



Harnessing **blockchain technology** for **commodity chains**

Introduction

With a wide range of potential benefits – such as improved traceability, food safety, and environmental sustainability, as well as increased farmer income – blockchain has become an increasingly popular technology option for commodity value chains. Yet, there is little knowledge among agri-food professionals of how the technology works, and there is (still) limited evidence of the impact blockchain has on the efficiency, the transparency of transactions, and the costs and benefits this may have for smallholders in particular. Most agri-food stakeholders also lack a detailed understanding of which potential applications are most relevant and valuable to their needs, or in software terms, what is the right ‘use case’. This article provides a brief introduction to blockchain, give examples of its use in the agri-food sector and how it has benefitted smallholders, provide some key questions for those that are thinking of investing in blockchain, and offer some further sources of information for those interested to dive deeper. The most up to date evidence of proven business cases and tangible developmental impacts are also considered.

Blockchain and its use in food and agriculture

Blockchain is essentially a distributed ledger. One of the first examples of the idea underlying today’s blockchain were split tally sticks in Medieval England (Jenkinson, 1911). A tax collector would come to a farmer, calculate the tax that the farmer would owe by the end of the harvest, and ‘write’ that tax on a stick using a system of notches (narrow for pennies, wider for shillings). Then the stick was split lengthwise – one half was given to the farmer, another kept by the tax collector. This way the two halves both record the same notches, and uniquely matched each other. At the end of the tax year the farmer would bring the required amount of money, which would be verified by the half of the stick kept by the collector. In modern language we could say that the tally stick was a two-element blockchain. Its key property is that information is distributed to all participants of a transaction, and it cannot be forged by anyone because each piece has to match the others precisely and uniquely, creating a chain of trust.

Blockchain is most well known as the underlying technology for reliable, decentralised financial transactions, using cryptocurrencies (i.e. bitcoin), without the need of central trusted authorities such as banks and financial institutions. Normally trusted transactions are verified by a central authority. Blockchain allows parties of the transaction to perform a verification without referring to any such authority and this can be extremely useful, for example, in establishing provenance within the chain of supply. The conventional banking system has also recognised the benefits of blockchain and 15% of financial institutions are currently using this technology for their transactions (IBM, 2017).

Today, most sectors have launched blockchain trials, and recognise this technology's intrinsic advantages as a foundational technology which may have transformative effects across any sectors where some form of trusted information sharing is important. Blockchain uses mathematics to distribute trusted information across digital wallets held by each participant in a network, which are known as 'ledgers'. Information stored in this 'distributed ledger' is trustworthy, because any change needs confirmation by the majority of the participants. The use of digital technology automates this majority confirmation process, so that the user simply sees a record of transactions that is secure and which cannot be changed by anyone, including any

central party. When this technology is thoughtfully applied, and efficiently integrated with existing processes and systems, the resulting benefits include:

- transactions can occur almost in real-time, and are irreversible and immutable, leading to increases in accuracy and confidence in the information, and a reduction in fraud;
- reliability of information is assured, as this is shared with multiple participants, who maintain identical copies (i.e. lists of transactions, or 'blocks'), and therefore no single point of failure exists;
- transparency of data related to finances, products and locations increases, leading to faster audits and more trust between value chain players; and
- almost any asset and document can be represented in code, making their ownership easily exchangeable using blockchain technology.

Many specific challenges that normally hamper the agri-food sector were already targeted by blockchain pilots, such as the lack of trust between value chain players, complex and paper-heavy processes, lack of transparency, and the many problems that most smallholders face (i.e. lack of digital identities, credit histories, field and crop data to make decisions on agri-inputs, lack of access to markets, etc.).

Freshly roasted coffee beans in a roasting machine.

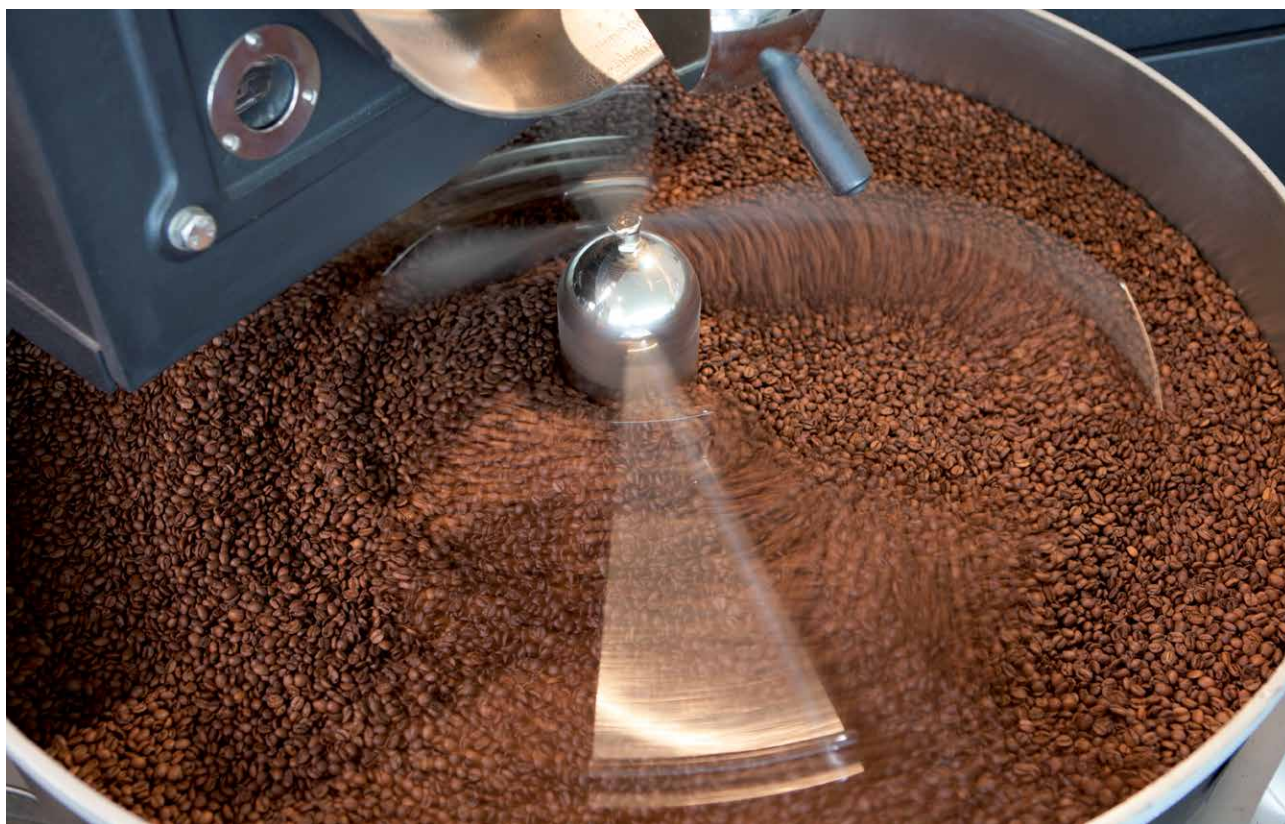
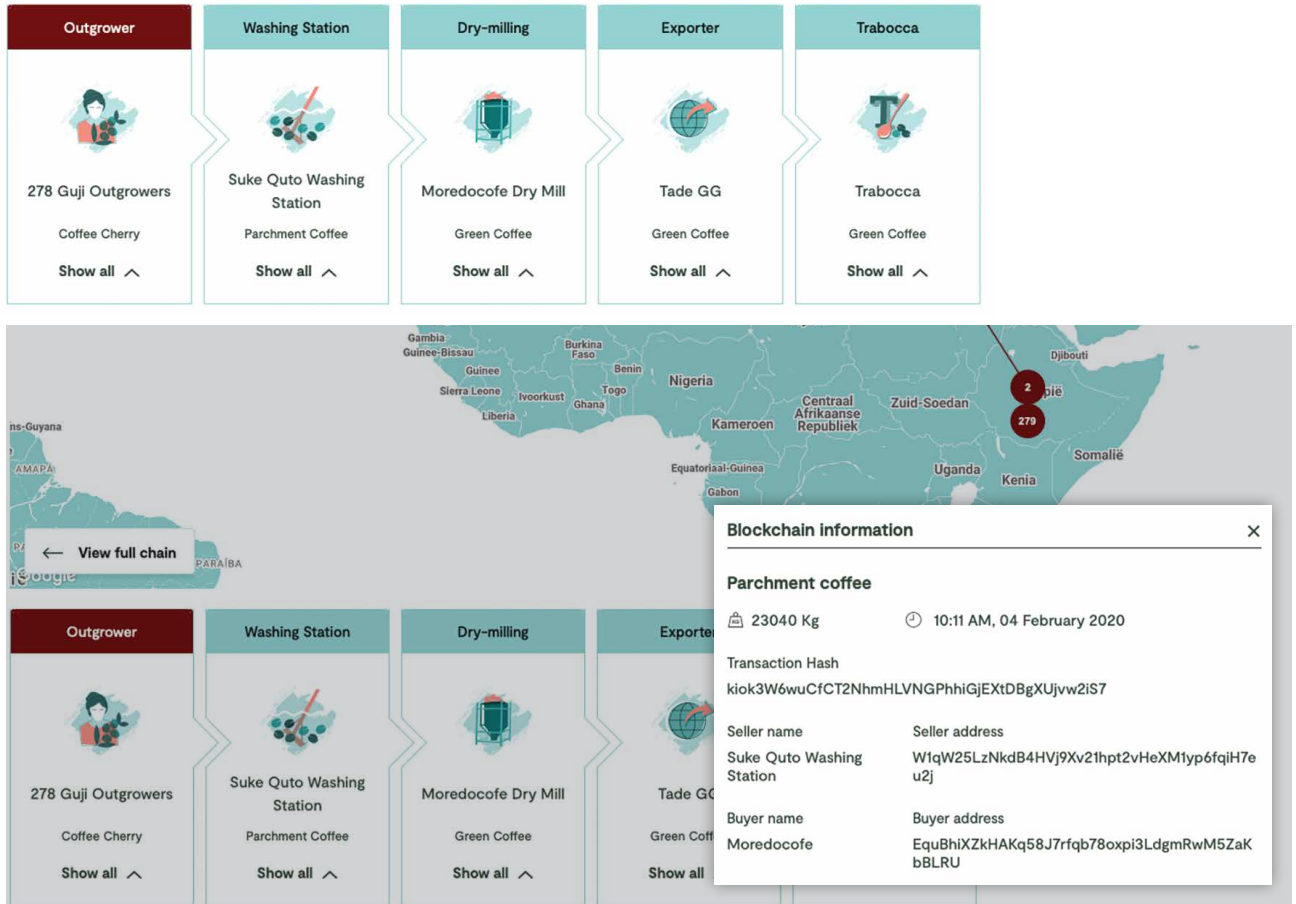


Photo: Adobe Stock

Figure 1: Trabocca's supply chain visualised on the Trace platform, by Fairfood (FairFood, b)



A 'blockchain use case' can be defined as the process of organisations aiming to tackle one or more of these problems using blockchain (among other solutions), by evaluating their challenges, strategic objectives, and those of their investees, and choosing specific blockchain applications.

As newcomers, investors and value chain stakeholders wishing to 'see it in action', are advised to dive into a number of blockchain use cases such as the ones shown here, and to ask critical questions on the different technical, business or developmental aspects. One example is Trabocca, a Dutch specialty coffee trader, which recently launched a traceability system using Fairfood's Trace platform (FairFood, a). This company aims to prove its claims of paying a higher price (63% over local prices) to individual Ethiopian farmers. The added value of such transaction data becoming transparent is the assumption that Trabocca's customers will also be encouraged to pay a higher price. Figure 1 shows the user experience of Trabocca's blockchain use case, and the immutable transaction data stored in the distributed database (i.e. quantity, seller and buyer names and digital addresses (wallet), timestamp and location).

Use cases of blockchain in the food and agriculture sector have been categorised in different ways by different organisations, but generally include: supply-chain efficiencies (i.e. authenticity, provenance, deliveries, certification), consumers or brand trust (i.e. loyalty programmes, consumer participation, recalls), and payments and contracts (i.e. smart contracts, cross border payments) (Deloitte, 2018; IBM, 2019).

An extensive series of pilots and experiments were implemented by front-running companies, public institutions, non-profits, and private-public partnerships, from large projects (i.e. Walmart, Nestlé, WWF, Cargill, Ahold, United Nations Development Programme) to smaller initiatives (i.e. Moyee Coffee, Tony Chocolonely, Oxfam, Fairfood, FairChain Foundation). These pilots were initiated to identify and test use cases and to create proofs of concepts. Many agricultural commodities were already part of blockchain pilots, such as: coffee, cocoa, coconuts, maize, wine, seafood, dairy, spices, etc.

Potential supply chain and smallholder benefits

Potential benefits of blockchain in agri-food chains are: improved transparency and traceability in supply chains, increased



Photo: F. Fiordella (IRI/CCAFS)

trust between value chain players, improved information exchange, cost efficiencies related to faster and cheaper transactions and faster product recalls, and a fairer value distribution. Many claims have also been made about how blockchain can help achieve positive social and environmental impact for smallholder farmers, communities, and societies. These include higher prices, improved financial services, new income streams, and more efficient technical assistance.

Pilot projects using blockchain technology, which specifically target smallholder impact and the empowerment of farmers, have been classified according to their purpose, as follows (FairFood, 2019):

- Building up a self-sovereign digital identity;
- Controlling and monetising farmer data;
- Providing access to finance and insurance;
- Providing access to international markets;
- Increasing yield and productivity, and earning a living income;
- Proving brand promises and ownership claims; and
- Sending and receiving payments.

These benefits have been claimed by most blockchain users and stem from the technology's intrinsic advantage: its distributive character. However, keeping in mind the very short (about five years) history of blockchain application in agriculture, all the benefits have been assumed. To try and validate the different claims, pilots and proofs of concepts have been implemented to test, fail and learn. Without interviewing those involved in each project, it is not clear which ones are underway and which ones have been discontinued (and deemed successful or not).

Information available on the use cases implemented so far is insufficient to prove their business case, or to provide evidence of quantifiable and statistically significant (additional) impact at field or farm level. After analysing 50 use cases in the food industry, Deloitte (2018) warns businesses of potential pitfalls, and advises anyone engaging with this technology to have a carefully planned strategy in place. Similarly, an analysis by McKinsey of the feasibility and impact¹ of 90 use cases in 14 sectors, found the agricultural sector to come out well below average for feasibility, although the sector scored reasonably well and similar or better than many other sectors in terms of potential impact (only public sector, technology, financial services, and healthcare scored better on potential impact) (Carson et al., 2018).

¹ Impact is understood here as reductions in transactions complexity and costs, and improvements in transparency and fraud controls.

The limited feasibility so far of blockchain for the agri-food sector is also shown by efforts documented by the German development agency, GIZ (Maupinet et al., 2019), and the Food and Agriculture Organization of the United Nations (FAO) (Sylvester, 2019). Many of the use cases featured in those reports, even those considered 'best-practice', have since been discontinued. Reasons for failure of these cases include: not educating all stakeholders from the beginning on the ins and outs of blockchain, unrealistic expectations of economic and developmental returns, failures to integrate blockchain with existing software and operations, and faulty budgeting.

Many blockchain pilots obtained substantial funding and private sector interest, as well as public and media attention, because of their potential, theoretical benefits. However, from analysing the available evidence, it is observed that initial estimations of the (potential) business case and economic returns of the pilots were insufficient or completely lacking.

Factors to consider during implementation

Another issue that is hampering the use of blockchain is a lack of common standards and policies that regulate the use of the technology. The Organisation for Economic Co-operation and Development (OECD) organises a yearly Global Blockchain Policy Forum, attended by senior decision-makers, ministers,

bank governors, and others from finance, fin-tech, economy and agriculture institutions, (central) banks and ministries. At the 2019 edition of this forum, participants highlighted that the policy and regulatory framework for blockchain is presently still under-developed (OECD, 2019). A lack of common standards is a major limitation, proven by the many investments in pilots which did not offer a return on investment (ROI), or did not get out of the pilot stage. So far, many governments are following a technologically neutral regulatory approach, not promoting or banning specific technologies like blockchain (Carson et al., 2019).

Nevertheless, many blockchain experts and communities of practice still consider the technology to be 'revolutionary' and advise innovation funds and impact investors to start experimenting (The New Fork, 2020). At the World Economic Forum (2019) business leaders also advised deployment of blockchain in supply chains, to accelerate the exploration of its 'interoperability', 'integrity' and 'inclusivity' issues.

- Achieving the potential benefits of blockchain requires linking it with other technologies such as sensors, Internet of Things (IoT), satellite data, mobile technology, farm management software, etc. This requires their 'seamless interoperability', which is the capability of different information systems, devices and applications to access, exchange, and



Photo: Syda Productions, Adobe Stock

use data in a harmonised way, to provide a timely and seamless transfer of information.

- Data integrity – the assurance of the accuracy and consistency of data over its entire life-cycle – requires new forms of partnerships in which actors agree to share more data, collected (as much as possible) digitally and objectively.
- The blockchain technology is by its nature inclusive, and it can serve the most vulnerable groups, such as smallholder farmers. However, because practical implementation depends on numerous supporting services, inclusivity should be regarded as the purpose and projects employing blockchain technology for development should specifically aim to produce field level impact.

The inclusivity aspect must take a central place on the blockchain agenda for impact investors. Future applications of blockchain in agricultural value chains must ensure that smallholders benefit. Exclusion pressures do exist, not only due to traditional barriers to accessing technology (as a result of low literacy or income levels), but also due to other dimensions such as gender, age and location. Access to and use of technology and the internet is not evenly distributed between men and women, young and older people, and between cities and rural areas (Aker & Mbiti, 2009). Achieving inclusiveness requires the willingness of different supply chain partners to agree on similar or compatible socio-economic or environmental goals and awareness of the different barriers that need to be overcome to achieve this. To ensure that these issues are taken into account, and investors in the agri-food sector are able to make informed decisions about deploying blockchain, stakeholders need a better practical understanding of how blockchain works and under which circumstances it may bring benefits and for whom, and that more evidence is generated of the actual impact realised.

Blockchain: how it works and common terminology

Understanding blockchain technology starts with getting familiar with the common terminology. Blockchain can be defined as a secure, distributed, immutable database, also called ledger, shared by all parties in a distributed network where transaction data can be recorded. Transactions are organised in blocks. A 'hash' is generated from a string of text or numbers using a mathematical function, for each block, based on its contents, which is referred to in the subsequent block. To add a new block to the chain, 'nodes', which are devices connected to a blockchain network (and hence people), need to reach a consensus, assuring that all users involved agree on information added to the ledger. All the blocks that are confirmed and validated via a consensus mechanism are linked together from the first to the last validated block, hence the name blockchain.²

When blockchain technology is considered for solving an existing challenge in agricultural value chains, the development and deployment of the solution requires a series of choices. These choices may require technical knowledge, but they may have influence on the power balance in the chain and the impact achieved, therefore all stakeholders should be able to take part in an informed decision-making process.

Two key choices relate to the 'governance mechanisms' and the 'blockchain types' (i.e. public vs private) used to verify the data (see box 1). Opinions are divided both in the scientific and in the commercial communities, with respects to the options available. For this reason, before engaging with blockchain as an investor or user, crash courses on the subject and in-depth discussions with diverse experts are recommended.³

Box 1: Key technical choices to make when using blockchain

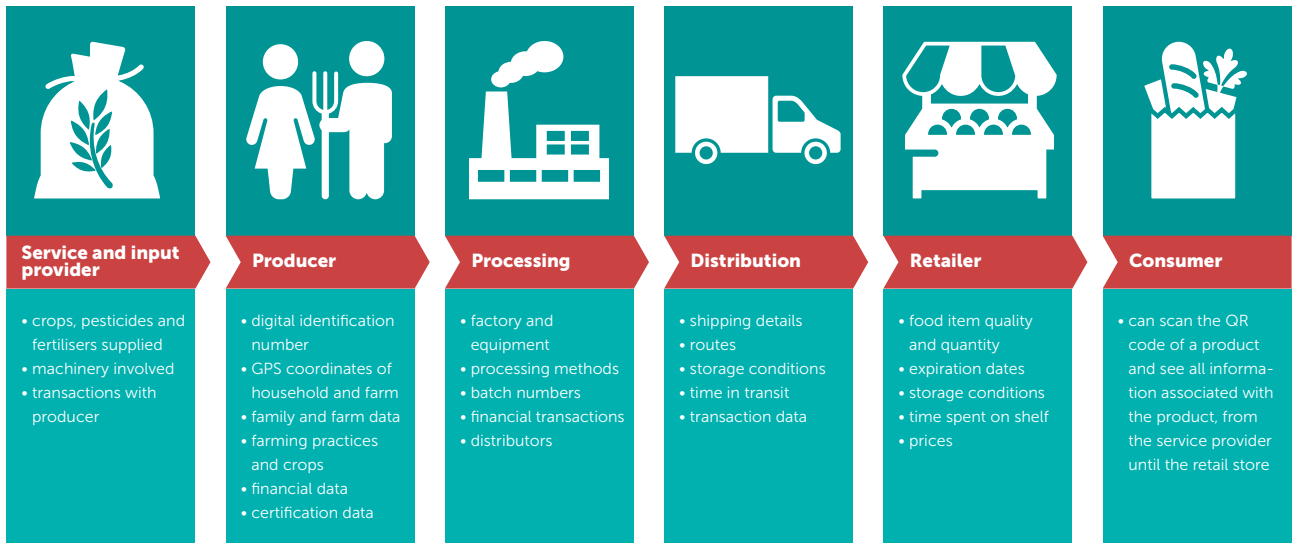
- 1 How open is it? The three broad types of blockchain are public, hybrid and private. Choosing between these types is referred to as choosing the 'Permission design', i.e., whether permission is needed to access the blockchain.**
- 2 Choice of consensus algorithm, i.e., how a new block is added to the blockchain.**
- 3 Whether or not to use a smart contract, i.e., whether to use the blockchain as a virtual machine where programmes representing business processes are run.**
- 4 Whether or not to use cryptocurrency, i.e., whether the consensus algorithm and smart contract operations depend on an artificial currency or not.**

Source: Ge et al., 2017.

² For common terminology used in blockchain technology see: Fairfood. *Blockchain Knowledge Base*. <https://fairfood.nl/en/blockchain-knowledge-base/>; and Consensus. *A Blockchain Glossary for Beginners*. <https://consensus.net/knowledge-base/a-blockchain-glossary-for-beginners/>.

³ The World Economic Forum published a new toolkit in May 2020, covering a set of Modules to guide organisations in developing and deploying blockchain solutions: World Economic Forum. *Blockchain Toolkit Modules*. <http://widgets.weforum.org/blockchain-toolkit/modules>

Figure 2: Data written on the blockchain in food systems could include a wide range of information (Kamilaris et. al., 2019)



Each organisation in a modern supply chain holds products, finances and data, and has its own version of ‘truth’ about a product’s journey and the transactions involved. This can lead to errors, fraud, delays and inefficiency. Blockchain can reduce these complex bilateral communications and informational linkages and leakages by providing a single, shared, ledger where tampering is easily observable and that records the transactions as they occur, with approval from all participants (World Economic Forum, 2019).

Reliable data entry is one of the commonly raised issues of concern. To illustrate how blockchain networks deal with this, we provide an example from a generic smallholder value chain. When a farmer wants to sell their produce, they will first create a digital identity which should be verified by a third party, a fingerprint (or other typical approaches used by websites and banks), and input personal, farm and product data. The same applies to an agent who wants to buy the farmer’s products, who can authenticate, see the offer and bid a price. Products can be weighed digitally, with data placed behind QR or product codes, using phone cameras or scanners to read them and start a provenance trail. The transaction itself can be done using one or two mobile phones, with each participant authenticated on a device. The agreement between the two parties and its details (i.e. quantity, price, quality, time, etc.) is captured as a transaction. This is often done using offline applications, with transaction data (represented by a ‘hash’) being uploaded into the blockchain, using secure, encrypted channels. Any other value chain partners in the network will then have the same

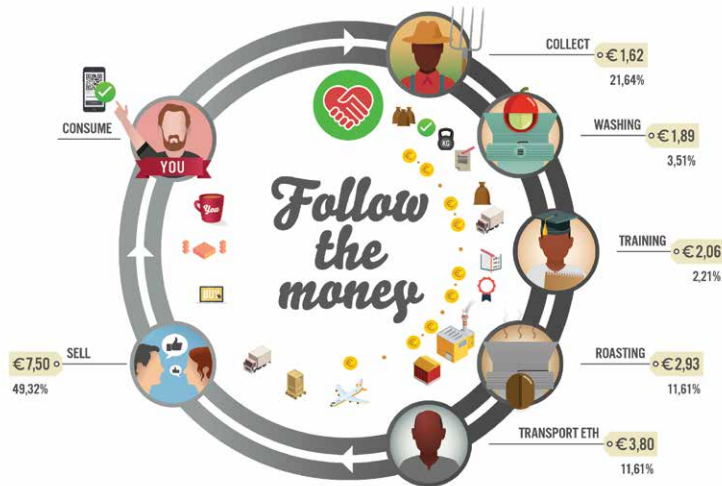
proof of the exchange. Figure 2 provides examples of data written on the blockchain in agri-food chains.

Third parties can be eliminated in most blockchain use cases, but auditors and data validators still play a key role, mainly in eliminating fears related to data entry, directly on the blockchain and specifically through applications which integrate with blockchain databases. However, the responsibilities of such third parties are not yet clear. Although standard setters such as Fairtrade (Thompson, 2019) and Rainforest Alliance (Nestlé, 2020), and the auditors they work with, are researching or even engaging with blockchain pilots, more regulation is perhaps needed before their roles can be fully understood.

An example of blockchain in the agri-food sector: the case of Moyee Coffee and FairChain Foundation

To provide more understanding of how blockchain might provide benefits to smallholder farmers the case of Moyee Coffee, a potential CFC investee, is highlighted. Moyee Coffee is a social enterprise, which strives to ensure that a larger share of the value of the coffee remains in the producing country (Ethiopia), by investing in high standard roasting facilities there⁴. Its guiding principles are to promote inclusive business models, share value fairly, and provide more transparency. Supported with technical assistance by the FairChain Foundation (FairChain Tech), Moyee Coffee uses blockchain technology to make payments to farm-

⁴ See www.moyeecoffee.com.



ers visible, and to connect them to impact goals such as a 'living income for farmers'.

The Moyee-FairChain partnership is digitising Ethiopian coffee farmers and workers, providing them with digital identities, wallets, yield and income histories, access to their own data, and links to finance. The following blockchain use cases have been implemented:

- Traceability and transparency of payments to farmers, in order to deliver on the brand's transparency claim and create loyal customers⁵. Moyee uses an online dashboard, showing each farmer's profile and the coffee sold to Moyee, with transactions and invoices captured on the blockchain database. An important element for Moyee, necessary to achieve more loyalty from such transparent data, is the use of the same dashboard for informing its consumers about what blockchain is and why it can be trusted.
- Enabling consumers to contribute directly to achieving verifiable, quantifiable socio-environmental sustainability impact. Moyee launched a '1 Million Tree Revolution' campaign, during which consumers are able to invest €0.25 in planting a tree by scanning a QR code provided with each cup of coffee, and to receive proof of impact that was captured on the blockchain (i.e. invoice, GPS location and time-stamp of planted trees, photos)⁶.
- Access to finance (i.e. a microloan) for individual smallholder farmers. Still under implementation, Moyee aims to use past transaction data, which shows each farmers' deliveries and income from coffee sold to Moyee, to create credit scores and provide finance to eligible farming families. The microloans will come from Moyee crowd funders, and will be

paid into farmers' digital wallets in token form. Spending is restricted to farm inputs and food products pre-selected by women from the farming communities, in a local shop that was strengthened for this purpose. This approach implies multiple use cases: connecting consumers with farmers, believed to lead to improved customer retention and loyalty, providing access to finance for farmers, and reducing transaction costs (consumers' money is pooled and transferred only once via traditional financial institutions from the Netherlands to Ethiopia, and it is tokenised and distributed through the digital wallets of farmers).

For the traceability use case, each supply chain partner provides data on quantity and quality of the coffee, and financial transactions, and documents such as invoices, in tailored input screens or directly to FairChain Tech. Existing farm management software (i.e. FarmForce) is used for farmer and crop data collection, which is integrated into the blockchain database.

Measuring results of this project and the effects resulting from adding blockchain investments is yet to be done, and the business case of Moyee is not yet proven. Moyee is a social enterprise, whose ROI may be achieved through customer retention and acquisition from the increase in transparency.

Is blockchain the right investment?

When deciding on new projects taking advantage of blockchain, investors and companies need to assess if it is feasible and beneficial for each particular challenge or assumed advantage, and, if so, which blockchain capabilities are most suitable. Understanding the suitability and feasibility of a blockchain use case can be achieved by evaluating a number of key questions.

1 Is there a business case for blockchain? And does this apply for all involved?

An important factor that is considered when assessing a business case for any investment, is the ROI. The added value needs to be assessed for all different participants, users and beneficiaries. The actor(s) carrying most of the financial costs of an investment in blockchain should note that as this is a new technology, there is limited proof of ROI from existing pilots. Additionally, depending on the use case, ROI may not be encouraging in the short term (Deloitte, 2018).

Initial investments are relatively high, as projects require substantial learning, man-power and time to set up terms

⁵ See the Blockchain FairChain Coffee Harvest Timetable www.moyeecoffee.com/livefeed

⁶ See <https://www.moyeecoffee.com/trees/>

and processes, and choose the right development partners. Those embarking on a blockchain project must be able to accommodate changes in their own processes, software use, partnership forms, and possibly culture.

Four types of potential economic impacts may be generated by the use of blockchain: membership revenue, transaction revenue (fees), cost avoidance and savings (related to reductions in capital and operating expenditures), and savings due to efficiency gains (IBM, a). IBM's Food Trust, a collaboration between major food companies (Dole, Driscoll, Golden State Foods, Kroger, McCormick and Company, Nestlé, Tyson Foods and Walmart) targets a ROI from its blockchain investment via supply chain cost-efficiencies, due to the very large supplier base, and a large number of transactions. The Moyee case above provided an example of ROI (potentially) achieved through customer retention from the increase in transparency, expanding on IBM's list of economic impact. Trabocca, the coffee trader used as an example at the beginning of this article, believes that the added value of its transaction data becoming transparent will push its customers to pay a higher price. This assumption will be tested by offering the same coffee, at two different prices, adding a surcharge for the blockchain traceable coffee.

2 Does blockchain provide social and/or environmental benefits? And to whom?

Apart from ROI, blockchain also has the potential to generate development impacts. However, quantifying such long-term impacts across investees and portfolios is challenging. There is a lack and/or a high cost of trustworthy data on the social or environmental results of an investment, making credible accounting of impacts difficult. There are also challenges around the allocation of an impact-related claim to an investor, risking the 'double-counting' of claims. Furthermore, blockchain interventions have not been the focus of traditional methodologies used in impact measurement and evaluation in agricultural value chains.

New initiatives in the area of development impact bonds, or impact and carbon credits, are looking at blockchain to capture trustworthy proof that certain benefits were achieved. These initiatives, however, face roadblocks in monetising impacts (e.g., illiquid impact markets, uncertain returns, high transaction costs). A further challenge is the issue of who is able to benefit as some groups may have easier access and/or may have less difficulty understanding how it works than others. The complexity of blockchain may lead to a new digital divide, based on levels of digital skills and access to and control over technologies needed to access it.



Photo: Manel



Photo: Adobe Stock

3 How can blockchain technology drive value in a business? Is it strictly necessary?

Due diligence is required for investors to assess the necessity, scope and scale of blockchain solutions. Some organisations (i.e. Agri-Wallet, AgUnity) highlight the use of blockchain for creating digital farmer identities and providing access to finance, when in fact the same results can be achieved without blockchain. Necessity can be perceived by some organisations as ‘keeping the front-runner’ position or ‘staying innovative’, while others might ask themselves if blockchain is necessary to achieve an increase in farmer incomes. Investors should ask critical questions about the added value of blockchain in solving their challenges, in comparison with existing software solutions. Due to the immature nature of the technology, any blockchain investment has high risks and costs. When considering a blockchain investment, a deep understanding of existing process and systems in use is necessary. This requires inter-disciplinary skills, and is generally time and resource intensive.

How feasible it is to improve record-keeping, to move transactions on blockchain applications, and to integrate existing technologies, is often determined by the type of assets. For example, assets such as equity can be easily digitised and managed on a blockchain system, whereas connecting physical goods requires data input, and perhaps hardware (i.e. IoT, or biometrics), which can still be tampered with (Carson et al., 2018). Physical assets can be represented as digital tokens (tokenisation) on blockchain, which makes them more easily and quickly exchangeable (IBM, b). Besides the tokenisation of financial assets (OECD, 2019), other ex-

amples are carbon credits (IBM, 2018), real estate (IBM, 2018) and plastic waste (IBM, c).

4 Are there any ongoing projects and existing digital solutions, which could be replaced, enhanced or initiated with blockchain technology?

Some organisations may be in the midst of replacing existing software, or researching other supply chain or farm digitalisation and automation options. In that case, the right software development partner, could offer blockchain technology as a straightforward add-on, as a way to store some data in a distributed database, without focusing on blockchain’s many other potential benefits. Common integrations with blockchain are Enterprise Resource Planning software, used for example in procurement, accounting, risk management, project management, supply chain operations, and compliance. Many blockchain developers are building integrated solutions, most of them adding a blockchain use case, database and user-interfaces as extra features to the existing software already in use by their customers (Carson et al., 2018).

5 How willing are partners in the investment to collaborate?

A so-called ecosystem must be established for any blockchain use case, such as a supply chain partnership, a public-private partnership or other type of cooperation. To assess the feasibility of using blockchain, investors must consider the willingness of the collaborating parties to share data, create transaction rules, and make investments. Aligning strategic incentives of the partners involved is critical for a successful blockchain project (Carson et al., 2018).

Evidence of blockchain's impact

With only about five years of blockchain use in agri-food chains, there are at present no impact evaluation studies available of the technology for the sector, but only analyses of the effects of existing pilots. The way forward requires a patient deep dive into past and present use cases, categorising them, and analysing their business case, ROI, tangible benefits and quantifiable effects. Some examples known to achieve scalability and therefore assumed to provide benefits or a ROI, include:

- Dutch supermarket Albert Heijn is tracing orange juice from Rainforest Alliance-certified plantations to its stores (Ahold Delhaize).
- Agri-Wallet partners with Rabobank, IDH (Sustainable Trade Initiative), and the Dutch entrepreneurial development bank (FMO), to provide affordable supply chain finance to farmers, buyers and suppliers, using blockchain technology (FairFood, 2020).
- Fairfood is using its Trace platform for traceability of nutmeg from Indonesian smallholder farmers to Dutch Coop supermarkets (Verstegen). A second user of Fairfood's platform is Trabocca, a specialty coffee trader, which is tracing Ethiopian coffee from 278 small farmers to its European roaster customers, making the transactions and payments to farmers visible in the process (FairFood, b).
- Ripe.io tracked cattle in an Australian supply chain, exploring how smart contracts can support the automation of certifications, compliance of export regulations, and compliance of domestic regulatory obligations (Meat and Livestock Australia).
- In the fresh and frozen tuna sector, WWF and its blockchain partners tracked fish from vessel to supermarket, to prove that blockchain technology can prevent illegal fishing (WWF).



Photo: Adobe Stock

Conclusions

It is clear that to date there are a large number of blockchain test use cases in the agri-food sector, with claims of economic and/or developmental benefits. However, there is still little evidence of returns on investment or tangible outcomes and development impact in agriculture value chains, and a large number of blockchain pilots have failed. This does not necessarily mean that benefits are not possible, just that the use of blockchain in these chains is still immature. Blockchain use cases are in their infancy and pilot projects can validate claims for added value. Only through trial and error can investors in blockchain technology accelerate the scaling up of use cases, succeed in maximising supply chain and smallholder benefits, and define long-term business cases. This requires sufficient budgets and resources, as well as enough knowledge to be able to make agreements on governance and data systems, privacy and legal aspects. In addition, it is of key importance that investors who are interested in development outcomes are aware of the potential biases in terms of who is able to engage with blockchain, and devise ways in which to overcome potential barriers for specific user groups. The above requires a multi-disciplinary and multi-stakeholder partnership (ecosystems) approach to any blockchain investment.

It is important to note that blockchain has limited use on its own and must be considered together with investments in other technological and non-technological solutions. Blockchain adoption processes must also be well planned, as there will be numerous challenges along the way, as well as potential solutions. There is little to no uniformity in the processes advised by experts for engaging with blockchain and creating the right use case. Therefore, investors must do their due diligence, and work with advisors and partners in impact and technology-driven ecosystems, in order to reach a moderate level of understanding to be able to make the right choices.

Until practical uses of blockchain become common knowledge in the agri-food sector, with off-the-shelf solutions for different supply chain and farm-level problems, and public and private value chain players have become comfortable in using blockchain applications, the percentage of failed use cases will remain high. High risks are of course inherent in developing and applying a new technology, and high potential rewards should make the technology worth the effort, at least in some cases. Preparation and due diligence, training and discussions with different experts are therefore strongly recommended before investing in blockchain.

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