GSMA

Blockchain in Agriculture: Global Lessons and the Kenyan Experience

June 2025

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Contents

Acronyms and abbreviations

3G	Third generation (mobile network)
4G	Fourth generation (mobile network)
5G	Fifth generation (mobile network)
ACRE	Agriculture and Climate Risk Enterprise
AI	Artificial intelligence
B2B	Business-to-business
B2C	Business-to-consumer
CBK	Central Bank of Kenya
DLT	Distributed ledger technology
ESG	Environmental, social and governance
EUDR	European Union Deforestation Regulation
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross domestic product
IBM	International Business Machines
ID	Identity document
ILO	International Labour Organization
IMF	International Monetary Fund
IVR	Interactive voice response
IoT	Internet of Things
KIAMIS	Kenya Integrated Agricultural Management System
KSH	Kenyan shilling
KYC	Know your customer
LMIC	Low- and middle-income country
MFI	Microfinance institution
NDC	Nationally determined contribution
NFT	Non-fungible token
NGO	Non-governmental organisation
OMA	One Million Avocados
PIN	Personal identification number
PKI	Public key infrastructure
QR	Quick response (code)
RISA	Rwanda Information Society Authority
RLMUA	Rwanda Land Management and Use Authority
SaaS	Software as a Service
SADC	Southern African Development Community
UN	United Nations
USAID	United States Agency for International Development
USD	United States dollar
USSD	Unstructured supplementary service data
VCM	Voluntary carbon market
WFP	World Food Programme

Definitions

Agribusiness	A formal buyer, trader or exporter of agricultural produce, or input supplier. (Source: GSMA)
Agricultural value chains	The actors and activities that bring basic agricultural produce from the field to final consumption, with value added to the produce at each stage. Agricultural value chains can involve processing, packaging, storage, transport and distribution. Value chains can be formal or informal depending on the strength of the relationship between farmers and buyers. (Source: GSMA)
Agritech	A company providing tech-based solutions to increase efficiency, transparency and profitability in agriculture. (Source: GSMA)
Asset tokenisation	The process of creating a digital representation of a real thing. (Source: McKinsey & Company)
Blockchain	A DLT: a database of records or transactions stored on separate, connected devices in a public or private computer network. (Source: McKinsey & Company)
Commercial farmers	Farmers who sell most of their produce and invest in their farms as a business. (Source: 60 Decibels)
Crowdlending	Crowdlending is a form of crowdfunding financing where multiple investors pool their individual contributions to support a project. Contributors receive a portion of profits in return for their investment.
Dipping	A veterinary practice where livestock are immersed in a chemically treated water bath to treat or prevent disease.
Distributed ledger technology (DLT)	A digital system for recording the transaction of assets. There is no central data store, but rather data is stored in multiple places simultaneously. (Source: TechTarget)
Non-fungible token (NFT)	Blockchain-based tokens that represent a unique asset like a tree, a farm or an animal. NFTs act as irrevocable digital certificates of ownership and authenticity for a given asset, whether digital or physical. (Source: AWS)
Parametric insurance	Insurance policies that release payments when a trigger event happens. Most policies are based on predetermined indices, or thresholds, that must be met. In most cases, payment is automatically disbursed to policy holders once the indices established in the policy are exceeded.
Pre-commercial farmers	Farmers who sell a substantial share of their produce and show some market orientation through investments and interactions. (Source: 60 Decibels)
Smallholder farmer	A farmer in a LMIC who produces crops or livestock on two-hectare plots of land or less.
Smart contract	A computer code embedded in a blockchain network that is programmed to autonomously and automatically execute actions when a pre-determined set of criteria is met. (Source: McKinsey & Company)
Subsistence farmers	Farmers who consume most of their crops and have low market orientation in their investments. (Source: 60 Decibels)
The Internet of Things (IoT)	Describes the coordination of numerous machines, devices and appliances connected to the Internet through multiple networks. (Source: GSMA)
Virtual asset	Refers to any digital representation of value that can be digitally traded, transferred or used for payment.

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Executive summary

Defining blockchain technology

Blockchain is a digital technology, referred to as a distributed ledger technology, for recording and sharing information in a secure, transparent, and tamper-proof manner. It can be used to record transactions, manage data, and automate processes without needing a central authority. These core features of blockchain, immutability and transparency of data and transaction records, have led to its increasing adoption in the digitalisation of agricultural value chains to address some of the most pressing challenges facing smallholder farmers as well as the agribusinesses that work with them, such as limited access to finance to procure quality inputs and cushion against climate shocks, lack of price transparency in informal and inefficient markets, weak land ownership records and low trust between stakeholders in the value chain.

This report presents six key use cases of blockchain technology in agricultural value chains, based on an extensive desk review and interviews with blockchain solution providers in low- and middle-income countries (LMICs). It also assesses the relevance and applicability of these use cases to the agriculture sector in Kenya, which offers a strong enabling environment for digital innovation in agriculture, and already has some existing blockchain initiatives in agriculture and finance, indicating a readiness to scale impactful blockchain-based solutions to improve the livelihoods of smallholder farmers and strengthen agribusinesses.

Key use cases of blockchain in agriculture

Digital identity

Lack of identity documentation and a formal financial history is a significant challenge for many smallholder farmers across the globe, leaving them struggling to access critical products and services such as credit, insurance and subsidies, even as they face higher risks from increasing climate variability, and continue to farm with more poorer quality inputs as they are more affordable, resulting in lower yields.

Blockchain technology offers a viable solution for creating and maintaining digital identity records. Blockchain enables multiple trusted partners to record their interactions with an individual on a shared, tamper-proof platform, strengthening trust in that individual's digital identity over time. This digital identity could help farmers more easily meet the Know Your Customer (KYC) requirements of financial institutions, and facilitate access to essential financial services such as credit and insurance.

Agriculture input verification

Blockchain can be used to verify the authenticity and quality of essential agricultural inputs, such as seeds or fertiliser. It can facilitate tracking of these inputs from suppliers to farmers, reducing the distribution of fraudulent and counterfeit products.

Credit, loans and crowdlending

Because data on a blockchain cannot be altered, blockchain helps reduce the risk of fraud and disputes over payments, making it well-suited to lending and credit provision. The use of blockchain-enabled smart contracts can automate loan disbursements, thereby reducing both the time required to access loans and the cost of servicing them.

Blockchain has also enabled the development of innovative crowdlending models, such as asset tokenisation. In this model, a physical agricultural asset – such as a plot of land or livestock – is digitally represented as a token on the blockchain. Each token reflects ownership or a share in the value of that asset and can be securely bought, sold, or traded in real time. This allows multiple investors to co-invest in a single asset, enabling smallholder farmers to raise capital more easily.

Insurance

Parametric insurance policies are set up to release payments to policyholders when a predefined trigger event, such as a flood or drought, occurs. Blockchain can enhance the efficiency of this process by automation through smart contracts, reducing the administrative burden of managing payouts, and improving the reliability and integrity of the data used to trigger payouts.

Traceability

Blockchain is well-suited to support the traceability requirements of "farm-to-fork" initiatives that aim to provide transparency across the value chain, from the growth of crops to the sale of the final product, as the immutability of records on the blockchain strengthens trust in the tracking information.

Blockchain can also be used to track the lifecycle of cattle, including vaccinations, dipping, sale and slaughter. Records of these events on the blockchain can verify compliance with regulations, such as for consumer assurance or export certifications.

Carbon credits

The voluntary carbon market (VCM) enables companies seeking to offset their carbon emissions to invest in initiatives that sequester carbon, for which they can then receive carbon offset credits. VCM offers farmers the opportunity to generate additional income by participating in carbon offsetting projects, by adopting more sustainable farming practices.

However, VCM projects can often lack transparency due to fragmented data reporting, limited third-party verification, and unclear arrangements on how to share benefits. Blockchain can help address these challenges by maintaining immutable records of agreements and transactions. Smart contracts, which are contracts coded onto a blockchain that automatically enforce the terms of an agreement, can be particularly useful for executing and enforcing terms between VCM project developers and implementers.

Blockchain for agriculture in the Kenyan context

Agriculture is central to Kenya's economy and the primary source of livelihoods for much of the rural population. Smallholder farmers are responsible for approximately 75% of the country's total agricultural output. However, farmers in Kenya face a range of challenges that undermine productivity: limited access to credit makes it challenging to meet production costs, lack of access to credit and insurance increases exposure to risk, while climate variability affects crop yields. Additionally, the use of poor-quality inputs, lack of sufficient and reliable data to inform decision making, and lack of verified identity documents, which can facilitate access to critical financial products and markets, further impact the productivity and efficiency of the sector.

Kenya has emerged as an early leader among LMICs in blockchain-enabled agricultural services, particularly in Africa. This is due to the country's conducive environment for innovation, including relatively advanced digital infrastructure compared to many other LMICs, high mobile phone penetration, and a policy environment supportive of digital innovation, as well as high uptake of mobile money services. There is a clear opportunity for Kenya to leverage blockchain in the agriculture sector further to address the challenges that Kenyan smallholder farmers and agribusinesses face.

Challenges in scaling blockchain solutions

Despite the promising use cases of blockchain in digitalising agricultural value chains to address pain points faced by smallholder and commercial farmers, blockchain solutions providers continue to face challenges in scaling blockchain solutions. Findings from this research indicate that a key challenge is securing funding. Many investors remain hesitant to back blockchain-based solutions, partly due to the technology's association with cryptocurrencies, which have been volatile and subject to negative media coverage and regulatory uncertainty. This perception often causes stakeholders to overlook the potential of blockchain in sectors such as agriculture and makes it more difficult for blockchain-based solution providers to raise investment.

To make their business model more viable, blockchain solution providers tend to solve several pain points for farmers simultaneously – for example, improving access to credit through verified digital identities while increasing market access for farmers via more transparent supply chains. By addressing multiple pain points, blockchain solution providers can deliver higher value to farmers while creating sustainable demand for their platforms.

Blockchain solution providers also face multiple technology-specific challenges. This includes poor quality or inaccurate data being entered onto the blockchain, resulting in sub-optimal outcomes. The cost of maintaining data and transaction records on blockchain is also higher than using conventional cloud-based data storage solutions, so data storage onto the blockchain must be considered, and only data essential to the use case stored on-chain.

Finally, a lack of on/off ramps solutions i.e. mechanisms that enable farmers to convert blockchain-based digital tokens into cash or mobile money and vice versa, limits everyday useability and reduces the incentive to adopt blockchain-based financial products.

Recommendations for scaling adoption of blockchain in agriculture in Kenya

Fully realising the opportunities blockchain offers for the agriculture in Kenya will require coordination and commitment from various stakeholders in the sector, including the government, NGOs and donors, startups and agribusinesses. Key recommendations for different stakeholder groups include:

Government

- Develop and implement policies and regulations that provide legal clarity for blockchain applications, particularly in areas such as digital identity, smart contracts, and digital assets, to increase confidence among innovators, investors, and users.
- Invest in training and outreach programs to build awareness and technical capacity among farmers, cooperatives, agribusinesses, and local government agencies on the benefits and use of blockchain technologies.
- Offer grants or opportunities for public-private partnerships to support blockchain solution providers building and implementing block-chain based solutions in agriculture. This includes piloting and scaling projects that demonstrate clear impact for smallholder farmers.

Startups

- Prioritise solutions that improve existing processes, such as integration with existing agriculture input verification and supply chain traceability processes, before introducing those that fundamentally disrupt them, such as blockchain-enabled alternative financing models like crowdlending and parametric insurance.
- Recognise that each use case presents distinct considerations for how blockchain can be most effectively deployed, and tailor implementation accordingly. For example, for traceability and data-verification use cases, it is important to implement data verification processes to ensure the validity of data input. Additional technologies such as AI and IoT could also be used to automate data input. For the digital ID use case, aligning blockchain-based ID systems with existing national ID systems can encourage trust and user buy-in.
- Design solutions that can cater to mobile data constraints, and poor connectivity environments.

Agribusinesses, donor and development partners, and NGOs

- Ensure that blockchain solutions are adapted to the context of rural smallholder farmers by partnering with community-based actors and organisations to identify prospective users, create awareness and support adoption by farmers.
- Build trust through the use of local champions who can advocate for and explain blockchain applications in simple, relevant terms to smallholder farmers.
- Deliver digital literacy and capacity-building initiatives among farmers, cooperatives, and agribusiness staff to increase awareness and confidence in blockchain-based services.

Introduction

What is blockchain?

Blockchain is an emerging digital technology that can be used to share information securely between participants on a network. It is a DLT: a database of records or transactions stored on separate, connected devices in a public or private computer network.[1] All participants in the network have the power to add a record to the database and have simultaneous access to the records in real time. The key characteristics of blockchain are its security, permanence of record uploads and immutability (data remains authentic and unmodified).[2] This lends itself well to the exchange of digital assets and the transfer of physical assets being tracked by the technology.

The first modern blockchain was launched in 2009, associated with the cryptocurrency bitcoin. Until 2015, blockchain was used to support specific cryptocurrencies. The development of Ethereum[3] – a blockchain platform that could run decentralised applications because it held executable source code in addition to data – enabled blockchain to become a technology with a much wider range of applications. While secure financial transactions are still one of the main applications, blockchain has evolved to support immutable record keeping and secure exchange in many other domains, including agriculture.

There are now more than 1,000 blockchain platforms available, a few which are being used for agriculture use cases.[4] These include IBM Food Trust, LACChain AgroWeb3, Ethereum, Polygon and Celo.

How does blockchain work?

Defining blockchain

A blockchain collects data in groups (blocks) that store data files called non-fungible tokens (NFTs). Once a block is filled, it is closed and linked to a previously filled block using a cryptographic signature, forming a chain of immutable data. Once a transaction is added to the blockchain, it cannot be removed or modified. All computers on a shared network, known as nodes, receive and retain this complete record of transactions.

Types of blockchain

There are three main types of blockchain networks.[5] While the underlying technology is the same, the way in which a transaction is verified and viewed differs.

Consortium blockchain: A group of members controls this type of blockchain. A consensus mechanism is used to verify and add records to the blockchain. This is done by pre-selecting a set of nodes as data verifiers.
Example: IBM Food Trust, a blockchain-based food traceability platform built on Hyperledger Fabric.

Private blockchain: Also known as a "permissioned ledger", this type of blockchain network is controlled by a centralised entity. While this blockchain can be publicly viewable, authorisation must be granted to individuals to verify and add records.
Example: BanQu, a permissioned blockchain platform designed for traceability.

Public blockchain: Also known as "permissionless blockchain", public blockchains are visible to the public and decentralised. Anyone can join or leave the blockchain and/or verify and append transactions. For this type of system to work, stringent consensus mechanisms must be implemented.
Example: Ethereum, an open-source blockchain platform that allows users to create smart contracts, it can be used for blockchain-enabled parametric insurance protocols.

Key uses of blockchain

Storing information

Blockchain creates permanent records that are immutable and can be shared between multiple parties, increasing trust and breaking down data silos.

Tracking the exchange of value

Blockchain can be used to record the transfer of assets, reducing the need for third-party processers, lowering transaction costs and preventing delays.

Digitalising and automating rules

Smart contracting software can be built into blockchain networks to streamline processes.

Smart contracts

Smart contracts are an extension of blockchain. They can be built onto a blockchain to automate the execution of transactional agreements. A smart contract is a computer code embedded in a blockchain network that is programmed to autonomously and automatically execute actions when a pre-determined set of criteria is met.[6] They work based on "if/then" statements.[7]

*Example: "**If** there is no rain in Turkana, Kenya, for more than 60 days **according to** theweathernetwork.com, **then** pay the farmer 50% the value of their insured crops."*

The key feature of smart contracts is that they remove the need for a trusted third party or intermediary to mediate transactions. Smart contracts underlie many blockchain applications, including supply chain management, insurance protocols and digital identities.

Blockchain in action

Figure 1
Blockchain in action

Step 1

A transaction is submitted to a blockchain network via a digital device.

Step 2

The transaction is received by the computers (nodes) in the network, which verify its validity.

Step 3

One computer (node) consolidates the data into a block and sends it out to the network.

Step 4

The newest block is added to the chain of blocks and the transaction is completed.

Previous block tag: 0
Data: ABC
Unique hash: A1B2

Previous block tag: A1B2
Data: XYZ
Unique hash: C4D2

Previous block tag: C4D2
Data: PQR
Unique hash: M2L4

Source: UN Innovation Network[8]

Once the transaction is complete, it is stored on all computers (nodes) in the network and cannot be removed or modified. If a mistake is made, a new block must be added to the chain with the updated information. This, combined with its decentralised nature and ability to drive the removal of intermediaries, provides several important benefits, including **increased trust**, **greater transparency** and, potentially, **faster transaction times** and **lower costs**.[9]

Secure	Because blockchain is decentralised, it is considered a highly secure platform. Permissioned blockchain platforms (private and consortium) are considered more secure than public blockchains.
Democratic	Blockchain platforms are not hierarchical and are therefore considered highly democratic. Public blockchain platforms allow anyone to input and validate data.
Global	Blockchain does not recognise borders, making transactions between individuals or entities in different countries seamless.
Immutable	One of the greatest strengths of blockchain is its immutability. Once data has been logged on a blockchain and verified, it cannot be changed or altered. This increases trust between the parties engaged in a transaction.
Transparent	Information on the blockchain can be made visible to all relevant actors, including farmers, government, investors and insurance providers, making it highly transparent.

Key enablers to deploy blockchain in agriculture

The use of blockchain depends on five key enablers: 1) network coverage and data connectivity; 2) smartphone adoption; 3) a favourable regulatory environment; 4) a vibrant startup ecosystem; and 5) digital and digital financial literacy.

Network coverage and data connectivity

Blockchain technologies require access to a broadband network, which can be a challenge in some rural areas. Although many blockchain solutions have an offline mode for data collection, users (including farmers and agribusinesses) must be able to access the internet to upload data, access relevant dashboards and receive payments. In some instances, blockchain solutions rely on data collected from Internet of Things (IoT) sensors that track various parameters (soil health, weather, animal health, etc.). These require always-on connectivity.

Smartphone adoption

Access to a smart device (a smartphone, tablet, laptop or PC) can facilitate the use of blockchain-based solutions. Some solutions can collect farmers' data at the collection point rather than at the farm, making smartphone ownership less critical among farmers. However, many digital financial services require users to have access to a mobile device, preferably a smart device to scan a QR code, sign up for a service or access funds. Some solution providers, like AgUnity, have provided customers with mobile devices to bring them onboard. Blockchain-based credit provider hiveonline provides a mobile device to every savings group that signs up for credit through the hiveonline platform.[10]

Favourable regulatory environment

Blockchain innovators benefit from clear and transparent regulations on the use of blockchain technologies and cryptocurrencies. Several countries, like China, Bolivia, Nepal, Algeria and Egypt, have placed restrictions on the use of blockchain and cryptocurrencies,[11] making these countries less attractive destinations for blockchain-based innovations. Other countries have failed to provide clear rules for blockchain and crypto, publicly dissuaded users from using cryptocurrencies or not enacted user protections, creating uncertainty for startups and investors. While a clear set of rules benefits all stakeholders, it is important that governments do not overregulate, which can do as much to discourage innovation and investment as non-existent or untransparent regulation.

Vibrant startup ecosystem

A vibrant startup ecosystem is necessary for innovation and to scale blockchain solutions. This includes having local incubators and accelerators, a strong local investor community, spaces for collaboration and opportunities to share best practices. Although 2022 and 2023 were challenging for blockchain and crypto-based startups (with funding falling by an estimated 74% in 2023), the outlook has been more positive in 2024 and 2025.[12] Somewhat unique to the blockchain industry, blockchain platforms themselves have played a leading role in funding many of the early innovations in the sector, including in the agritech and fintech industries.

Digital and financial literacy

For many farmers and agribusiness clerks, it can be a challenge to use digital agriculture solutions in general and blockchain solutions in particular. Capacity building is therefore a significant part of the implementation (and cost) of any blockchain solution. Many of the blockchain solution providers interviewed for this research deliberately left the term "blockchain" out of their discussions with farmers and agribusinesses to avoid creating confusion. Some also cited complications experienced by farmers with early crypto solutions (such as forgetting their crypto wallet PIN and losing access to their funds). Digital and financial literacy are therefore essential to the successful deployment of blockchain solutions.

Kenya's agricultural value chains are well positioned to benefit from blockchain

Technology landscape

Kenya has emerged as a regional leader in technological innovation and has a thriving technology ecosystem. This is the result of a combination of factors, including innovation in mobile payments, investment in startups, the expansion of technological infrastructure, such as mobile broadband and digital public infrastructure, as well as government commitment.

Government commitment: The Kenyan government has played a key role in creating a conducive environment for tech entrepreneurs and companies. The country benefits from a history of technology-enabling policy initiatives, including the 2018 AI and Blockchain Taskforce, the 2019 Data Protection Law, the Digital Master Plan 2022–2032 and the 10-year National Innovation Masterplan, unveiled in 2023, which recognises the role of emerging technologies.

International hub: Kenya's growing tech ecosystem has attracted international actors, including big tech companies such as Microsoft and IBM, which have both established research labs in Nairobi.

Investment and innovation in the agriculture sector are thriving

Kenya is one of the top destinations for agritech investment in Africa, alongside Egypt and Nigeria. Between 2014 and 2023, Kenya attracted 33% of all investment deals and 56% of investment volume. In 2024, total investment in Kenyan agritechs increased by 45%, with startups Twiga Foods and Sun Culture raising a significant proportion of the overall funding.[13]

In 2022, the FAO identified 113 institutions providing digital agricultural solutions, 64 of which are headquartered in Kenya.[14]

The FAO has identified blockchain technology as a leading opportunity for high-impact digital solutions in Kenya's agriculture sector, citing its potential to advance cybersecurity, enhance links and foster transparent monitoring and traceability throughout agricultural value chains.[15]

Mobile ownership and mobile internet adoption

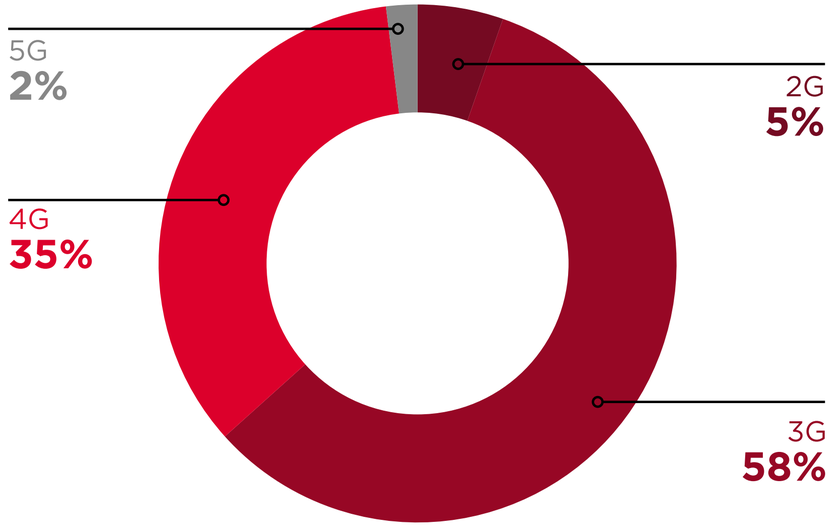
Smartphone adoption and mobile internet are stepping stones to the adoption and scaling of blockchain-enabled solutions. Kenya's mobile broadband coverage provides the foundation for blockchain adoption in agriculture. However, limited uptake of mobile internet limits the reach and impact of many blockchain-based solutions.

Mobile broadband coverage is near universal in Kenya. Most connections are 3G and 4G, with 5G expected to rise. Kenya, along with South Africa, will account for more than half of all 5G connections in 2030.[16]

Most of Kenya's population (92% of men and 91% of women) own a mobile device. The gender gap in mobile ownership is virtually non-existent (1%), the lowest in the region. However, there is a gap in smartphone adoption, with 52% of men and 37% of women owning a smartphone. Mobile internet adoption remains relatively low, with 58% of men and 39% of women using mobile internet.[17]

Figure 2

Percentage of connections by network technology in Kenya (2024)



Source: GSMA Intelligence

Kenya has an enabling environment for blockchain solutions to be deployed at scale

Network coverage, data connectivity and smartphone adoption

Kenya enjoys some of the highest mobile adoption rates in Africa, with 92% of the population having access to mobile services. More than half of Kenyans have access to a smartphone, according to the GSMA.[18] 60 Decibels estimates that 34% of smallholder farmers have access to a smartphone and 62% already use their phones for farming activities, primarily to access information and inputs.[19]

New regulation, however, may affect these smartphone adoption rates. On 1 January 2025, a new mobile user law went into effect in Kenya requiring every mobile device imported or assembled in Kenya to be registered and given an international mobile equipment identity (IMEI).[20] Without this number, mobile operators will not be able to initiate service. Although the new rules intend to combat tax evasion, they have raised concerns about data privacy and government surveillance that may prevent vulnerable populations like smallholder farmers from acquiring a mobile phone.

There is also broad mobile broadband coverage. According to market leader Safaricom, 97% of the Kenyan population is covered by a 4G network.[21]

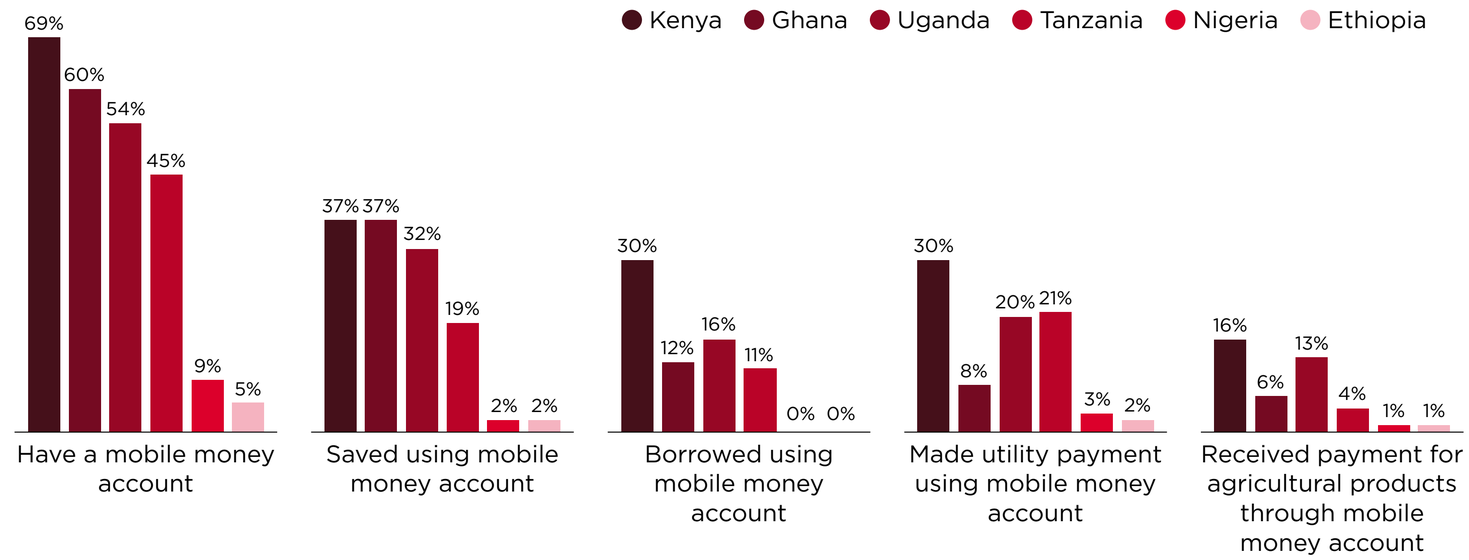
Digital and financial literacy

Kenya not only has one of the highest mobile money penetration rates among emerging markets, it is also a pioneer in other digital financial services like savings and credit (see Figure 3). The mobile money adoption gap between men and women in Kenya is much lower than in most other emerging markets – an indication of the success of interventions to create gender parity in mobile money.

While Kenya's enabling environment lends itself well to the uptake of blockchain-enabled interventions in agriculture, digital financial services, literacy and digital skills are still key barriers to mobile internet use. According to the 2023 GSMA Consumer Survey, these skills were the second most-cited barrier for both men and women.[22] More upskilling programmes, such as the government's Digital Literacy Programme[23] and the Ajira Digital Programme,[24] are therefore needed to increase the uptake and impact of blockchain led solutions, particularly among farmers in rural areas.

Figure 3

Share of population aged 15+ using digital financial services, selected African countries (2021)



Source: World Bank (Global Findex Database)

Favourable regulatory environment

While there is no dedicated national policy on blockchain in Kenya, the country is taking steps to develop regulation related to virtual assets and cryptocurrency, which will make it easier for blockchain service providers to operate and safer to share data on the platform. For instance, the Treasury Cabinet is working on a National Policy on Virtual Assets and Virtual Asset Service Providers,[25] which will allow for innovation while maintaining the security of blockchain users.

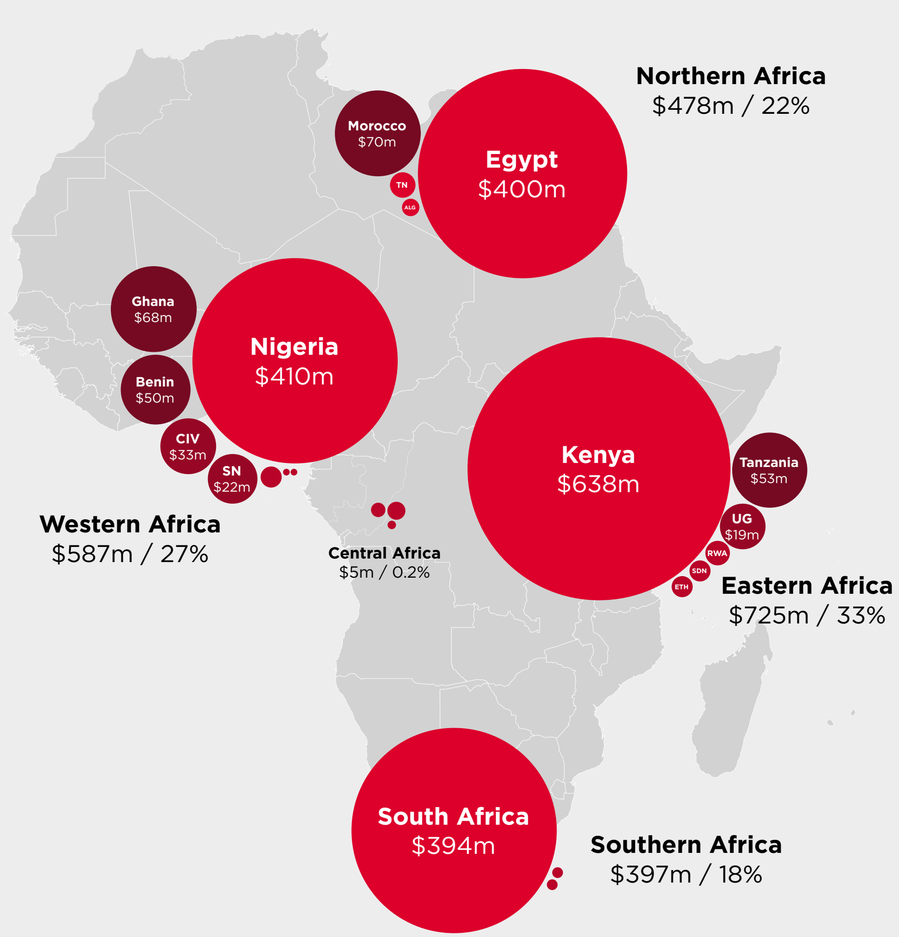
Vibrant startup ecosystem

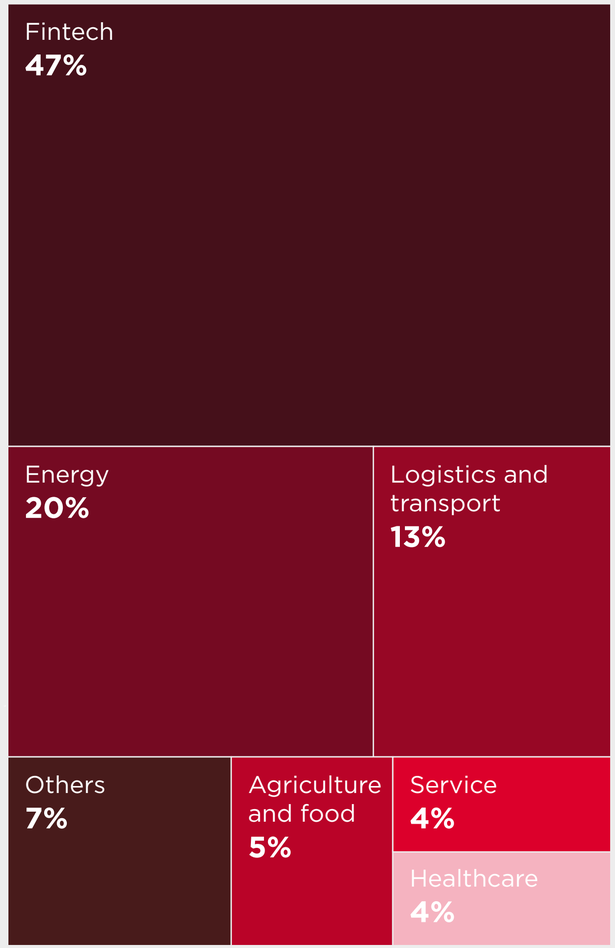
Despite its smaller size relative to other countries in Africa, Kenya has established itself as a leading technology hub in Africa, particularly in fintech where Kenya is considered a pioneer. According to Africa: The Big Deal, Kenya attracted the most funding of any country in Africa in 2024, almost 30% of the total (see Figure 4).[26] Kenya's government has taken several measures to create a more welcoming environment for startups after facing some criticism about excessive red tape.

Figure 4

Total funding by region and by vertical in Africa, 2024

Total funding raised (exc. exits) in 2024





Source: Africa: The Big Deal[27]

Research objectives and methodology

Agriculture is the cornerstone of LMICs – a primary source of livelihoods that contributes between 10% and 40% of GDP (1) and underpins food security, employment and rural development.

Blockchain offers the potential to improve the transparency, traceability and efficiency of agricultural value chains and the productivity, sustainability and resilience of the sector. While it is being adopted for a range of use cases and solutions in agricultural value chains, an assessment of its applications, impact and commercial sustainability is limited. This research aims to fill this gap by examining lessons and best practices that can be applied to the agriculture sector in Kenya.

This research:

1. Identifies best practices in the use of blockchain for the digitalisation of agricultural value chains in LMICs.
2. Identifies and assesses existing and potential uses of blockchain to address challenges facing the agriculture sector in Kenya.
3. Presents recommendations for stakeholders in value chain digitalisation, from donors and funders to solution providers and users, on how to implement blockchain solutions at scale.

In exploring the opportunity to leverage blockchain technology, this research also considers the potential of other emerging technologies, such as artificial intelligence (AI), that are being used in conjunction with blockchain in the agriculture sector.

A mixed-methods approach was adopted for this research, with the following objectives:

Desk-based secondary research aims to:

- Provide an understanding of the current landscape and challenges faced by smallholder farmers in Kenya
- Identify key initiatives by national and international organisations supporting the development and deployment of blockchain for agriculture in Kenya
- Map out blockchain use cases and solution providers in Kenya's agriculture sector
- Provide an overview of blockchain use cases in agriculture in other countries

Semi-structured interviews aim to:

- Understand the characteristics of blockchain for agriculture, including key enablers and barriers to adoption
- Assess the maturity of the identified use cases for blockchain technology in agriculture
- Identify use cases with the most promise for sustainable development in agriculture, and the initiatives needed to support the use of blockchain in agricultural value chains

Key audiences

This report aims to provide agribusinesses, cooperatives, farmer groups, and the investors and donors that support them, with insights into the viability, sustainability and scalability of blockchain initiatives. Other sector players, including governments and multilateral agencies, can also benefit from these insights.

Primary audience

Agribusinesses, cooperatives and farmer groups will gain insight into how blockchain is being deployed to address agricultural challenges in LMICs. The report offers examples of solutions, key lessons and best practices.

Those in **Kenya** specifically will gain insight into which use cases are most relevant for the country.

Impact investors and donors will gain insight into the most promising use cases of blockchain in agriculture, as well as an understanding of how blockchain solution providers may be best supported financially.

Agritechs, fintechs and insurtechs will gain insight into various blockchain use cases, including examples of business models and assessments of commercial viability, particularly in the Kenyan context.

Secondary audience

Institutional actors, such as **governments, multilateral agencies and NGOs**, will find useful information on opportunities to use blockchain to support their agriculture sector programmes, including opportunities for collaboration with other actors in the sector.

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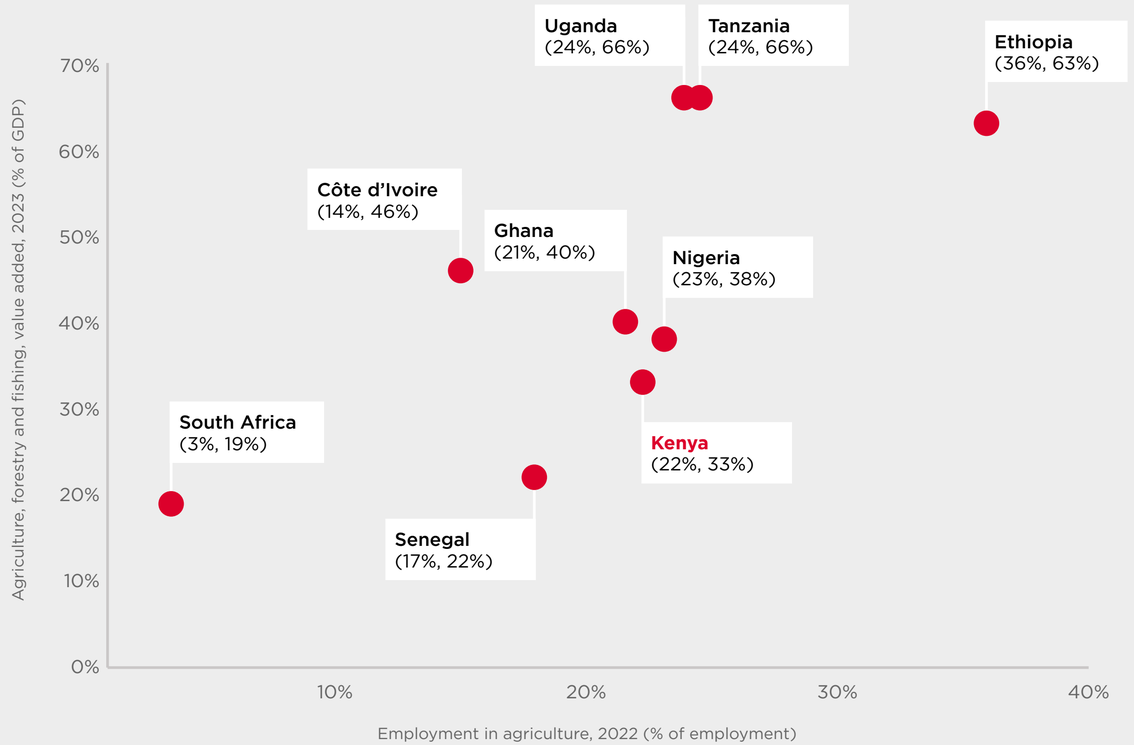
Blockchain for the digitalisation of agricultural value chains in Kenya

The role of agriculture in Kenya's economy

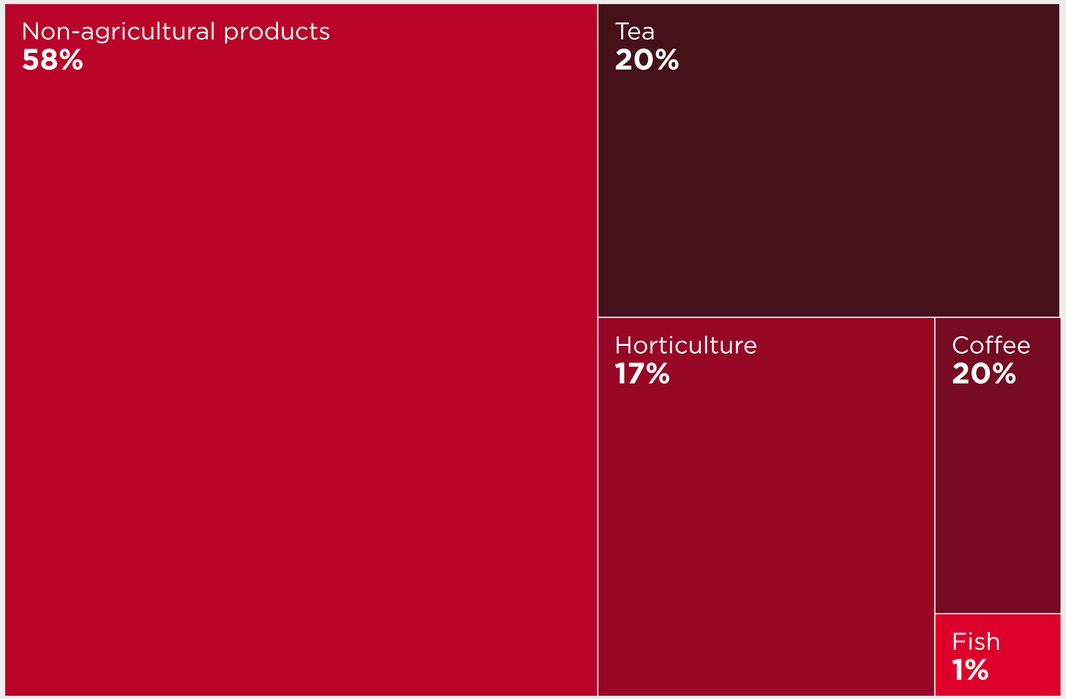
Agriculture plays a pivotal role in the Kenyan economy. According to the World Bank, agriculture accounts for 21.6% of Kenya's GDP, a similar share as other African countries (see Figure 5).[1] Agriculture also accounts for roughly 33% of all employment in Kenya (although roughly 70% of rural employment).[2] In 2019, 53% of households in Kenya were engaged in agriculture, which, in addition to those formally employed in the sector, also includes subsistence farmers.[3] Agriculture is a key source of exports, with tea, horticulture (flowers, fruits and vegetables), coffee and palm oil leading the way (see Figure 6).[4]

Figure 5
Agriculture as a share of GDP and employment, selected African countries



Source: World Bank

Figure 6
Distribution of Kenya's exports by value, 2024



Source: Central Bank of Kenya

The importance of smallholder farmers

Smallholder farmers, typically defined as having up to two hectares of land for agricultural production, play a critical role in Kenya's agriculture sector, accounting for 75% to 80% of agricultural outputs.[5] Maize is the most common crop grown in Kenya (see Figure 8) and cows make up the majority of livestock farming (see Figure 9).

Figure 7
Smallholder farmers in Kenya, in numbers

6.4 million[6]
Smallholder farmers

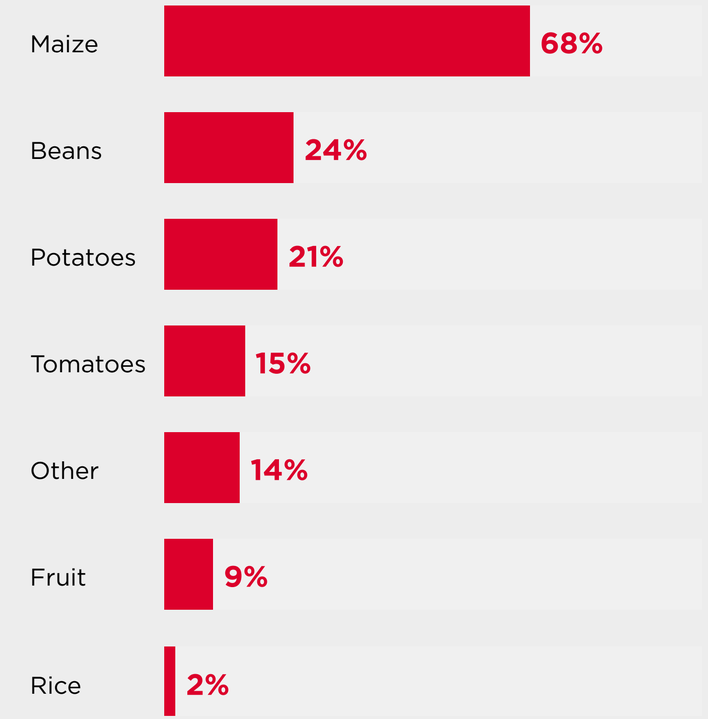
10%[7]
Share of population under 35 working in agriculture

~44%[9]
Of smallholder farmers are women

Average age
60 years[8]

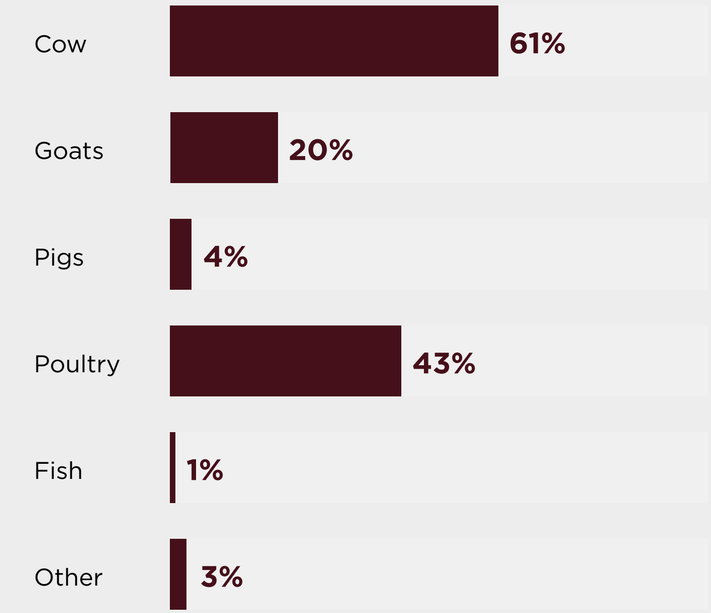
Average annual income
<3,000 USD[10]

Figure 8
Most common crops grown in Kenya
(% of farming households)



Source: Geopoll

Figure 9
Most common livestock raised in Kenya
(% of farming households)



Source: Geopoll

Key challenges in Kenya's agriculture sector

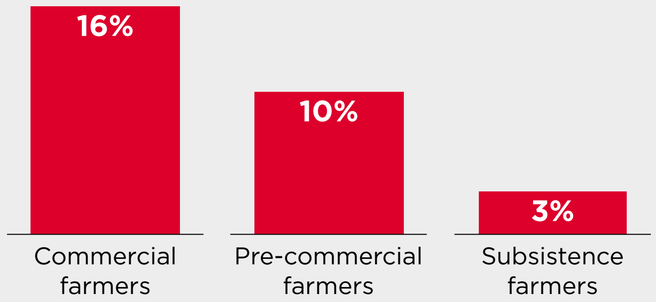
Farmers in Kenya contend with many of the same challenges facing smallholder farmers in other LMICs. These include limited access to credit, insurance, markets and agronomic information, and vulnerability to climate change, all of which contribute to low productivity. Several blockchain solutions aim to mitigate these challenges through secure and transparent record-keeping and automated transactions.

Limited access to credit

Access to capital is critical for smallholders in Kenya as it enables them to acquire high-quality inputs and machinery – both of which are vital for higher yields and income. Traditional financial providers, like banks and microfinance institutions (MFIs), often struggle to extend credit to smallholders given the high cost of delivery and higher perceived risk of non-payment (see Figure 10). This leads many smallholder farmers to rely on informal channels for capital, including family, friends, community members or value chain actors like crop buyers and intermediaries, potentially subjecting them to predatory practices and high levels of debt.

Figure 10

Share of farmers accessing credit in Kenya during the 2023–2024 masika (heaviest rain season), by farmer type[11]



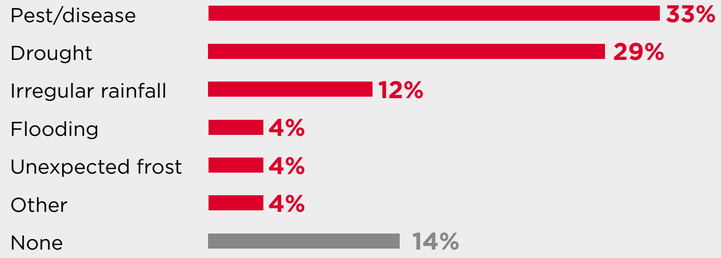
Source: 60 Decibels[12]

Vulnerability to climate change

Kenya's smallholders are among the most vulnerable to the effects of climate change. According to the ND-GAIN Country Index, which measures a country's vulnerability to climate change and readiness to respond, Kenya ranks 145 out of 187 countries globally.[13] In a 60 Decibels survey of smallholder farmers,[14] 86% stated they had experienced a significant climate event in the past 24 months, including drought, irregular rainfall, pests and diseases, among others (see Figure 11), with 63% reporting that they were still recovering from the event.

Figure 11

Share of agricultural households in Kenya that have experienced climate shocks in the past 24 months...



... and the share of those households that recovered after the initial climate shock

Source: 60 Decibels[15]

Limited access to insurance

Climate volatility creates more risk for smallholder farmers, particularly when they are not protected with insurance. Smallholders have even less access insurance than credit, with a mere 2% of Kenyan farmers covered (see Figure 12). This leaves farmers ill-prepared to recover financially from agricultural losses when disaster strikes, impacting their ability to access capital for inputs in the next crop season.

Figure 12

Snapshot of digital insurance use among smallholder farmers in Kenya

2%
of smallholders have insurance

9%
access insurance digitally

2 out of 5
smallholders with digital insurance have received an insurance payout

1 out of 5
smallholders with digital insurance who have received an insurance payout are dissatisfied with the amount or timeliness of the payment

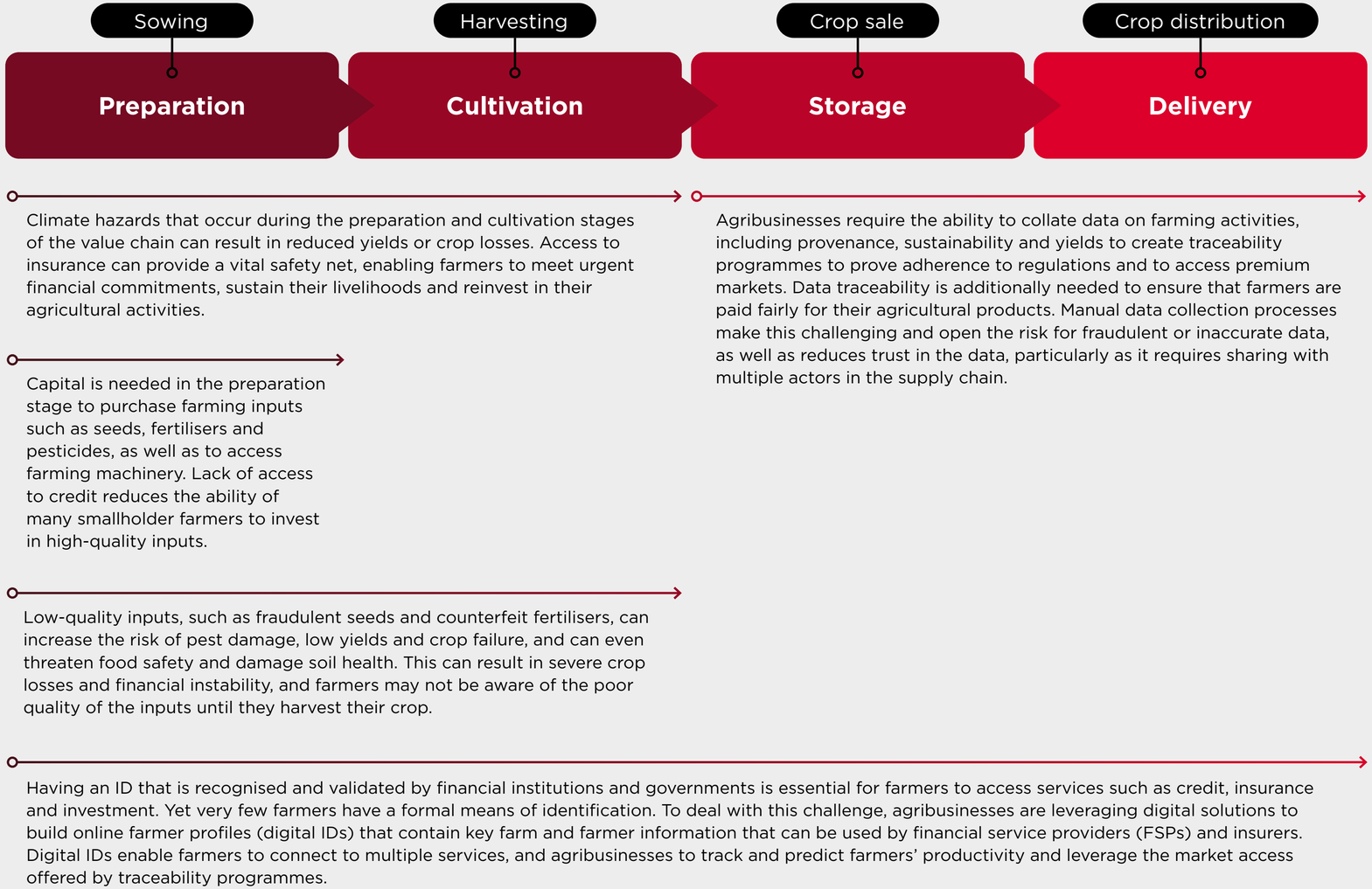
Source: 60 Decibels[16]

These challenges appear in all stages of the agricultural value chain

Agricultural value chains refer to the actors and activities that bring agricultural products from the field to final consumption, with value added to the product at each stage. Agricultural value chains can involve processing, packaging, storage, transport and distribution. Value chains can be formal or informal depending on the strength of the relationship between farmers and buyers.[17] Agribusinesses, formal buyers, traders or exporters of agricultural products, as well as input suppliers and cooperatives, provide crucial links between smallholder farmers and commercial agriculture supply chains.

The core challenges experienced by farmers, including limited access to credit and insurance and vulnerability to climate change, have an array of impacts on value chain activities, resulting in low crop yields, high production costs and economic vulnerability (see Figure 13). Other challenges, such as low-quality inputs, a lack of trusted data and limited ownership of recognised and verified IDs, also affect the productivity and resilience of the value chain. Figure 13 shows the stages of the agricultural value chain and the impact of the challenges at each stage.

Figure 13
Core challenges experienced by farmers



Source: Adapted from GSMA[15]

The role of blockchain in the digitalisation of agricultural value chains

Blockchain-powered solutions that aim to address the core challenges of smallholder farmers are typically applied at the start of the value chain when farmers are securing credit and buying inputs, or at the end of the cycle, when crops are stored and sold to buyers (see Figure 14). Its core characteristics of security, transparency and immutability enable service providers across the value chain to increase trust between stakeholders and make record-keeping and transactions more efficient. Blockchain can also be used to create digital IDs for farmers which feeds into all stages of the value chain.

Figure 14
Benefits of blockchain at various stages of the value chain

Data gathered from farmers about their farm, as well as their on- and off-farm activities, can be stored on a blockchain and enables smallholder farmers to:

- **Obtain a digital ID** to access credit, insurance, agronomic advisory, competitively priced inputs and other services (e.g. Kenya-based agritech hiveonline).
- **Gain access to credit** by allowing third parties (such as agribusinesses and financial institutions) to access their information via dashboards powered by blockchain (e.g. Kenya-based data analytics company Antugrow).
- **Gain access to overseas investors** through crowdlending platforms enabled by blockchain (e.g. Spain-based crowdlending platform EthicHub).
- Tokenise their assets (e.g. avocado or coffee trees) to access credit for inputs and machinery (e.g. Kenya-based asset tokenisation platform Project Mocha).

QR codes on input packaging that are powered by blockchain help smallholder farmers to:

- **Gain access to parametric insurance** products (e.g. Germany-based insurtech Etherisc).
- **Participate in loyalty programmes** that give them access to inputs, credit and other services (e.g. Kenya-based input supplier FarmStar).

Data collected by farmers (directly or through satellite imagery or on-the-ground sensors) about their location, input use, carbon capture, labour practices and other data can be stored on blockchain to:

- **Facilitate the traceability** of goods produced in rural areas and sold domestically or abroad (e.g. international non-profit organisation Fairfood's blockchain platform Trace).

Smart contracts stored on blockchain can be activated when certain climate events occur (e.g. excess rain or drought) and:

- **Enable automatic insurance policy disbursements** to those holding parametric insurance policies (e.g. Kenya-based MFI Fortune Credit Limited).

Data on the season's harvest, including the quality, volume and price, can be stored on blockchain and:

- **Validate to consumers, employees and investors** that a fair price was paid for the goods, that the goods are what they claim to be (e.g. international food and drink Prince's Group and non-profit blockchain platform Provenance.
- **Enable smallholders to access post-harvest credit** by storing their goods in a warehouse and selling when the price is highest (e.g. India-based agritech Whrrl).

Data on the movement of agricultural products from farm to fork is captured on blockchain to:

- **Help exporters, agribusinesses or smallholder farmers meet rigorous international traceability standard**s like EUDR, such as the blockchain software-as-a-service (SaaS) traceability platform Bext360.

Source: authors' analysis

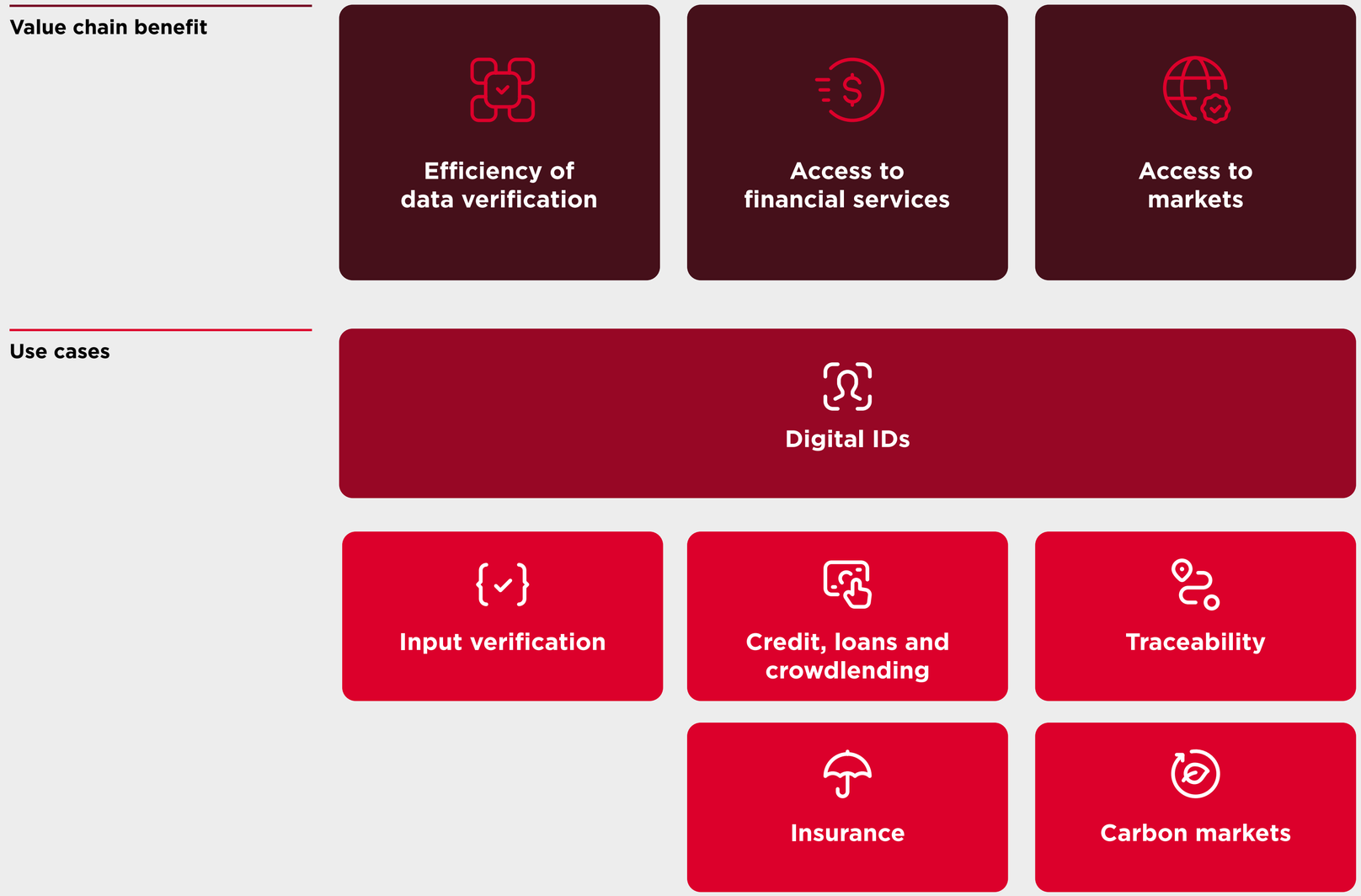
Key use cases for blockchain in agriculture

Blockchain has the potential to benefit smallholder farmers, agribusinesses and cooperatives in all stages of the agricultural value chain.

Figure 15 depicts the key use cases identified as part of this research, categorised by the benefit they provide to the agricultural value chain: efficiency of data verification, access to financial services and access to markets.

The digital ID use case is unique in that it serves all three areas. Digital IDs also feed into each of the other use cases, acting as a prerequisite for the services provided.

Figure 15
Key use cases for blockchain in agriculture



Source: authors' analysis

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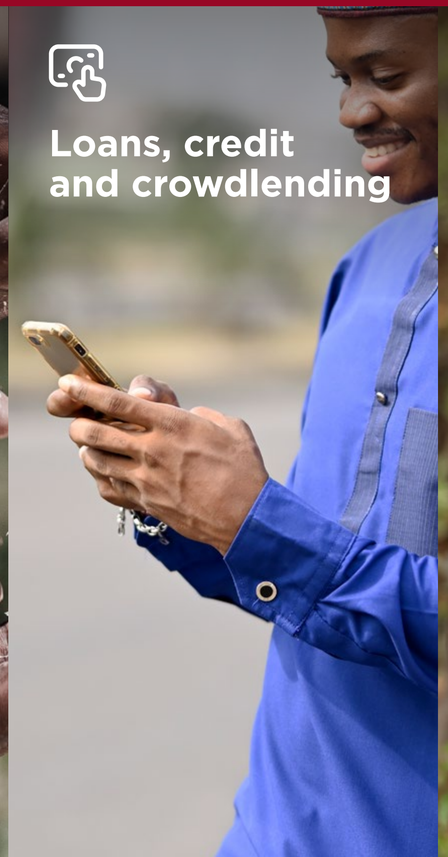
Blockchain use cases and applications



Use case 1

Digital identity

Challenge

Rural populations, particularly smallholder farmers, are among those most likely to be affected by a lack of formal identification.[1] Without an officially recognised ID, it can be difficult to access government and financial services, secure property rights, register livestock and formally participate in commercial agriculture supply chains.[2]

Being able to confirm an individual's identity is also critical for governments and private entities. For governments, it makes it easier to disburse benefits, collect taxes and improve forward planning and emergency response.[3] For private entities, it reduces risk, prevents fraud and enables them to comply with know-your-customer (KYC) regulations.[4]

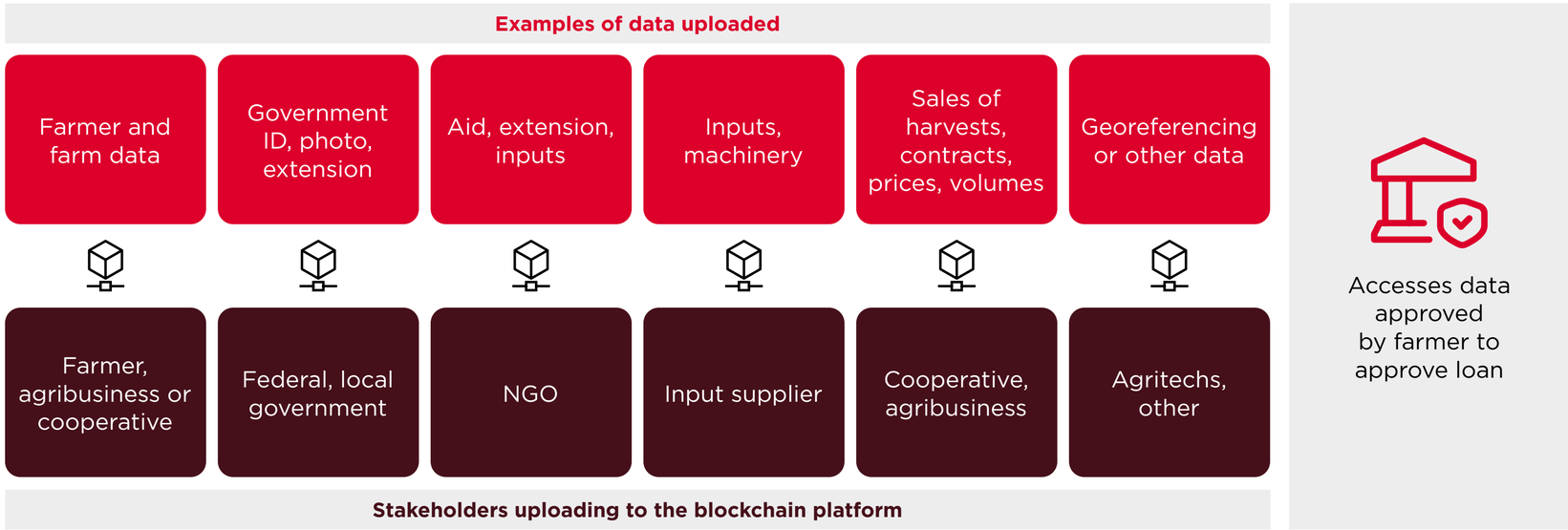
Digital IDs can provide accurate identity information, accelerate the roll-out of services to vulnerable populations, reduce the incidence of fraud and automate service delivery.[5] Blockchain has emerged as a technology that can facilitate the creation and maintenance of digital IDs. Its core characteristics of immutability, transparency and security, as well as its distributed nature, make it well suited to this use case. Blockchain allows an unlimited number of trusted partners to contribute their interactions with an individual to the platform, thereby strengthening and improving trust in their digital ID over time. This makes it easier for farmers to approach financial institutions, open accounts and secure loans (see Figure 16).[6]

Farmers with a mobile phone can manage their digital ID directly on their device. For those who do not have a mobile device or simply feel more comfortable with a physical ID card, smart cards or printed cards with QR codes can be made available. Agribusinesses and cooperatives can also manage farmers' digital IDs via apps or web pages. Each time the farmer engages in a transaction with someone in the agricultural ecosystem, their personal QR code is scanned, and the relevant transaction data is uploaded on blockchain, adding yet more data to the farmer's digital identity.

By creating a unique identification on a blockchain, multiple data points can be added, verified and shared between stakeholders, and then used in combination with other blockchain-powered solutions, such as credit scoring, traceability, land registration and market access. Examples can be found on the next page.

Figure 16

How blockchain can help build self-sovereign digital identities



Source: authors' analysis

Applications

Blockchain-enabled digital IDs are often provided within another service that addresses a specific challenge for farmers, for example, access to finance, traceability and access to agronomic information and advisory services.

Access to finance

hiveonline

Startup hiveonline launched the digital ID platform myCoop.online in 2022, which is now operational across Ghana, Kenya and Mozambique.[7] The platform facilitates the collection and storage of farming data against a unique farmer ID. Through the ID, farmers build a reputation score, similar to a credit score, which enables them to connect with buyers and financial institutions (see Case study 3 for more information).

Access to market linkages

IDENTI

IDENTI is a Peruvian agritech that uses blockchain to provide farmers with a verifiable digital ID.[9] The ID platform connects farmers, input suppliers and financial service providers, creating a streamlined agronomic ecosystem that benefits all parties (see Case study 1 for more information).

Traceability

Dayaxa Frankincense

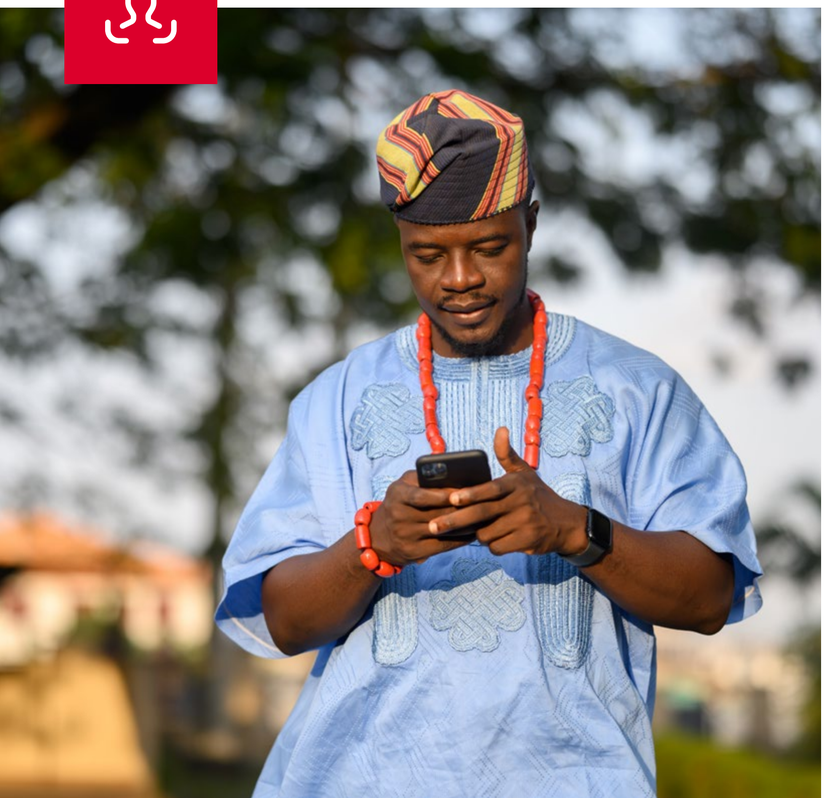
Somaliland-based community enterprise and GSMA Innovation Fund alumnus, Dayaxa Frankincense, launched a blockchain-enabled mobile app in 2020, developed in partnership with Bext360, to facilitate transparency in the frankincense supply chain.[8] Frankincense farmers are registered on the app and provided with a unique digital ID. Data on when and where the resin is harvested, shipments from village to warehouse and digital receipts are attached to this ID. Using blockchain, Dayaxa Frankincense can securely share this data with sellers, encouraging purchases by demonstrating fair pay and, ultimately, driving more profit back to the harvesters.

Land registration

Medici Land Governance

In 2018, public benefit corporation Medici Land Governance reached an agreement with the Rwanda Land Management and Use Authority (RLMUA) and the Rwanda Information Society Authority (RISA) to develop a “paperless, secure, fully interoperable, transparent and tamper-proof” land registration system. The Ubutaka app uses fingerprint scanners, signature pads, digital cameras and public key infrastructure (PKI) to record voluntary land sales and upload the information on blockchain for validation and storage. Since deploying blockchain, transaction times have been reduced from two to eight weeks to two to four days.[10]

Sustainability and scalability of digital ID programmes



A lack of awareness of the benefits of digital identification, and lack of trust in how their data will be collected and shared, results in low farmer buy-in of stand-alone digital ID services. As a result, most startups providing digital ID capabilities use a business-to-business (B2B) model aimed at financial institutions, agribusinesses and cooperatives (see Table 1). Some of the funds generated from B2B customers are used to offer incentives to farmers to encourage them to sign up for an ID. This incentive can take the form of mobile airtime (e.g. DIGID), free agronomic advisory (e.g. IDENTI) or more favourable conditions on loans and other financial services. Access to new markets is also a significant incentive for smallholder farmers to participate in digital ID programmes.

Government digital ID programmes are the largest in scale, but may be affected by shifting government priorities or budget cuts. Outside these initiatives, farmers are more likely to adopt digital IDs when they are part of a broader solution, such as a traceability programme (see Use case 5) or access to financial services (see Use case 3), as the benefits are clearer and farmers have more visibility into how their data will be used and shared.

Table 1

Digital ID business models

Government or NGO pays	Agribusiness or bank pays	Commission
A government or NGO pays for the provision of digital IDs to individuals to facilitate payments and other social benefits to citizens. The NGO or government may pay a fee to set up the system plus a per farmer fee to set up the digital ID.	An agribusiness pays for a broader traceability solution that includes digital identities for registered smallholder farmers. This can take the form of a set-up fee followed by an annual subscription fee to the platform. Alternatively, a financial service provider pays a subscription fee to access a platform that provides farmer data that can be used for credit scoring.	Stakeholders (agribusinesses, input suppliers, financial services companies, etc.) pay a commission on every transaction that occurs as a result of farmer data being accessed on the blockchain platform.
Gravity DIGID (Kenya), AgriStack Farmer ID (India), Southern African Development Community (SADC) Digital Farmer ID	*Fairfood (Indonesia), BanQu (Zambia, various), IDENTI (Peru)*	*IDENTI (Peru)*

Case study 1

IDENTI

IDENTI is a Peruvian agritech founded in 2019 (formely Agros) with some funding and technical support from government accelerator, ProInnovate. IDENTI supports smallholder farmers in Peru to access agronomic advisory, quality inputs and financial services by connecting them to the digital economy.

IDENTI is active across the coffee, cocoa and avocado value chains and has around 10,000 farmers on its digital ID platform.

IDENTI leverages blockchain technology on its IDENTI platform to create a verifiable digital ID for each farmer on its platform. IDENTI incentivises farmers by providing free agronomic advisory to those who register for a digital ID. Farmers can use their ID to access information on weather, pricing, inputs and other topics. Those with a smartphone can access this information through WhatsApp, while those who have a feature phone or basic phone, or do not have access to data, can use interactive voice response (IVR) instead. For input suppliers, financial service providers and exporters, accessing farmer data from IDENTI, can lower their customer acquisition costs and help them reach new customers. To ensure farmers remain in control of their data, they must provide their consent every time their data is accessed by a third party.

IDENTI operates with a B2B model that generates revenue from corporate customers, notably input suppliers and financial service providers. As of the end of 2024, IDENTI is working with more than 50 corporate customers. These customers pay a monthly or annual subscription fee to access the farmer data on the platform. IDENTI also charges a commission on transactions carried out on its network.

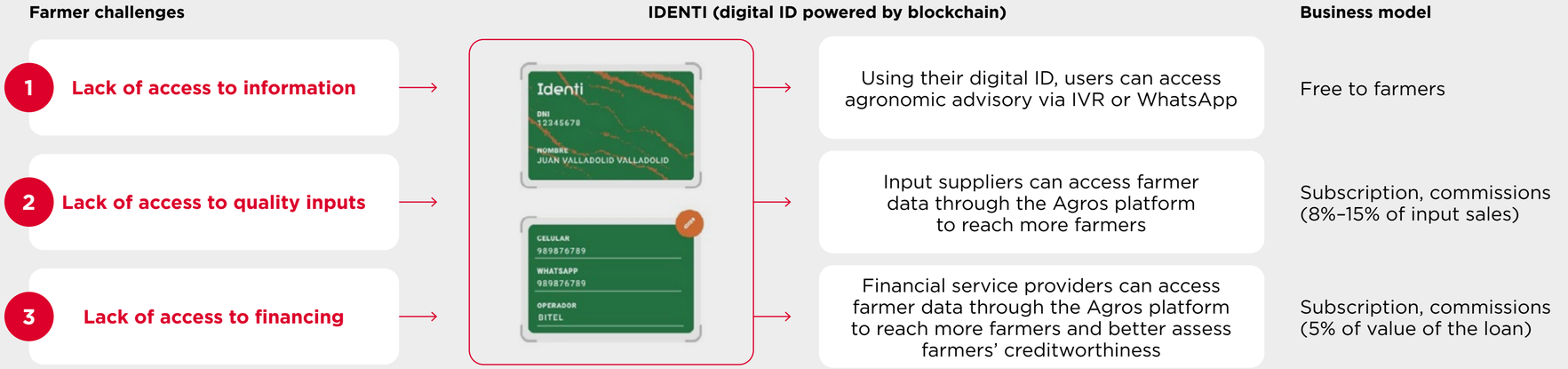
As of the end of 2024, there were more than 10,000 farmers on the IDENTI platform. By being able to access agronomic advice, higher quality inputs and credit products, many farmers have reported up to a 30% increase in earnings.

Financial service providers report benefits related to lower origination costs and improved farmer vetting. The long-term vision of IDENTI is to create an ecosystem centered around smallholder farmers. Information collected for farmers' digital identities can be leveraged not only to support smallholders' agricultural activities, but also to facilitate the provision of other services critical to rural populations, like healthcare (via telemedicine) and education. IDENTI has incorporated physical store fronts (called Casas Agrayu) that can help with customer acquisition, farmer registration, training as well as distribution of inputs, telemedicine and other services to smallholder farmers. IDENTI is planning to expand beyond Peru and Columbia to other Latin American countries like Ecuador and Chile, and, eventually, to Africa. It also sees potential to use the data it collects through its platform to support traceability and certification efforts. It has already provided certification to 5,000 farmers in Peru and Colombia, confirming zero-deforestation in the production of their crops and ensuring compliance with EUDR regulations.

The main challenge for IDENTI has been keeping farmers engaged so that they continue to use their digital IDs and access new services. Initially, IDENTI used agronomic advisory to keep engagement levels high. More recently, they have looked to zero-deforestation certifications for EUDR compliance and access to financial services as a way to maintain engagement. Its longer-term goal is to build a full ecosystem centered around rural users that enable them to access a wide number of agricultural and non-agricultural services.

Figure 17

IDENTI blockchain-powered digital identity



Source: IDENTI

Blockchain-enabled digital IDs are opening access to credit and insurance in Kenya, but farmers and cooperatives need more support

In the short term, the opportunity for a government-led, blockchain-enabled digital identification programme in Kenya may be limited. The Kenyan government, through the Ministry of Agriculture and Livestock Development, teamed with FAO to develop a digital farm and farmer identification platform called the Kenya Integrated Agricultural Management System (KIAMIS). KIAMIS leverages mobile apps, cloud computing, software platforms and AI to deliver farm and farmer ID services in Kenya. As of October 2024, roughly 6.5 million farmers had registered on KIAMIS, making them eligible for various services including agronomic advisory, linkages to inputs and access to credit programmes, machinery, social services and subsidies.[11] The government benefits from having farmers on the platform as it can more closely monitor the efficacy of social benefits and subsidy programmes, as well as production trends.[12]

As the cost of blockchain goes down, there may be potential to move KIAMIS, or at least portions of it, onto blockchain as this would make the platform more transparent, trustworthy and secure. This could open opportunities for farmers to grant access to their data to third parties, like agribusinesses and banks, and to gain access to services like loans and to new markets for their products.

Other countries are considering the integration of blockchain into their national digital identification programmes. For example, in India, the government is managing the largest digital ID programme in the world. Through the Aadhaar system, citizens are issued a 12-digit identification number linked to their demographic and biometric data to provide access to government benefits and other services.[13] There are currently 1.4 billion Indians registered on Aadhaar.[14] For farmers, the government has created AgriStack, a digital ID system linked to their Aadhaar identification number and enables them to receive government services ranging from subsidies to insurance and inputs.[15] AgriStack's digital ID holds information on land tenure, crops grown and crop sales. There are roughly 36 million farmers registered on AgriStack.[16] The goal is to add more than 50 million new famers on the platform over the next two years.[17] Because much of the Aadhaar information is centralised on a single database, the security risk is significant. For this reason, the Indian government has been considering the use of blockchain to increase the security and immutability of citizen information.

In the short term, there may be potential to develop blockchain-enabled digital ID solutions in Kenya in the area of traceability, particularly given new export regulations such as the European Union Deforestation Regulation (EUDR). The EU accounts for 55% of Kenya's total coffee exports, with seven of the top 10 coffee export destinations.[18] Kenya is also a leading source of cut roses for the EU, accounting for nearly a third of Kenya's exports to the EU.[19] Dozens of digital traceability solution providers in LMICs provide blockchain-enabled digital ID services to facilitate crop traceability. These include solutions already available in Kenya, such as Fairfood's Trace (Farmer Cards) and TraceX (Farmer ID). For these solutions, blockchain connects stakeholders across the value chain in one platform, allowing them to build trust and accountability for the data shared across the various stages.

Blockchain-powered digital IDs could also be used to help farmers participate in international voluntary carbon markets (VCMs) and facilitate access to financial services like credit and insurance. Solutions that are already active in Kenya, such as hiveonline (see Case study 3), could be provided with more support to scale through capacity building and raising awareness among farmers, cooperatives and agribusinesses.

To the extent possible, digital ID solutions implemented in Kenya should be aligned with KIAMIS data. This would limit the number of organisations that farmers are required to share their data with and ensure greater buy-in and trust.

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Use case 2

Agricultural input verification

Challenge

Consistent access to high-quality inputs, such as seeds and fertiliser, are a challenge for smallholder farmers.[1] When low-quality, out-of-date or mislabelled input products enter the supply chain, this can have a detrimental impact on crop viability, contributing to poor harvests and low yields.[2] For smallholder farmers, who typically purchase inputs on credit, this can increase the risk of over-indebtedness. Table 2 highlights the consequences and impacts of fraudulent seeds for the agriculture sector. Counterfeit fertilisers and seeds present the additional risk of reducing soil health, which can have long-term impacts on future crop yields.[3]

Blockchain can be used to host digital verification platforms. It can facilitate the verification of the quality and legitimacy of agricultural inputs, such as seeds, and then trace the movements of such inputs from supplier to farmer, curbing the prevalence of distribution fraud. Similarly to the digital ID use case, a unique ID is created on blockchain and, in the example of seeds, key information such as seed batch, production location, seed type and purity, is stored on the chain. As blockchain allows for numerous stakeholders on a platform to work together, regulatory bodies can authenticate the data as the seeds flow through the supply chain (see Figure 18). Verification of goods can be stored and transactions securely monitored, substantially reducing the possibility of counterfeit goods. Additional tools, such as QR codes, can be used to access the information on blockchain, enabling farmers and agribusinesses to view and trust the authenticated data on the seed product before purchasing.

Table 2
The outcomes and impacts of fraudulent seeds in the agriculture sector

Outcome	Impact
Reduced crop productivity	Farmers who unknowingly purchase counterfeit seeds or seeds that do not meet minimum regulatory quality requirements can experience reduced crop yields, resulting in less food production.
Economic hardship for farmers	Losses incurred due to fraudulent seed practices can push farmers into financial distress, jeopardising their livelihoods and the well-being of their families.
Loss of confidence in seed companies	The circulation of illegal seeds can erode farmers' trust in seed companies, leading to decreased reliance on formal seed markets and reduced access to quality seeds.
Risks to plant health	Seeds transported within a country or across borders that do not meet quality standards or have the required documentation risk spreading pests and diseases.
Food and feed safety risks	Seeds that do not meet minimum quality and health standards may result in crops with lower nutritional value or greater susceptibility to disease, affecting the safety and nutritional content of the food and feed supply chains.

Source: World Trade Organisation (WTO)[4]

Case study 2

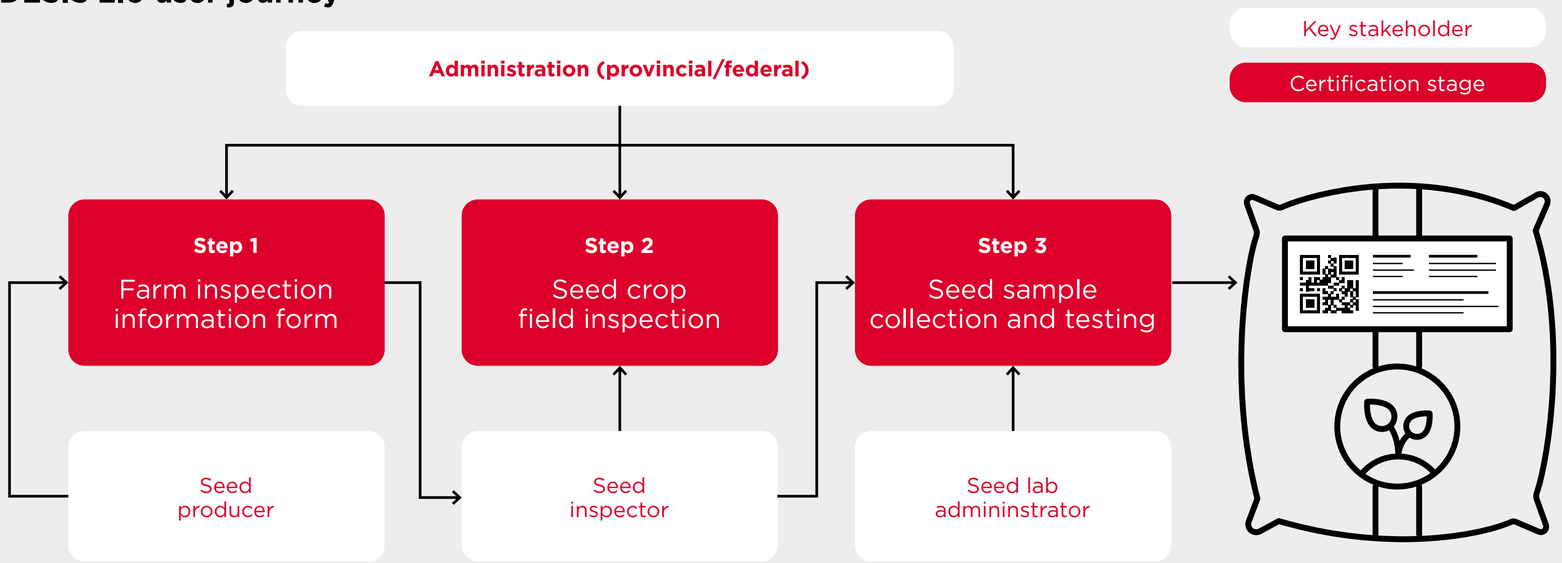
DESIS 2.0

DESIS 2.0 is a blockchain-powered seed certification system launched by GeoKrishi, a Nepal-based startup and GSMA Innovation Fund alumnus, in partnership with the Nepal government's Seed Quality Control Centre. The national system was launched in 2024 and is currently being piloted in three Nepalese provinces for rice, maize and wheat seeds. With this custom-built, private blockchain infrastructure, the government can track both the verification of seed producers, and the quality of seed batches distributed to farmers and agribusinesses in the country. Farmers and agribusinesses can also access the data prior to purchasing seeds, enabling them to make an informed decision based on the verified quality and type of seed.

Blockchain allows different stakeholders to upload data in all three stages of the seed certification process (see Figure 18), while also enabling provincial and federal government to monitor and verify this data. This creates a trusted, easy-to-access and verifiable seed certification system. Each seed producer is provided with a unique blockchain ID that stores relevant data. Once seed is ready to sell, each batch is assigned a unique ID that holds information from the seed sample testing, farm data from the producer, as well as information including the number of seed bags in the batch and the weight of each bag. A QR code is produced and attached to each seed bag, which is used to upload additional data as the bag moves through the supply chain, including financial data on each transaction. Farmers and agribusinesses can scan the QR code to access all this data before they purchase the seed. As blockchain does not allow for changes to be made to data once it is uploaded, the risk of fraudulent and counterfeit products is reduced. The immutability of blockchain also helps to (re)build trust in the seed production and sale process. While fraud can still occur, blockchain offers an additional layer of protection for farmers and agribusinesses when they purchase seed.

As GeoKrishi progresses through the stages of the DESIS 2.0 pilot, the system will be expanded to include more provinces and cash crops. While data on the impact of this solution is still limited, there has been positive feedback from government partners and stakeholders involved in the certification system.

Figure 18
DESIS 2.0 user journey



Source: GeoKrishi

Blockchain could help curb fraudulent seed distribution in Kenya

In August 2024, the Kenyan government formed a multi-agency committee, reported to include national government administrators, security personnel and representatives of government agencies, to tackle the distribution of fraudulent seeds and expired fertilisers in the country,[5] which are increasingly leading to crop failures and the decline of soil health. Smallholder farmers bear the brunt of the impacts, including financial losses from failed harvests and reduce their ability to fund the next crop cycle.[6]

The Kenya Plant Health Inspectorate Service (KEPHIS) is mandated to oversee the certification of the quality of seeds and fertilisers, as well as to test and monitor the presence of harmful agrochemicals on agricultural produce.[7] Producers and distributers of seeds must register with KEPHIS; failure to do so results in a fine or a jail term.

In 2021, KEPHIS launched the digital Seed Certification and Plant Variety Protection portal, designed to increase efficiencies, improve the quality of service delivery and traceability of seeds and reduce administrative costs.[8]

Given the persistent distribution of fraudulent seeds in Kenya, there is an opportunity for blockchain to enhance the efforts of KEPHIS to increase transparency and reduce fraud. The immutability of blockchain and multistakeholder access makes the portal well suited to this technology. While still in early stages, GeoKrishi's private blockchain platform DESIS 2.0 (see Case study 2) provides an interesting model that could be replicated in Kenya.

To realise this opportunity, key challenges need to be addressed. For a private blockchain network, significant investment is needed to build a platform to host a seed verification system. This includes technical training for staff to ensure that the platform is used effectively, and that data is sufficiently verified. The success of a nationwide, blockchain-enabled seed verification system depends on seed purchasers. Awareness and capacity building among farmers and agribusinesses is therefore necessary, as well as widespread ownership of smartphones to enable scanning of QR codes to verify seed quality at the time of sale.

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Use case 3

Credit, loans and crowdlending

Challenge

One of the biggest challenges for smallholder farmers is access to capital through credit or loans. In a typical agricultural cycle, farmers invest upfront in seeds, fertilisers, pesticides, machinery and labour. They must then wait months until harvest to be paid for their crops and offset the costs already incurred. Most smallholder farmers turn to family members, local community lenders and input suppliers to borrow money, often at prohibitively high interest rates. This is because traditional banks and MFIs find it time consuming, risky and expensive to serve smallholders. A study by Dalberg, USAID and Mastercard Foundation found that total credit to smallholder farmers is around $56 billion per year, only $14 billion of which comes from formal financial institutions (see Figure 19).[1] There is an estimated $170 billion funding gap for smallholder farmers annually.[2]

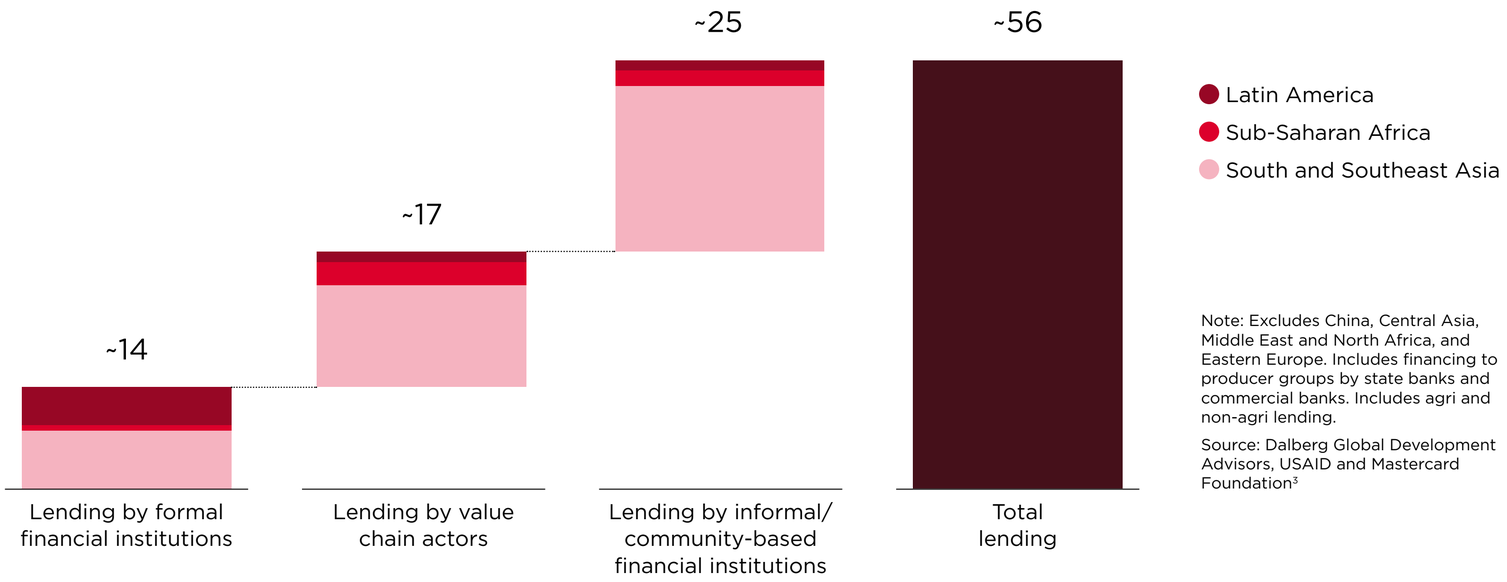
Blockchain is well suited to supporting digital lending products because of the immutable transaction history it can create. It can be used to store and verify farmer records, such as farm and household data, procurement records and mobile money transactions. This data can then be accessed in real time by financial service providers as reliable documentation to extend credit to farmers or to process it through a credit-scoring algorithm. Using blockchain, farmers can create a digital financial footprint that is trusted by lenders and, since the data cannot be changed, the risk of fraudulent activity and disputes about payments is mitigated. Additionally, the use of smart contracts can automate loan disbursements, reducing the time involved in securing a loan, as well as the cost of servicing the loan.

When integrated in crowdlending platforms, which enable investment by sourcing and aggregating funds from investors (individuals, organisations or companies), blockchain can be used to facilitate transactions between investors and farmers. Blockchain enables investment terms to be transparent for all parties and can give investors real-time insight into farming activities and the associated risks, increasing trust and, ultimately, the desirability of the investment.

Blockchain also has the advantage of eliminating borders. As part of a crowdlending model, blockchain makes it easier to move money between low- and middle-income market lenders and mature market borrowers.

Figure 19

Total supply of smallholder farmer lending (annual disbursements, USD billion)



Note: Excludes China, Central Asia, Middle East and North Africa, and Eastern Europe. Includes financing to producer groups by state banks and commercial banks. Includes agri and non-agri lending.

Source: Dalberg Global Development Advisors, USAID and Mastercard Foundation[3]

Applications

Blockchain is well suited to financial services, with numerous agritechs and fintechs in LMICs using blockchain to increase the security, transparency and immutability of their offerings. Smart contracts, an element of blockchain, are used by service providers such as Whrrl to automate transactions. Asset tokenisation is one of the newest use cases identified through this research and can be considered a subset of crowdlending. Asset tokenisation requires blockchain infrastructure to function and is an interesting model for farmers to access capital.

Credit and loans

Whrrl

In 2019, India based agritech, Whrrl, launched its commodity tokenization blockchain platform connecting farmers, warehouses and banks and enabling farmers to secure loans against their harvested crops once they are in warehouse storage. As of 2025, Whrrl has tokenised $750 M of commodities on the platform.

IoT devices are used to collect data, such as the weight and volume of stored commodities, stock levels, environmental conditions such as temperature and humidity, as well as security data including access logs and motion detection, all of which is stored on blockchain to ensure an immutable database for collateral ownership can be maintained, preventing fraud by removing the risk of multiple lending and falsified receipts. Additionally, using smart contracts, Whrrl is able to automate transactions like approval, margin calls, and loan transfers when specific, pre-agreed conditions are met.

Crowdlending

EthicHub

EthicHub is a Spain-based crowdlending platform that connects individual and institutional investors in high-income countries (HICs) with coffee farmers in Latin America (see Case study 4).[5] Through the use of blockchain, EthicHub eliminates the intermediaries typically associated with cross-border financial transactions, reducing the cost of lending. The transparency provided by blockchain also helps to build a trusted relationship between lenders and borrowers.

Assets tokenisation

Asset tokenisation involves the representation of an agricultural asset (e.g. a tree, a farm, an animal) as a digital token that resides in a blockchain and can be securely exchanged in real time. This allows smallholder farmers to access financing by selling a fraction of their asset to an investor, either domestically or abroad. Because the transaction is logged on a blockchain, it is transparent to all parties in the investment, minimising the potential for fraud. Governments around the world are developing regulation to protect digital assets, de-risking the model for both asset owners and investors.

One Million Avocados (OMA)

Startup OMA partnered with blockchain platform Dimitra in 2022 to provide avocado farmers in Kenya with access to capital and precision farming techniques via asset tokenisation in Kenya (see Case study 5).[6] In 2024, OMA partnered with Project Mocha, another Kenya-based startup, to replicate the asset tokenisation model in the country's coffee value chain.

Sustainability and scalability of blockchain-enabled credit, loans and crowdlending

The business model employed for credit and loan services depends on whether the organisation providing the service is a financial institution (bank or MFI), fintech or agribusiness/cooperative, as each may have different priorities and incentives. It also depends on whether the organisation is providing credit and loans, credit-scoring services or is facilitating crowdlending. Credit-scoring services provided by a fintech to a financial services provider, for instance, typically follows a software-as-a-service (SaaS) model whereby the client (bank or MFI) pays the fintech an initial fee to set up the credit-scoring algorithm based on the specific data points relevant to the industry and customer segment. The fintech may then charge a monthly fee to access the service and, in some cases, a fee for each credit report requested through the platform. In a crowdlending model, service providers typically charge a commission on transactions, or a share of the interest rate spread between what the lender receives and what the loan recipient pays (see Table 3). Many of the startups interviewed providing credit and loans to farmers attempted to expand into adjacent services to find new ways to monetise their relationships with farmers. In some cases, such as for EthicHub, this means helping loan recipients secure a market for their products and charging a commission on the sale.

Table 3

Credit scoring, loans and crowdlending business models

Traditional credit model	SaaS model	Crowdlending model
Financial institutions or agribusinesses providing loans to smallholder farmers monetise their services through the interest charged to smallholder farmers for the provision of the loans.	In this model, a service provider, typically a fintech, charges a customer (usually a financial institution, cooperative or agribusiness) an initial fee to set up the credit programme and fine-tune the algorithms used for credit scoring. The customer then pays a monthly fee for the use of the platform for the life of the contract. Or, via a commission-based model, the provider takes a percentage of the loan allocated to the customer. In the credit-scoring model, there may be an additional fee charged for each credit score conducted over the platform.	In the crowdlending model, service providers often charge a commission on all transactions made on the platform. Most often, this is a share of the spread between the interest rate charged to the loan recipient and the interest rate paid to the lender.
Banks, MFIs, agribusinesses	*Fintechs*	*Crowdlending platforms (e.g. EthicHub)*

Case study 3

hiveonline

Founded in 2016, hiveonline is a fintech scaleup headquartered in Denmark that facilitates access to financial services, agricultural inputs and market buyers, using mobile-based digital solutions to bring trusted data and relationships to rural savings groups and farmer cooperatives across Sub-Saharan Africa.

hiveonline has two key revenue streams from its three services:

1. **Working with NGOs:** hiveonline works with NGOs and charges per project. This helps it reach more farmers and ensures a stable revenue stream. hiveonline has plans to alter this model whereby NGOs will pay for usage rather than per project.
2. **Platform fees:** hiveonline also receives a commission from lending. When a loan is facilitated with a bank or lending institution, hiveonline charges the bank a commission fee. It also charges a commission for the purchase of agricultural products.

hiveonline aims to move towards a predominantly platform fees, in which it is financially sustained by commission, including charges based on usage. Longer term they plan to provide electronic money services to provide frictionless payments within the platform alongside their integrations with mobile money providers.

hiveonline currently operates in Ghana, Kenya and Mozambique with three interconnected solutions: the agriculture marketplace platform myCoop.online, the digital savings groups platform vsla.online and an e-voucher system. Blockchain underpins each of these solutions, enabling hiveonline to become a reliable and trusted ecosystem solution, connecting off-takers, NGOs and rural farming communities on a single platform to provide opportunities for equitable trading relationships.

The immutable and secure nature of blockchain is crucial to building this trust and has enabled hiveonline to curate a digital financial profiles for over 70,000 smallholder farmers (see Figure 20). hiveonline has also partnered with banks in Mozambique and Kenya, securing approval to facilitate loans to users. The company is currently scaling its platform interactions in both countries.

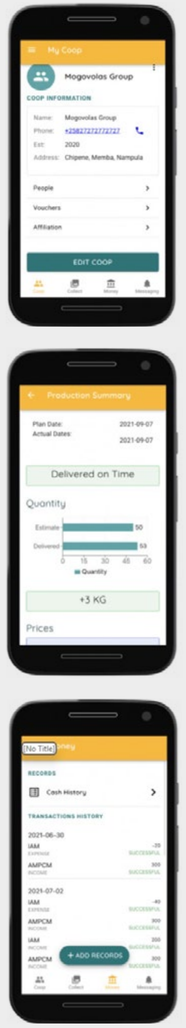
By building a financial reputation farmers can prove to lenders that they are reliable and open access to agricultural inputs and markets. This, in turn, enables them to enter commercial agriculture supply chains and build financial resilience.

Blockchain acts as a bridge between financial services and cooperatives, creating a trusted network of farmers, cooperatives, buyers and financial institutions. Financial data is sensitive and can affect an individual's suitability for a loan. However, blockchain provides assurance that the data is valid. It also allows more than just financial data to be stored within the same record, increasing the richness of data shared.

Figure 20

myCoop.online financial reputation system

1. A unique digital identity is created for farmers in the association or cooperative.
2. Data on crop forecasts, crop deliveries and transactions are stored on the users profile.
3. A financial track record is built based on commitments met, for both cooperatives and producers.
4. Users trade and interact with buyers, dealers and banks in a digital ecosystem, growing their reach and profitability.
5. Data is made available with real-time dashboards, enabling financial institutions, buyers and support agencies to view candidates for loans, crop purchasing and agricultural inputs based on a history of reliable financial behaviour.



hiveonline

Impact and achievements

70,000 farmers profiled on the platform

Production and sale of **52 crop types supported**

Regulatory approval from the Central Banco de Moçambique to facilitate third-party lending and financial inclusion for rural communities

Case study 4

EthicHub

Crowdlending

EthicHub is a Spain-based crowdlending platform launched in 2017 that connects individual and institutional investors in high-income countries with coffee farmers in six countries in Latin America: Mexico, Peru, Colombia, Brazil, Honduras and Ecuador. The mission of EthicHub is to provide smallholder farmers with access to capital to improve productivity and increase their incomes. EthicHub also connects smallholder farmers to coffee buyers. By removing several layers of intermediaries, EthicHub enables smallholder farmers to keep a higher percentage of coffee sales.

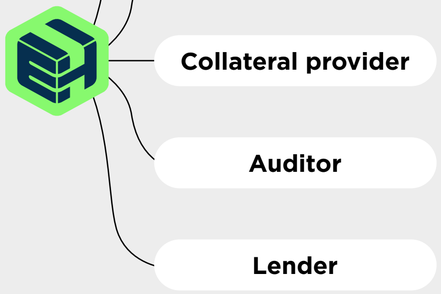
EthicHub leverages blockchain to connect lenders and borrowers. One of the key advantages of blockchain is that it eliminates borders, facilitating lending between investors in Europe and borrowers in Latin America. By eliminating the intermediaries typically associated with cross-border financial transactions, EthicHub reduces the cost of lending. Blockchain also offers full transparency, which helps earn the trust of both lenders and borrowers.

EthicHub generates income in two ways. First, from the difference between the interest rate charged to smallholder farmers and the interest rate paid to lenders and collateral providers (see Figure 21), equivalent to 4% of the loan. Second, for facilitating the sale of coffee grown by farmers in Latin America, EthicHub receives a share of the sales.

Since 2018, EthicHub has extended more than $5 million in loans to 10,000 smallholder farmers in six countries. Default rates are roughly 2%, below industry standards. Loan recipients have reported improvements in production and income as a result of the loans they received (see Figure 22). EthicHub is hoping to expand its presence to other markets and into new value chains like cocoa.

Figure 21

Stakeholders in the EthicHub business model

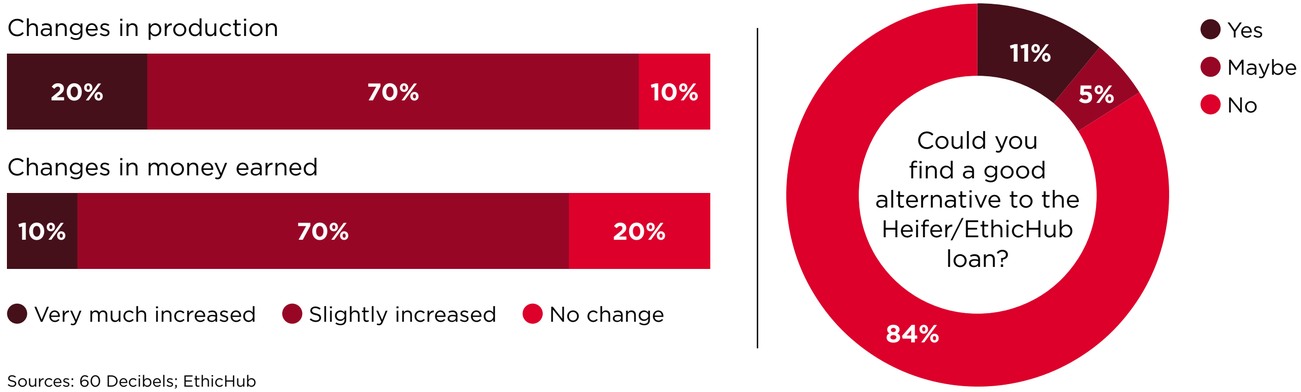


Originator	Responsible for identifying projects and farmers that would benefit from working capital.
Farmer	Farmers are approved by local leaders who validate their reliability based on income, yield and land ownership data. Farmers sell green coffee to buyers in Europe and China through EthicHub.
Collateral provider	Reduces risk to the lender by providing collateral for the loan. This includes collateral from farmer groups, local leaders and auditors.
Auditor	Responsible for referring and auditing originators. NGO Heifer International is the auditor in Mexico.
Lender	Provides capital for the loan.

Source: EthicHub

Figure 22

Benefits reported by farmers receiving EthicHub/Heifer International loans



Sources: 60 Decibels; EthicHub

Case study 5

One Million Avocados

Asset tokenisation

In 2022, startup One Million Avocados (OMA) partnered with global agritech Dimitra to launch an asset tokenisation solution in the avocado supply chain in Kenya. The solution helps farmers access the capital and input knowledge they need to operate efficiently and be commercially viable.

OMA facilitates investment in avocado trees grown by farmers in Kenya in return for a percentage of the profits from avocado sales. This has been integrated with a transparent system of precision agriculture to build trust in the investment opportunity and support more resilient farming.

Investment in agricultural profits has unique and varied risks, such as weather patterns and soil degradation, among others. By using Dimitra's tokenisation platform to convert avocado trees into digital assets, which are geotagged and linked with real-time growth updates, investors can gain real-time insights into their investment and the associated risks and gains, building trust and making funding more desirable.

As part of the initiative, farmers are provided with a wealth of information through access to precision farming tools such as drone and satellite imagery and soil sensors. These monitoring tools provide insight into estimated crop yields and support more efficient resource use.

To date, OMA has supported more than 100 households with seedlings, employment and trade. The biggest challenge it faces is scaling up. Onboarding more farmers runs up against a lack of awareness and scepticism about how a blockchain-based solution could support their farming practices, particularly given the legal uncertainties surrounding blockchain use in Kenya.

Business model

OMA operates under a profit-share model to generate income.

Once avocados are harvested and sold, the share of profits are as follows:

- **10%** to OMA
- **60%** to the farmer
- **20%** to the investor/investors
- **10%** towards operational costs to maintain the avocado orchards

OMA is also working on a carbon credit system to generate an additional revenue stream. Once this is live, profits will be split between the coordinating parties and the farmer, with the farmer taking 50% of the net profit and OMA and Dimitra splitting the remaining 50%. For more information on this business model, see Case study 9.

Other technology used

A combination of drones and satellite imagery is used for land suitability assessments and to predict avocado yields. AI is used to analyse location data to produce a percentage rating of land suitability. It is also being tested for use in yield prediction, as it currently predicts avocado yields with 80% accuracy.

Kenya is an early leader in blockchain credit solutions, but fintechs need more support to scale

According to the Central Bank of Kenya (CBK), the agriculture sector accounted for only 3.6% of gross loans in 2020,[7] despite accounting for 21.8% of GDP and one-third of employment. However, this number is likely underrepresented as some smallholder farmer loans may be classified as "personal and household" loans. Historically, interest rates have ranged from 15% to 35% or more, making it difficult for smallholders to pay back their loans (see Figure 23). According to the CBK, the share of nonperforming loans (NPL) in the agriculture sector can range from 10% to 33% in any given year (see Figure 24).

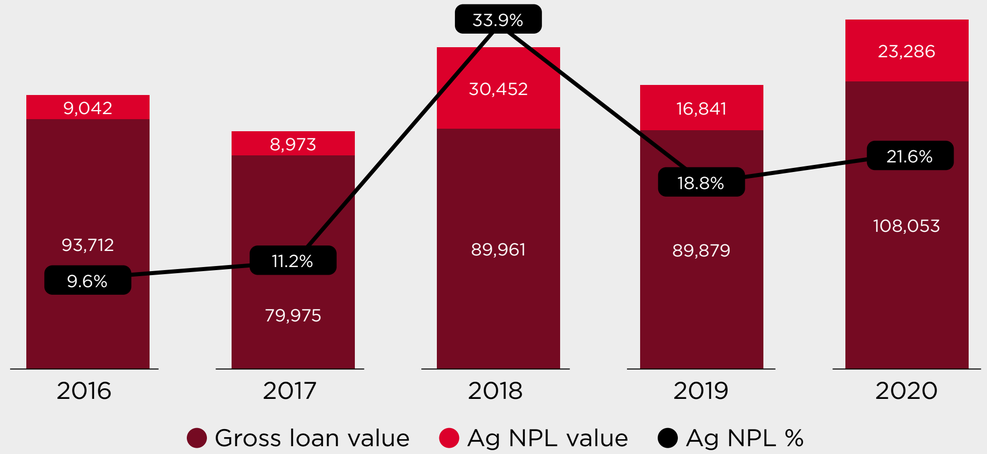
In 2016, the government attempted to address the barriers to credit facing Kenyan nano, micro and small businesses by establishing a cap on loan interest rates. However, this initiative resulted in fewer loans to those considered higher risk, like smallholder farmers.[8] According to research firm 60 Decibels, only 16% of commercially-oriented farmers, and 3% of subsistence farmers, have been able to access credit through formal channels. This inability to access credit at affordable rates affects farmer productivity and makes it difficult for smallholder farmers to exit the cycle of poverty. Blockchain enables financial service providers, fintechs, agribusinesses, governments and NGOs to deliver loans to smallholder farmers more cost-effectively by simplifying onboarding, automating disbursement of loans through smart contracts and derisking the credit process.

Kenya is an early leader among LMICs in the provision of blockchain-backed credit solutions with startups like Cinch, hiveonline and agriKOPA providing credit and credit-scoring solutions, while groups like One Million Avocados and Project Mocha are at the forefront of asset tokenisation. There may also be an opportunity for some of the leading providers of digital lending to smallholder farmers, like One Acre Fund, Apollo Agriculture and DigiFarm, to incorporate blockchain in their operations to further automate processes and reduce operational costs.

Figure 23

Gross loans and NPLs in agriculture portfolio of Kenyan commercial banks

Value (columns) in Million KSH 2016-20; NPL% of overall loan portfolio



Sources: Mercy Corps Agrifin, The World Bank Group and Government of Japan – Secretariat of Science, Technology and Innovation Policy, Cabinet Office

Figure 24

NPL: Agriculture vs. overall portfolio

% of loan value disbursed 2020

	Agriculture loans only	Overall portfolio
Commercial Banks	22%	14%
Microfinance Institutions	27%	26%
SACCOS	16%	8%

Sources: Mercy Corps Agrifin, The World Bank Group and Government of Japan – Secretariat of Science, Technology and Innovation Policy, Cabinet Office

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Use case 4

Insurance

Challenge

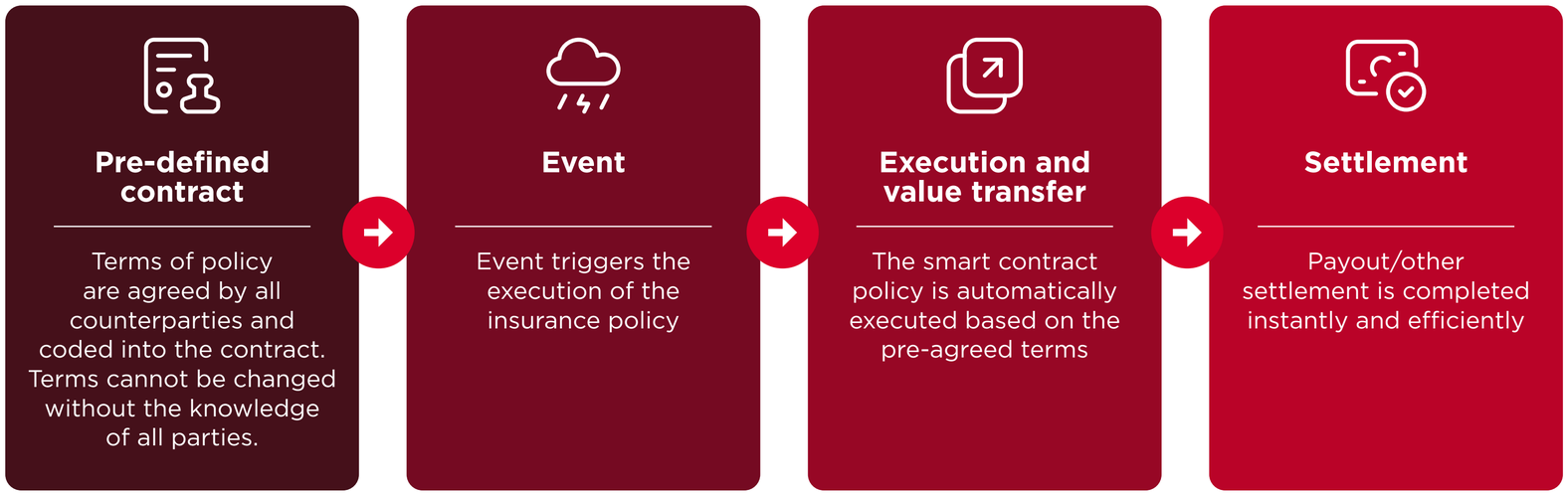
Smallholder farmers around the world are at increased risk of the effects of climate change. Many are one climate-related disaster away from falling deeper into poverty, yet few smallholders are insured against such disasters. Social enterprise One Acre Fund provides smallholder farmers in East Africa with asset-based financing and estimates that only four out of 54 countries in Africa have affordable agricultural insurance and only 3% of farmers in Africa are insured.[1] The traditional insurance model has been difficult to implement in rural settings. Insurance companies find it challenging to maintain a viable business model for smallholder farmers as it is costly and time-consuming to verify claims in rural areas. The resulting high premiums, low awareness and understanding of insurance policies and lack of trust in the service, put insurance out of reach for most smallholder farmers.

Parametric insurance policies have emerged in recent years as a way to lower costs for insurance providers while making premiums affordable for smallholder farmers. In contrast to traditional indemnity-based policies, parametric insurance policies do not compensate for actual losses, but rather, release payments when a trigger event happens. Most policies are based on predetermined indices, or thresholds, that must be met, such as rainfall levels, temperature or soil moisture levels. These can be monitored by satellites, weather stations or on-the-ground sensors. In most cases, payment is automatically disbursed to policy holders via mobile wallet, bank transfer or through a partner bank once the indices established in the policy are exceeded. In some instances, the payment takes the form of seeds and fertilisers rather than cash. There is no need for insurance companies to visit the farms and assess damage, reducing costs and significantly improving the commercial viability of delivering insurance to smallholder farmers.

Blockchain can make parametric insurance even more efficient by automating processes, using smart contracts, reducing duplication and improving the quality and integrity of data collection (see Figure 25).[2] According to ACRE Africa, which provides risk mitigation services across Africa, blockchain can enable weather and other relevant data to be fed directly into digital insurance policies on smart contracts. This accelerates the roll-out of insurance policies, speeds up payouts (to within hours) and lowers the cost of delivery.[3] Fortune Credit Limited Anticipatory Cash Transfers pairs blockchain technology with predictive analytics to disburse insurance payments to pastoralists ahead of a natural disaster, enabling the insured to invest in feed or other measures that can help them minimise the financial impact of the insured peril (e.g. drought).[4]

Figure 25

Blockchain in parametric insurance



Source: The Digital Insurer

Applications

Insurance services are among the most prominent blockchain-based use cases identified in this research. Most of the blockchain initiatives identified were deployed in Africa, specifically Kenya, as well as a handful in South and Southeast Asia. Most of the services have been launched within the past six years, the majority since 2020.

Insurance

BIMA Bolt

Insurance agency ACRE Africa partnered with insurtech Etherisc and smart-contract provider Chainlink, to launch BIMA Bolt in 2020.[5] BIMA Bolt is a blockchain-powered parametric crop insurance product for farmers in Kenya. ACRE Africa reports numerous benefits from the use of blockchain, including reduced operational costs and insurance payout times, and increased trust among farmers in the insurance product.

Fortune Credit Limited Anticipatory Cash Transfers

While not an insurance product, Fortune Credit Limited partnered with Mercy Corps Ventures, DIVA Technologies and Shamba Network to implement an innovative model whereby pastoralists receive cash transfers ahead of climate disasters.[7,8] Pastoralists participating in the programme have policies on smart contracts on blockchain. Donated funds from crypto donations and grants via DIVA Technologies are held against the smart contract in escrow. When the associated weather models anticipate that a drought or excessive rains are imminent, cash transfers are sent automatically to insured pastoralists in the Horn of Africa so that they can take steps to protect their livestock.

Lemonade Crypto Climate Coalition

The Lemonade Foundation, a nonprofit organisation based in the United States, launched the Lemonade Crypto Climate Coalition in 2022 to solve three challenges in Kenya: accurately quantifying weather risks, automating claim assessment and providing adequate funding and reinsurance.[6] Blockchain-enabled smart contracts facilitate automated payouts, reducing the cost of handling claims to zero. Blockchain also reduced the cost of capital and reinsurance.

Igloo Weather Index Insurance

Singapore-based insurtech Igloo teamed up with PVI Insurance, SCOR and the Vietnam Meteorological and Hydrological Administration (NVMHA) to launch weather index insurance in November 2022 to provide financial protection for paddy rice farmers in Vietnam.[9] Weather index insurance covers farmers against excessive rain or drought, with annual premiums ranging from $8 to $42 per hectare. Through the use of smart contracts enabled by blockchain, weather index insurance reduces transaction costs and accelerates payout times for farmers. In March 2023, Igloo extended its weather index insurance to coffee farmers and its overall coverage to 50,000 hectares throughout Vietnam. In January 2024, Igloo teamed with Vietnamese mobile operator MobiFone and Aurora Mobility Solutions to make weather index insurance available to customers of MobiFone's MobiAgri digital platform. MobiAgri is a mobile service that provides farmers with access to agronomic advisory, agricultural best practices and financial services. MobiAgri users can access a suite of services, including access to the MobiAgri app and data storage, as well as Igloo's weather index insurance product, for a daily fee of approximately $0.20.

Sustainability and scalability of insurance applications

Blockchain-powered parametric insurance projects have somewhat limited scale (approximately 25,000 farmers). However, large insurtechs like Etherisc that oversee multiple projects have surpassed the six-figure mark. Etherisc manages more than 100,000 smallholder farmer policies on blockchain.[10]

Providers of blockchain-powered parametric insurance have adopted various business models (see Table 4). Under the bundling model, insurance is offered as a value-added service to farmers to create loyalty and minimise the risks associated with working with smallholders (e.g. crop losses, the effects of climate change). B2B models (where a donor, cooperative, agribusiness or financial institution pay to provide insurance to the smallholder farmers they work with) are typically easier to scale since the parametric insurance company is dealing with a single client who takes care of identifying customers, signing them on and, in some cases, disbursing payments in the event of a triggering peril (like drought or excess rain). The B2C model has historically been considered challenging given the difficulty of acquiring individual customers and farmers' unwillingness to pay for insurance premiums. Disbursing insurance payouts can also be difficult when SIM cards expire, as phone numbers are often the sole point of contact between insurers and their customers. Etherisc's efforts to reach more customers and pricing of policies in the $0.50–$1.00 range is starting to make the B2C model more tenable.

Table 4
Business models identified in blockchain-enabled insurance solutions

Donor pays	Farmer pays	Cooperative or farmer group pays	Farmer pays via bundling services	Government subsidies
Donor pays into a pool that is then used to fund insurance policies for smallholder farmers, similar to crowdlending.	Farmers pay for the insurance policy directly. In the case of ACRE Africa, the farmer uses a scratch-off code on the seed bag to sign up for the policy. The insurance premium typically covers a specified period during the crop cycle.	Cooperatives or farmer groups are the policy holders. In the event of a triggering peril, the insurance company issues funds to the cooperative or farmer group which, in turn, disburses funds (or inputs) directly to smallholder farmers. Smallholder farmers pay indirectly through their dues.	Financial institutions bundle parametric insurance policies into loans provided to smallholder farmers. This helps financial institutions minimise the risk of lending to smallholders, who can use their insurance payments in the event of crop losses to repay their loan.	National government subsidises parametric insurance premiums for farmers to reduce the financial barrier and increase uptake of insurance. The farmer or cooperative/farmer group pays the reduced premium to access the policy.
Fortune Credit (Mercy Corps Ventures)	*ACRE Africa (Etherisc), Lemonade Foundation, Aon/Oxfam*	*n.a.*	*Fortune Credit*	*Government of Thailand (exploration stage)*

Case study 6

ResilientGrowth parametric insurance, Ensuro

Insurance

Ensuro, a blockchain-based insurance and (re)insurance company, teamed up with InsurTech Ibisa and Kenyan MFI Fortune Credit to launch ResilientGrowth for corn farmers in Bungoma County, Kenya, in 2023.[11] ResilientGrowth is a blockchain-powered parametric insurance product that provides coverage against drought. Farmers can access ResilientGrowth insurance through the purchase of inputs or by applying for an input loan through Fortune Credit (see Figure 26).

ResilientGrowth leverages smart contracts stored on the Polygon blockchain platform, as well as the parametric insurance model, to offer affordable, transparent and efficient insurance policies to smallholder farmers.[12] Satellite weather data collected through the Ibisa platform is leveraged to trigger automatic disbursement of insurance payouts based on the predefined conditions of the policy.

Through the use of blockchain, Ensuro benefits from lower operational costs, simplified channel strategies and increased efficiency. Following the success of the 2023 pilot, the ResilientGrowth partners expanded the product to include new crops and additional counties in Kenya. Ensuro is targeting other countries in Africa and Latin America and a wider array of crops. It is also looking into new business models that embed the ResilientGrowth insurance product in smallholder farmer lending.

Figure 26

User journey for ResilientGrowth parametric insurance

01 Farmers apply for a loan to Fortune Credit

02 Loans are used to buy farm inputs. Each bag of input purchased has a warranty sticker

03 Farmers activate the warranty by removing the sticker cover to reveal a unique code

04 Farmers send the code and the location through USSD

05 Once the warranty is activated Fortune credit sends USDC (a digital currency) to the Ensuro smart contracts

06 Ensuro's protocol secures solvency capital in USDC from reinsurers seeking returns to cover risks

07 The smart contract is connected to an oracle that monitors rainfalls level

08 The USDC are then converted into Kenyan shillings and used for the next round of farm inputs

Source: Ensuro

Figure 27

ResilientGrowth payment thresholds

Critical drought: **70% payout**

Severe drought: **30% payout**

Moderate drought: **20% payout**

Blockchain-enabled insurance could help make smallholder farmers more resilient to climate hazards

Kenyan smallholder farmers are particularly vulnerable to climate change, with 86% of farmers reporting that they have felt the effects of climate change in the past 24 months, and 63% stating that they are still recovering from them (see Key challenges in Kenya's agriculture sector). Agriculture in Kenya is largely rainfed, with only 2% of arable land having access to irrigation.[13] As a result, smallholder farmers are at the mercy of increasingly unpredictable and volatile weather, including droughts, hailstorms and excessive rain. Between 2020 and 2024, Kenya had its worst drought in more than 40 years, leading to significant livestock losses, lower crop productivity, pest infestations, loss of water and displacement of rural populations. The chance for a drought in any given year is around 40%[14] and the International Monetary Fund (IMF) estimates the economic impact of these events to be significant (see Figure 28).

Figure 28

Cost of climate events for Kenya's economy

Flood

5.5%

of GDP every 7 years

Drought

8%

of GDP every 5 years

Source: IMF[15]

Table 5

Players active in Kenya's agricultural insurance market

Insurance	(Re)insurance	Blockchain platforms	Multilateral
ACRE Africa	Hannover Re	Pula	World Food Programme
Fortune Credit	Ensuro	Etherisc	
Ensuro		Ensuro	
		Ibisa	

Source: GSMA, Acre Africa, Fortune Credit and Ensuro

"I was almost giving up on farming due to vagaries of weather. The rains were erratic, coming at an unexpected period. By 2018, I had reduced the land under cultivation from five acres to one acre, but with the insurance cover, I have gradually increased to three acres."

– Farmer, Ndaragua[16]

Mitigating the effects of climate change is important for Kenya's economy and the well-being of smallholder farmers, and agricultural insurance is an important tool. Given the high cost of climate change for the Kenyan economy, it is no surprise that the government introduced subsidies of up to 50% on livestock and crop insurance in 2015 and 2016, respectively.[17] The insurance subsidies apply mostly to pastoralists affected by drought, as well as smallholder farmers growing two of Kenya's main staple crops: maize and wheat. The private sector has seen the great potential of index-based insurance in Kenya, with startups like Pula, Apollo Agriculture and ACRE Africa among the largest providers of index-based insurance in Africa. Pula, for example, has insured more than 15 million smallholder farmers in 22 countries with policies under $10. To bring down prices even further (in some cases to under $1), several of these providers have started looking into blockchain. In 2022, Pula backed the Lemonade Crypto Coalition with its blockchain-based index insurance. ACRE Africa and Fortune Credit have teamed with blockchain-startups like Etherisc and Ensuro to provide blockchain-based index insurance to smallholder farmers and pastoralists. Given that so few smallholder farmers in Kenya are insured, the opportunity remains significant for these and new players to enter the market.

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Use case 5

Traceability

Challenge

Most agricultural products go through numerous intermediaries, anywhere from three to 10, between the farm and the final consumer. Traditional pen-and-paper methods used to track produce are prone to error and loopholes,[1] and data related to pesticide and fertiliser use is rarely collected. This makes it difficult to prove adherence to EUDR and other regulatory frameworks, and increases the risk of farmers being underpaid for their products, leading to exploitation. Pen-and-paper methods also create challenges when the source of food contamination or disease and virus outbreak must be identified in crops and cattle.

Over the past year, a variety of factors increased the need for traceability solutions that can help farmers, businesses, governments and consumers track agricultural products (see Table 6). The introduction of EUDR, for example, has led many solution providers to develop specific solutions for EUDR compliance and dedicate sections on their websites to help clients navigate the new rules.[2]

Digital traceability solutions help agribusinesses create more transparent transactions with smallholder farmers, improve efficiencies and operational profitability by transitioning processes from paper to digital, and meet the increasingly stringent traceability requirements of regulators worldwide. Farmers can benefit from more transparent transactions, access to higher quality inputs, access to new buyers and markets and the creation of a digital track record of transactions that can be leveraged to access financial services.[3]

Blockchain's distributed ledger technology is well suited to support the traceability requirements of "farm-to-fork" initiatives as it facilitates trust in data sharing. For this reason, an increasing number of digital procurement solutions are relying on blockchain to give all stakeholders in the value chain access to the information they need. This includes smallholder farmers, crop buyers, exporters and even consumers in destination countries. Bext360, a traceability solution provider, works with major Italian retailer Esselunga to track cocoa production across 12 countries, including Togo, Nicaragua, and Peru. Information from every stage of the supply chain – from production to retail – is captured on Bext360's blockchain platform, enabling verified sustainability and compliance reporting.

Table 6

Drivers of demand-side traceability solutions

Establish oneself as a provider of premium, high-quality products	Establish oneself as a purpose-driven brand promoting ethical practices	Regulatory compliance around deforestation or the use of pesticides (e.g. EUDR)
• Dutch spice company Verstegen leverages Fairfood's Trace blockchain platform to ensure the spices it sources are of premium quality.[4]	• Italian supermarket Esselunga uses Bext360's blockchain to ensure cocoa farmers are remunerated fairly and employ sustainable practices.[5] • Dutch-based Princes Group uses the Provenance blockchain solution to ensure the tuna it sells is caught ethically (using nets safe for dolphins or pole-caught).[6] • Pure Africa uses Fairfood's Trace blockchain platform to ensure coffee farmers are paid a living wage.[7] • Dayaxa Frankincense, in partnership with US-based FairSource Botanicals, uses a custom-designed, blockchain-enabled traceability app developed by Bext360 to ensure frankincense farmers are paid fairly and that the supply chain is free from exploitation.[8]	• TraceX has developed a new blockchain-powered platform branded as the "EUDR Compliance Platform" to help customers comply with the new European deforestation regulation.[9] • Koltiva's KoltiTrace introduced an EUDR compliance solution to help agribusinesses meet more stringent EUDR requirements.[10]

Applications

Traceability is one of the most established use cases of blockchain, with ongoing pilots and projects since the mid-2010s. Traceability is also the most diverse use case, with initiatives identified in Latin America, Africa and Asia, and in value chains ranging from coffee and cocoa to rice, fresh produce, seafood and livestock, among others. Traceability has three main applications in these value chains: to ensure adherence to regulation, to certify the quality of production, which includes farm-to-fork tracing, and to make financial data more transparent to ensure fair pay for farmers. The use of blockchain in procurement solutions also builds trust between value chain actors and reduces the opportunity for fraud. Some early results are promising. AgriLedger in Haiti, for example, has reported a 20%–25% increase in productivity since the introduction of blockchain-based traceability.[11] It has also been able to help smallholder farmers increase their incomes by reaching buyers in Europe directly, rather than through third parties.

Regulation adherence

E-Livestock Global

Agritech E-Livestock Global launched a livestock-tracing software and app of the same name in 2024.[12] The software combines AWS cloud storage with blockchain to facilitate cattle management in Zimbabwe. It connects farmers, government, banks and insurance providers, and allows data on animal ownership, dipping, vaccinations and more to be securely uploaded, stored and monitored. Blockchain ensures that data is trusted, verifiable and able to be shared with multiple stakeholders simultaneously, ensuring regulations are met and fraudulent activities are minimised. Combining blockchain with AWS cloud storage keeps costs down while ensuring key regulatory-related activities can be monitored (For more information, see Case study 8).

Farm to fork

Provenance

Provenance is a blockchain traceability platform based in the United States that enables its clients, including some of Europe's largest retailers, to track crops and seafood from farm to fork. The seafood industry, in particular, is characterised by a lack of transparency, lack of ethical sourcing and significant mislabelling. According to some estimates, 36% of seafood at restaurants are mislabelled.[13] Provenance worked with Dutch retailer Princes Group, for example, to track tuna all the way from the ocean to grocery stores.[14] Princes wanted to ensure that the tuna being sold was in fact tuna, that it was caught ethically (on verified ships using poles or nets that are safe for other sea life) and that the fishers were paid fair wages.

Fair pay

Fairfood's Trace and Trabocca

Dutch coffee importer Trabocca used Fairfood's Trace technology to determine whether the coffee farmers it was sourcing its coffee from in Ethiopia were earning a living wage. Separately, it commissioned a study to determine the living wage in Guji province, the home of these coffee farmers.[15] By using the Trace blockchain solution to track coffee across the entire value chain, Trabocca determined that 42% of farmers sourcing Trabocca coffee earned a living wage. With a better understanding of the supply chain, Trabocca was able to design a set of interventions to improve farmers' wages. It was also able to use the supply chain data to position its coffee as a sustainable and ethical product that could be priced at a premium.

Sustainability and scalability of traceability applications

Most providers of traceability solutions work directly with agribusinesses, farmer groups, cooperatives and, in some cases, governments and NGOs, under a SaaS model. A provider will scope out a project with a customer and typically charge an initial set-up fee to customise the traceability solution to their needs. It will then charge a monthly fee for the use of the platform, typically based on the number of users or transactions. In some cases, the provider may make a free version of its solution available to smallholder farmers – known as a "freemium" model – to attract users with the basic capabilities of the platform and then upsell them over time to a more premium version (see Figure 29).

Figure 29
Bext360 traceability platform pricing

Producer Plan
$0/m
- ✓ Origins Mobile App
- ✓ Data Collection Workflows
- ✓ Parcel Registration
- ✓ Polygon Maker
- ✓ Growing Practice Tracker
- ✓ EUDR Compliance

Standard Plan
$925/m
- ✓ Supply Chain Tracker
- ✓ Asset Manager
- ✓ Mobile App
- ✓ Data Collection Workflows
- ✓ Polygon Maker
- ✓ Admin Portal
- ✓ API Access
- ✓ Customizable Dashboard
- ✓ B2B and B2C Mock Website
- ✓ EUDR Compliance

Enterprise Plan
Request Quote
- ✓ Supply Chain Tracker
- ✓ Asset Manager
- ✓ Mobile App
- ✓ Data Collection Workflows
- ✓ Parcel Registration
- ✓ Polygon Maker
- ✓ Admin Portal
- ✓ API Access
- ✓ Customizable Dashboard
- ✓ B2B and B2C Mock Website
- ✓ EUDR Compliance
- ✓ Consultation
- ✓ Project Management
- ✓ Custom Solutions
- ✓ White Label Solutions
- ✓ Marketplace
- ✓ Scope360

Source: Bext360

Case study 7

Verstegen

Traceability

Verstegen is a Dutch spice company that works with smallholder farmers in countries like Indonesia to bring spices like white pepper, nutmeg, mace, cinnamon and garlic to Dutch consumers. The company positions itself as a premium provider of spices and sauces, selling only the best quality products. Verstegen also emphasises its commitment to social and environmental responsibility. Paying smallholder farmers a living wage is a key part of its value proposition. However, given the number of intermediaries in the spice value chain, Verstegen could not tell what smallholder farmers in each country were being paid.

In 2019, Verstegen began working with Fairfood to introduce the Trace blockchain-based platform to gain better visibility into the nutmeg supply chain in Indonesia. The partners set up the initial project with grant funding from the United States Agency for International Development (USAID). Verstegen decided to continue funding the programme after grant funding ended in 2022. Leveraging blockchain, Verstegen is now able to access data from farmers, collectors, processors and exporters to log every transaction along the supply chain. Consumers can also access this data through a QR code available on every bottle of Verstegen nutmeg (see Figure 30).

Verstegen has since expanded the use of Trace beyond nutmeg to other spices in its portfolio. Verstegen can charge a premium for its spices given its ability to ensure traceability. Smallholder farmers, for their part, have seen their wages increase by roughly 4%–5% since Verstegen began using Trace.[16] Because their entire transaction history is stored on a physical card (Farmer Card), farmers have easier access to credit.[17]

Figure 30

Verstegen traceability solution[18]

Consumers can scan this QR code to learn about the provenance of their nutmeg

Verstegen

Levi
Sulawesi Utara, Indonesia

Farmer
Farmer 421
3 products

Collector
Collector 2
3 products

Processor / Exporter
Processor / Exporter 2
2 products

Brand
Verstegen Spices & ...
Product: Nutmeg

Transactions

Nutmeg	Outgoing to Multirempah Collectors	198.5 kg, 24 January 2023, Verified with card	View blockchain details
Nutmeg	Outgoing to Multirempah Collectors	23.1 kg, 16 December 2022, Verified with card	View blockchain details
Nutmeg	Outgoing to Multirempah Collectors	20.8 kg, 08 December 2022, Verified with card	View blockchain details

Blockchain information

Nutmeg 198.5 kg, 24 January 2023	Seller name Levi	Seller address Blockchain logging in progress...
Transaction hash Blockchain logging in progress...	Buyer name Multirempah Collectors	Buyer address 302a300506032b65700..

Source: Verstegen

Case study 8

E-livestock Global

Traceability

Launched in 2024, E-livestock Global is an agritech startup that is using blockchain to digitally manage livestock-related data. Their solution allows farmers to track all data on their cattle, including birth, dipping, vaccines and death, as well as data related to colour, breed and lineage. It also enables governments to track payments and compliance with vaccine and dipping regulations.

E-Livestock Global currently operates in Zimbabwe and uses AWS cloud storage in combination with blockchain.

E-Livestock Global aims to enhance the traceability of cattle management through a combination of blockchain and AWS cloud storage. Prior to the solution, processes such as dipping (when livestock are immersed in a bath of liquid pesticide or other treatment) were documented on paper, which runs the risk of loss, fraud and human error. Digitalising the documentation removes these risks.

Blockchain is used sparingly to reduce costs. Only data linked to regulation and compliance, such as dipping and vaccination data, is stored on blockchain. All other data is stored on the cloud.

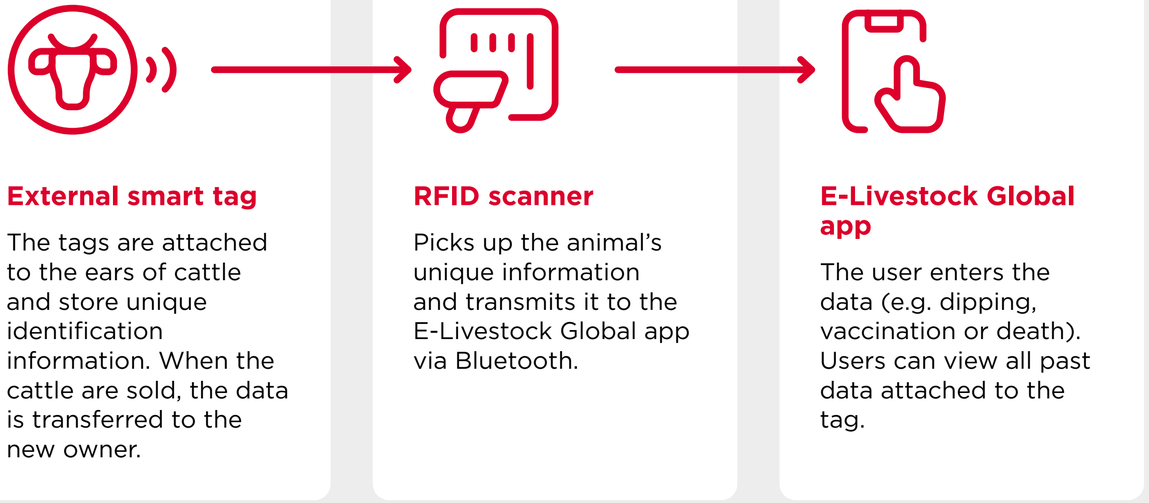
E-Livestock Global chose to use blockchain because of its capacity to build user trust and remove the risk of fraud when data is shared between farmers and third parties, such as governments, banks and insurance companies.

Less than a year old, E-Livestock Global is already creating a web of connections in the livestock ecosystem (see Figure 31). So far, there are 10,245 animals, 40 farms and 167 users in the system.

E-Livestock Global charges farmers $2 per tag and an additional $1 per animal per year to maintain its data in the system. The scanners are another $1,000 and typically owned by the dipping/vaccination centres and abattoirs. Cooperatives or other aggregation points can purchase one scanner to be shared among multiple smallholder farmers. Commercial farmers, who have large capital reserves and herds, can purchase their own scanners. Figure 31 depicts how the tag and scanner allow users to upload data to the E-Livestock Global app.

Figure 31

How E-Livestock Global tracks livestock in Zimbabwe



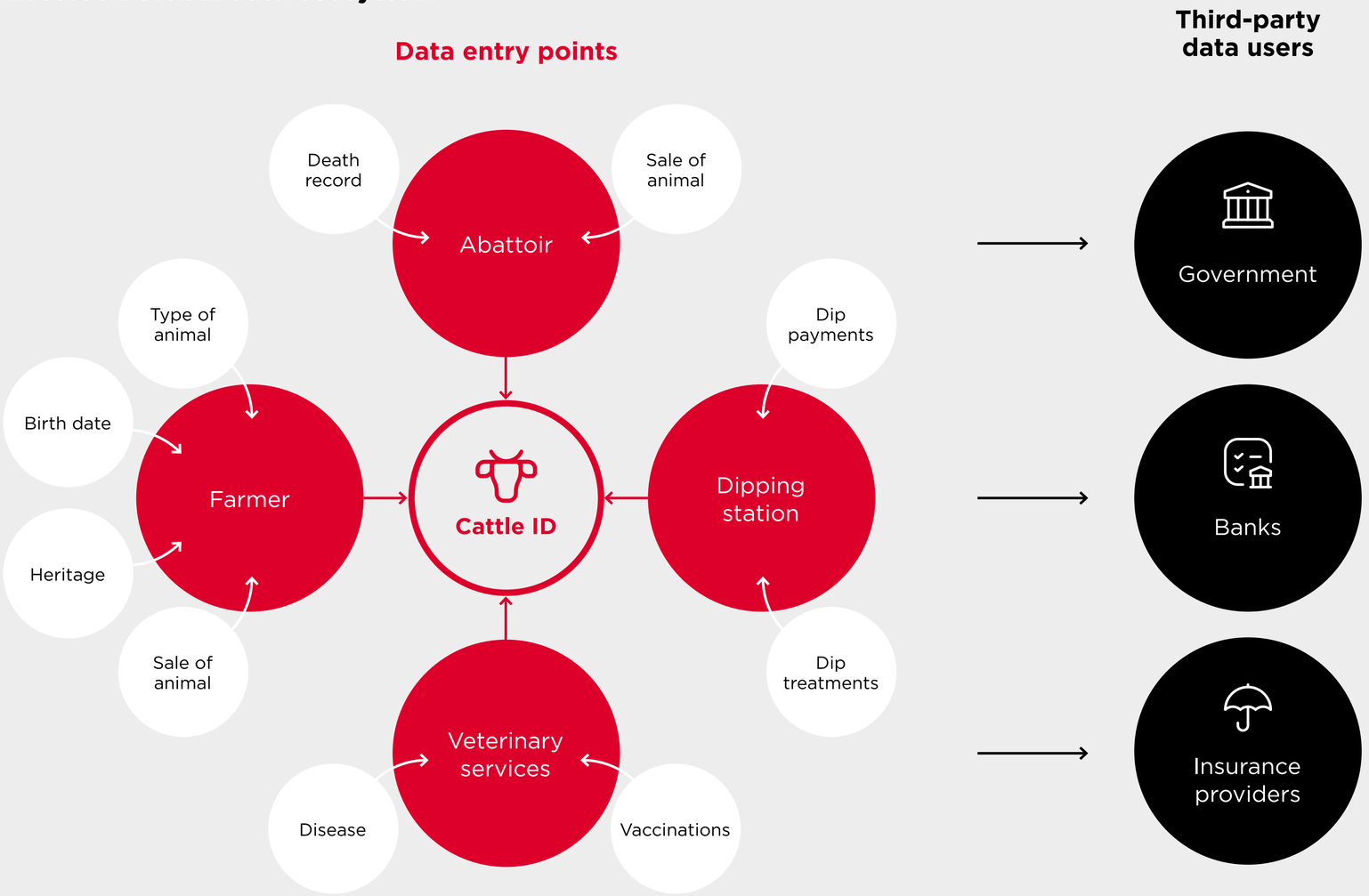
The E-Livestock Global solution works offline, allowing users to scan a tag, connect to the app and upload data to the database without needing to connect to the internet. Once the smartphone is connected to the internet, the data is uploaded either to blockchain or the cloud and appears in the app to all relevant users.

Case study 8

E-livestock Global, *continued*

Traceability

Figure 32
E-livestock Global data ecosystem



Source: E-Livestock Global

Blockchain could strengthen adherence to international and national regulation

EUDR

In June 2023, the European Parliament passed the European Union Deforestation Regulation (EUDR), an initiative aimed at curbing the impacts of deforestation around the world. Companies exporting commodities into European markets were given 18 months (through the end of 2024) to comply with new rules requiring them to demonstrate that their products did not come from land subject to deforestation after 31 December 2020.[19] Given the difficulties associated with compliance, the European Union (EU) announced in October 2024 that it would be giving companies an additional 12 months (until 31 December 2025 for larger firms, 30 June 2026 for SMEs) to comply with the new rules.

The two value chains most impacted by EUDR in Kenya are coffee and palm oil. Reaching the full potential of these industries will require greater compliance with EUDR rules and the implementation of digital traceability solutions that help farmers, cooperatives and exporters provide the necessary data trail.

National Horticultural Traceability System

Horticultural products, including flowers, vegetables and fruits, are Kenya's second largest agricultural export after tea. In the 2010s, Kenyan horticultural exports to Europe were intercepted in greater numbers as traces of banned pesticides and other substances were identified on Kenyan vegetables like peas and beans. This landed Kenya on an alert list and caused exports to drop precipitously, impacting farmers and the Kenyan economy.

In response, the Kenyan government, with the support of USAID, introduced the National Horticultural Traceability System (NHTS) to help Kenyan farmers and agricultural companies be more competitive internationally.[20] Domestically, a few well-publicised incidents of the use of chemicals to prolong the shelf life of meat at selected supermarkets, as well as some cases of food-related illnesses, have also created demand for traceability systems. Some restaurants and grocers have implemented traceability systems using apps and QR codes to enable customers to see where their produce comes from.

Blockchain, and the immutability and transparency it offers users, is an example of a digital technology that can enable regulatory compliance and make Kenyan farmers globally competitive. There is opportunity for the Kenyan government to use blockchain to monitor adherence to both national systems, like the National Horticulture Traceability scheme and to international regulation, such as EUDR. However, it is important to consider combining blockchain with other technologies such as cloud storage, as blockchain is best suited to data that must be validated, such as by law or to share with multiple stakeholders simultaneously. Other data should be stored on the cloud to reduce redundancies in blockchain use.

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Use case 6

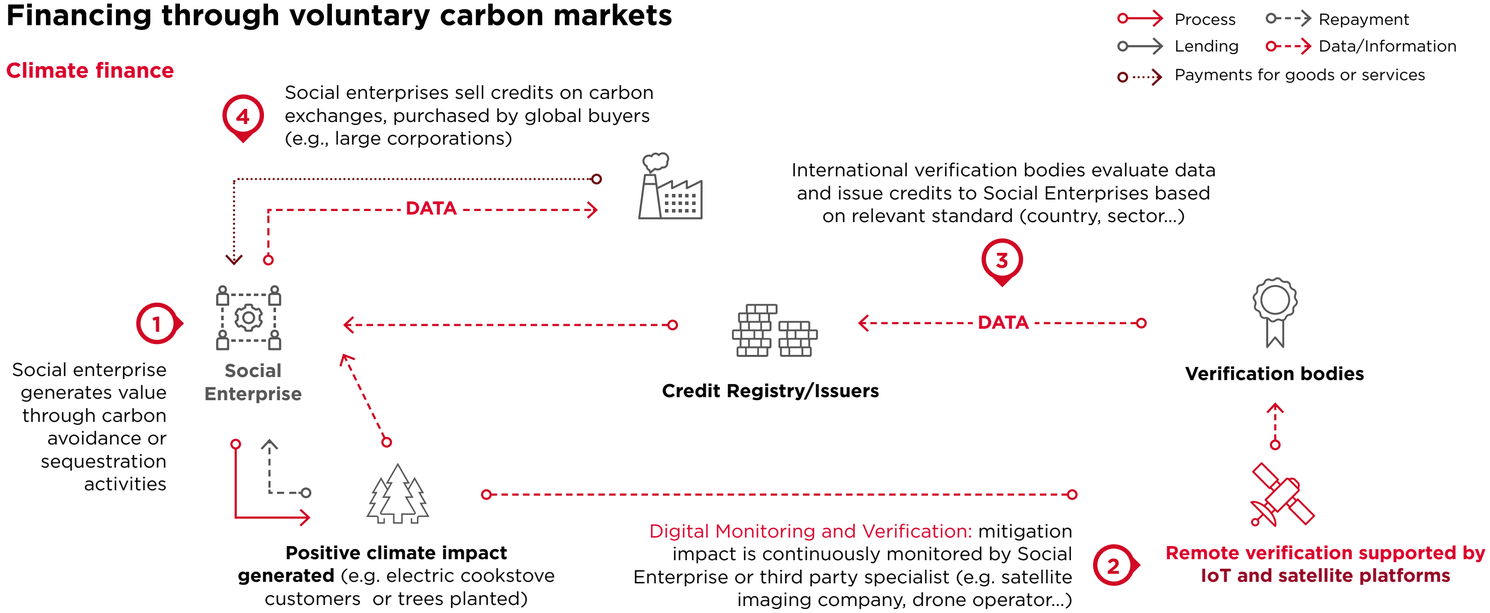
Carbon credits

Challenge

Climate change is having a significant impact on smallholder farmers around the world. According to a Bayer survey of farmers in eight countries in 2023, 71% have already experienced the effects of climate change on their farms,[1] including lower crop yields, more pests and higher costs. Almost 16% of farmers reported a decline in income in the two years prior to the study because of climate change. Farmers in Kenya and India were among the most concerned.[2] One solution to tackle the climate crisis is the voluntary carbon market (VCM), whereby companies wishing to offset their carbon emissions pay into the carbon credit market to support initiatives that sequester carbon. In exchange, these companies receive carbon offset credits (see Figure 33). A carbon offset credit is equivalent to the reduction of one tonne of greenhouse gas (GHG) emissions captured, avoided or reduced.[3] A monthly or annual payment provides an incentive for farmers to adopt regenerative farming practices and halt deforestation. Despite the market reaching a peak of $2 billion in 2021, demand has fallen sharply in VCMs due to questions about credibility, project implementation and a lack of regulation and transparency. Credits related to farming and land use are some of the most contentious examples, with serious concerns raised about validation processes and methodology.[4]

Figure 33

Financing through voluntary carbon markets



Source: GSMA

Scandals related to double counting, the overestimation of C02 impacts and negatively affected communities have created bad press for credit buyers, project developers and market intermediaries. Regulatory changes in Europe, bans on the use of credits in corporate net-zero claims and evolving regulations surrounding the use of proceeds in host countries, have also impacted the market. At the same time, the operationalisation of UN Article 6 mechanisms has created new opportunities for high-impact projects to find alternative routes to market in line with Nationally Determined Contribution (NDC) accounting.[5]

Blockchain has become a tool to address some of the challenges facing VCMs, specifically the lack of transparency and security.[6] Although blockchain can help make carbon markets more transparent, this will only happen if it is widely adopted and used across both the voluntary and compliance markets. A more novel use case would be applying blockchain to smart contracts in relation to the use of proceeds and revenue sharing among project developers and host communities.

Blockchain also offers the potential to facilitate the transfer of carbon credits into other service offerings, such as insurance products (see Use case 4). Smart contracts can automate the exchange of carbon credits into a farmer's mobile wallet and/or towards deductions in service costs. Using blockchain in this way is an innovative approach to ensuring the carbon credit market brings tangible value to smallholder farms.

Applications

Scope360

Traceability solution provider Bext360 introduced Scope360 to provide blockchain-verified carbon data across the supply chain.[8] Using Bext360's mobile app and traceability platform, clients can track both carbon sequestration from reforestation and land-use initiatives, as well as carbon emissions linked to farming, processing, and transport activities. By capturing primary data at every stage, Scope360 enables agribusinesses, cooperatives, and farmer groups to generate precise carbon footprints and leverage this information for compliance, reporting, and participation in carbon markets.

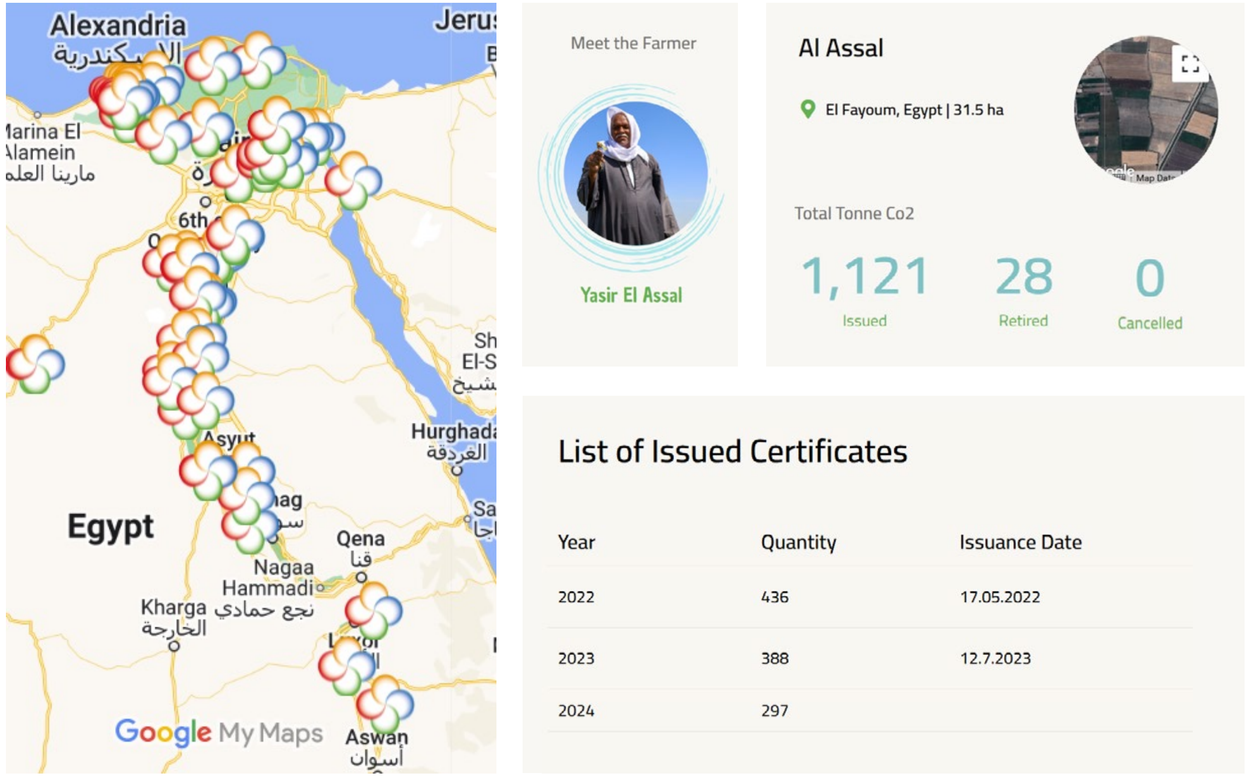
Dimitra Carbon

In 2024, traceability solution provider Dimitra introduced Dimitra Carbon, a blockchain-based platform linking governments and corporations seeking to meet ESG targets or implement carbon offset projects for smallholder farmers in LMICs. Carbon credits are sold as $DMTR tokens on the blockchain platform and shared with smallholder farmers implementing sustainable practices.[7]

The Economy of Love

The Economy of Love (EoL) was initiated by the Egyptian Biodynamic Association (EBDA), an association of organic farmers, in 2019 to support sustainable farmers, companies and consumers.[9] In 2021, EoL expanded into carbon credit issuance and governance. Blockchain is used to register projects and issue credits, facilitating the accurate and verifiable mapping of carbon credit awards that are visible to everyone via the blockchain platform (see Figure 34). To date, EoL has issued 261,761 tonnes of CO2 and retired 26,442 tonnes of CO2.[10]

Figure 34
Mapping of carbon credits awarded by Economy of Love, Egypt



Source: Economy of Love

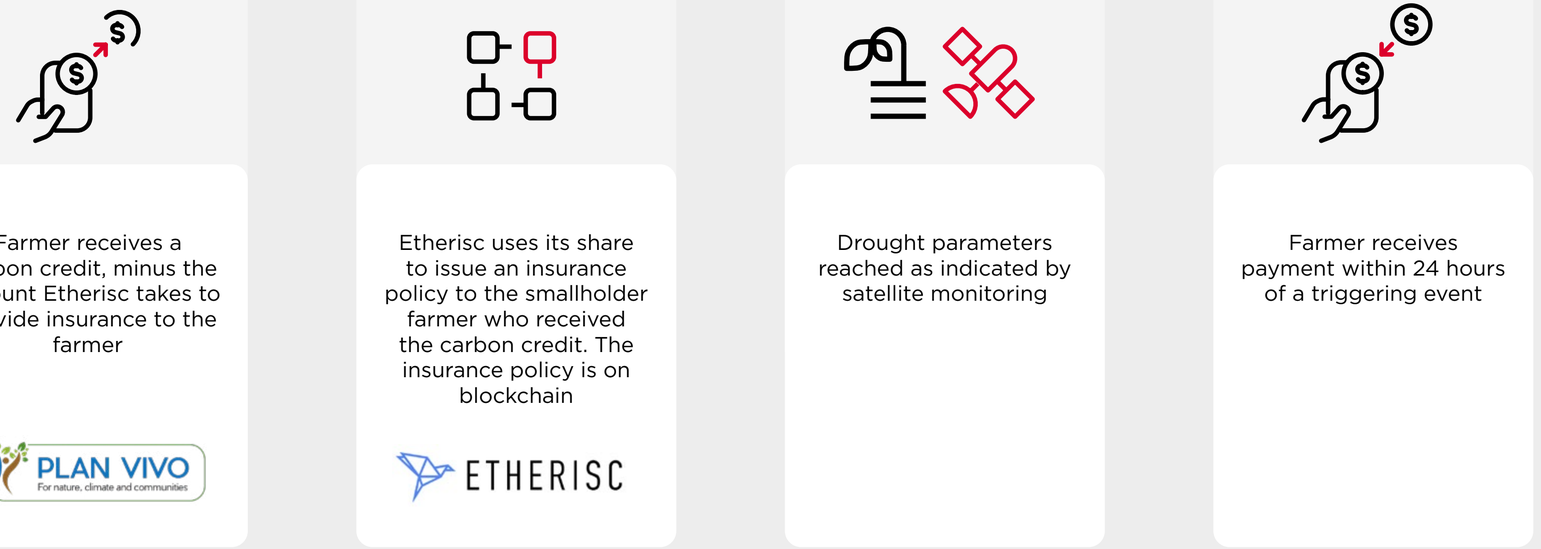
Sustainability and scalability of carbon credit applications

Most carbon credits are paid for by individuals, governments and companies looking to offset their carbon emissions. Blockchain-enabled carbon credit solutions can be used to help smallholder farmers access other services, such as insurance or traceability solutions. Farmers receive benefits in the form of an annual or monthly check or digital mobile money transfer that compensates them for implementing regenerative farming practices that lead directly to carbon capture (e.g. planting shade trees on a coffee farm).

Platforms linking smallholder farmers to these international carbon markets take a share of the transaction. In the case of Etherisc, which launched a pilot in 2024 in Uganda to test this model, will take $1 of the $15 per month farmers are expected to receive from the international carbon market and apply it to an insurance policy that covers smallholders during a specific period in the growing cycle (see Figure 35).

Figure 35

Business model for Etherisc carbon credit programme in Uganda[11]



Source: GSMA, Etherisc

Case study 9

Etherisc

Carbon credits

Etherisc was founded in 2016 as a blockchain-based open-source platform that provides parametric insurance to smallholder farmers in LMICs. Etherisc works in a range of countries in Africa and Asia, including Kenya, Burkina Faso, Sri Lanka, Uganda and Mozambique.

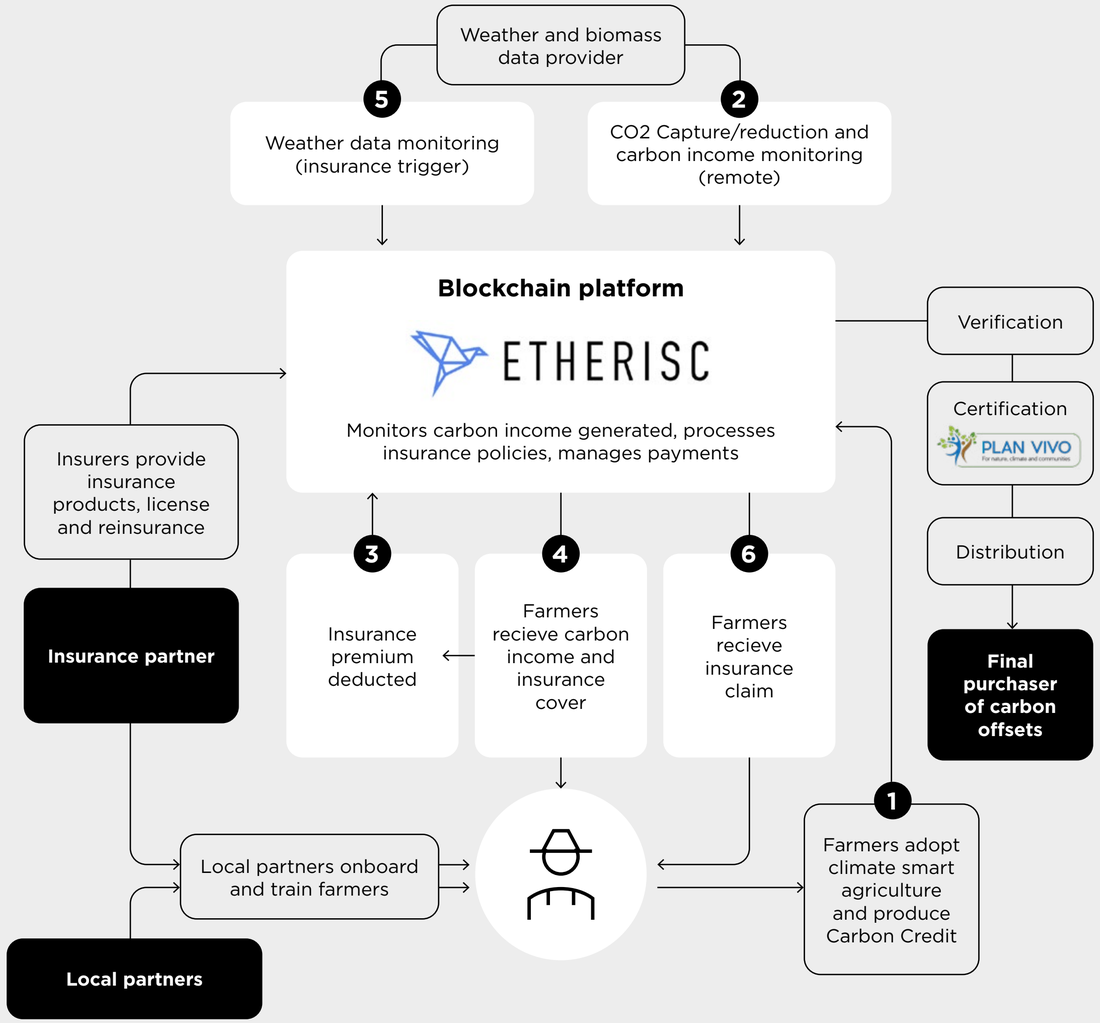
In 2023, Etherisc announced plans to use its existing blockchain platform to connect smallholder farmers to the international carbon market, generating a new source of income for smallholders. To measure carbon capture, it leverages the same satellite system it uses to track insurance trigger points for excess rain or drought. Etherisc launched its first carbon initiative in Uganda (see Figure 36).

Etherisc sees blockchain as a way to address some of the main challenges of traditional insurance, including high cost, lengthy payment disbursement and lack of transparency. With blockchain, insurance payouts are reduced from months to days (or even hours) and operational costs are reduced by as much as 80%.[12] The use of smart contracts also allows payments (both insurance and carbon markets) to be automated. By connecting the Etherisc software to M-PESA's mobile payment gateway, payments can be made directly to a farmer's mobile phone.

By implementing regenerative farming practices, farmers can earn supplemental income from the sale of carbon market credits while also increasing their productivity by up to 40%, according to Etherisc. Etherisc transfers the income from the carbon credits directly to the farmer's mobile wallet, deducting $1 each month to cover its parametric insurance.[13] Farmers can use the extra income to invest in higher quality inputs and fertiliser, further increasing their productivity. In this model, Etherisc can shift responsibility for paying insurance premiums from the smallholder farmer to the purchaser of carbon credits (the one looking to offset its carbon footprint).

Figure 36

Etherisc carbon market initiative in Uganda, concept overview



Source: Etherisc

Case study 9

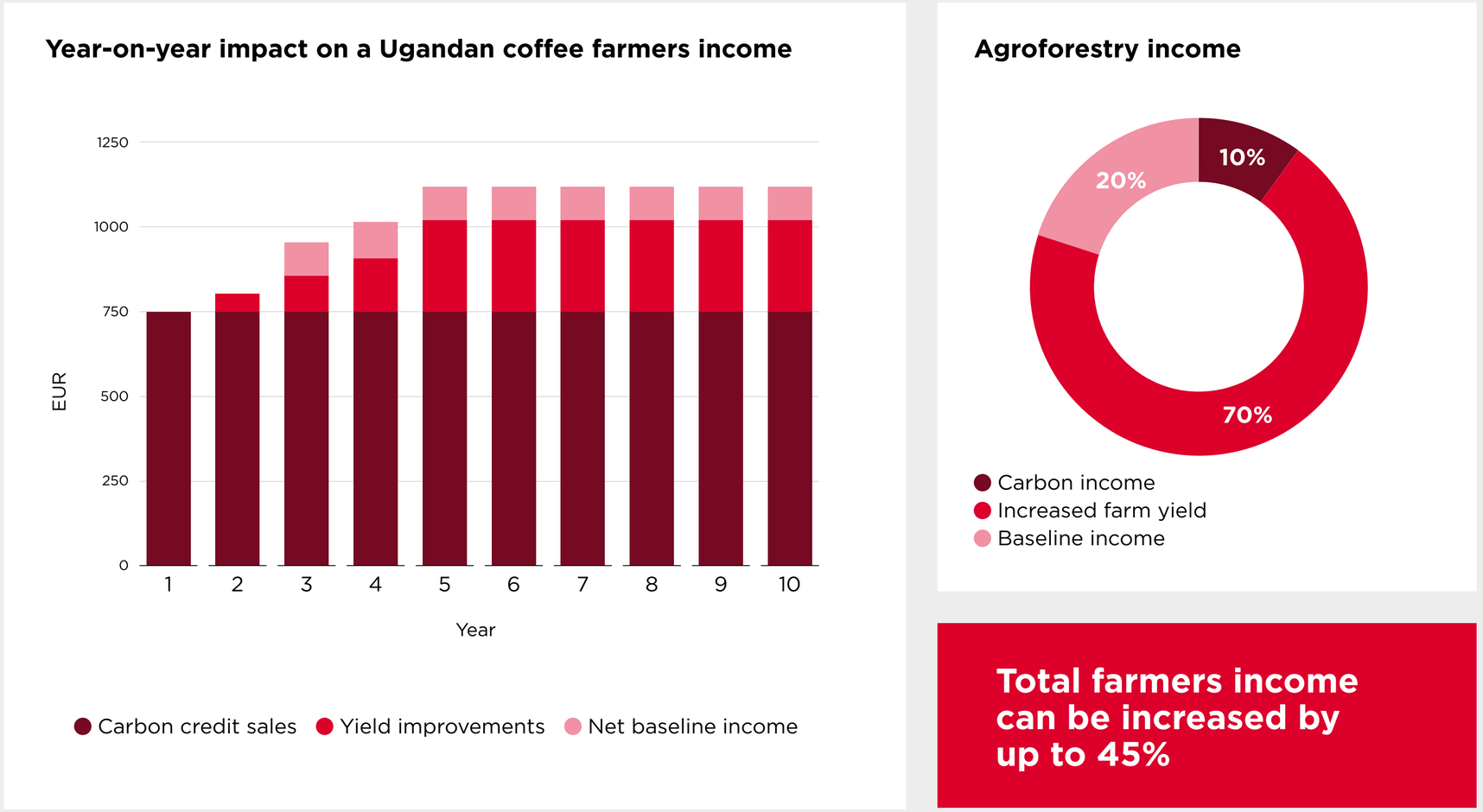
Etherisc, *continued*

Carbon credits

The initiative is still in early stages, so impact data is not readily available. However, Etherisc estimates that through participation in carbon markets, smallholder farmers in Uganda may be able to increase their income by as much as 45% (see Figure 37).[14]

Figure 37

Projected income increases for participating smallholder farmers in Uganda



Total farmers income can be increased by up to 45%

Source: Etherisc

The opportunity for blockchain to facilitate carbon credits to smallholder farmers in Kenya

Kenya is at the forefront of the fight against climate change in Africa. In 2020, it updated its NDC by committing to a 32% reduction in GHG emissions by 2030, up from 30%.[15] It expects to fund 21% of these efforts itself while relying on international assistance for the remaining 79%.[16] Kenya was among the first countries in the world to enact climate change legislation: the Kenya Climate Change Act of 2016. In 2023, the law was amended to consider carbon markets, making Kenya a leader in legislating carbon markets.[17] The 2023 amendment called for the creation of a carbon registry and mandated that a minimum of 25% of aggregated earnings be shared with affected communities.[18] This rule was put in place given earlier concerns that some of the communities where carbon capture projects were being implemented were not benefitting monetarily from the projects they had been involved in.

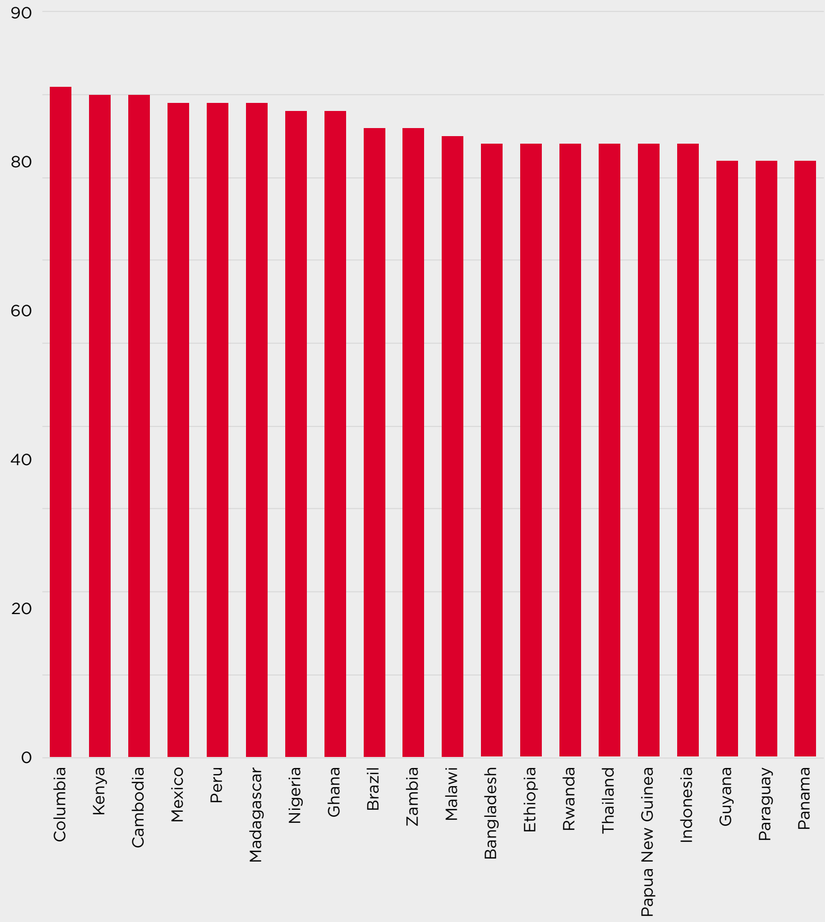
According to Abatable, Kenya ranks second globally in the Voluntary Carbon Market (VCM) Investment Attractiveness Index, behind only Colombia (see Figure 38), and number one in the world for carbon market readiness.[19] Given that agriculture accounts for roughly one-third of all carbon emissions in Kenya, there should be significant opportunity for agribusinesses and smallholder farmers to participate in, and benefit from, international carbon markets, supported by tech startups, NGOs and other groups.

A growing number of digital agriculture providers, from insurtechs like Etherisc to traceability platforms such as Dimitra and Bext360 and NGOs like Solidaridad, are making strategic moves into the carbon market.

Not all are using blockchain to support these initiatives, but it does afford the projects greater transparency, ensures there is no duplication of projects and helps protect smallholder farmers by guaranteeing their share of benefits from projects undertaken in their communities.

Figure 38

Voluntary Carbon Market (VCM) Investment Attractiveness Index, 2024



Source: Abatable[20]

Note: Abatable's VCM Investment Attractiveness Index ranks countries according to their current voluntary carbon market conditions and their potential to play a significant role in the future of carbon markets.

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Key findings and recommendations

This research highlights the potential of blockchain technology to support smallholder farmers and other actors in the agricultural value chain to improve productivity and incomes while strengthening resilience to the effects of climate change. Capitalising on the opportunities of blockchain will require coordination and commitment from various stakeholders in the agriculture sector, including government, NGOs and donors, investors and agribusinesses. This section presents four recommendations for the use of blockchain in a way that is sustainable, scalable and impactful.

Overview of key findings

Past research conducted by the GSMA AgriTech team has found that the implementation of digital agriculture services, including those employing blockchain technology, is easiest in more formal value chains like coffee and cocoa.[1] Although these are two of the main agricultural value chains using blockchain, fruits and vegetables, livestock, seafood, honey, spices, grains and, especially in Southeast Asia, rice, are also prevalent. Suitable value chains for each use case vary – for example, asset tokenisation is best suited to value chains in which crops can be easily verified and tracked via satellite technologies (like coffee and avocado trees). For the carbon credits use case, eligible crops are those that allow for carbon capture. In this case, coffee and cocoa are again among the preferred value chains. When it comes to traceability, the research found greater interest in value chains like seafood (where mislabelling is a major problem), livestock, fresh produce and commodities subject to regulations like EUDR (palm oil, coffee, cocoa).

However, the blockchain market is still in its infancy. Many of the organisations introducing blockchain-based solutions have done so in the past 10 years, most since 2020. Traceability solutions are some of the most mature use cases, with insurance and carbon market monetisation more recent use cases. Few solutions have surpassed the 5,000 subscriber mark. Traceability service providers and insurers have some of the highest subscriber numbers. Etherisc, for example, has more than 100,000 insurance policies on-chain when aggregating all its projects worldwide.[2]

There is a clear opportunity for Kenya to leverage blockchain in the agriculture sector, with significant potential impact for farmers and agribusinesses as the blockchain market develops. The country is an early leader in blockchain in the agriculture sector and the key findings suggest the blockchain market is evolving. Yet blockchain service providers continue to face challenges which are contributing to a challenging growth environment.

Key findings

01

Kenya has emerged as an early leader among LMICs in blockchain-enabled agricultural services, particularly in Africa. This is due to the country's startup-friendly environment, users' familiarity with digital services and its position as a global leader in mobile money and other digital financial services.

The most prominent use cases are in the financial services sector, with the research identifying more than a dozen initiatives that help smallholder farmers access credit or insurance (see Figure 39). This is not surprising given the openness of Kenyan smallholder farmers to using digital financial services and the maturity of the underlying digital financial services infrastructure. One of the main impediments to the development of blockchain-based financial services in Kenya are challenges with off-ramp transfers from blockchain wallets to mobile money wallets. This is set to change as more organisations like Kotani Pay emerge. Kotani Pay is particularly attractive to smallholder farmers given that funds can be accessed via a smartphone or USSD, making it more accessible.

Figure 39
Current and planned blockchain-enabled services in Kenya

Insurance	ensuro	The Lemonade Foundation	acre AFRICA	ResilientGrowth
	Fortune Credit Delivering Dreams	ETHERISC	ibisa	
Credit	hiveonline	Cinch	agroKOPA	Whrr Sustaining Lifeblocks
Asset tokenisation	One Million Avocados	Project Mocha Tokenisation of Coffee	FARM STAR	Investa Farm
Carbon credits	ETHERISC	DIMITRA		
Traceability	DIMITRA	AgUnity Connecting the last mile		

Sources: GSMA and organisations featured above

Key findings

02

Blockchain innovators have struggled to secure funding.

Many of the organisations interviewed for this study have faced challenges when trying to secure financing. They have largely had to rely on a combination of bootstrapping, innovation funds (e.g. Crypto for Good, Zero Fund) and donors (e.g. USAID, WFP, UNDP, Lemonade Foundation). The GSMA identified some early impact investors in this space, with Mercy Corps Ventures one of the most active. Interestingly, the research found that a significant share of funding for early pilots and startup ventures comes from the blockchain platforms themselves. Ethereum Foundation, Polygon, the Celo Foundation and others have provided early funding (grants or through equity) to some of the projects identified in the research.

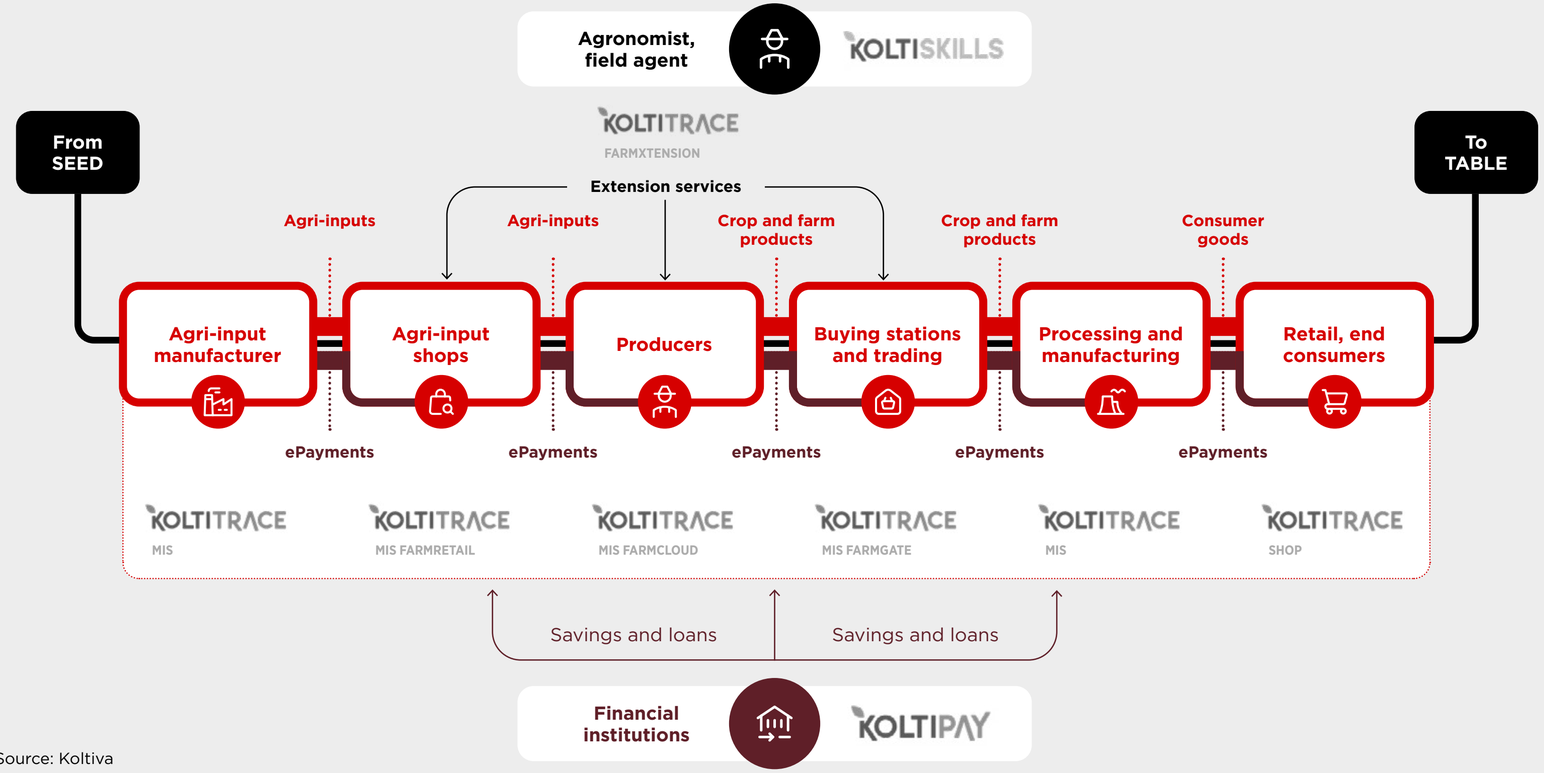
One of the challenges blockchain startups have encountered is the reticence of investors to put money into blockchain-based solutions. Blockchain has been closely linked to cryptocurrencies and meme coins, which have been the subject of misunderstanding and significant negative press. For years, Kenya's government warned its citizens against what it perceived to be the risks associated with cryptocurrencies. Forgetting a PIN, for instance, could lead to the loss of one's entire crypto portfolio. As additional layers of security have been built in, and given the role of stablecoin in helping Africans navigate high inflation and depreciation of their currencies, the tide is starting to shift.

03

To make their business model more viable, blockchain providers seek to address multiple pain points for farmers.

Providers of traceability solutions, for example, are leveraging the data they collect to create transaction histories that farmers can use to secure credit. The data can be stored in a digital ID managed by the farmer, a physical ID card with a QR code that contains all the farmer and transaction data or on the blockchain platform itself, accessed by financial institutions if the farmer authorises the transfer of data. Traceability and digital financial service providers are also leveraging their blockchain platforms to help connect users to international voluntary carbon markets. Companies like Koltiva, an Indonesian agritech, have integrated their blockchain platform with existing digital platforms to provide a full suite of services, ranging from digital advisory and extension to financial services, digital traceability and digital marketplaces (see Figure 40).[3]

Figure 40
Koltiva's digital agricultural services portfolio



Source: Koltiva

Key findings

04

Blockchain service providers cite multiple blockchain-specific challenges encountered during the deployment of their solutions. These constraints, including poor quality of data inputs, the cost of blockchain and the lack of suitable on/off ramps, contribute to a challenging growth environment.

High digital financial services (DFS) usage	Blockchain solutions are often used to facilitate payment to smallholder farmers, extend credit or pay-off the claim on a parametric insurance policy. High mobile money penetration rates are a key enabler for these types of blockchain solutions. Familiarity with other types of digital financial services (savings, credit, insurance) can also act as a stepping stone for adoption of crypto accounts.
Interoperability between services	Interoperability between different blockchain solutions and between blockchain solutions and other services, is key to the advancement of blockchain in agriculture. Interoperability between blockchain-enabled financial services and traceability solutions, for example, allows data to be shared and more seamless applications of the technology. Interoperability facilitators like on/off ramps ensure farmers can accept payments.
Access to high quality data inputs	Blockchain solutions are only as good as the data that is housed on the platform. Once the data has been uploaded, it is secure and immutable. However, if the data inputted is erroneous, the value of the blockchain solution is greatly diminished. One strategy agritech digital ID startup Gravity Digital ID implemented was to validate the initial information provided by the smallholder farmer with five community members. The farmer uploads information via USSD or mobile app and provides the phone number of five contacts. If all five contacts verify the information, the data is deemed reliable and the smallholder farmer receives a high reliability ranking and an incentive in the form of mobile airtime.[4]
Cost of blockchain	Using blockchain solutions to store data generally more expensive than cloud-based solutions. For this reason, many of the blockchain providers interviewed for this study only uploaded selected data to the blockchain platform. A hashtag on the blockchain links to relevant data stored off-chain on the cloud. Blockchain solution providers expect that as the cost of blockchain platforms decreases, more information will be able to be stored on-chain. Heifer International, for instance, found that specific use cases where data immutability and public confidence in provenance are critical (e.g. specialty coffee), blockchain is appropriate. In contexts where internal supply chain management is the primary need, cloud-based ERP systems without blockchain integration are more practical and cost-efficient.
Lack of suitable on/off ramps for crypto	Some of the solutions required smallholder farmers to have crypto wallets to accept payment or loan disbursement. This was particularly true of credit, crowdsourcing and asset tokenisation solutions. These crypto wallets need to have on/off ramps so that the funds can be accessed by smallholder farmers. Examples of these on/off ramps include Kotani Pay, Paychant and Yellow Card. A few initiatives identified struggled to move beyond the pilot stage because of the difficulty associated with on/off ramps. Input supplier FarmStar, for example, partnered with Mercy Corps Ventures to introduce a blockchain-based incentive programme that rewarded farmers for purchasing the company's flagship Evergrow fertiliser. Users could use loyalty points earned through the purchase of fertiliser toward additional fertiliser, insurance or cash. Farmers struggled to use off-ramps, limiting the utility of the programme.[5]

Recommendation 1:
The government can play a vital role in accelerating the adoption and scaling of blockchain-enabled solutions for the digitalisation of agricultural value chains

Regulations

The effective deployment of blockchain-enabled solutions in agriculture requires clear regulations on data privacy, cryptocurrencies and tokenised assets. Kenya has taken initial steps to regulate cryptocurrency and in January 2025, Kenya's National Treasury launched a public consultation seeking input on regulations from industry stakeholders. Timely progress on this legislation – incorporating input from relevant stakeholders including cryptocurrency platforms, agritechs and blockchain-based startups - would help blockchain innovators operate with greater confidence and increase consumer trust in blockchain initiatives across the use cases.

Awareness and capacity building

A key barrier to scaling blockchain solutions is the lack of awareness among agribusinesses, farmers, and government organisations about the technology, its applications, and data-sharing processes in particular. This lack of awareness often leads to distrust. To overcome this challenge and enable effective scale-up, the government can play a central role in championing blockchain and leading targeted awareness campaigns. By highlighting how blockchain can enhance profitability and resilience in agriculture, trust in the technology can grow, encouraging wider adoption among agribusinesses and farmers.

Funding and technical support

The most successful blockchain solutions harness its core strength, creating an immutable data/transaction record, in existing systems that currently lack transparency or effective regulatory oversight. This is particularly relevant in traceability and input verification use cases, for example E-Livestock Global in Zimbabwe and GeoKrishi's DESIS 2.0 in Nepal, respectively. These solutions, powered through blockchain, provide government agencies with a channel to effectively monitor multiple stages of verification from numerous stakeholders within a clearly defined process. However, developing solutions which are tailored to the unique needs of government agencies requires a technical understanding of existing processes and funding to run pilots, provide training and run awareness campaigns. As a key beneficiary, the government is well positioned to take a partnership role, providing investment and technical know-how, to catalyse development and adoption. Private, customised blockchain networks provide an additional layer of tailoring and can offer more secure systems with tighter control over data sharing. This requires significant investment that the government is well positioned to provide.

Spotlight example | **GeoKrishi's DESIS 2.0** (Case study 2)

Recommendation 2:

To catalyse adoption and achieve scale, blockchain innovators such as agritechs, insurtechs and fintechs can prioritise solutions that improve existing processes before introducing those that fundamentally disrupt them.

The blockchain use cases in agriculture explored in this report can be broadly categorised into two types: process-enhancing and process-disrupting (see Table 7).

Process-disrupting use cases represent innovative, though often niche, applications that leverage blockchain to reimagine longstanding systemsm – such as insurance models or access to agricultural finance e.g. through credit scoring and crowdlending platforms. In contrast, process-enhancing use cases integrate blockchain technologies into existing processes to improve transparency and efficiency.

Findings from this research suggest that process-enhancing use cases present greater near-term potential for scale. While this does not imply that disruptive solutions should be abandoned, they tend to face steeper barriers to adoption and often require extensive capacity building among stakeholders. A pragmatic approach may involve starting with process-enhancing solutions before introducing more disruptive innovations, or alternatively, offering process-enhancing solutions in addition to disruptive ones.

Table 7

Division of use cases by type

Process-disrupting	Process-enhancing
Insurance	Digital IDs
Credits, loans and crowdlending	Input verification
Carbon credits	Traceability

Spotlight example | **hiveonline** (Case study 3)

Recommendation 3: For blockchain to be most effectively deployed, considerations specific to each use case must be taken into account.

Blockchain's core functionalities of increasing trust between stakeholders, creating an immutable record of transactions and, in digital financial services use case applications, decreasing transaction times, make it a suitable technology to facilitate the applications seen throughout this report. Combining blockchain with other technologies and considering the context in which data is stored and shared could support blockchain innovators to better strategise their deployment of blockchain.

Below are some key considerations for the three 'process-enhancing' use cases.

Traceability and input verification

Blockchain is not a fail-safe solution. While it enables secure and tamper-proof data sharing, it cannot prevent users from uploading incorrect or falsified information. Therefore, robust data or transaction verification processes are essential before data is recorded on the blockchain. To reduce the risk of human error, innovators may also use technologies like IoT and AI to automate data entry.

Targeted use of blockchain can improve efficiency. Blockchain is most effective when used to track compliance with regulations—such as agricultural input supply, livestock vaccinations, the EUDR, or Kenya's National Horticulture Traceability System. Data unrelated to regulations (e.g., farmer profiles) can be stored using cloud platforms or Enterprise Resource Planning (ERP) systems and linked to the blockchain using a reference (e.g., a hash), avoiding unnecessary use of blockchain and the associated cost.

Assessing the suitability of blockchain is critical. Blockchain is valuable where regulatory compliance needs to be monitored or where trust between stakeholders is lacking. However, in supply chains where trust is already established, more conventional tools for data and transaction records like cloud storage or ERP systems may be more appropriate and cost-effective.

Digital IDs

Tailoring the digital ID system to the use case is key to adoption. Blockchain-enabled digital IDs are typically not standalone solutions – they serve as critical enablers for other blockchain-powered use cases such as credit access, traceability, or input verification. As such, the digital ID system should be designed with the specific needs of its end users in mind. For instance, financial institutions, governments, and agribusinesses will each have distinct requirements, and these must be addressed to ensure meaningful adoption and functionality.

Integration with existing systems builds trust and improves efficiency. Although there are no known nationwide digital ID systems built entirely on blockchain, digital ID components embedded within other use cases can still align with national ID systems. By linking blockchain-based digital IDs with official national ID databases, solutions can reduce the need for farmers to repeatedly share their data with multiple actors. This not only streamlines processes by minimising duplication, but also encourages user trust and broader institutional buy-in.

Spotlight example | **E-Livestock Global** (Case study 8)

Recommendation 4:

By ensuring blockchain solutions are adapted to the context of rural smallholder farmers, agribusinesses, cooperatives, and donors can better drive scalability.

Local partnerships

Because agriculture is primarily concentrated in rural areas, reaching target populations can be challenging. Establishing strong local partnerships is therefore essential for the successful rollout and scaling of blockchain-based solutions. Agribusinesses, cooperatives, local NGOs, and community leaders are well-positioned to act as trusted intermediaries. These actors can help identify prospective users, build credibility within communities, and support adoption.

Building trust

Blockchain remains a relatively opaque and technical concept for many, and there are numerous misconceptions of the technology due to its association with cryptocurrencies, which have seen volatility and occasional association with scams and fraud. This can contribute to mistrust in the technology. Engaging local community champions – mobilised by agribusinesses, donors, or agritech companies – can help demystify the technology, debunk myths, and demonstrate value. These champions can play a pivotal role in building trust and communicating the benefits of blockchain to farmers unelated to cryptocurrencies.

Literacy and capacity building

Many blockchain startups spend significant time and resources training smallholder farmers how to use their devices or providing financial literacy training – resources that could be better spent on farmer acquisition and product development. Although Kenyan smallholder farmers are more digitally savvy than their counterparts in other African countries and abroad, there is still a proportion who have never owned a mobile phone or subscribed to a digital financial service and require some training. Donors and NGOs can play a key role in supporting digital and financial literacy training that not only underpin the use of digital agriculture solutions, but also strengthen broader efforts in financial inclusion.

Low data solutions and data support

For blockchain solutions to succeed in rural agriculture settings, they must be designed for low-connectivity environments. Offline functionality and low-data usage are essential features. However, even with these adaptations, data still needs to be uploaded – typically by farmers or agribusinesses visiting the field. Donors can support this need by investing in community data hubs located near farming areas, where users can connect to upload information. Collaborating with local stakeholders will ensure these hubs are conveniently located and actively used.

Spotlight example | **hiveonline** (Case study 3)

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