Blockchains for Access, Use and Benefit Sharing of Digital DNA Sequences

Heyjie Jung, Federica Fusi, and Eric Welch
Arizona State University | School of Public Affairs
Center for Science, Technology, and Environmental Policy Studies (CSTEPS)

Research Question

What opportunities and challenges does blockchain technology provide for access, use and benefit sharing of genetic resources for food and agriculture?

Abstract

- **Access to Benefit Sharing (ABS)** is a international policy framework designed to promote and ensure access to genetic resources and encourage fair and equitable benefit sharing between providers and users of genetic resources.
- Current ABS systems for genetic resources for food and agriculture (GRFA) face **new challenges due to the increasing use of digital sequence information (DSI).** Digitization of DNA sequences hinders the monitoring of the usage of digital DNA sequences and prevents scientists and policy makers from tracking and identifying GRFA ownership and origin.
- **Blockchain technologies** might offer opportunities to address digitization challenges. Yet there are several open questions for policymakers and scientists regarding the use of blockchain in the context of GRFA exchange and benefit sharing.

Definition	ABS framework	Blockchain
Principles	Ensuring access to GRFA and promoting fair and equitable sharing of benefits coming from the use of GRFA.	Facilitating decentralized transactions in a trustless context and promoting accountability of the transaction system.
Application	The Convention on Biological Diversity (CBD) system based on bilateral exchange of genetic resources and the multilateral Treaty system based on common pooling of genetic resources and decoupling of benefits sharing from access to genetic material. *We refer to the Treaty's ABS framework, but similar considerations might apply to the CBD system as well.*	Decentralized ledger of all transactions across a peer-to-peer network where participants can confirm and have access to transactions without a central certifying authority. *We consider blockchains as varying from permissionless to permissioned and from public to private.*

ABS principles	Digitization challenges[1]	Blockchain applications
Identification	It is hard to identify the original source of the gene sequences and scientists are increasingly less likely to return to the original physical material.	It maintains a secured track of all transmissions and edits over time and allow to easily find origin and uses of DSI.
Monitoring	It is hard to track transmission, therefore exchanges of GRFA are sometimes not transparent.	Transactions are openly and publicly recorded and accessible to the public and research community.
Value generation	The creation of value depends from the use of multiple and diverse sequences in a variety of combinations (e.g. synthetic biology). The value of a single sequence is hard to quantify.	Because all transactions become trackable, it can aggregate all uses of data and combinations and allows to track even small sequences. But it still needs a way to calculate the value of sequences.
Standardization	Due to the increase in number of holders of digital sequence information, it is hard to create an aggregated and standardized system. It would require a central authority to manage collective rights and pool benefits.	Smart contracts can standardize the access, use, and benefit sharing of DNA sequence data by requiring proper authorization when scientists upload or use GRFA data and metadata. But it might still require a central authority to implement standards and regulations.
Decoupling of monetary benefits from providers	The average value of an individual contribution is decreasing as scientists combine and integrate a variety of DSI in new sequences. Benefits are diluted among multiple actors.	It can increase the fragmentation of DSI and multiplication of DSI exchanges which might reduce willingness to pay fees and increase difficult to share benefits among actors.
Diversification of benefits	It is hard to encourage monetary benefit-sharing due to low monitoring.	It reduces the transaction costs for accessing DSI and opportunities for exchange increase. But it might result in the decentralization and loss of control on the exchanges from a central authority.

Open questions for blockchain use

Technical/financial capacity : Who will support and implement blockchains?
1. Speed of transaction is slow due to technical issues
2. Capacity varies across individuals, organizations, and countries ('digital divide')

Design of an ABS system with blockchain: Who will authorize access to the blockchain? Who will get access to, exchange and DNA sequence on the blockchain?

Compatibility with ABS : Will everyone have equal benefit sharing? Can blockchain overcome and be integrated in the current relationships with private and public genebanks and other organizations? How will exchanges be tracked for benefit sharing?

Individual compliance : How would scientists react to blockchain use?
1. Cultural shift from a close and private system to open and public available information

Research and Collaboration : Will scientists without technical/financial capacity for blockchain be left out from the exchange of GRFA? Will different levels of technical/financial capacity worsen the discrepancy among developed and developing country scientists' productivity and their collaboration opportunities?

Reference: [1] Welch, E. W., Bagley, M., Kuiken, T., & Louafi, S. (2017). Potential implications of new synthetic biology and genomic research trajectories on the International Treaty for Plant Genetic Resources for Food and Agriculture.

Center for Science, Technology and Environmental Policy Studies
Arizona State University