Traceability Tokens Backing Commodity Finance

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Abstract

This document outlines a tokenization framework for commodity financing where issuance and redemption events are anchored to verifiable supply-chain traceability data. It summarizes the proposed lifecycle, data requirements, and risk controls needed to make the instrument trustworthy for lenders and investors.

1 Introduction

A large share of working-capital loans for agricultural exporters is still underwritten with limited visibility into the physical flow of goods. Financial institutions rely on fragmented documents—warehouse receipts, bills of lading, quality certificates—that are often delayed or manually reconciled. This opacity increases the cost of capital and leaves lenders exposed to double-financing fraud or quality downgrades discovered late in the process. Meanwhile, agribusinesses in Brazil are investing heavily in digital traceability to satisfy regulatory and sustainability demands from global buyers. This report explores how those trusted data feeds can anchor a tokenized financing instrument whose issuance and settlement mirror the lifecycle of the underlying commodity lots.

2 Supply-Chain Blueprint

2.1 Actors and Checkpoints

The reference supply chain centers on Brazilian soy exports. Key actors include producers and cooperatives that originate grain lots; certified storage operators responsible for grading and warehousing; third-party logistics providers and rail operators moving goods to port; export terminals issuing loading confirmations; and auditors or certification bodies monitoring sustainability criteria. Critical checkpoints are: (i) harvest and initial grading with issuance of electronic fiscal invoices (NF-e); (ii) warehouse intake where lots receive unique identification and quality assays; (iii) outbound logistics events such as truck departure and rail arrival, recorded through CT-e transport documents; (iv) port-side fumigation and loading confirmations; and (v) customs clearance and export manifests.

2.2 Data Standards

Traceability events are modeled with the GS1 Electronic Product Code Information Services (EPCIS) standard, which captures what, when, where, and why for each commodity movement. ISO 22005 defines how identification schemes maintain chain-of-custody continuity from farm to port, while Brazil's Ministry of Agriculture (MAPA) mandates the use of NF-e and CT-e documents that

already provide structured timestamps and counterparties. These artifacts form the minimal data set required for the token state machine: creation requires a validated NF-e and warehouse intake notice; transitions between storage and transport states consume CT-e events; export confirmation relies on the Conhecimento de Embarque (bill of lading) and Siscomex customs filings.

3 Token Lifecycle Model

1. **Creation:** Tokens are minted when a lot is deposited into a certified warehouse and linked to a validated NF-e. An oracle ingests the EPCIS event and locks the token supply to the lot's net weight and quality grade.
2. **In-Storage State:** While grain remains in storage, periodic quality audits and inventory reconciliations update token metadata. Degradation beyond tolerance automatically routes the token to a review queue for potential haircut.
3. **Transit State:** Upon issuance of a CT-e and departure scan, tokens transition to transit. Multi-sig confirmation from the warehouse operator and transporter reduces risk of phantom movements.
4. **Export State:** Loading confirmations, moisture/quality tests, and customs clearance events advance the token to an export-ready state. The token supply is now eligible for settlement with financiers.
5. **Settlement or Default:** Successful delivery and payment trigger redemption. In the case of dispute (damage, non-delivery), the token enters a default branch where collateral reserves or insurance claims are activated.

4 Risk and Compliance Framework

- **Oracle Architecture:** Use redundant oracle committees combining MAPA-certified data providers, warehouse management systems, and logistics integrations. Messages are signed using Brazil's ICP-Brasil digital certificates to ensure legal enforceability.
- **Fraud Mitigation:** Require proof of exclusivity through hashed warehouse receipts and enforce position limits per counterparty. Automated anomaly detection on EPCIS event cadence flags missing scans or duplicate lot IDs.
- **Dispute Resolution:** Establish a 48-hour dispute window post-export where auditors can freeze redemption and request additional evidence. Smart contracts must support role-based overrides for regulators.
- **Regulatory Compliance:** Map the token structure to Brazil's CVM guidelines on receivables certificates and to EU/US commodity rules when the instrument is offered cross-border. Maintain audit logs to satisfy anti-money laundering (AML) and know-your-customer (KYC) requirements for all participants.

5 Implementation Roadmap

1. **Discovery (Q4 2025):** Finalize partner list of cooperatives, warehouses, and financiers; design data-sharing agreements; build event ingestion prototypes.

2. **MVP (Q1 2026):** Deploy oracle bridge ingesting NF-e and EPCIS data; launch smart contract with basic creation/transition logic; run closed pilot on 10 grain lots.

3. **Scale-Up (Q2 2026):** Integrate insurance/guarantee providers, extend to multimodal transport, and connect to secondary trading venue for tokenized receivables.

6 Conclusion

Grounding financing tokens in verified traceability data reduces information asymmetry between commodity exporters and capital providers. The proposed model combines existing regulatory documents with global data standards to deliver near real-time assurance on collateral quality. Future work must validate oracle resilience, evaluate economic incentives for data sharing, and test how investors price the additional transparency. Pilot deployments with Brazilian soy exporters provide the critical proving ground before extending the framework to other commodities.

References

Provide structured bibliography once sources are consolidated.