Digitalizing Commodity Trading Value Chain: An Assessment for Turkey

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Abstract. In the value chain of the agricultural commodity sector, innovative solutions have been introduced in order to reduce deficiencies, to improve efficiency and to secure food supply as well as to advance cooperative advantages from farm to fork. Likewise, traditional commodity trading venues have also been challenged.

In this study, we analyse digital technologies that can be utilized to transform commodity-trading venues in the agricultural sector in Turkey. A framework for agricultural commodity trading chain digitalization is proposed and its implications for research and practices are discussed. Based on the literature review, blockchain technology is proposed for digitalization of contract farming, commodity financing via token based smart contracts, commodity-backed token and smart contract trading and commodity hedging.

Keywords: Agriculture 4.0 · E-commodity · E-trade · Food supply security · Farm to fork · FinTech in agricultural sector · Precision agriculture

1 Introduction

Regarding access to financing in agricultural production, intelligent platforms such as commodity exchanges, contract farming and crowdfunding practices with smart contracts come to the forefront. In some of these practices, dematerialization and securitization are required for a remote access and financialisation. Trading platforms are mostly specialized markets, which facilitates primary and/or secondary offerings, and provide liquidity for those who are in need of exit mechanisms or hedge their positions. They also help the stakeholders to evaluate not only their position but also trends in the markets via information gathered and disseminated by the platform operators. Data analytics provided by data vendors as well as other expert data providers also help these stakeholders to identify and address inefficiencies in the chain. The modelling process that supports making data understandable and obtaining useful information as a result, reaching results and making decisions is defined as data analytics. Data analytics is used effectively in many areas including agriculture.

Intelligent trading systems improve market efficiency via eliminating information asymmetry, advance price formation; lower transaction costs and optimize the trades. Main drivers for the e-trade platform for agricultural sector are; to eliminate food inflation.
by helping efficient price formation in one centralized market that has an access for all stakeholders; to promote food warehousing in order to help food supply security; provide a benchmark for the Turkish agricultural sector products pricing and integrate agricultural sector producers and consumers in a centralized platform.

At the farm level, using advanced technologies by determining the soil and plant characteristics such as soil moisture, level of plant nutrients in the soil, soil texture, crop conditions, yield, instead of the usual conventional application methods applied to the whole field is so called “precision agriculture”. It is based on variable application, which is applying fertilizers or pesticides to each part as needed, cultivation at different depths, sowing in different norms, different levels of irrigation and drainage [7]. Major components of the precision agriculture method are global positioning system (GPS), geographic information systems (GIS), product monitoring instruments, plant, soil and weed sensors, remote sensing and variable rate application (VRA), unmanned air and unmanned aerial and ground vehicle, Internet of Things (IoT), digital image processing, big data analytics, block-chain and digital twin [12, 16].

This paper is organized as follows. Section 2 reviews digitalization concept in institution and sector level. Technologies used in the agricultural supply chain are investigated in the third section. Fourth section covers financial service providers in the agri-business that can be utilized to transform commodity-trading venues and improve imperfections, efficiency and automation in the agricultural sector. Fifth section discusses a digitalization framework for agricultural commodity trading chain from farm to fork in Turkey. Last section concludes the paper and states the outcomes of the study and recommendations for future research.

2 Digital Transformation

Technological developments change every aspect of our lives, transform sectors and professions and, change the way we do business. Traditional methods have been replaced with technological solutions and agricultural sector is no different. Institutions, which will adapt to continuous change in technology and society, will become sustainable.

For the establishment of the digital ecosystem framework that provides standardization and integration of food trading value chain, identification of core problems and defining strategic objectives and initiatives in order address these problems are significant. Defining digital ecosystem problems and providing solutions for deficiencies in existing value chain and technologies appropriate in the agri-business requires research and development activities. Digitalizing and securitization of food trading value chain and enable the vertical integration of agriculture, industry and trade.

For the future agri-business sector, transformational and institutional excellence should be managed with strategic tactics due its low financial literacy, conventional structure and customs. Mitigating shortcomings and efficient conversion of sources of the sector requires managerial ability since studies show that there is a positive significant relationship between managerial ability and transformational management [1] and [8].

Digital agriculture requires managerial and risk management efficiencies for resource allocation and technology decisions. This also requires more information and analysis
of the state-of-the-art. In order to reap the efficient management in agri-business, as in other industries, digital transformation should be utilized. Furthermore, the co-operation among stakeholders (e.g. agriculture players, solution providers) should be enhanced [18].

In order to change perception of farmers that smart farming solutions are expensive and suitable for large-scale farmers, and their use as complex [2], bottom-up approaches might be utilized to eliminate this sceptical approach.

3 Supply Chain

3.1 Precision Agriculture

In order for ensuring food supply security and increasing efficiency, precision agriculture can be considered as the activation of production, distribution, financing and all other processes by collecting and analyzing sector-related data. In this regard, data collection and management emerges as an important and basic need. In this context, adequate and widespread internet connection, easy access and sharing of the data produced, and the creation of an ethical and managerial framework for artificial intelligence and data management are the points that experts draw attention to.

Thanks to its geographical conditions, climate, water resources and favourable lands, Turkey has a strong agricultural origin. The use of information and communication technology, digitalization of agriculture, smart agriculture applications, R&D investments are of great importance in the agricultural technology transformation, which is called Agriculture 4.0, for Turkey. In order to strengthen agriculture-technology relationship, digital agriculture applications (drone, sensors, cloud technology, autonomous tractors, machine learning, artificial intelligence, etc.) have increased considerably in recent years.

The followings are the information and communication technology utilized in Turkish agriculture sector:

- Sensors are one of the important applications of technology use in agriculture, agricultural machinery and fields are equipped with sensors and they communicate with each other to measure humidity, vegetation, temperature, steam and weather conditions.
- Unmanned aerial vehicles are used in agricultural sector based on remote sensing and plant monitoring techniques that will form the infrastructure of data to be used in precision agriculture. The developments in imaging systems in agriculture in recent years and especially in remote sensing issues are widely effected the use of the vehicles. There are passive applications for disease, water stress detection, yield/maturity estimation, weed flora detection, water resources control and monitoring of workers in plants. The Agricultural Unmanned Aerial Vehicle (ZİHA), developed in cooperation with the Agricultural Credit Cooperative technology company TARNET and the Ministry of Agriculture and Forestry General Directorate of Agricultural Research and Policies (TAGEM), is a domestic and national solution.
- Internet of Things (IoT) is a technology, which includes the ability to monitor an object on the earth with the electronic equipment on it or by connecting additional hardware over the internet, to see, analyze and control the physical properties of this object or the data it has produced. Its use in agriculture can be exemplified such as soil
temperature and humidity sensor, wind and pressure sensor, irrigation sensor, animal and machine tracking systems.

- Big data analytics is in the use of agricultural data for the need for production and productivity increase. In contrast to the classical data analysis methods in the agricultural sector, that big data, machine learning and data mining applications come to the fore. Technology-assisted precision agriculture applications is increasing every day. TARBIL - Agricultural Monitoring and Information System, prepared by the Ministry of Agriculture and Forestry in cooperation with Istanbul Technical University, monitors drought and other agricultural threats and makes yield estimates by following the data of earth observation satellites and ground stations. TARBIL is a big data platform that also supports sensitive agricultural practices. The analysis of large data sets in agriculture will guide policy makers to follow trends on the basis of market and product, future production planning, and therefore to solve future problems in advance [15].

3.2 Licensed Warehousing

In Turkey, licensed warehouses (LWH) operate within the framework of Law No. 5300 titled the Licensed Warehousing Law on Agricultural Products and related legislation on agricultural products. The Ministry of Trade regulates and authorizes LWHs and products to be stored in warehouses. Digitalization of the agricultural products are through Electronic Warehouse Receipts (EWRs) which are issued by the LWHs based on the underlying products stored in secure silos or other types of storages according to the nature of the agricultural product.

Since main pillar of the digitalization and securitization of the agricultural products is LWHs, monitoring the warehoused products, securing stored products and their physical delivery process as well as surveillance of the LWHs as whole have significance importance in establishing a robust commodity market. In this regard, collecting and evaluating instant data from physically remote environments from LWHs is very important in terms of subsequent financial activities, increasing the resolution, decreasing the error and reducing the costs required for the units operating based on these data. This situation brings about the problems of collecting data from very intense and different sources.

The conversion of data, especially taken in real time requires pre-decisions and preferences to be created where they are as possible. In new approaches, Fog Computing is defined to evaluate the results of information transformation processes performed with Edge Computing.

3.3 Logistics

After global food supply crisis in 2008 and Covid-19 pandemic, food safety has become a significant issue for all countries. Since the traditional logistics in agri-food business could not respond the demands of the market, constructing a traceable agri-food supply chain system is also becoming vital. Traceability with reliable information in the end-to-end (production, processing, warehousing, distribution and selling) agri-food supply chain would effectively guarantee the food safety [17].
The internet of things (IoT) plays an important role in integrating technology into the agricultural supply chain. IoT technology will be included in the agricultural food supply chain to enable the automation of the control mechanism in the chain, especially in the following years. The information obtained with the IoT technology will be exchanged safely thanks to block chain technology.

Block chain is preferred due its feature in eliminating security problem and providing reliable data transfer, which is the weakest aspect of internet technology. IBM Food Trust is a project that provides food safety, traceability and supply chain automation of companies using block chain and IoT technology. Companies such as Starbucks, Fairfood and Albert Heijn are also working on projects based on block chain to increase transparency and security of the agriculture and food supply chain [9–11].

In addition to IoT, block chain technology is used together with radio frequency identification (RFID) technologies in the agricultural sector food supply chain field. RFID technology is the transfer of digital data encoded in RFID tags to digital media via radio waves.

4 Financial Service Providers

4.1 Contract Farming

Contract farming is an agricultural production method carried out according to an agreement between a buyer and farmer(s), which establishes conditions for the production and marketing of a farm product or products. The farmer agrees to provide contracted quantities of a specific agricultural product and might get advance payment in the form of cash, seed, fertilizer and etc.

Contract farming arrangements in Turkey regulated at the Law level in the Agricultural Act. In the Act, contractual production is defined as “the agricultural production method carried out with written contracts based on the mutual benefit of producers and buyers and other real and legal persons”. In addition, in the article 13 of the Act titled “Contractual production” the following regulation has taken place: “The Ministry makes the necessary regulations for the development and expansion of contracted production in the agricultural sector. In order to encourage contracted production, priority is given to producers in providing the supports specified by this Law.” In addition, in the first paragraph of the article 20 related to the “Application Principles of Agricultural Supports”, it is regulated that the contractual production pre-funding payments can be differentiated.

First step of the digitalization of the contract farming has taken by the Ministry of Agriculture and Forestry by the launch of the DITAP – Digital Agricultural Product E-Platform. Within the scope of planned and sustainable production, DITAP was introduced in April 2020 as an advertisement board which brings buyers and sellers on a same platform on a voluntary basis and enable to create demand for agricultural raw materials. Registries of both the buyer and the producer will be made through e-government, and in the system where the buyer’s credibility will be verified by the Ministry of Trade, the existence of the producer will be controlled through the agricultural information system.

DITAP can also realize crowdfunding functions in the agricultural sector.
4.2 Crowdfunding

As an alternative to traditional financing channels, crowdfunding platforms support entrepreneurship and technological development via providing finance for new ideas, from micro enterprises to new formations.

Due to less financial literacy in the agricultural sector, use of new technology is limited or inefficient, digitalization and access to finance are inadequate in agricultural activities.

In addition to the incentives provided by the Ministry of Agriculture and Forestry to farmers registered in their farmer registration system with the possibility of production through contracted agriculture, crowdfunding will be an important opportunity in access to finance. Crowdfunding platforms will be an important opportunity to increase investor confidence through various risk reduction policies and to bring farmers, women and children in the agricultural field as entrepreneurs.

Fund raising activities for return, awards or donations basis through crowdfunding platforms without any share holding are not subject to the Regulation on Share-Based Crowdfunding issued by the Capital Markets Board. Likewise, for debt-based, peer-to-peer transactions in foreign practice, the regulation has been added to Article 35/A of the Capital Market Law No. 6362.

By using blockchain infrastructure for a reliable internet-based structure in crowdfunding, buyers will be able to monitor their positions and offer the opportunity to sell their positions. With the definition of the contract subject to production in the blockchain infrastructure, the contract will become a tradable security and will be able to gain the feature of use as a collateral. Thus, with the registration of the production contract to the blockchain infrastructure, both the authenticity can be questioned and the contract will be traded as a security. There is no legislation yet regarding the issue of creating a record of this nature and making this record clear. Possible transactions can be carried out in over-the-counter markets.

4.3 Commodity Exchanges

Agricultural as well as other commodity trading platforms abroad operate venues on derivative instruments. Metal futures and options contracts are traded on the London Metal Exchange (LME). Futures contracts with wheat, canola and corn underlying are traded at Euronext-Paris. In the USA, the Chicago Mercantile Exchange is another example for futures and options markets on agricultural products. Shanghai, Dalian and Zhengzhou exchanges are the leading exchanges in the Asia-Pacific region for the commodity derivatives. In the absence of the derivatives market, bilateral over the counter forward contracts, mostly related with the contract farming are executed in the sector in Turkey.

Regarding spot market, before the establishment of Turkish Mercantile Exchange Inc. (TMEX), a digital trading platform on agricultural products under the roof of a national exchange did not exist in Turkey. There were 7 active trading platforms for EWRs distributed in local cities with limited product and limited licensed warehouses. Investors were looking for prices on different local exchanges and were limited to trading with customers in local markets. Transactions at different prices could be made for the
same product in different locations, and this information was made available to the market after the transactions took place.

TMEX is the first national mercantile exchange under a centralized roof and on a single trading platform that serves for transformation of agricultural sector and is the first step towards the digitalization of agricultural products. TMEX was established on June 8, 2018 and launched its spot Electronic Warehouse Receipt (EWR) Market on July 26, 2019. The main field of activity of TMEX is to operate markets on electronic warehouse receipts (EWR) and derivative contracts with EWR underlying. TMEX Trading Platform brings all agricultural sector stakeholders (e.g. producers and consumers) in order to achieve an efficient market formation. TMEX introduced a centralized e-trade platform and help securitization and digitalization of the agricultural sector by launching its spot market. Access to supply and demand on a national scale has been provided by the Platform. The Platform facilitates continuous auction and negotiated deals in the EWR Markets. The TMEX Platform contract farming function facilitates netting of advance payment of the buyer, during the settlement process after executing the deal on the Platform. Post trade operations are executed by the Settlement Bank (Central Clearing House) and EWR depository (CSD-Central Securities Depository) (Fig. 1).

Farmers take their products to licensed warehouses → Product classification by authorized labs at warehouses → Products are stored at the warehouse based on their type and class → EWRs issuance by warehouses on behalf of farmers at the CSD System → TMEX Trading Platform: EWRs traded at the EWR E-Trade Platform → Post Trade operations at the Settlement Bank and CSD → EWR use for production (by canceling EWRs), collateral or resale

Fig. 1. EWR trading ecosystem Source: drawn by the authors

TMEX Trading Platform serves food supply security via promoting licensed warehousing and EWRs, eliminates intermediaries in the food supply chain where all participants including producers and traders access to the e-trade platform directly, provides a benchmark for the Turkish agricultural sector products pricing, serves food inflation policies by helping efficient price formation in one centralized market that has an access for all stakeholders and improve transparency.

The Exchange secures trading and settlement with 100% settlement finality, integrates Turkish Grain Board (TMO) as a market maker at certain harvest times as well as major contract farming buy sides with the sellers in a faster and more reliable environment. Introduction of contract farming solution, offers a secure advanced payment collection system via direct netting during the settlement process of the trades which eliminates operational and legal risks in the advanced payment collection from the sellers.

In line with its international peers, TMEX is expected to launch its derivative market in the coming years.

5 Proposal for Digitalizing Commodity Trading Value Chain

Our proposal is to study within the available geo-agribusiness, juristical and technical restrictions to deliver solutions to real world issues as working on resolving the challenges to achieve digitalizing commodity trading value chain.
First phase is digitalizing of contract farming. Contract farming (CF) is defined as forward agreements allows the obligations of producers and buyers as partners. Thus, contract farming ensures a response to market collapse with respect to inputs, outputs, insurance, funding and information by decreasing the transaction costs, transfer of goods and bargaining.

The industry, big grocery stores companies and leading capital companies, who control the larger part of the contract farming market, use these contracts to take advantage of themselves while dishonestly shifting risks on producers. This many times leave the producers in long-term debt, unforeseeable and irregular payments, small or negative gain and financial turmoil.

DITAP and TMEX may develop a smart contract farming technology implementation that allows buyers to purchase agricultural smart farming contracts in Turkey. DITAP and TMEX new utility-based smart contract farming technology bring out equitable and transparent trading that provide with producers and buyers the best value. Traders on contract farming will get funding for their production projects while every step is being followed up transparently via blockchain.

The platform will leverage blockchain technology to manage the contractual liabilities between the contract producer and the buyer as well as utility tokens for the circulation of cultivation inputs (fertilizer, seeds, pesticides, equipment/machinery, transportation, labour, rent, etc.). The utility-based smart contract farming records buyer, producer, balance, status, project and required additional data. The utility-based smart contracts will also save parties’ performance and achievements for forward agreements.

The buyer funds the producer via the digital asset-backed token to pay cultivation inputs from the suppliers. Information of every transaction is added into the blockchain contract, establishing a transparent environment where all parties are able to trace the transactions in the architecture design.

Farmers gain access to a various pool of funds that were never reachable before due to the peer-to-peer structure of the smart contract. Supporter will be able to get the advantageous circumstance to provide finance small-scale farming projects.

After the process of contract farming service is completed, the harvested product in the field should be digitized. In this level, to permit easy transaction on the blockchain, agricultural products and their supply chain workflow must first be tokenized via TMEX EWR tokenization protocol.

Second phase is commodity financing. Token based and big data analytics enabled marketplace connecting supply chain actors and finance providers for a range of products on a peer-to-peer basis. We propose a more efficient way to deal and valorise utility-based tokenization by supporting contract-farming projects. The value generated by contract farming valorisation and exchange on the suggested commodity trading value chain platform will be able to reallocated to the ecosystem where it will increase its assets levelling up the token trade back. Security token crowdfunding, fractional financing, of specific projects chosen by token holders and agri-businesses will be able to result in an interest paid back or sharing the profit by the crowd-funders at the end of the term. Our trading value chain platform, users will be able to exchange their tokens with new crowd-funders. With the ecosystem, crowd-funders are guaranteed to obtain their initial capital and the profit or the interest. In case of necessary, the platform should act as a
cooperative (as a facilitator) and ensure the crowdfunders’s gain by making agreements with large buyers for harvested products.

Third phase is commodity-backed token and smart contract trading and commodity hedging. TMEX focuses on commodity tokenisation, EWR trading, risk management and financial applications (centralised or decentralised finance and insurance solutions). Regulatory and supervisory authorities should participate to guide standardisation of product grade, the improving of pricing framework and licenced warehousing.

There are examples such as EFT, SWIFT, RIPPLE, BiGA regarding the transfer of financial instruments and the transfer of information arising in these transfers. Ripple is a digital network where financial transactions take place as well as hosting a cryptocurrency. Society for Worldwide Interbank Financial Telecommunications (SWIFT) is a member-owned cooperative that provides safe and secure financial transactions for its members. SWIFT is a vast messaging international network used by banks and other financial institutions to quickly, accurately, and securely send and receive information, such as foreign money transfer instructions. Electronic funds transfer (EFT) is the electronic transfer of domestic money from one bank account to another, either within a single financial institution or across multiple institutions in a country, via computer-based systems, without the direct intervention of bank staff. BiGA, on the other hand, is a system for the tokenization of gold, whose physical provision is blocked and whose standards are specified with blockchain technology in order to facilitate the transfer transactions, has a blockchain network that requires permission and is in the special category. It is designed with Hyperledger platform [3].

Barter Block developed by Binkabi allows of reliable, cost-effective and direct trading, as leveraging the ability of blockchain technology [4].

BitMari’s blockchain framework allows buyers to buy agricultural farming contracts in Africa. BitMari Smart Farm Contract technology creates honest, convenient, transparent agreement that give the buyer and producer the best value [5] (Table 1).

We will plan to design the commodity-backed token and smart contract-trading ecosystem with four components.

First leg of token backed commodity and smart contract trading is **EWR Transferring System (EWRTS)**. The essential aims of this EWRTS is to set up a framework that allows transfer of EWR (dematerialized agri-commodity) with specific quality, via blockchain technology. The physical equivalents of the agri-commodity safeguarded in reliable custody in the licenced warehouses and silos. Price of agri-commodity has noteworthy fluctuations observed in the markets that haven’t been enough regulated. In order to prevent from unforeseen volatility in prices, every digital asset of current agricultural sector, is pre-defined on physical principle in blockchain. Hence, a digital asset is to be created that is secure from speculations.

Agri-commodity physically stored at licenced warehouses and silos is transferred to TMEX pool account without serial number instructions. TMEX keeps them in the bank accounts opened in the name of TMEX in Turkey, and their electronic transfer (EFT) between the accounts. EWRTS enables the accountholders to transfer their commodity deposits among themselves as though they make transfer in cash money.

Second leg of token backed commodity and smart contract farming trading is **Contract Farming Transferring System (CFTS)**. Smart contract farming participants,
Table 1. Agricultural tokens

| Name                        | Market cap | Price       | Blockchain       |
|-----------------------------|------------|-------------|------------------|
| AgaveCoin AGVC              | $23.25M    | $0.05952    | Ethereum         |
| Agrocoin AGRO               | $3.79M     | $0.03110    | Ethereum         |
| Carboncoin CARBON           | $1.75M     | $0.00011    | Own Blockchain   |
| Ecbit ECOB                  | $605.06K   | $0.00136    | NEM              |
| Blocery BLY                 | $347.04K   | $0.01976    | Ethereum         |
| Herbalist Token HERB        | $52.56K    | $0.00001    | Ethereum         |
| Ifoods Chain FOOD           | $52.53K    | $0.00002    | Ethereum         |
| PLAAS FARMERS TOKEN PLAAS   | $50.17K    | $0.00331    | Ethereum         |
| Eva Cash EVC                | $10.91K    | $0.01212    | Ethereum         |
| Agrolot AGLT                | $8.88K     | $0.00010    | Ethereum         |
| Hintchain HINT              | n/a        | $0.00353    | Own Blockchain   |
| ASY AGRO ASY                | n/a        | $0.05460    | Ethereum         |
| Gric Coin GC                | n/a        | $0.02004    | Ethereum         |

Source: [6]

farmer and contract buyer are registered on CFTS. When the two participants have agreed, the buyer will continue to buy the smart contract. By doing so, the buyer will provide finance the contract and assign a blockchain address with a digital money balance, based on utility token, to pay contract farming inputs and manage operations and obligations of the contract until its expiry. CFTS will also let that possession of the contract is transferable all rights and title to the contract will be transferred to the new owner.

Third leg of token backed commodity and smart contract trading is Cross-Border Interbank Commodity Payment System (CICPS). CICPS is a payment and barter system that offers clearing and settlement services for its participants in cross-border EWR token payments, barter and trade. CICPS does not facilitate EWR token transfer: rather, it sends payment orders, which must be settled by correspondent accounts that the institutions have with each other. Each financial institution and merchants, to exchange banking transactions, must have a banking relationship by either being a bank or affiliating itself with one (or more) to enjoy those particular business features. Conceptually, barter is a trading and financing tool based on early economy history, though it is still novel today. Simple definition of barter system is the exchange of goods or services without money. The main doctrine of the barter system is that the exporter has to import as much as the cost of the goods exported and the importer has to export the goods as much as the cost of the goods imported. In this type of international exchange trade, the foreign trade transactions are realized without the use of convertible foreign exchange and foreign trade deficit does not arise [13]. For instance, Iran sold petroleum for weapon
in the past. Pepsico sold pepsi to Russia in exchange for Russian vodka, and then this vodka had been sold in U.S.A in the 80’s. Philips Morris sold his own cigarette to Russia in exchange for urea used making artificial fertilizer, then exported this urea to China, and purchased glassware to market in U.S.A [14].

Fourth leg of token backed commodity and smart contract trading is **EWR and Crowdfunding Token Trading System (ECTTS)**. ECTTS will enable trading of the commodity-backed EWR tokens, each unit representing one unit of agri-commodity in licenced warehouses and silos. ECTTS provides services such as issuance of new tokens when EWR is created, redemption of tokens to EWR, transfer of tokens between participants and reconciliation of transactions. Additionally, the system enables around the clock peer-to-peer trading of digital tokenized EWR. ECTTS will also enable trading of the contract farming’s crowdfunding tokens (Fig. 2).

**Phase 1: Digitalization of contract farming**
- Manage the contractual obligations between the buyer and the contract farmer
- Utility tokens for the distribution of farming inputs
- Contract farmers’ funding

**Phase 2: Digitalization of crowdfunding smart contracts, commodity financing**
- Token based and big data analytics enabled marketplace
- Connecting supply chain actors and finance providers for a range of products on a peer-to-peer basis.

**Phase 3: Commodity based token and smart contract trading and commodity hedging**
- EWR Transferring System
- Contract Farming Transferring System
- Cross-Border Interbank Commodity Payment System
- EWR and Crowdfunding Token Trading System

![Fig. 2. Proposed phases for the digital transformation of trading value chain](image)

### 6 Conclusion

Technological developments have started to transform agro-food business from farm to fork. Digitalization is a new concept for agri-food business compared to other sectors and transformation of the conventional commodity-trading venues and automation in the agricultural sector is newly addressed areas.

In this paper, we discuss a digitalization framework for agricultural commodity trading chain via blockchain technology based on literature reviews and practices in
this context. Our proposal is to work within the current geo-agribusiness and provide solutions for legal and technical limitations whilst working on resolving the challenges to achieve digitalizing commodity trading value chain. As depicted in Fig. 3, major areas that should be considered and addressed are selection and prioritization of trading value chain for the digital transformation, appropriate technology to be utilized, regulatory framework and market readiness.

![Fig. 3. Components of the digital transformation of trading value chain](image)

It is expected that blockchain technology will be widely used in many different sectors in the medium term, including agriculture, food and finance sectors, with the integration of the closed circuit system requiring permission, including the only nodes authorized by platform administrators in the system and smart contract transactions. Achieving these targets requires the blockchain protocol to address issues relating to audit and fiduciary functions, trading regulation and licensing, standardisation of product grade, pricing and trading framework, licenced warehousing, liquidity, discovery, disagreement and arbitration. Every tokenised agri-product is managed by a smart contract.

For this infrastructure, there needs to improve regulatory mind-set in Turkey. For further research, experts and regulators of commodity, financial and capital markets should search how to create new rules for the suggested digitalization framework for agricultural commodity trading chain in this paper and how to change the mind-set. There needs to be a trustee who represents interests of the beneficiary. The agri-product is subject to supervision and confidence process before and after token issuance.

Another subject and target for further research is to select the best blockchain protocols or to create new blockchain protocol. Ripple, Hyperledger, Binkabi, BitMari and
BiGA technology stand out compared to Ethereum and NEM technologies because they are more suitable for centralized auditing.

Blockchain technology has also had a huge impact on the agricultural and agricultural commodity market, producing solutions for the reliability of the agricultural supply chain as well as infrastructure for the establishment of platforms where agricultural products can be traded and supported by stakeholder in this ecosystem.

With the blockchain, system becomes more reliable sources of investment for farmers to fund and the need for farmers to sell products at fairer prices will have a huge impact, especially on the incomes of small farmers.

In licensed warehousing, blockchain technology can be used both to migrate the existing system to the blockchain structure, which will allow it to be monitored at less cost and in a reliable manner, and to use digital agricultural products in various financial transactions as a means of payment/exchange by tokenized.

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