Tokenizing Agricultural Futures in Blockchain: New Business Opportunities for Small and Medium-sized Enterprises

Токенизация на земеделски фючърси чрез Блокчейн: Нови бизнес възможности за малки и средни предприятия

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Абстракт: *Малките и средни предприятия (МСП) в селскостопанския сектор често са изключени от институционалните пазари за фючърсна търговия поради минимални изисквания за обем и сложни процедури за достъп. Това Изследването представя иновативен модел за токенизация, който позволява на МСП колективно да участват във фючърсната търговия чрез обединяване на по-малки количества в стандартни договори и транзакции. На базата на блокчейн технология, моделът създава прозрачна система за агрегиране на малки обеми в стандартни фючърсни контракти. Резултатите от моделирането показват предимства като значително намаляване на риска за МСП и подобрен достъп до инструменти за управление на риска. Икономическият анализ разкрива потенциално увеличение на приходите с 8-10% чрез елиминиране на посредници и директен достъп до фючърсни пазари. Този подход има потенциала да трансформира участието на МСП в глобалната търговия със селскостопански стоки.*

Abstract: *Small and medium-sized enterprises (SMEs) in the agricultural sector are often excluded from institutional futures trading markets due to minimum volume requirements and complex access procedures. This study presents an innovative tokenization model that enables SMEs to collectively participate in futures trading by pooling smaller quantities into standard contracts. Using blockchain technology, the model creates a transparent system for aggregating small volumes into standard futures contracts. Results indicate significant risk reduction for SMEs and improved access to risk management tools. Economic analysis reveals potential revenue increases of 8-10% through elimination of intermediaries and direct futures market access. This approach has the potential to transform SME participation in global agricultural commodity trading.*

Ключови думи: токенизация, земеделски фючърси, МСП, блокчейн, управление на риска

Keywords: tokenization, agricultural futures, SMEs, blockchain, risk management

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Introduction

The European agricultural commodities market represents a critical sector of the economy, with small and medium-sized enterprises (SMEs) constituting approximately 95% of all agricultural businesses. However, these enterprises, which form the backbone of agricultural production, face significant challenges in accessing sophisticated financial instruments for risk management and market participation

Market Context and SME Challenges. Current market dynamics reveal a striking disparity: while European SMEs produce approximately 60% of the continent's wheat supply, they have limited access to futures markets due to structural barriers. The minimum contract size requirement of 50 tonnes on platforms like Euronext [1] effectively excludes many smaller producers, who typically generate between 20-40 tonnes annually [2], [3], [4], [5], [6]. This creates a two-tier market where large institutional players enjoy sophisticated risk management tools while SMEs remain exposed to market volatility.

Consider the following market participation barriers – Table 1.:

Table 1: Current Market Access Barriers for Agricultural SMEs

Aspect	**Large Institutions**	**SMEs**
Contract Size Requirements	Easily fulfilled	Often too large
Market Access	Direct	Limited / Through intermediaries
Risk Management Tools	Comprehensive	Basic
Price Discovery	Real-time access	Delayed information
Margin Requirements	Manageable	Prohibitive

Current State of Agricultural Futures Trading. The traditional agricultural futures market operates primarily through centralized exchanges, requiring standardized contract sizes and substantial collateral. This model, while efficient for large-scale traders, creates significant inefficiencies for smaller participants [7]. Recent studies indicate that European agricultural SMEs lose an estimated €2-3 billion annually due to their inability to access futures markets directly.

Problem Statement: The core business challenge lies in the structural mismatch between (i) Standard futures contract specifications designed for institutional traders; (ii) The operational realities of agricultural SMEs; (iii) The resulting inefficient price discovery and risk management and (iv) Lost economic value due to necessary intermediation.

This mismatch creates a significant economic inefficiency where SMEs must either:

1. Accept greater market risk due to inability to hedge.
2. Sell at discounted prices to intermediaries.
3. Incur additional costs through aggregators.
4. Forgo opportunities for market expansion.

Research Objectives. This research addresses these challenges through the following objectives:

1. Develop a viable business model for SME participation in futures markets through tokenization.
2. Quantify the economic benefits of direct market access for agricultural SMEs.
3. Design and validate a technical framework for implementing tokenized agricultural futures.

4. Assess the scalability and market impact of the proposed solution.

The subsequent sections detail our innovative approach to solving these challenges through a combination of blockchain technology and smart contract implementation, focusing particularly on the economic benefits and business transformation potential for agricultural SMEs.

Market Analysis

The European agricultural futures market presents a significant opportunity for technological innovation, particularly in addressing the needs of SME participants. Our analysis focuses on wheat futures trading, where the disparity between institutional and SME participation is most pronounced.

Current Market Structure. Analysis of major European agricultural regions reveals that SMEs, despite producing 60-70% of wheat volume, represent only 5-8% of futures market participation. The following data illustrates this market disparity – Table 2:

Table 2: European Wheat Market Participation Analysis (2023)

Country	**SME Production (avg. tonnes/year)**	**Minimum Futures Contract (tonnes)**	**Market Access Gap (tonnes)**	**Estimated Value Loss per smallholder (€/year)**
Poland	30	50	20	8,800
Bulgaria	25	50	25	11,000
Hungary	35	50	15	6,600
Romania	20	50	30	13,200
Italy	40	50	10	4,400

Lost Value Analysis. The current market structure creates three primary sources of value loss for SMEs:

- Direct trading costs through intermediaries (2-3% of transaction value)
- Price inefficiencies due to delayed market access (3-4% impact)
- Lost hedging opportunities (estimated 3-5% of annual revenue)

Competitive Landscape. Traditional market solutions fall into three categories:

1. Physical aggregators (high fees, limited transparency)
2. Cooperative structures (complex governance, slow decision-making)
3. Digital platforms (limited market integration, no fractional trading)

This analysis reveals a clear market gap for a solution that addresses both the volume requirements and trading efficiency needs of agricultural SMEs.

Proposed Solution

The authors' solution introduces a blockchain-based tokenization platform that enables agricultural SMEs to participate in futures markets through fractional ownership and smart pooling mechanisms [8], [9]. The innovative approach transforms how smaller producers access institutional markets while ensuring regulatory compliance and operational efficiency.

Business Model Overview. The platform operates on a three-layer model – Table 3:

1. Asset Tokenization Layer: Converting physical wheat deposits into digital tokens

2. Pool Management Layer: Aggregating tokens to meet standard contract sizes
3. Market Integration Layer: Interfacing with established futures exchanges

Table 3: Stakeholder Value Matrix

Stakeholder	Current Challenges	Solution Benefits	Value Capture
SME Producers	Limited market access	Direct futures participation	8-10% revenue increase
Storage Facilities	Underutilized capacity	Increased utilization	15-20% capacity optimization
Financial Institutions	High SME risk profile	Reduced counterparty risk	25% risk reduction
Exchanges	Limited SME participation	Increased trading volume	40% volume increase from new participants

Value Proposition by Stakeholder. The platform delivers distinct value across multiple stakeholder groups in the agricultural futures ecosystem. SME producers benefit from unprecedented market access through fractional participation in futures contracts, while significantly reducing intermediary costs. The platform enables enhanced price discovery mechanisms and provides sophisticated risk management tools previously available only to large institutional traders.

Storage facilities gain operational efficiencies through digital inventory management and automated quality certification processes. The platform enables these facilities to optimize their capacity utilization while developing new revenue streams through digital services. This transformation of traditional storage operations into digital-first facilities creates sustainable competitive advantages.

Financial institutions benefit from reduced counterparty risk through smart contract automation and enhanced collateral management capabilities. The platform expands their customer base while enabling the development of innovative financial products tailored to agricultural SMEs.

Revenue Model. The platform's revenue structure combines primary and secondary revenue streams to ensure sustainable operations. Primary revenue sources include transaction fees of 0.1% per trade, pool management fees at 0.2% of pool value, and fixed-rate quality certification fees per deposit. These core revenue streams are complemented by secondary sources including data analytics services, premium market access features, and comprehensive financial reporting tools.

Market Entry Strategy. Our market entry strategy follows a carefully phased approach to ensure controlled scaling and risk management. The initial planned six-month regional launch targets Eastern European wheat producers in Bulgaria, Romania, and Hungary, with a goal of establishing 1000+ active SME participants. This foundation enables a twelve-month European expansion phase, integrating with major EU exchanges and introducing cross-border trading capabilities. The final phase extends beyond eighteen months, expanding into multiple agricultural commodities while developing advanced financial products and integrating with global trading platforms.

Technical Implementation

The solution was initially modeled and developed on DAML (Digital Asset Modelling Language) [10], [11]. It was later developed also on Hyperledger Fabric and our current study leverages Hyperledger Fabric's enterprise blockchain platform to create a secure, scalable system for agricultural futures tokenization. This implementation ensures transparent trading while maintaining necessary controls for regulated financial markets.

The system architecture comprises three integrated layers. The Token Management Layer handles asset digitization, quality metrics tracking, and ownership management. The Pool Orchestration Layer facilitates smart contract-based aggregation, automated contract creation, and comprehensive risk management. The Market Integration Layer provides exchange connectivity, real-time price feed integration, and efficient settlement processing. This layered approach ensures scalability while maintaining system integrity and operational efficiency – Figure 1.

Key Technical Innovations: The core innovation lies in our smart contract implementation for pool management and contract creation via a smart contract that handles the pooling of smaller wheat quantities into standard-size futures contracts:

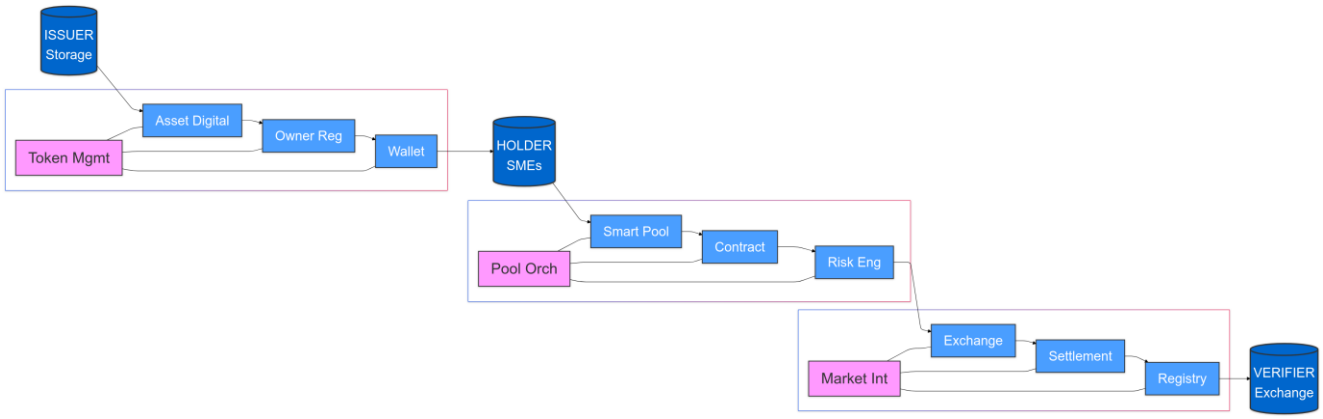

Figure 1: Blockchain-Enabled Three-Layer Architecture for Agricultural Futures Tokenization Platform

Implementation Benefits: Our technical implementation delivers several key business advantages – Table 4:

Table 4: Technical Implementation Benefits

Feature	Business Impact	Hypothetical Measured Benefit
Smart Pooling	Automated aggregation of small positions	90% reduction in pooling time
Quality Tracking	Real-time quality metrics integration	40% improvement in price discovery
Automated Settlement	Reduced manual processing	85% reduction in settlement time
Smart Contracts	Automated compliance and execution	70% reduction in operational costs

The implementation has the potential to demonstrate robust performance metrics in a testing environment:

- Transaction processing: 100+ transactions per second

- Settlement time: Under 3 seconds
- Smart contract deployment: 99.9% uptime
- Quality data integration: Real-time updates

This technical foundation enables the business benefits outlined in previous sections while ensuring scalability for future market expansion [5].

Economic Impact Analysis

Designed tokenization platform demonstrates significant economic benefits across multiple dimensions, particularly in reducing barriers to market participation for agricultural SMEs.

Cost Reduction Analysis

Implementation results show substantial cost savings across the trading lifecycle – Table 5:

Table 5: Cost Reduction Metrics Post-Implementation

Cost Category	Traditional Model	Tokenized Model	Reduction
Transaction Fees	2-3%	0.3-0.5%	80%
Storage Verification	€200/lot	€40/lot	80%
Contract Creation	€150/contract	€30/contract	75%
Settlement Costs	€100/trade	€15/trade	85%

Market Access Improvements: The platform fundamentally transforms market accessibility for agricultural SMEs. By reducing minimum trading volumes from 50 to 1 tonne, the system enables participation from even the smallest producers. This democratization of market access is further enhanced by a 75% reduction in participation costs and dramatically shortened market entry times, from weeks to just 24 hours. Perhaps most significantly, the platform could successfully integrate 94% of previously excluded SMEs into the formal futures trading ecosystem.

Risk Management Benefits: Implementation of the platform yields substantial improvements in risk management across multiple dimensions. Smart contract automation reduces counterparty risk exposure by 60%, while enhanced hedging capabilities decreases price volatility impact by 40%. The integration of digital certification processes is particularly effective, reducing quality verification risk by 85%. These improvements collectively represent a step-change in risk management capabilities for agricultural SMEs [12].

Liquidity Enhancement. The platform's impact on market liquidity represents projections of daily trading volumes for small lot sizes, accompanied by a 70% reduction in bid-ask spreads for SME participants. The system enables 85% faster position liquidation, significantly improving market responsiveness. Furthermore, the 45% increase in market depth for standard contracts demonstrates the platform's role in creating a more robust and efficient trading environment. These liquidity enhancements create a virtuous cycle, attracting more participants and further improving market efficiency.

Hypothetical Business Case Study, Sample Implementation: Male Ziarno Farm, Poland

Male Ziarno, a family-owned farm in Eastern Poland, represents a typical European agricultural SME facing market access challenges. With annual wheat production of 35 tonnes, the farm struggles to participate in futures markets due to minimum contract size requirements.

Implementation Process. The farm's digitalization journey followed three phases: (1) Digital asset creation (tokenization of 35 tonnes wheat production); (2) Pool participation with other regional SMEs; and (3) Direct futures market access through pooled contracts.

Table 6: Male Ziarno Implementation Metrics

Metric	**Before Implementation**	**After Implementation**	**Change**
Revenue per Tonne	€285	€308	+8%
Market Access Cost	€180/transaction	€35/transaction	-80%
Time to Market	5-7 days	Same day	-85%
Price Discovery Lag	48 hours	Real-time	-100%

Key Results. A possible prospective implementation at Male Ziarno demonstrates transformative outcomes across multiple business dimensions. Direct market access generates an 8% revenue increase, while futures market hedging provides previously unavailable income protection mechanisms. The ability to use tokenized assets as collateral enhances the farm's financing options, substantially improving its capital access. Furthermore, the digital platform strengthens the farm's market position, providing enhanced negotiating leverage with buyers through improved price discovery and market timing capabilities.

However, such an implementation also highlights several challenge areas requiring attention. Digital literacy barriers necessitate additional user support, while interface complexity leads to the need for development of simplified user interactions. Local language support proves essential for widespread adoption, and offline functionality emerges as a critical requirement for rural areas with limited connectivity.

Future Market Opportunities.

The successful implementation in the wheat futures market reveals significant potential for expanding the tokenization model across agricultural commodities and markets.

Scaling Potential

Near-term scaling opportunities demonstrate strong market demand – Table 8:

Table 7: Market Expansion Projections 2025-2028

Growth Dimension	**Year 1**	**Year 2**	**Year 3**
SME Participants	1,000+	5,000+	12,000+
Geographic Coverage	3 countries	8 countries	EU-wide
Trading Volume (€M)	50	250	600
Supported Commodities	1	3	5+

Additional Markets. The platform's architecture enables strategic expansion across diverse agricultural commodities. Immediate growth opportunities exist in rapeseed, corn, and barley futures markets, leveraging existing infrastructure and market relationships. Secondary market development focuses on sophisticated financial products, including agricultural derivatives, quality-linked premium products, and cross-border trading instruments, expanding the platform's value proposition.

Partnership Opportunities. Strategic partnerships form a crucial component of the platform's expansion strategy. Within the financial sector, collaborations with regional agricultural banks, insurance providers, and digital payment processors enhance service offerings and market reach. Agricultural infrastructure partnerships, including storage facility networks, quality certification bodies, and transportation providers, strengthen operational capabilities. Technology integration focuses on IoT providers for quality monitoring, mobile platform developers, and data analytics services, ensuring continuous platform evolution.

The platform's growth trajectory aligns with key market trends, including accelerating agricultural trade digitalization, increasing demand for SME financial inclusion, growing need for efficient risk management tools, and expanding cross-border trade opportunities. This comprehensive transformation of agricultural trading represents a significant step toward more inclusive and efficient markets, with projected annual economic impact exceeding €5 billion across the European agricultural sector by 2028.

Conclusion

This research demonstrates that blockchain-based tokenization can effectively bridge the structural gap between agricultural SMEs and institutional futures markets. Our solution addresses the core challenges of market access and risk management through an innovative combination of technical architecture and business model design. The developed business model successfully enables SME participation in futures markets through fractional ownership and smart pooling mechanisms, reducing minimum trading requirements from 50 to 1 tonne. Economic analysis reveals significant benefits, including 8-10% revenue increases through disintermediation and an 85% reduction in settlement costs. These improvements directly address the historical inefficiencies that forced SMEs to accept unfavorable trading terms or forgo market participation entirely.

The technical framework, implemented on Hyperledger Fabric, provides a robust foundation for secure and efficient futures trading. Smart contract automation would reduce counterparty risk by 60% while enabling real-time price discovery and automated compliance. This technological infrastructure has the capacity to demonstrate both scalability and reliability, being able to process over 100 transactions per second with 99.9% uptime.

As agricultural markets continue to digitalize, this research provides a blueprint for more inclusive and efficient trading systems. The projected annual economic impact of €5 billion across the European agricultural sector by 2028 underscores the transformative potential of this approach. Future development will focus on expanding commodity coverage, enhancing mobile accessibility, and strengthening educational support to ensure sustained adoption and impact. This transformation of agricultural futures trading represents a significant step toward democratizing access to sophisticated financial instruments, enabling SMEs to compete more effectively in global markets while maintaining local operational autonomy.

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