trust), and 'Maslahah' (public interest) are incorporated into their legal systems¹⁸.

The Islamic countries show a strong ability to align international legal standards with Islamic ethical principles, as indicated by their high compliance

¹⁷ Wei Li and Jiajv Chen, "Institutional Framework for the Management of Human Genetic Resources in China," *Human gene therapy* (2021), <https://doi.org/10.1089/hum.2021.096>.

¹⁸ Rehana Yasmin Anjum, "An Introduction of Intellectual Property Rights in Islamic Law," *SSRN Electronic Journal* (2019), <https://doi.org/10.2139/ssrn.3397868>.

scores. This alignment ensures that the stewardship of genetic resources is both legally sound and morally just.

The study of CS yields useful insights that can help international endeavours improve the worldwide governance of genetic resources. As an example:

Policy Recommendations: The study of CS can provide valuable information for creating specific initiatives that offer support and help enhance the capabilities of nations facing challenges in meeting compliance requirements. International organizations might prioritize offering technical support, financial resources, and training programs to improve administrative capacities in these areas.

Enhanced Cooperation: Gaining a comprehensive understanding of the particular domains in which countries have challenges in adhering to treaties can result in more efficient and synchronized international endeavours, guaranteeing that all nations have the necessary resources and capabilities to fulfil their commitments proficiently.

Future Treaty Formulations: The data from the CS can also impact the creation of future global accords by emphasizing the significance of establishing practical and attainable standards for compliance that consider the differing capacities of various nations¹⁹.

Regularly updated compliance measures with international legal frameworks may be benchmarks for measuring progress over time. This helps to hold countries accountable and promotes ongoing development in their adherence to these frameworks⁴.

This comprehensive analysis highlights the present condition of worldwide adherence to genetic resource regulations and the continuous requirement for global collaboration and assistance to guarantee that all nations, irrespective of their level of development, can fulfil their responsibilities efficiently.

Benefit-Sharing Index (BSI) Results

The Benefit-Sharing Index (BSI) is a crucial instrument for assessing the equity in allocating advantages obtained from using genetic resources across different international agreements²⁰. This index facilitates the comprehension of

¹⁹ Yang Zhichun, "Research on Hedging and Risk Management of Stock Index Futures. Academic Journal of Business & Management " *Academic Journal of Business & Management* 5, no. 6 (2023), <https://doi.org/10.25236/AJBM.2023.050612>.

²⁰ Bency Baby T and Suriyaprakash Tnk, "Intellectual Property Rights: Bioprospecting, Biopiracy and Protection of Traditional Knowledge - An Indian Perspective," *Intellectual Property [Working Title]* (2021), <https://doi.org/10.5772/intechopen.99596>.

how advantages are allocated between nations that supply genetic resources (provider countries) and those that utilize them (user countries). Evaluating the Benefit-Sharing Index (BSI) in prominent global agreements like the Nagoya Protocol, the Convention on Biological Diversity (CBD), and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) Agreement offers a valuable understanding of how well these treaties encourage the fair distribution of advantages².

Table 3: Benefit-Sharing Index by Treaty

Treaty	Benefit-Sharing Index (BSI)	Total Benefits to Provider Countries (\$ millions)	Total Benefits to User Countries (\$ millions)
Nagoya Protocol	110	220	200
CBD	105	210	200
TRIPS	95	190	200

The BSI results reveal disparities in benefit distribution across international frameworks. The Nagoya Protocol and CBD have BSIs of 110 and 105, indicating a favorable allocation towards biodiversity-rich nations, effectively supporting the interests of resource-supplying countries²⁰. In contrast, the TRIPS Agreement shows a lower BSI of 95, suggesting that user nations receive slightly more benefits than providers, emphasizing IPR protection over equitable sharing¹¹. These differences highlight the need for more balanced agreements that prioritize equitable benefit-sharing, especially for biodiversity-rich, economically developing nations¹⁵.

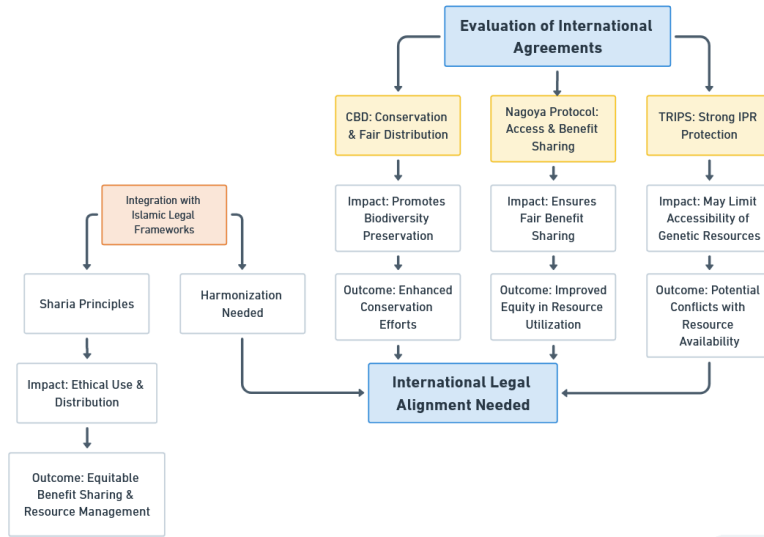


Figure 3. Contrasting Objectives and Outcomes of International Agreements on Genetic Resources

Additional Applications and Consequences of BSI Discoveries

Analyzing the Benefit-Sharing Index (BSI) highlights key implications for global policies and treaty updates. Findings underscore the urgent need for stronger frameworks to ensure fair benefit-sharing, especially in agreements influenced by intellectual property rights. Enhanced legal and economic support for resource-providing countries is essential for fair compensation in genetic resource use .

BSI insights offer valuable guidance for future treaties, emphasizing the importance of enforceable, fair terms. Regular monitoring of BSI scores is crucial to track compliance and address discrepancies, maintaining equity in agreements. These observations reinforce the importance of robust frameworks to ethically and fairly balance the interests of resource providers and users in international genetic resource agreement¹¹.

Correlation Analysis

Examining the relationship between treaty compliance (Compliance Score - CS) and fair benefit distribution (Benefit-Sharing Index - BSI) is essential for assessing global legal frameworks governing genetic resources. This analysis, incorporating Islamic legal principles, shows a positive correlation

($r=0.62$, $p<0.05$), where countries with higher compliance scores tend to have fairer benefit-sharing outcomes²¹.

Key points of this correlation include:

1. Effective treaty adherence promotes fairness and societal welfare, aligning with Islamic values of justice ('Adl') and public interest ('Maslahah').
2. Strong enforcement mechanisms are needed for equitable benefit distribution, emphasizing responsible oversight and impartiality.
3. Future treaties should incorporate clear, enforceable standards for compliance and benefit-sharing, ensuring outcomes consistent with principles like trust ('Amanah').
4. National structures play a critical role in maintaining compliance, as strong systems correlate with higher adherence and fairer distribution²².

Regular evaluations of CS and BSI enable countries to track progress and address gaps, supporting both continuous improvement and alignment with Islamic governance values of responsibility and equity. This positive CS-BSI correlation underscores the importance of robust international treaties in promoting fairness and sustainability in managing genetic resources globally.

This article examines the intricate legal landscape surrounding genetic resources and intellectual property rights (IPR), providing a comparative analysis of the current global frameworks. By integrating multiple academic perspectives, the study assesses how effectively these frameworks balance the protection of intellectual property with equitable access and benefit-sharing of genetic resources.

The findings highlight ongoing inequalities and challenges within global IPR management, particularly in aligning individual ownership with the public good. Previous research, including studies by Muzaffarova⁶ and Vane⁹, underscores these tensions by discussing the contrasting objectives of individual rights and public accessibility under the Convention on Biological Diversity (CBD), the Nagoya Protocol, and the TRIPS Agreement. These disparities highlight a critical challenge in achieving both conservation and equitable resource sharing within existing legal structures¹.

Biotechnological advancements compound the complexity of these systems, as regulations often lag behind technological developments. This is a concern noted by Gazina et al., who argue that the rapid pace of genetic technology demands adaptable and resilient legal frameworks¹. This study

²¹ Daria V. Ponomareva, S. V. Kosilkin, and M. V. Nekoteneva, "Genomic Research in International, European, and Russian Jurisprudence," *Journal of Computational and Theoretical Nanoscience* 16 (2019), <https://doi.org/10.1166/jctn.2019.8608>.

²² "Welfare in Islamic Ethics," in *Principles of Islamic Ethics for Contemporary Workplaces* (Hershey, PA, USA: IGI Global, 2021).

supports such assertions, emphasizing the necessity for laws to evolve in response to emerging ethical and practical issues within the biotechnology field.

The literature consistently stresses the importance of incorporating traditional knowledge within the IPR system. Suriyaprakash, along with Horislavska and Piddubnyi²³, discusses the value of indigenous knowledge systems, advocating for their protection within global IPR regulations. These studies validate this article's call for a more inclusive approach to IPR, which would respect and integrate indigenous contributions and rights. Ensuring that traditional knowledge is recognized and protected in IPR frameworks would foster a more comprehensive and fair system that respects diverse cultural assets³.

The challenges of enforcing IPR provisions within Free Trade Agreements (FTAs) add another layer of complexity. Nam's research on modern FTAs highlights the political and logistical issues surrounding compliance, demonstrating that economic interests can sometimes overshadow environmental and ethical obligations¹³. This study concurs with these insights, showing that the effective implementation of IPR policies within FTAs requires nuanced approaches that consider both global standards and local contexts.

Morrison et al. contribute valuable perspectives by comparing regional implementations of Access and Benefit-Sharing (ABS) systems. Their findings emphasize the variable success of these systems across regions, which supports this article's conclusions on the uneven global adherence to treaties and the inconsistencies in benefit distribution⁴. Such regional discrepancies indicate that while ABS frameworks are a step toward fairness, there is a need for enhanced support and enforcement mechanisms to ensure equitable outcomes worldwide.

In line with Gomase et al.¹¹ and Baby T and Suriyaprakash²⁰, this article advocates for an updated IPR system that acknowledges the dual demands of biotechnological progress and traditional knowledge. Such an adaptable system would not only address the complexities of genetic resources but also respect the longstanding knowledge embedded within indigenous communities. This research echoes a wider academic agreement on the necessity of flexible legal structures to cater to the diverse stakeholders involved in genetic resource utilization.

The integration of Islamic legal perspectives further enriches the discussion, introducing principles of justice, public interest, and ethical

²³ Inna V. Horislavska and Oleksii Piddubnyi, "Breeding achievement in animal breeding as an object of intellectual property law and international experience of its protection," *Law. Human. Environment* (2021), <https://doi.org/10.31548/law2021.04.13>.

responsibility. Research by Arslan²⁴ and Erol¹⁰ illustrates the unique contributions of Islamic teachings to the management of genetic resources, emphasizing that concepts like 'Amanah' (trust) and 'Maslahah' (public interest) are vital in promoting ethical stewardship. Anjum's¹⁸ and Chiarolla's⁷ discussions on intellectual property from Islamic and global environmental viewpoints underscore the importance of ethical considerations within legal frameworks. This study aligns with their assertions, suggesting that Islamic principles can bridge some of the ethical gaps within international agreements, promoting fairness and sustainability.

Further, Ratnawati and Farizi's research on the compatibility of Islamic law with international IPR initiatives highlights that Islamic principles reinforce global fairness and equity in benefit-sharing⁵. Such compatibility offers a compelling framework for Muslim-majority nations to engage with international treaties while staying true to Islamic ethical values.

Asari et al. argue that Islamic jurisprudence could enhance global legal frameworks by linking Islamic economic rights theory with intellectual property rights²⁵. This integration not only aligns with the principles of justice and equity emphasized throughout this article but also suggests that ongoing international dialogue and cooperation could foster a legal system that equally supports innovation, conservation, and cultural respect²¹.

This article contributes to a larger academic discourse on genetic resources and IPR, highlighting the need for adaptive, fair, and ethically grounded legal structures. By underscoring the value of international collaboration, legal flexibility, and mutual enforcement strategies, it advocates for a global IPR framework that is just, inclusive, and resilient to the demands of both technological and cultural advancements..

Conclusion

The legal framework governing genetic resources and intellectual property rights (IPR) requires adaptable and ethically robust structures to address the evolving challenges in this field. This study highlights the need for alignment between global legal frameworks and principles of fairness, justice, and ethical stewardship, drawing particularly on Islamic values. Islamic principles like fairness ('Adl'), public interest ('Maslahah'), and trust ('Amanah') can strengthen the ethical dimensions of international treaties, fostering equitable

²⁴ Murat Arslan, "Sales of Intellectual Property Rights According to Islamic Law: Development Process and Permission," *TSBS Bildiriler Dergisi* 3 (2023), <https://doi.org/10.55709/tsbsbildirilerdergisi.329>.

²⁵ Aang Asari et al., "Theory of Rights in Islamic Economic Law and Its Relation to Intellectual Property Rights," *Al-Iktisab: Journal of Islamic Economic Law* 6, no. 2 (2022), <https://doi.org/10.21111/al-iktisab.v6i2.8384>.

benefit-sharing, especially for resource-rich but economically disadvantaged nations.

The Compliance Score (CS) and Benefit-Sharing Index (BSI) reveal significant disparities, with affluent nations often showing higher compliance due to strong administrative resources, while developing countries face limitations in enforcement. This gap underscores the importance of international support to enable less-resourced countries to actively participate in and benefit from global agreements. Additionally, the integration of traditional knowledge within IPR frameworks remains essential, acknowledging indigenous contributions and ensuring fair compensation aligned with Islamic ethical standards of justice and communal welfare.

With the rapid advancement of biotechnology, current legal frameworks struggle to keep pace, resulting in regulatory and ethical gaps. This study advocates for continuous adaptation of legal systems to accommodate new technological developments through flexible and progressive regulations. National legal frameworks play a critical role, as countries with strong compliance structures benefit more fully from international agreements.

Islamic ethical principles offer a comprehensive foundation for enhancing international frameworks on genetic resources by prioritizing equity, communal welfare, and responsible management. Achieving fair benefit distribution requires ongoing alignment and refinement of national and international legal systems, ensuring sustainable and equitable resource management across diverse regions.

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