CONCEPT NOTE

# Agricultural supply chain traceability

## Introduction

Supply chains are intrinsically complex flows of goods, money and services. Their traceability refers to the collection, documentation, and application of information related to all processes in the supply chain in a manner that provides

guarantee to the end-user and other stakeholders along the supply chain on the provenance, location and life history of a product. It represents the ability to conduct a full backward and forward tracking to determine characteristics of the good by means of records. In line with the UN's sustainable development goals, the sustainable management and traceability of these supply chains can positively affect lives to receive a higher income around the globe – which is especially true in low income countries, where 63% of the employed population still work in the agricultural sector.

## Problem description

Often, the opaqueness of supply chains hinders customers from understanding the provenance of a product, as well as its social and environmental impact for smallholder farmers and other participants of the supply chain. While increasing numbers of customers seek out organically produced goods, industry fails with the demand to provide such goods at a satisfactory standard. Currently, the only way for customers to be promised higher standards is through certification schemes. These schemes tend to be too costly for single smallholder farmers and even corporates may shy away from the investment. Hence, farmers and workers may carry on receiving low prices for goods that could be distinguished as sustainably sourced.

Customers experience a lack of comprehension of existing sustainability labels and a lack of clarity on the detailed origin of goods. They lack comprehensive information on, for example, the emission occurring along the chain and the human rights situation in production locations. This uncertainty is understood to be a barrier to increasing purchasing behaviour for sustainably sourced goods for customers with a high purchasing power. The lack of transparency along complex supply chains, thus makes it difficult to unveil the low wages for smallholder farmers, the poor working conditions for farm and factory workers, the environmental impact and the lack of sustainable farming and processing practices.

The lack of transparency in supply chains stems, among other things, from their complex nature that commonly involves a wide range of stakeholders: farmers, processors, marketers, handlers, consumers, governments, and the general public. Along the chain, participants have their own interests and are reluctant to share economically sensitive information that can generally cause barriers on the exchange. Smallholder farmers are the weakest actors and have the least bargaining power in the supply chain to actively influence prices and payouts.

## Advantages of sustainable supply chains based on Blockchain technology

Blockchain is a type of distributed ledger technology (DLT) and stores information with the consensus of all participating parties. Once the information is stored and verified by all parties, it creates an indelible record, resistant to tampering by any individual party. Unlike a centralised database held by a single entity, a Blockchain continues to run even if individual participants pull out or go

bankrupt. Blockchain technology allows immediate transactions and enables networks to associate transactions with conditions: If transaction A has happened, then transaction B will be automatically executed. An example of such, a smart contract is an immediate payout of an invoice when the product has been delivered to the next stage in the supply chain and both parties agree that all standards are fulfilled.

Smart contracts – structured as if… then… clauses – define the rules and penalties around a digitally represented agreement and also automatically enforce the obligations arising out of that agreement. Usually, these actions are connected with the execution of transactions on the Blockchain. The conditions can be triggered by certain events on the Blockchain, requests from users, transactions, or other smart contracts. The advantage lies in particular in the fact that it is not dependent on a central instance and can therefore also execute anonymous processes securely.

A **token** is a digital asset that is stored on the Blockchain and can be connected to a real-world value. Tokenisation in this context allows association of unique information to goods and services to a certain time period, and can be used as collateral to unlock financing. The advantage here is that every payment along the chain will be recorded and the traceability of transactions enable transparency. For developing and emerging markets, Blockchain technology has the ability to offer transparency on how goods are being sourced, processed and transported as each step along the chain of custody can be immutably recorded in real-time onto the Blockchain. This capacity to shed light on the origins of consumer goods is one of the more promising attributes of Blockchain technology for local producers, logistical partners, and custody. It could reward those using sustainable practices thanks to a layer of trust that has been created by a decentralised ledger and the increased price consumers may be willing to pay. All logistical information can be on-chain and all parties will trust a single source of truth that will lead to a faster facilitation of trade.

## Leveraging decentralisation

Nevertheless, if transparent supply chains are indeed beneficial to local producers, the added-value in terms of decentralisation has to be highlighted with the benefits for the first-mile actors. Blockchain-powered decentralised platforms are more easily utilised by larger actors of the value chains that are trading together without trusting each other, but provide little benefits to first-mile actors. Currently, there are more supply chain business cases in the private sector that focus on centralised and permissioned ledger solutions to help larger enterprises and put less of a focus on decentralisation and sustainability. Decentralised supply chain leads to transparency, availability and the resulting verification of all parties' data and more sustainable farming practices. The decentralisation of data can enable access to finance and immediate payment which supports the first-mile actor financially. The assumption is that transparency of production processes, customers are willing to pay more for a sustainably sourced product. This could incentivise the first-mile actor to produce more sustainably to receive a higher income.

## Potential challenges

There is no one-size-fits-all solution. Every supply chain has to be checked if it has the potential to effectively leverage distributed ledger technology. The capacity to run Blockchain-powered supply chains will largely rely on the ability to tokenise a traded good. The more unique and identifiable the good is, the more its digital twin will faithfully reflect its identity. Bridging this representational gap between the real good and its digital token implies that at any given point along the supply chain, the person holding the digital and the physical item can make sure that it corresponds and

has not been subject to any tampering. Unprocessed coconuts or pineapples for example are easier use cases for traceability as they can be easily marked and traced – off-chain and on the Blockchain. In comparison, fungible goods such as coffee, are harder to track. Reducing the risk of such fraudulent activity along the supply chain remains a key challenge for Blockchain use cases in agricultural supply chains – the so-called oracle problem.

Traditionally, sustainable supply chains have to be verified by a third party to prove their environmental, social, and ethical production practices. As this third party needs to be trusted, the validation process is often centralised in human hands – be it non-governmental organisations, certification issuers or auditors. While this does not mean that trusted third parties need to be systematically replaced, this merely indicates a current unlikeliness of leveraging full decentralisation. While trying to achieve a high level of decentralisation, information exchange between all stakeholders on the supply chain has to be standardised. Furthermore, a data model that everyone can access is crucial in this context to fully leverage the value chain cooperation. By opting for a decentralised model, the governance is equally distributed, however, the data quality and credibility has to be ensured. Individual data of single actors that is not crucial for other actors along the chain should not be accessible. A good balance between data transparency and privacy is required.

### Oracles

Oracles are an extension of the smart-contract concept. They enable smart contracts to interact with systems outside the Blockchain. In this way, they can react to external data or events and process them on the chain. This external data can be of any nature: Inputs from digital platforms (e.g. CRM or marketplaces) or website input (via a Web API) are conceivable, as are values from all possible areas recorded by sensors.

Achieving good data quality is not part of the Blockchain technology solution. There are different ways achieving this goal, one is the Internet of Things (IoT) technology, where sensors monitor and record certain situations and environments, in an accurate and unbiased manner. A second solution is to diminish the human error by educating and capacitation of those handling the data, e.g. through training courses, guidelines, and handbooks.

## Ideal application context

Some promising contexts are those that allow strong consumer engagement, as observed for coffee, cocoa or cotton: consumers in developed countries value sustainably sourced and traceable coffee, chocolate and clothes and are thus more likely to withstand higher prices for demonstrated sustainability.

The focus should be kept at one challenge at a time and not trying to solve all problems at once. Therefore, the effort of the project e.g. tracking the origin, improving the financial flow of payments, decentralised verification of products has to be planned in detail and be openly communicated. For a project to be successful, the identification of benefits of all actors in the supply chain is an imperative precondition. Understanding – and potentially optimising – current processes along the chain is the first step before digitising the assets that will be displayed on chain.

The verification that the digital product is appropriately identifiable in the real world is still an unresolved problem. Attempts to solve it continue, using Internet-of-Things devices such as sensors or QR codes in order to reduce opportunity for human error or fraud. These more technologically advanced methods, however, always require accurate cost-benefit calculations to ensure that projects are economically viable and market-ready. Often, regular checks through

certification or uploading of pictures are still required to ensure the digital chain displays the correct information at a low cost. In order to access this information, all parties should have the same viewing permissions to access the due-diligence information.

Digital readiness is a crucial point in deciding whether Blockchain technology can be applied in the agricultural supply chain and if first-mile actors have access to the needed infrastructure (including reception in the chosen location). Additionally, affordable internet access is crucial.

## Current initiatives

Numerous Blockchain initiatives revolve around supply-chain applications, but fewer display true social and environmental benefits. Among those are coffee and fish projects – both fungible and thus interchangeable commodities, meaning that the afore-mentioned limitations have to be considered. However, the piloting of these projects showcases that significant progress can be made before designing perfect solutions.

*Provenance*

- Coffee: Provenance delivers sustainably produced commodities to consumers by selecting trusted producers. Blockchain technology records the product's chain of custody until it reaches retailers. This is enabled by Radio Frequency Identification (RFI) and Near Field Communication (NFC) tags as well as QR codes which can be used to create a digitised identity for the product on chain and keep track of its origin and transaction history.
- Fish: Local fishermen send an SMS to register their catch on the chain. Their catch is thus given an ID and can be transferred to the supplier digitally. The identities of the fishermen are also recorded, so that local NGOs can verify their compliance with social and environmental standards. Information about the processed fish is added to the chain. On the retail side, consumers should be able, to directly check the journey of the product by scanning QR codes on the package.

*Bext360*:

- Bext360 uses artificial intelligence and Blockchain to cut intermediaries out of the coffee supply chain and deliver visible improvements for local producers. AI devices assess the coffee beans' quality and origin, then upload the corresponding information, effectively tokenising the coffee on the Blockchain and enabling instantaneous payments to producers. The coffee, whose quality has been certified, is then tracked on Bext360's Software-as-a-Service (SaaS) platform throughout its journey.

*ScanTrust (Goodchain)*

- Goodchain uses product label QR codes where consumers can trace back the origin of the product and producers earn IMPACT points. Those points can be exchanged for cash and used to fund projects.

*Centrifuge (Tinlake)*

- Tinlake is a platform that enables stakeholders e.g. farmers, processors, marketers, handlers to draw loans against non-fungible assets, such as financial documents, invoices or agreements with buyers. The newly created asset is represented on-chain as a Non-Fungible Token (NFT).
- It enables producers to borrow money in stable coins such as DAI (a pegged token to the dollar). This allows instant smart-contract-based lending and supports a new open-source solution for the financial flow in supply chains.

*Minespider*

- Minespider is an open and interoperable protocol to track fungible commodities in the supply chain. Actors will upload ownership and provenance information on the chain and create encrypted certificates that are stored in a decentralised database. Every purchase of an encrypted certificate will be associated with an amount of commodities transferred that will be registered on the Ethereum blockchain. Thus, actors along the supply chain can track and trace the good.

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Registered offices
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Blockchain Lab
Friedrichstr. 246
10969 Berlin, Deutschland
T +49 61 96 79-0

E blockchain@giz.de
I www.giz.de/blockchain

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**Responsible**
Franz v. Weizsäcker, Berlin

**The Authors**
Anna Mehrländer/Lars Wannemacher, Berlin

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