

ICT Update

a current awareness bulletin for ACP agriculture

Issue 88
September 2018



agriculture

<http://ictupdate.cta.int>

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**Unlocking the potential of
blockchain for agriculture**

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ICT Update



ICT Update is a bimonthly printed bulletin with an accompanying web magazine (<http://ictupdate.cta.int>) and e-mail newsletter.

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Layout: Steers McGillan Eves Design Ltd

French translation: ISO Translation & Publishing

Publisher: Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA), Wageningen, The Netherlands

With thanks to FAO for distributing ICT Update through e-Agriculture (www.e-agriculture.org)

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Blockchain: finding real benefits beyond the hype

Chris Addison and Ken Lohento

Business transactions in agriculture have been transformed by the digitisation of the value chain. The first big impact came with barcodes, which made it possible to track items through a value chain. Then came handheld mobile data collection devices, more affordable sensors to track conditions, followed by the internet to transform links with consumers. Mobile phones now take over many of these roles. Barcodes have been replaced with RFID and QR codes. Despite this progress, there are still many challenges relating to the traceability of products and transparency in supply chain management. Database systems managing transaction records were managed in isolation, not open to all the other stakeholders in the chain; they were open to fraud, and transactions were difficult to secure.

One technology apparently has the potential to provide answers to a number of issues in agriculture, from farmer IDs to smart contracts, from traceability and improving certification, digital payments, insurance, consumer feedback and improved logistics. It is the blockchain.

The articles in this issue begin by providing a history and defining the blockchain. We learn why more people need to be educated on the blockchain before choosing how to use it.

Common themes recur in these cases. The blockchain is often a background addition to existing processes in the value chain and lends itself to recording transactions, thus ensuring issues of provenance and allowing certification. Applications use a mixture of public and private blockchains

One technology apparently has the potential to provide answers to a number of issues in agriculture, from farmer IDs to smart contracts and traceability... It is the blockchain.

depending on the context, but a number seem to choose private blockchains so they can be integrated into existing systems and provide fast transaction recording and privacy in transactions, especially when the technology is deployed to support a specific supply chain network.

Nearly everyone in this issue agrees that some knowledge is needed before moving to select a solution. IBM suggests asking five questions: Is the protocol open source and openly governed? Who will be part of the network? What use case will drive the transactions on the network? And is the technology modular and easy to use? These questions mean assessing whether the system will need to be a public or private blockchain, and which function the system should be optimised for. If the main issue is traceability, this will clearly lead to a different approach than for value transfer (involving cryptocurrency or tokens).

We hear about projects being implemented around the world, such as the case of traceability in the Caribbean using BreadTrail and the use of blockchain in the cocoa sector in Columbia. We also hear about applications in Africa, particularly covering electronic payments, including an attempt to rebuild the agricultural value chain in East Africa. We learn how blockchain benefits and challenges smallholder farmers in Africa and how it has the potential to reduce value chain losses. The company Goldman Sachs estimates that blockchain could facilitate global savings of up to US\$6 billion per year in business transactions.

Apart from the benefits that the technology can generate, its limits and fallacies are also discussed in this issue.

Supporting ACP agribusiness to benefit from blockchain

Aware of the opportunity of blockchain for agriculture in ACP countries and of the weak understanding of this technology in ACP countries, in October 2017 the Technical Centre for Agricultural and Rural Cooperation (CTA) organised a workshop to discuss that issue: 'Perspectives for ICT and agribusiness in ACP countries: Start-up financing, 3D printing and blockchain'. It was organised in the framework of the forward-looking activities that CTA organises periodically on digital technologies, and one of its main focuses was the blockchain.

The objectives included developing a better understanding of the opportunities provided by the blockchain and its relevance for the agricultural sector and developing recommendations which will favour the design of strategic actions to address it. About 30 participants took part in the workshop from Africa, the Caribbean and Pacific countries, the European Union and beyond. They included representatives of public institutions, agribusinesses, start-ups, financial institutions and international organisations.

The participants acknowledged that the blockchain is still in its infancy. However, when fully deployed it can potentially provide many benefits in the area of business and governance in developing countries, beyond the agricultural sector. They advised that blockchain is just an enabler, transparent to most small-scale farmers, and it can only be valued when stakeholders subscribe to utilise it in trust and confidence.

Key recommendations adopted at the end of the workshop included the following:

1. Promote agricultural value chain engagements, as well as the use of digital technologies in the agricultural sector, two key elements critical to blockchain adoption in agriculture by farmers and agribusinesses;



The objectives of the workshop included developing a better understanding of the opportunities provided by the blockchain and its relevance for the agricultural sector.

2. Educate key stakeholders, including financial institutions, businesses, start-ups, and policymakers, about blockchain technology, so that they can seize its benefits;
3. Work closely with leading country-level outgrower and agricultural finance schemes to test blockchain solutions;
4. Support developers and startups to engage in the blockchain space, notably by creating actionable training programmes, massive online open courses and training of trainer activities; and
5. Develop ecosystems promoting blockchain in agriculture in Africa, the Caribbean and Pacific countries.

As a response to some of the recommendations made, CTA has launched a series of activities. A knowledge platform will be created which will promote blockchain use cases in agriculture and favour collaboration with international initiatives such as those put in place by the European Commission. In addition, CTA will launch a call for proposals on blockchain in agriculture in ACP countries. ●



About the authors

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Eliminating the trust factor



Henk van Cann is co-founder of Blockchain Workspace, an organisation based in Amsterdam, the Netherlands that provides training on the blockchain to make the technology understandable to a broad audience. Henk spoke to *ICT Update* about

the need to educate people about the blockchain before they start using it and judging it, and why trust is one of the key drivers for moving away from centralised systems and towards blockchain technology.

Q How did you become interested in the blockchain?

I co-founded Blockchain Workspace, and also Blockchainbird, because at the time most of what me and my partner were hearing at meetings and conferences about the blockchain was technical. You could see in the eyes of the people visiting these meetings that they didn't really understand why this had all been created and how it was developing. We started looking for ways of making it easier to explain to people, often by way of analogy.

We also run a few blockchain labs in Leiden and Amsterdam. What we try to do there is teach each other how to use these analogies. For example, we like to use the analogy of the first mass-produced car, the T-Ford. Though no one drives one anymore, it

Q So educating people is a priority. What about all of the people that have jumped onto the bitcoin bandwagon recently?

We always say, 'don't buy anything you don't understand.' But people like to speculate and they will lose money. Especially the initial coin offerings (ICOs). I'm concerned about the ICOs. They tend to present themselves in a low-profile manner, but what it ultimately comes down to, in meetings or conferences, is 'buy my ICO'. That's a shame, because there's a big difference between looking for the blockchain's real added value, say in the agricultural sector, and doing an ICO. Because in the 98% of the cases, the ICO is worthless.

Q How is blockchain technology developing in Europe?

I don't travel enough to other parts of the world to be able to make a strict

comparison, but my gut feeling tells me we're doing well with the blockchain. Of course we're using it from a privileged position: we have bank accounts, we have passports. So we will use it differently than someone in Tanzania, for example, or in Venezuela. But when it gets to them they will be better at using it than us, and probably quicker too. And it will get to them, in fact it's already

happening. Because as soon as somebody has a mobile phone or access to a mobile phone, even if it's just a single mobile phone for an entire village, people can create virtual identities with it. That's where it all starts. As soon as you have a virtual digital identity then you can start to use the first blockchain applications. So to answer your question, Europe may be slightly ahead of certain parts of the world, certainly in the attention we're giving the blockchain, but I wouldn't dare to say we're ahead in terms of evolution. You can't say where we'll be in two years.

Q What needs to be done to get farmers and small agribusinesses in a country such as Tanzania to fully realise the merits of blockchain technology?

We quite simply need to start by giving farmers access to a digital keychain. A keychain would give them access to an account in which they can receive cryptocurrencies. Why? Because it gives them a chance to play with it. They'll probably learn faster than we think. Or if they don't, their children will. Because that's what we're seeing in Europe as well. People over the age of 30 aren't necessarily so keen to get into the blockchain, but the youngsters are. From 16 years onward, people are spending huge amounts of time and money on cryptocurrencies. And they won't go back to centralisation anymore. They already feel the vibes of decentralisation, so for farmers in

rural areas in Africa, for example, to pick up on this they need to have a mobile phone.

Q A smartphone?

Yes, a smartphone. And they need to have an energy supply, solar energy for example, to charge the phones but also to have an internet connection. You don't need an internet connection all the time. You can tend to your herd or crop and make a transaction on your phone – to wherever in the world, it doesn't matter – and once you get back to your internet connection the transaction will be broadcast. Some people think we need an internet connection everywhere in developing countries but that's not true.

Q Is the slow speed of bitcoin transactions a stumbling block?

To answer that, let me revert to the bitcoin/T-Ford analogy again. The T-Ford paved the way for other newcomers, cars that have very smart ways of doing quick, cheap transactions. In other words, there are quicker cryptocurrencies, and the Lightning Network on top of the bitcoin is meant to address this problem as well.

Q Is it just a matter of speed? I'm thinking of something like m-pesa, which is quick of course. Is the difference the transaction fee?

No, the difference is centralisation. M-pesa is a company and they have centralised services. The key question

you need to ask yourself is: where is there a wish to eliminate the trust factor? If we trust m-pesa as a company and can trust that company for the coming decades, why would we use the blockchain? Why use the bitcoin? There's no need to. But if you want to eliminate trust, then you can use the blockchain and the currency on top of it.

So always ask: who don't you trust?

Let me give you another analogy to make it more tangible. If there's a fire extinguisher somewhere in this room, chances are it has been audited and checked. There's an auditor, who comes by once a year to do a check, take a picture and put it in his database. And as long as it's there, you can ask them to provide that information from that audit. But as soon as there are serious problems – the building burns down to the ground, for example – where do all of these people end up? Usually in court. At that point, people may have a reason to be less open about their data.

So there's potentially a point in time where we lose trust. And perhaps we have good reason to lose trust because depending on the situation there may be a lot of money involved or culpability. Now suppose we would have had a blockchain beforehand, then we could have eliminated trust. It's a very easy task. You demand that the auditor take his data at some point in time – after an audit, for example – and make a proof of this data, which you put on the blockchain. You can do that: put any amount of digital data there and make a fingerprint of that data on the

blockchain.

To use another analogy: a couple of centuries ago, people would write a letter, put it in an envelope and then seal the envelope with wax. And that sealed letter would eventually be put somewhere safe, and that's the blockchain. In the future they might need that letter again. Once opened you could see who signed the letter. That's the only true application of the blockchain. Nothing else. You can't feed your dog with it.

How important is it for people to know how the technology works?

That's a good question. I would say they need to understand the basics. The technology offers great freedom but with this freedom comes great responsibility – so you have to do your estate planning. And that means key management. It means that you have to have decent copies, on decent mediums, in decent locations. There's a three-to-one rule for that: three copies, at least two mediums, at least one other geographic location. That's what you do with the keys. There's a complex world behind blockchain technology, and while we don't need to know every detail about the inner workings of the machine, it would be handy – to use the car analogy again – if we could recognise the fuel tank, the carburettor and the electrical engine. To know that the engine didn't start because there's no spark, so to speak. ●

People need to understand the basics. The technology offers great freedom but with this freedom comes great responsibility – so you have to do your estate planning.

had an undeniable impact on transport. Before the T-Ford, people moved around by horse. The bitcoin is like the T-Ford, the new innovation on the block, while the Fiat currencies are the horse.

Assessing the need for blockchain applications

Nikolet Zwart

Using the Oxford Blockchain Strategy Framework, **Nikolet Zwart** has analysed a use case of adding value through the local processing of food by multinational agribusinesses to illustrate the usefulness of any kind of blockchain analysis.

Agribusiness wishes to transform value chains: make them shorter, more transparent, inclusive, traceable and preferably digitised. Though not the solution in itself, blockchain technology can provide the key to this transformation. Indeed, business models and value chains need to be entirely rethought, whereby the so-called 'distributed ledger' of the blockchain can be used to ensure transparency and inclusion.

This can be illustrated by analysing a use case, using the Oxford Blockchain Strategy Framework, developed by Oxford University. This framework helps to assess the usefulness of any blockchain application.

Rethinking food value chains

Many of the food products of multinational food companies are produced in the South, shipped back to the North to undergo treatment (e.g. coating, drying and cutting), after which these products are too expensive to be sold in the South.

To break this cycle, local Southern suppliers of farm inputs to farmers and subsequently the farmers themselves may be enabled to do the processing locally to add value for the exporting food companies. This will reduce the prices of the products, resulting in higher profits for the food companies and domestic markets that are created bottom up. The supplier can buy or lease a processing device, such as a drying tool, coating tool or cutting tool, on credit.

When the supplier sells the processed products, the credit can be redeemed. Using the additional proceeds the suppliers can buy fresh produce from other farmers in the neighbourhood for domestic sales, create a stock, and thus gradually expand their business and strengthen the farmers' community. In the event a certain food product requires registration or certification by a national authority, this can be done via the distributed ledger of the blockchain as well.

Why blockchain technology?

Our use case consists of five or six predictable, repeatable processes that lend themselves well to automation, namely:

- a supplier buying or leasing the processing tools;
- the transfer of credit from the fund to the supplier;
- the supplier buying the fresh produce of the farmer;
- the processing of the fresh produce by the supplier; and, if needed
- its registration or certification and the sale of the processed food to an exporting company.

The processes will run for a long time, in different emerging countries where at present few processed

products, if any, are sold. But gradually suppliers and farmers will be able to lift themselves out of poverty.

All value chain players in a specific sector will take part in this approach. This will ensure that already volatile markets are not disrupted by new technologies. Instead these new technologies will help to create stable, bottom-up markets.

In all five processes conflicts or disparate data would be remedied by one party or a limited number of parties. The fresh produce, the processing tools, and the processed products represent a high value, as do the loans, and even the potential registration or certification by a national authority (which represents value to the food processor, to the national government and to the planet).

Since the suppliers perform their activities on contracts with multinational food companies on the one hand and smallholder farmers on the other hand, and these contracts are interrelated, immutable records are a requirement. The same applies for any necessary license payments for the technologies, in-app payments, the registration or certification, and the micro-loans.

If you take all of these elements into consideration, then the blockchain is an appropriate tool for the envisaged use case. The next step is to figure out the best way to actually apply blockchain technology.

The three layers of the blockchain

Blockchain technology consists of several layers: the protocol layer, the network layer and the application layer. With regard to each of these layers decisions have to be made and different parties and expertise need to be involved.

Protocol layer

Decisions need to be made in the protocol layer about whether to use a public or a private blockchain. The design expectations need to be clear: how fast, flexible and user friendly should the blockchain technology be? Do we need to use or create a developer community or do we have our own developers that can do the job?

In our case there is a need for a private implementation of the blockchain. The several transactions require privacy and security. We will need a permissioned version, which means that anyone using the blockchain will need permission to read information, transact and write new blocks on the chain. This permission will be controlled by the consortium formed to serve the blockchain.

Since it will be a complicated blockchain with many interconnected transactions it should have great flexibility in speed, programmability and functionality. In the end we hope to reach millions of suppliers and farmers in the South to make it easy to become part of the blockchain. A consortium can be formed for developer resources and other technical capacities, involving technology universities and the private sector.

Network layer

Decisions need to be made in the network layer about the computers and other devices on which the blockchain will run, or the 'node'. How will these devices be integrated with the technology that is already being used? How much data needs to be stored?

The nodes will be run by the suppliers, the fund and the multinational food companies (and potentially also the national authority).

Read access will be given to everyone on the different blockchains. Write access will be given to everyone on the blockchains as well, however only for their own transactions (smart contracts). With regard to registering through a

national authority, only this authority will be authorised to write and everyone (even outside the blockchain) will be able to read.

Any farmer, even illiterate ones, any supplier and any (local or global) corporation should be able to access the blockchain in their daily activities just as easily and quickly as possible. The device used should be robust, weather resistant, cheap and preferably handheld. The technology integration should enable suppliers to perform the calculations via their in-house systems, while performing their commercial activities.

The data storage requirements regarding network capability, archiving and regulation will be high, since all

The application is going to be used by many stakeholders, who differ in background. So it should be flexible, accessible and easy for non-technical persons to use.

transactions will be stored on the blockchain for a long time for the sake of traceability, transparency and knowledge building. The national authority will need to have an extensive data storage capacity as well.

Application layer

Decisions need to be made in the application layer with the users of the application in mind. How does this new technology fit in present behavioural patterns and existing workflows?

The application is going to be used by many stakeholders, who differ a lot in background, culture, education and profession. This means that the application should be flexible, easily accessible, simple to use, and attractive for non-technical persons. It should include educational resources, such as train-the-trainer courses on different topics, and early warning systems.

We will make use of existing organisational structures as much as possible since we involve the suppliers as key actors to develop farmers' communities and enhance food security. The present workflow of all actors will be digitised via smart contracts on mobile devices. The behavioural changes necessary to implement this use case will be included in an extension package (train the trainers on the same devices that will be used for the blockchain entrance and smart contracts).

The analysis in this article has led to the formation of actual consortia aimed at setting up blockchain technology in emerging countries, including in the multinational seed business, and between Southern women groups. Public-private partnerships enhancing food and water security via blockchain are also being considered, for which we are seeking public funding. Please contact Nikolet Zwart if you are interested in joining. After all, in the field of blockchain decentralisation and inclusion are key. ●

About the author



Nikolet Zwart is an independent lawyer specialised in public-private partnerships in agribusiness, the creation of tools, and the

use of technology for inclusion and gender equity, based in Noordwijk, the Netherlands.

Right: A pile of shea nuts on top of a mud oven being roasted. Mali, West Africa

The blockchain: opportunities and challenges for agriculture

Nathalie Toulon

Nathalie Toulon from the AgroTIC Digital Agriculture Chair in France discusses the many ways in which the blockchain can potentially change agriculture, for example by enhancing trust, transparency and efficiency, and several pitfalls to take into account. Like any new technology, the blockchain should not be viewed as a panacea. For it to serve development, it will need to mature.

The blockchain is being heralded as a new approach to data storage and transmission that has great potential for agriculture, both for agribusiness and consumers. It is undoubtedly attractive, combining cryptography to guarantee the integrity and permanence of data, a peer-to-peer architecture that avoids centralising intermediaries, and principles of collective governance where each player can access transactions and guarantee their legitimacy. As such, the blockchain promises increased trust, transparency and fluidity of transactions within multi-stakeholder systems.

More transparent traceability and efficiency

Not surprisingly, issues of traceability in the supply chain are the first uses being explored: blockchain is above all a ledger technology. It's an effective tool for verifying proof of existence, full records, and the ownership or origin of exchanged information.

The aim is total traceability: to store data about the location of production and slaughter, product storage and transportation in such a way that it cannot be tampered with, allowing one to retrace the steps to the source of any problem more quickly. As the blockchain is linked with the connected objects, it also facilitates real-time alerts (failure to respect a designated temperature, for example).

Furthermore, the blockchain can be used for certification. By integrating smart contracts (computer programs that run autonomously as soon as certain criteria are met) the technology promises to reduce procedural delays and costs, and systematise controls. The aim is to bring this traceability all the way to the consumer to restore public trust, which has taken a beating as a result of a succession of food scandals, particularly in Europe and the United States.

Bureau Veritas, an international certification company, recently presented Origin; the 'first blockchain-based label to give consumers a complete end-to-end proof of a product's journey, from farm to fork'. This is done by making data available to consumers through QR codes placed on products.

As mentioned, the blockchain is a way to earn trust and therefore develop greater synergy between players in the same network: each player feeds into his or her data and has access to other members' data without anyone having exclusivity. 'The use of blockchain only makes sense,' says Emmanuel Delerm, project director at Carrefour, 'if several people work on it. Its distributing and decentralised character is what is essential.'

From traceability imposed by public authorities, we move to a 'value added' traceability for companies, embracing a logic of strategic management of the value chain. The PlayitOpen start-up, for example, offers companies a web application associated with the Ethereum blockchain, reporting on their commitments to sustainable development during the production of goods and services. These commitments become digital assets (sponsorship funds, carbon, trees, quality certificates, etc.), which can be traced and exchanged. This tool was mobilised by the PUR Project company through the 'International Platform for Insetting' for an action aimed at supporting agroforestry.

A transaction accelerator

In early 2018, the Louis Dreyfus Company, Shandong Bohi Industry, ING, Société Générale and ABN AMRO announced they had completed 'the first full agricultural commodity transaction using a blockchain platform'. This

transaction of agricultural commodities included a full set of digitised contract documents and automatic data-matching, thus avoiding task duplication and manual checks. The transaction demonstrated significant efficiency improvements for all participants in the chain. It reduced the time spent on processing documents and data fivefold, introduced real-time monitoring, a shorter cash cycle and reduced the risk of fraud.

As an open register recording of who sells what, who buys what and at what price, the blockchain offers solutions to small producers who struggle to understand markets and benefit from fair remuneration. The peer-to-peer network can enable transactions from sellers to buyers without intermediaries and therefore without commission.

AgriLedger, a philanthropic initiative, applies the technology to create a circle of trust around small farmer cooperatives in developing countries. The company offers a mobile application connected to the blockchain to record transactions, a service bundle to plan product distribution more efficiently through a better understanding of markets, as well as secure identity management and a value 'safe', allowing small producers to access the world of banking services, micro-payments and loans.

Another example in the area of facilitating access to loans is Twiga Foods, which offers a mobile procurement platform for sales outlets, kiosks and market stalls in Africa. It has collaborated with IBM in Kenya to offer a pilot micro-credit application for food vendors. Traders enter their procurement purchases from mobile devices. Their creditworthiness is assessed and then blockchain technology is used for the administration of the loan until acceptance of repayment terms.

The blockchain and smart contracts for connected farms

By offering lower management and transaction costs, the blockchain is seen as a technology that provides an alternative to traditional agricultural insurance. It allows the development of index insurance, particularly in developing countries: compensation could be triggered for all farmers in a given area without expert intervention as soon as an indicator threshold is reached (such as the number of days of drought), under conditions defined in advance and written in a blockchain. This development is still in the idea stage, however, and still needs to be tested.

Finally, blockchains and smart contracts will definitely play an important role for tomorrow's connected farming, whether for communication between connected objects and micropayment management linked to the actual use of objects (as proposed by the Filament start-up, for example), or to ensure greater transparency in the sharing of agricultural data. The issue of managing farmers' consent in the use of data is currently being explored in France by the CASDAR project – an agricultural and rural development programme – ('Multipass' project), which will test the blockchain as a way of building greater trust.

A technology that needs to mature

There are many potential uses of the blockchain in agriculture, but there are several areas in which we must remain vigilant:

- **Societal:** The blockchain can only work if all the links in the chain feed into it and decide together how it will evolve. By eliminating certain intermediaries, new structures of power will be established and roles will be redistributed. A balance needs to be struck.

The blockchain is a way to earn trust between players in the same network: each player feeds into his or her data and has access to other members' data without anyone having exclusivity.

Food giants Nestlé, Tyson Foods, Unilever and Walmart have already joined up with IBM to explore the potential of blockchain for traceability. The French group Carrefour is also counting on it for its chicken quality line, as well as eight other quality lines, such as eggs (from hens reared without antibiotics), oranges (without pesticides after flowering), tomatoes (without herbicides) and Norwegian salmon (without antibiotics or GMOs).

- **Regulatory and legal:** The legal framework of the blockchain remains vague. In the case of developments in the financial sector, there are still questions about the legal value of the 'ledger', about responsibilities in the event of poorly designed smart contracts, and about the adaptation of tax and commercial regulations.
- **Technical:** Technologies come into play, but questions still remain about scaling up. Today, the blockchain exists mainly through proof of concept addressing a limited number of users. It needs to prove it can perform (speed of transactions, storage capacity, volume of the ever-growing chain) for a wider audience. There are also questions of interoperability, in particular regarding the integration of blockchains into existing information systems.

We also need to improve our understanding of the blockchain. In order for it to be used transparently, companies will need to understand its benefits while remembering that this type of technology is not a panacea. 'It can't do everything by itself,' says Alexandre Stachtchenko, co-founder of Blockchain France. 'While it knows how to manage digital assets extremely well, as soon as physical products come into play, it becomes necessary to add QR codes, connected objects, sensors... The blockchain is only an architecture that catalyses all these technologies.'

In the end, the blockchain is one technical option among several others. There are big differences between public blockchains that revolutionise relationships of trust

and private blockchains that remain 'under control'. Furthermore, there are many situations where this technology is not appropriate. It is therefore important to have a clear vision of the needs and to understand how the blockchain can contribute to these needs.

Supporting companies in the digital transition of agriculture

The explosion in new digital technologies such as the blockchain raises many questions for economic actors who need to adapt. The AgroTIC Chair, a French 'business chair' type of mechanism, was created to build strong links between the world of research and business in order to support the digital transition of agriculture. Since November 2016, three French agricultural education and research institutions (Montpellier SupAgro, Bordeaux Sciences Agro and Irstea) have joined forces with 24 'sponsor' companies from the world of farming and digital technology, as well as technical partners, to lead actions of collective interest contributing to the development of digital agriculture. At the request of its members, the AgroTIC Chair therefore took an interest in blockchain technology, in order to study its opportunities in agriculture, resulting in a study that is available in both English and French. After outlining the basic principles, the study sheds light on the key issues facing this technology by presenting different cases of its use. It also highlights the obstacles to its adoption and underlines the fact that it still needs time to mature in order to go beyond the stage of 'excessive hopes' to reach that of 'real advantages and concrete applications'.

Beyond the technological aspects, the blockchain raises broad questions on the digital transformation of a particular sector (the roles participants play, the definition of added value and the evolution of production and distribution networks). Given the need for strategic thinking, it is important for the various players to work together to take better charge of the blockchain issue. For this, collective experimentation and demonstrating proof of concept is without a doubt the best approach. ●



About the author
Nathalie Toulon is deputy manager of the AgroTIC Digital Agriculture Chair, established by agricultural research engineering schools Montpellier SupAgro and Bordeaux Sciences Agro, along with the Irstea research institute in France.

Related links
 AgroTIC blockchain studies
 English version: goo.gl/TMvFFD
 French version: goo.gl/4xX4Pz

We also need to improve our understanding of the blockchain. For it to be used transparently, companies need to understand its benefits and remember that this technology is not a panacea.

Blockchain

A TECHNOLOGY WITH BIG POTENTIAL FOR FARMERS

Applications

- ▶ Enhance data security and ensure the authenticity of land records
- ▶ Accelerate transactions
- ▶ Bringing transparency to the supply chain
- ▶ Build trust between parties & devices
- ▶ Real-time information access

Blockchain's market

The blockchain market size is expected to grow from USD 411.5 million in 2017 to USD 7,683.7 million by 2022

- Faster transactions
- Simplified business process with transparency and immutability
- Rising cryptocurrencies market
- Reduced total cost of ownership

Agrofood supply chain management

Stakeholders involved in a supply chain network trade more quickly and in a transparent manner

Recommendations from CTA blockchain workshop

- ✓ Promote agricultural value chain and ICT4Ag
- ✓ Educate agribusiness stakeholders, financial institutions, policymakers
- ✓ Closely work with leading outgrower and agricultural finance schemes to test use cases
- ✓ Support start-ups to engage in the blockchain
- ✓ Develop platforms and ecosystems promoting blockchain in agriculture

More on: <http://bit.ly/CTA-Blockchain>

Cryptocurrency: more education, less hype



John Weru is a Kenya-born writer, blogger and co-founder of PayHub East Africa. In a conversation with *ICT Update*, John talked about the rise of cryptocurrency, the potential of the blockchain to improve efficiency in the agricultural value chain in Africa, and the urgent need to educate people about the technology itself and the economy that it is creating.

Q How did you originally get interested in the blockchain?

My interest in the blockchain began with a news report on Al Jazeera in late 2014. That was the first time I had heard about the technology and what's behind it. It was around that time that I also learned about somebody who had bought 5,000 bitcoins at less than a dollar each, so he's about US\$5 million richer now. Naturally that got me curious and I wanted to see what this is all about. So that's how I got involved in the bitcoin and the blockchain space. I started out by blogging about it. I wrote for a bitcoin exchange and for a number of bitcoin news websites. And from there I never looked back. I also started coding blockchains: I got a book and tried to see if I could code blockchain on my own. So I started to find ways of immersing myself more in the technology.

I frankly don't see where the fear comes from with banks. Let's understand one thing: the whole cryptospace is not going anywhere.

Q You are co-founder of a company called PayHub. Did that emerge from your interest in blockchain technology?

Yes, actually it was a convergence. The original founder of PayHub Solutions, headquartered in France, has been involved in the fintech space for quite some time. So when we started chatting and I told him about my interest in the blockchain, we agreed that this was probably a technology that was worth watching, especially in view of the fairly poor financial systems in Africa. We thought it would be a good idea to see what we can do with it. We started by wanting to enable financial inclusion on the African continent.

Q Many people immediately think of bitcoin when they hear the word blockchain. How did the bitcoin come about?

The founder of bitcoin, Satoshi Nakamoto, wrote a white paper back in 2008. In it he explains the idea behind blockchain technology and what it's designed to do. It's more or less a consensus mechanism that bypasses the traditional third party that acts as a go-between in financial transactions. So I understood it from that perspective. Especially in the wake of the financial crisis the world was going through, I understood that blockchain was designed to solve that problem by ensuring that transactions are done by consensus and in a very transparent, open and public way.

That was an interesting approach. I personally don't have any political agenda as to why I got involved in the blockchain, but I did see it as a solution to many of the problems that we're encountering, for example sending money on the African

continent. It's expensive to send money here: until very recently the charges and transaction fees could amount to as much as US\$10-US\$15 per transaction. The bitcoin and the blockchain seem to be making that easier for those of us who don't live in our country of origin. So it's from that angle that I – and many others – got interested in the bitcoin and what it can do.

Q Banks have been reluctant to accept cryptocurrency, fearing it almost, though some seem to be embracing it now. What are your thoughts on the establishment's role in blockchain technology?

I frankly don't see where the fear comes from with banks. Let's understand one thing: the whole cryptospace is not going anywhere. You cannot undo the idea, it's already out there. And you cannot deny that the cryptospace will also need some kind of regulation. I think both parties will have to meet somewhere in the middle. And here I'm not only including the central banks but I also have in mind commodity trading commissions and regulators. And that is because bitcoin and other cryptocurrencies have a dual nature. They can function as currencies and they can also function as commodities. Now what we need in the industry are rules. The ones who are best placed to make those rules basically are the central banks. So I don't really see a situation where banks need to be unduly worried.

I'll give you another example from my home country. When m-pesa was launched, the banks in Kenya were similarly reluctant to embrace it. But the central banks decided to give this new technology space to see what it can do. Ultimately, it managed to address the enduring problem of financial inclusion. Before m-pesa only about 20% of Kenyans had bank accounts. After m-pesa that percentage must have risen to 70 or even higher. So m-pesa solved a problem that banks were not able to solve by themselves.

It's always my view that technology is judged by its ability to solve a problem. The fact that the cryptospace is growing so quickly does demonstrate that there must have been something in the market that it's responding to or that people are responding to. So I see them as being complementary.

Q Now the blockchain is becoming more accepted and known, people are looking for other ways to use it. What do you believe is its potential in the agriculture sector, for example?

Personally I am working on a project in agriculture, and what I'm trying to do is explore the possibility of the blockchain being used to improve the agricultural value chain in Africa. Right now, about 30%-40% of harvests in African agriculture are lost. And that's mostly because of inefficient value chain systems. So when it comes to things like being able to move commodities from one place to another there is quite a bit of loss. The problem is that a lot of the information that you need to make those decisions and improve the value chain is held up in companies and what you generally call information silos. Access to this information is very limited though.

So one of the projects that I'm working on would enable all the players in a value chain to be able to pull their data together onto a blockchain which can then be used to track the movement of commodities across the entire value chain. Of course that involves quite a number of actors and different kinds of technology. But that's how I see the blockchain being used: to improve efficiency.

Q What challenges are facing cryptocurrencies? Some people are concerned about their apparent volatility.

What I've noticed about cryptocurrencies is that there's a lot of exuberance and very little education. Right now most of the people who are getting into this space or who want to invest in bitcoins are doing so because they think they can make a lot of money. Very few people I meet are able to really have a discussion on what it is that drives bitcoin and its underlying technology. In fact, few people are interested in having that conversation. In their minds it's all about how to make money.

This actually gives the technology a bad name. The volatility in my view is the function of the lack of two things. A flexible and accommodating public policy. And second, an educated consumer. If we had educated consumers who are aware of what it means to put their money into bitcoin, then we would have a much more stable currency.



But I see this technology as something that can solve a lot of problems in Africa. That's what we at PayHub are trying to do in East Africa, to offer solutions that are practical and relevant to where we live. So my only wish is that we had more education and less hype. It's especially important that we look at other ways of using the blockchain, such as in agriculture. I see a situation soon where there will be a convergence between cryptocurrency, artificial intelligence and 3D printing to create whole new solutions and products that maybe right now we

I see this technology as something that can solve a lot of problems in Africa.

cannot conceive. But for that to happen we need the enabling environment, an environment where people are educated, where people are skilled, where people are trained, and where we have government policies that aid rather than interfere with the technology. ●

Building lives with dignity

Eva Oakes

Eva Oakes describes Choco4Peace's experience building a network based on blockchain technology in the cocoa sector in Colombia. The main aim is to get smallholders out of both cocaine production and poverty through access to finance.

Blockchain technology, increasingly known as the dark horse bringing sustainable solutions to shortages and inequalities in the agrifood industry, largely holds the tools needed to stop world hunger while addressing development issues on an international level. By aggregating investors and producers within integrated economic networks, blockchain technology has bridged an often hard-to-cross gap, bringing together suppliers attempting to meet a rising product demand and producers in developing countries who lack the means to both find buyers and export their product.

The potential of Colombian cocoa

Recognising the need of using blockchain technology, Choco4Peace, a start-up company based out of Montreal, Canada and Bogotá, Colombia, has begun creating such a network in Colombia's cocoa sector. Colombia is currently the fifth producer of cocoa worldwide, and third in Latin America. The cocoa is grown by approximately 38,000 families, with 90% of production being carried out by smallholders rather than large commercial agriculture companies.

Despite the high propensity for cocoa growth, with Colombia's Cocoa Development Ten Year Plan 2012-2021 reporting around 660,000 hectares of terrain available for growing cacao, Colombia's export potential is currently marginal, comprised of only a handful of producers capable of fulfilling certification requirements. Many of Colombia's potential cocoa crop lies in largely rural, hard-to-access

Blockchain technology makes it possible to integrate smallholder integration into larger economic networks..

post-conflict regions formerly occupied by guerrilla groups operating before the peace agreement in 2016. Occupancy commonly forced farmers in these regions to farm coca for the production of cocaine, and focusing on the production of cocoa was economically and logistically unfeasible.

Also contributing to Colombia's modest export potential

are unsustainable agricultural practices. According to the International Cocoa Organization, up to 40% of cocoa crops are lost annually due to incorrect conservation and upkeep. Not only is it, under current circumstances, impossible to translate the potential of cocoa production into the global market, but unsuitable practices hinder the amount of cocoa available for export.

In Colombia, the potential for cocoa is not only unique in terms of quantity but also quality. The Colombian cocoa sector is known for the production of cocoa 'fino aroma', a specialty cocoa which is rising in demand from international buyers distinguished from mass-producing companies in their qualifications they take into account when buying cocoa.

'Fino aroma' cocoa is typically used in the production of gourmet and high-quality chocolates, products for which demand has undergone explosive growth with no signs of decrease. Buyers of this type of cocoa emphasise the quality of the chocolate, while taking into consideration sustainability and ethics. As consumer preferences are shifting towards demand for better quality, origin, specific flavours, higher sustainability and traceability, a niche market has been established in which buyers interact directly with producers to maintain long-term relationships.

Using the blockchain in the cocoa sector

Choco4Peace is using hyperledger blockchain technology to allow the production of cocoa in Colombia to proliferate, while addressing a deficit of cocoa in the international market and bringing smallholders out of both cocaine production and poverty through access to finance. Blockchain technology is implemented through a combination of decentralised phone applications supporting an inclusive economic network, which aggregates smaller-scale cocoa producers with chocolate makers, socially oriented investors and stakeholders such as sustainable development service providers.

Cocoa producers in these post-conflict regions previously had little access to financial resources due to obstacles in the form of communication, transportation, product quality, corruption and more. Rural areas are particularly prone to these kinds of challenges, especially in the case of Colombia, where weak institutional power allowed guerrilla groups to overtake these areas and encourage the production of cocaine, while diminishing the livelihoods of the residing communities.

Where weak institutional power prevents the government's attempts to alleviate poverty and boost development efforts, Choco4Peace's use of blockchain technology steps in. The Colombian government has recognised the issue of the prevalence of coca growth and has pledged money to volunteer smallholders willing to transition from the cultivation of coca to that of cocoa. However, due to the government's lack of capacity, the amount of funds they are offering farmers are not sufficient for smallholders to be secure in this shift. Recognising this issue, Choco4Peace's blockchain platform uses blended finance, combining funds and tools offered with those of the Colombian government, enabling the private and public sector to collectively finance cacao entrepreneurs' ventures.

After identifying willing and capable producers, Choco4Peace's programme provides smallholders with capacity building tools such as insurance, training, technology and certification services in order to transform them from high-risk investments to low-risk investments. These steps not only serve as preparation for access to investors and financial resources, but additionally, they promote principles of sustainability. These tools instruct



smallholders to use sustainable cultivation practices with the goal of yielding higher crop productivity, improving quality, preventing the misuse of land and denigration of soil and maximising crop cultivation while natural resources are conserved.

Through the blockchain, the socioeconomic and environmental impacts of cocoa producers' sustainable farming practices are made visible through an accumulation of data, recorded on a transparent hyper-ledger platform. In collaboration with the IXO Foundation, an organisation using blockchain to provide a trusted global information network to encourage impact investors, Choco4Peace seeks to measure and generate a proof of impact through the accumulation of data based on interactions within the economic network. Blockchain technology's ability to store and provide extensive data is used as a means to build trust, incentivising investment in areas of need around the world as investors can see directly the impact their contribution makes.

Integrating smallholders into the economic platform

Choco4Peace's project targets rural smallholders in post-conflict areas, but more specifically within this criteria, Choco4Peace focuses on the empowerment of those most in need; women, youth and indigenous people, all of whom have suffered the impacts of Colombia's long war, and are willing to transition from cocaine production to cocoa cultivation. These producers, once identified and provided with the tools and training necessary, are entered into the economic platform, where they are aggregated with chocolate makers, investors and stakeholders.

The blockchain's ability to record all transactions allows both buyers and consumers to trace the cocoa's origin, ensuring trust, traceability and transparency, qualities often absent in relationships between investors and smallholders

in rural and often unstable areas. The use of this technological platform additionally reduces time and cost and increases cooperation by removing the necessity of communication through 'middle man' third parties, as increased transparency within interactions decreases the number of necessary actors.

Blockchain technology makes the possibility of smallholder integration within larger economic networks possible, impacting deficits not only in the international market but also at a micro level. By providing smallholders with access to finance, farmers and their families previously suffering from impoverishment, malnutrition and a general lack of resources due to both location and weak state infrastructure, are empowered by entrepreneurship through the growth of cocoa.

Through Choco4Peace's use of blockchain technology, chocolate, a widely-appreciated commodity throughout the world, is quite literally being used for the construction of peace, as blockchain technology provides a way for producers to build lives with dignity, transitioning from the production of cocaine to that of cocoa. Access to markets, fair prices and transparent and traceable trade, made possible by blockchain technology, make this positive transition feasible, bringing chocolate to the world while diminishing the harmful impacts of the cocaine industry and empowering those living in Colombia's post-conflict regions.

How sweet is chocolate for peace... ●

About the author



Eva Oakes (eva@choco4peace.org) is a communication strategist with Choco4Peace, based in Montreal, Quebec.

Above: Cacao harvest

#AgBlockchain: values and fallacies

Marieke de Ruyter de Wildt

In 2017, The Fork - an Amsterdam-based company working on blockchain for global food chain development - developed, reviewed and commented on about 20 applications of the blockchain in agriculture. After briefly explaining what it essentially is, we will summarise its value for agriculture - which is different to what is often communicated - as well as its limitations, and how you can start experimenting with it.

Open or public, decentralised or centralised?

The blockchain is basically a dataset of transactions, a ledger. It is a combination of 'a database' with 'the network', and an advancement on 'cloud computing'. There are at least four new characteristics to this database that jointly explain why there is a hype about the blockchain.

First, it is essentially open, and public. Anyone who is authorised can read and write to the database. Second, it is auto-synchronised. All copies of the database are exactly identical and are synchronised immediately and simultaneously. Third, it is immutable. It requires some time to realise what impact this characteristic can have on supply chains. It is permanent. Once information is entered, it can never, ever be deleted, changed or tampered with. For supply chains in general, but specifically for agriculture, this is of immense value. Fourth, it is distributed across the network. This is why these types of technology are increasingly being referred to as distributed ledger technology.

The fact that it is a distributed technology suggests it is part of our next industrial revolution. We live in a society in which most business models are decentralised, such as Uber, Airbnb and Facebook. Technologies such as the blockchain enable distributed business models. This is why it has tremendous disruptive potential.

There is an important footnote to mention about the open character: there are public and private blockchains. Knowing the difference is key. Bitcoin is an example of a public one and it is the most open ledger. Hyperledger is a private one. They do different things very well. So before assuming that everything is open and transparent to everybody on a blockchain, find out about the blockchain's specifics and governance structure. Who has access to what? Find out whether it belongs on the right or the left side of the picture below.

A final key point about the blockchain that everybody should know is that it is only a part of a set of technologies. The blockchain is nothing on its own. The blockchain exists with old-school databases like Excel sheets and ERP systems, with application programming interfaces that allow exchange between different systems, and most importantly, user interfaces or apps, or decentralised apps. The last three refer to the kinds of apps that you would find on your devices. Their functionality makes or breaks the impact of the underlying technologies as they make it possible for you and me to use technology properly.

Why the blockchain?

The blockchain indicates a new generation of technology. In fact, it is less about the blockchain and much more about decades of research and breakthroughs in security that have culminated in the next level of database technology. It entails a different approach to storing information. Whereas we previously could only transfer information over the internet, we can now safely transfer value from one user to another. This implies a completely different dimension of databases.

There are three technical reasons why you should start experimenting with the blockchain:

1. The truth: The blockchain encrypts information into code. This encryption cannot be removed, altered or omitted. This is essentially what establishes the truth, and hence trust between parties. It is this trait that makes it so vital for agriculture.

2. Ownership: In our experience the blockchain solves the data ownership problem, a key limitation to digitisation in agriculture. It gives data ownership back to users, as users have full ownership, control and transparency over their data. Data is replicated across several unrelated points, and no single point can act as gatekeeper and blur ownership issues. Users who store information on the blockchain retain access to it through encryption keys that they alone own, independent of the service or application that generated it.

3. Scalable track and trace: The blockchain is a distributed system. It is about rules with no ruler. Read that again. Rules with no ruler. There is no central party in control. Everybody is in control. The rules are embedded in the system itself, into the code. This makes the blockchain very robust and scalable. Track and trace was already very doable, but with a decentralized blockchain it is much more scalable and reliable.

There are also three business reasons why it is a matter of when you start, rather than if:

1. Risk management: because everybody in the network has the same information at the same time, and because you have accurate information, rather than information in hindsight, risk management will record unseen improvements.

2. Operational efficiency: only in part due to auto-synced information, efficiency gains have recorded a staggering 80% improvement (in finance, where implementation is most mature). Efficiency is also attributed to smart contracts. Smart contracts are pieces of code that automate if-then causalities.

3. Integrity or sustainability: with more decentralised structures, information travels faster and becomes more accessible to more people - ideally everybody - and transparency increases. It becomes much more visible who does what for which remuneration. Ownership is better organised, and it is far more difficult to hijack a system for individual purposes.

Blockchain has one of the strongest, if not the strongest, value propositions in the supply chain and more so in agricultural supply chains. Overall, supply chains have low levels of trust. The more complex they are, the less trust there is between parties, and the more expensive the transactions are. Agricultural supply chains are one of the most complex supply chain domains and suffer from very low levels of trust. Through the above mentioned reasons, the blockchain has the potential to impact this drastically in the next five years.

Why not the blockchain?

Of course, there are many concerns and limits regarding this new technology. The blockchain is still in its infancy. It is essentially what the internet was 20 years ago, meaning there is more we do not know than we do know. There are many misconceptions, ambiguity in definitions, mixing up of concepts and certainly many scams. For now, we can offer three disclaimers:

1. Do not implement the blockchain at scale. You will have to re-do and transport to other, newer, better technologies.

2. Do not use the blockchain for tracking and tracing only. We have better, more efficient solutions for that.

3. Do not start if you cannot combine proven blockchain experience with business savvy. Do not be misled by so-called experts, there are many scammers out there. Certainly do not let technology dominate or blind common business sense.

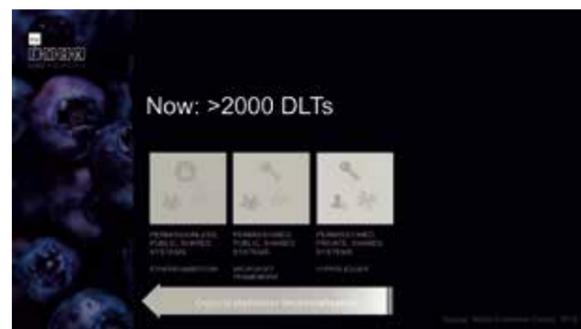
How to start with blockchain

There are three tastes currently. Either start with an existing product like steemit, a blockchain-driven social media platform. Buy and tweak a ready-made solution such as AgUnity, a mobile app that records and transacts incorruptible truth using blockchain technology. Or start with the technology from scratch. Choose your first experiment wisely though. We see four critical criteria here: complexity, high costs, information asymmetry and trust issues. ●

About the author



Marieke de Ruyter de Wildt is founder of The Fork, based in Amsterdam, the Netherlands, whose mission is to 'help you integrate blockchain technology in food supply systems'.



What	Why	Indicators	Product A	Product B	...	!	⚙️	👤
Complexity	Distributed systems deal best with scale, vulnerability and complexity	Many partners, inputs, processing, various countries etc	3	3	∞	∞	?	
High costs	Automation reduces costs	Low margins, many traders, seasonality etc	1	2	∞	∞	?	
Information asymmetry	Information ownership is better organized, safer and better distributed	Many smallholders, lots of paper, data silos etc	2	1	∞	∞	∞	
Trust issues	No need to trust people, rely on 3rd parties or deal with corruption	Many requirements, certificates, little transparency, collaboration etc	1	2	?	?	∞	

The rise of blockchain technology in agriculture

Andreas Kamilaris, Francesc Xavier Prenafeta-Boldú and Agusti Fonts

Blockchain appeared in our lives as a modern technology that promises ubiquitous business transactions among distributed untrusted parties, without the need of intermediaries such as banks. Several ongoing projects and initiatives now illustrate the impact blockchain technology is having on agriculture and suggest it has great potential for the future.

As blockchain technology gains success and proves its functionality in many cryptocurrencies, various organisations are attempting to harness its transparency and fault tolerance to solve problems in scenarios where numerous untrusted actors get involved in the distribution of resources. Two important areas are agriculture and the food supply chain.

Blockchain for agriculture

In December 2016, the company AgriDigital successfully executed the world's first sale of 23.46 tons of grain on a blockchain. Since then, over 1,300 users have been involved in the sale of more than 1.6 million tons of grain over the cloud-based system, involving US\$360 million in grower payments.

The success of AgriDigital has served as an inspiration for the potential use of this technology in the agricultural supply chain. Agriculture and the food supply chain are closely linked, since agricultural products are used as inputs in multi-actor distributed food supply chains. Indeed, the global

developing countries. There are several initiatives pursuing this path, three of which stand out in particular. AgriLedger describes itself as 'a Mobile App that records and transacts incorruptible truth using blockchain technology'. It uses distributed cryptoleger and mobile apps to create a circle of trust for small farmer cooperatives in Africa.

The American organisation FarmShare focuses on creating new forms of property ownership, community cooperation, and locally self-sufficient economies. It aims to use the blockchain to 'tokenize shares, incentivize volunteers, optimize resource sharing and minimize food waste'. OlivaCoin is a platform for the trade of olive oil. With its own cryptocurrency and traceability system, it aims to support olive oil producers by reducing overall financial costs, increasing transparency and giving them easier access to global markets.

Food safety and integrity

Food safety is about handling, preparing and storing food in ways that prevent food-borne illnesses. Food integrity refers to the fairness and authenticity of food in food value chains both at the physical level and the digital level. The digital level should provide reliable and trustworthy information on the origin and provenance of food products at the physical level. Food safety and integrity can be enhanced through higher traceability. Using the blockchain, food companies can quickly trace outbreaks back to specific sources, which could mitigate food fraud.

There is an impressive list of companies that have started to use the blockchain to safeguard food safety and integrity. Cargill uses it to let shoppers trace their turkeys from the store to the farm that raised them. Walmart, Kroger and other companies have partnered with IBM to integrate blockchain technology into their supply chains. Coca-Cola has employed it to identify cases of forced labour in the sugarcane supply chain. Carrefour is using blockchain to verify standards and trace food origins.

Other examples include Downstream beer, which calls itself the world's first blockchain beer. It uses blockchain technology to reveal production information. 'Paddock to plate' is a project designed to track beef and protect Australia's reputation for quality production, using BeefLedger as a payment platform. JD.com traces the production and delivery of beef raised in Inner Mongolia. GoGo Chicken is tracking chickens with an ankle bracelet, putting the information collected online. The Grass Roots Farmers' Cooperative uses blockchain to trace how animals are raised. Intel has released a demonstration case study showing how Hyperledger Sawtooth, a platform for managing blockchains, could

facilitate seafood supply chain traceability.

In January 2018, the World Wildlife Foundation announced the Blockchain Supply Chain Traceability Project to crack down on illegal tuna fishing. Ripe.io harnesses quality food data to create the Blockchain of Food. Consumers can use BreadTrail (as featured in this issue on page 22) to inform themselves of a product's origin. Finally, the 'blockchain for agrifood' project has developed a proof of concept application targeting table grapes from South Africa.

Benefits and challenges

Blockchain technology offers many benefits, providing a secure way to perform transactions among untrusted parties. To improve traceability in value chains, a decentralised ledger helps to connect inputs, suppliers, producers and buyers. In particular, blockchain is suitable for the developing world, where it can support small farmers by providing them with finance and insurance and facilitate transactions. Although small farmers supply 80% of the food in developing countries, they rarely have access to insurance, banking or basic financial services.

There are various barriers and challenges for the wider adoption of blockchain technology. A case study in the Netherlands revealed that small and medium-sized businesses are too small or lack the expertise to invest in the blockchain by themselves. Current uncertainties are preventing individual parties from developing a convincing business case. With respect to education, there is a lack of awareness about the blockchain, and training platforms are non-existent.

Moreover, an important barrier is regulation. The current experience of cryptocurrencies indicates that they are vulnerable to speculators and massive price fluctuations. So without some form of regulation, cryptocurrency is not a trusted means yet for use in food supply chains as a comprehensive solution. And there is still a lack of consensus among policymakers and technical experts on how to use blockchain technology and carry out transactions based on cryptocurrency.

In the meantime, it is hopeful that blockchain technology is being used by so many projects and initiatives. Together they aim to establish a proven and trusted environment to build a transparent food supply chain, integrating key stakeholders into the supply chain. Of course, as with any relatively new technology, there are still many issues and challenges that need to be solved. Blockchain technology must become simpler to understand and use. A number of start-ups have been working in this space, such as 1000 EcoFarms, which developed an entire platform to make it easier for farmers to use the blockchain.

We also need to address various issues on the public research agendas, while governments should invest more in research and innovation to develop evidence for the added value of the technology and design a clear regulatory framework for blockchain implementations. The near future will show if and how these challenges can be addressed by governmental and private efforts, in order to establish blockchain technology as a secure, reliable and transparent way to ensure food safety and integrity. ●

There is an impressive list of companies that have started to use the blockchain to safeguard food safety and integrity.

food chain is complex, bringing together farmers, warehousing, shipping companies, distributors and grocers.

Not only is the system inefficient, it is also imprecise. When you buy a vegetable at your local grocery store, the brand listed on the sticker may have no idea which farm the vegetable came from. The initiatives where blockchain technology could be used to solve real-life practical problems fall into two categories: supporting small farmers, and food safety and integrity.

Supporting small farmers

Supporting small-scale farmers and small cooperatives is currently by far the best way to improve efficiency in



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Related links

AgriLedger www.agriledger.com
FarmShare www.farmshare.org
OlivaCoin www.olivacoin.com

Promising blockchain applications for agriculture

Sander Janssen and Jaclyn Bolt

Sander Janssen and Jaclyn Bolt discuss the potential of blockchain technology for agricultural development by way of multiple examples, arguing that it needs to be combined with a strategy for digitisation, targeted capacity building of its users and an impact-driven approach.

Blockchain is a promising digital technology that offers new and interesting possibilities for agricultural development. It has several features that make it potentially useful for a range of interesting applications, especially in situations where no current digital information and data management solution for transactions exists. These particularly interesting features all focus on increasing trust: transparency of transactions, immutability and incorruptibility of transactions, distributed governance in a large network, possibilities for objective validation of achievements and low operating and transactional costs. Depending on the configuration of the blockchain and the type of applications, some of these features might be more relevant than others. We can think of several interesting applications for agriculture and social development for which we will highlight the most promising applications.

Value chain

Consumers have grown used to tracking and tracing through value chains with eco-labels and certification systems. But at the end of the chain, regardless of the involved labels, it is difficult for consumers or stakeholders to verify what has happened to a product along the way. Furthermore, certification processes in value chains are not always consistently reliable. What the blockchain could offer is more certainty about the integrity and correctness of the information accompanying goods. A nice example is the development of applying blockchain technology in the tuna value chain.

A consortium of the World Wildlife Fund (New Zealand, Fiji and Australia), ConsenSys, TraSeable and Sea Quest Fiji is setting up a provenance system based on blockchain

technology for the value chain of whole tuna. The aim is to eradicate illegal fishing in order to prevent the depletion of the natural tuna population, but there is also a focus on eliminating the slave labour prevalent in the fishing industry.

Caught tuna is directly labelled on the vessel with a radio frequency identification (RFID) chip through which the fish can be traced to the processing company. To lower barriers for smaller players in the value chain, expensive RFID chips are substituted by cheaper QR codes that are also accessible to consumers.

This code is fixed to the tuna so consumers can use their phone in the (super)market where the tuna is sold, from which they can access relevant data connected to a particular fish. Since the stored data is accompanied by proofs on an immutable blockchain, the customer can be sure that the location and circumstances for which data has been stored has not been tampered with as no actor along the chain is able to change the data.

Registry

In some developing countries proving who you are and what you own might be a challenging endeavour. For example, in India hundreds of thousands of civil cases take place every year concerning land ownership, and it is estimated that huge amounts of money are being paid in bribes at land registrars across India. The state government of Andhra Pradesh has partnered with Swedish start-up ChromaWay to apply the blockchain for a more transparent, resilient and secure registry.

In Ghana, BenBen Ghana has created a platform to capture transactions and verify land ownership data, enabling smart contracts through the blockchain to make sure land records are found or remain unchanged. Their aim for the future is to create smart mortgages. Factom (an American company) has piloted a project to document land ownership in the Honduras. This creates a safer environment for registration of land ownership, mortgages and contracts.

It should be noted that these developments usually attract a great deal of interest and they are greatly pushed by the desire for examples of applying this innovative technology. However, applying the blockchain for land registry is a process that might take years before true progress can be made and the abundance of attention for this innovation may be counter-productive in this respect. Nonetheless, it is worthwhile pursuing these developments because certainty in landownership is important for boosting local economic development.

Payments for ecosystem services

One of the areas in which blockchain technology has strong potential is establishing a cost-effective reward system for services that might otherwise not be monetised. Think, for example, of a combination of validation algorithms of performance and payments in the form of tokens. Tokens can be online monetary units that can be programmed for specific purposes. As they are online, they can be accessed from any device with internet access. This creates more direct payments where 'payers' could be assured that their spending is distributed to the right cause or person depending on the setup of the program.

Tokens can be used to pay, to reward or to create a new type of funding. Through the years we have seen examples where a payment for ecosystem services had been set up, but payers were not willing to contribute to the fund as this would be managed by entities that they deemed unreliable,



not cost-effective or corrupt. Using tokens, we can create an infrastructure for direct payments specified to an assigned goal and validating the goal achievement against objectively verifiable criteria.

For example, citizens or visitors of natural areas could pay for specific tokens, associated with specific parks they like or appreciate and could make the pay-out of the tokens on the condition that certain quality characteristics are achieved. Or farmers could be motivated to invest in field borders with trees if nearby citizens can reward them in a cost-effective way through tokens.

Insurance

Finding out exactly what has transpired is fundamental in the field of insurance. An insurance company wants to be sure of the true events and losses before pay-out can take place. At times this process can be tedious and long for the receiving parties, such as smallholder farmers. In recent years developments have focused on making this process more efficient, for example in index insurances where weather data can be combined with remote sensing. However, human intervention is still necessary for the verification of the data used. The blockchain makes it possible to establish predefined requirements, for example through smart contracts. This leads to advantages in efficiency, cost saving and reliability benefitting both farmers and the insurance company.

Several organisations are recognising the advantages of blockchain for insurance, for example Etherisc. Etherisc is building a platform for decentralised insurance applications, for example for crop insurance for smallholder farmers. Its aim is to develop a peer-to-peer risk platform that enables groups to build their own insurance risk pools and insurances on the platform. Smart contracts enable automated pay-outs (crop insurance) triggered by drought or flood events reported by government agencies.

Etherisc also wants to offer more affordable and accessible protection against the risk of death or serious illness of a community member offering more immediate emergency payment helping to get through critical times.

The transparency of the used blockchain infrastructure allows all participants of the value chain to audit all of the data and the used technology autonomously. This creates trust among all participants.

Turning promise into reality

Until now, blockchain technology has mainly been a promising technology. Even though it has just passed the peak in the Gartner's Hype Cycle (see 'Related links' below), which provides a graphic view of the maturity, adoption and business application of specific technologies in many application domains, it needs still to develop a great deal in agrifood.

We think its applications should not be technology driven. Producers should rather facilitate stakeholder engagement to understand how data and information relate to the value perceived by consumers. Developing successful applications not only means working on the blockchain technology itself, but especially on the governance and organisational structures for the collaboration, digitisation and standardisation of data and information – in combination with other technologies such as remote sensing and big data analytics.

The blockchain needs to mature, which can only be done through partnerships with the right players, and by implementing and testing it. We believe that blockchain technology offers potential for development if combined with a strategy for digitisation, targeted capacity building of its users and an impact-driven approach. ●

About the author



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and **Jaclyn Bolt** is business innovator at Wageningen University and Research in the Netherlands.

Related links

Gartner Hype Cycle 2017: goo.gl/ngeFBR
Blockchain use cases: goo.gl/nBS48N

The blockchain needs to mature, which can only be done through partnerships with the right players, and by implementing and testing it.

BreadTrail: from farm to fork

Darien Jardine, Nirvan Sharma and Reshawn Ramjattan

BreadTrail, an app created by Darien Jardine, Nirvan Sharma and Reshawn Ramjattan, makes introducing reliable and incorruptible traceability to the supply chain secure and scalable while providing benefits to everyone involved from farmer to customer.

As the agricultural economy in the Caribbean is in decline, the farmers that make up an essential component of most of the Caribbean's employment may suffer. In the agricultural sector, the farmer's produce moves through supply chains before it is finally ready for consumption. Tracking fresh produce through the supply chain is invaluable to customers and food companies. While several traceability initiatives from the FAO and IICA exist, adoption is still limited.

The FAO provides guidelines and processes for the implementation and adoption of food traceability systems. A notable exception is the recommendation of an ICT-based system to provide the immutability of transactions. Rather than going through the complicated process of trying to create a method of traceability that can be both trustworthy and secure from scratch, we decided to build off the backbone of blockchain technology, which has already proven capable of meeting these needs.

BreadTrail seeks to harness the decentralised, secure and validity characteristics of blockchain technology to

improve the traceability of agriculture-based products. Developed as an open-source project, BreadTrail comprises a mobile app compatible with Android and iOS, and a backend system that uses the blockchain to provide immutable and transparent farm-to-fork traceability for everyone in the supply chain from farmer to consumer. Making BreadTrail open source ensures that any interested person can use, contribute to or modify BreadTrail.

How BreadTrail works

To appreciate the value and applicability of BreadTrail, we use the example of tracing banana through a common value-added supply chain in the Caribbean. First, farmers use the app to record details such as the cultivation process, additives such as fertilisers and pesticides, or methods of harvesting the banana. After harvesting, the bananas are transported to a warehouse and processing facility where the name, location and time of arrival are recorded and stored in the blockchain.

Using the blockchain facilitates security, trustworthiness and immutability of the information recorded. In addition to the arrival information, BreadTrail records the techniques used to process the banana. For example, BreadTrail records the precautionary methods to protect the skin of the fruit such as wrapping or using polythene bags. In the next stage of the supply chain, the bananas are exported to customers or companies. Upon delivery, if the banana is contaminated or a consumer wishes to see the path of the banana, they can scan the identification code of the batch to see the product's trail through the supply chain. This entire process from start to finish would be fully documented using the blockchain that interfaces with an app that provides customers or companies with a suitable platform to view this path from the farm to fork.

BreadTrail and value chain interaction

To further contextualise how BreadTrail works, the illustration highlights the relationship between BreadTrail and a typical value chain of export-focused agricultural products. The illustration highlights the screens that record information at the farm, during processing, during transportation and at the final market or client, such as a restaurant. BreadTrail allows clients in a market or restaurant to see the full set of 'bread trails', i.e. the intermediary steps of a product. The clients view the product's 'bread trails' by using the mobile app to scan a unique product barcode which allows them to trace the end product's ingredients back to the farms from where they came.

BreadTrail makes introducing reliable and incorruptible traceability to the supply chain secure and scalable while providing benefits to everyone involved from farmer to customer. BreadTrail currently focuses on agro-based agricultural products. The inclusion of livestock and fisheries are future developments of the system based on the adoption of the platform. The authors developed BreadTrail at a hackathon organised by ITU/WSIS/FAO jointly with the AgriNeTT Research group of The University of the West Indies (<http://sta.uwi.edu/agrinett>). ●

About the author

Darien Jardine, Nirvan Sharma and Reshawn Ramjattan are computer science students at the Department of Computing and Information Technology at the University of The West Indies, St. Augustine, Trinidad.

Left: BreadTrail and value chain interaction



Resources



Cryptocurrency vs. traditional finance

Spore magazine has published an article on alternative finance platforms based on the blockchain. It writes that FinComEco, a fintech company aiming to build a 'farmer-centred ecosystem across Africa to open new financing channels for rural communities', and its partner Blockchain Commodities, a blockchain-focused commodities trader, believe that blockchain technology 'and the coins and tokens developed out of that' could serve as a 'fast, low-cost alternative to traditional finance'. goo.gl/KXUf92

Blockchain for development

GSMA for Development has published a report featuring short case studies on four blockchain platforms that are being used 'to improve people's access to self-sovereign identities, bring new levels of transparency to the distribution of international aid, and improve the efficiency of humanitarian cash transfers'. The report aims to shed light on how mobile network operators may 'be able to support and derive value from future "blockchain for development projects"'. goo.gl/zWQdQY

CTA workshop

In October 2017, the potential for the blockchain was discussed at a CTA workshop. The link below will take you to a site with the workshop conclusions.

<http://bit.ly/CTA-Blockchain>

'Blockchain benefits'

A BBC article shows how digital and blockchain technology is allowing 'farmers and smallholders' to discover 'new ways of doing business'. The article cites an interesting example in Russia, where the inhabitants of Kolionovo have started using a cryptocurrency called the kolion, developed by a 'local banker-turned farmer'. Initially he issued paper kolions to circumvent 'the 12% interest charged by the banks he approached for a loan'. But the banks banned the currency, so he started developing a 'cryptocurrency version'. goo.gl/DZpWFL

Proof of concept

Wageningen University and Research's pilot study entitled 'Blockchain for Agriculture and Food' presents findings from the 'Blockchain for Agrifood' project, which aims 'to contribute to a better understanding of the blockchain technology and its implications for agrifood'. It also aims to develop 'a proof of concept in an application based on a use case concerning table grapes from South Africa' where blockchain technology would be used. goo.gl/dC8AAe

Haitian smallholders

According to the Smallholder Farmers Alliance, 'Haiti is on the cutting edge' of testing blockchain technology 'with the announcement of a Blockchain Cotton Project that will benefit the country's smallholder farmers'. The project aims to reintroduce cotton into Haiti after 'a 30-year absence'. Field trials have been held with different varieties of cotton using organic principles and are being cultivated on a large scale this summer. Major buyers have shown interest in the cotton, such as Timberland, Vans and Patagonia. goo.gl/heQdJ8

Blockchain Africa Conference 2019

Hosted by Bitcoin Events, the Blockchain Africa Conference 2019 will take place in Johannesburg from 28 February to 1 March and in Cape Town on 6 March. Tickets go on sale on 1 September 2018. The aim of Bitcoin Events' conferences is to 'move Africa forward' and 'educate people by sharing insights into cryptocurrencies' and blockchain technology's revolutionary opportunities in Africa especially'. The conferences four main themes are 'embracing blockchain', 'use cases', 'regulatory environment' and 'technology hurdles'. goo.gl/iuf55Z

Five African use cases

IDG Connect, which 'produces, publishes and distributes local IT and business information', has published a list of five blockchain use cases in Africa. They include land management through Kenya's Land LayBy; reviving trade corridors with Binkabi in Nigeria, for example; tracing cobalt mining using Dorae in the Democratic Republic of Congo; creating a coffee supply chain in Ethiopia; and raising funds for community projects in Kenya. goo.gl/tmhNHi

From bait to plate

Ever wonder where your tuna comes from? Blockchain technology is going to strengthen tuna traceability to fight illegal fishing. The Conversation, an independent, not-for-profit media platform that uses information derived from researchers and academia, published an article a pilot project launched in January 2018 in the Pacific Islands tuna industry that uses 'blockchain technology to track the journey of tuna from "bait to plate". The aim is to help stop illegal, unreported and unregulated fishing and human rights abuses in the tuna industry.' goo.gl/UtWzvy

Africa Blockchain Lab

Gabriella Mulligan of Disrupt Africa – a blog providing information for start-up entrepreneurs in the technology sector – writes that 'Nigerian state-backed innovation hub KAD-ICT Hub and UK blockchain company Coinfirm have launched the Africa Blockchain Lab in Kaduna, aiming to bring together blockchain companies building solutions for Africa'. The lab provides a platform for entrepreneurs 'building blockchain-based products and services relevant to African economies'. goo.gl/dxW49b

To blockchain or not to blockchain

'The Suichies model,' writes Michiel Mulders, 'is a great start to help you decide if your project or idea requires the use of blockchain technology.' He says that by answering several questions you will end up with four possible results: public blockchain, hybrid blockchain, private blockchain, or don't use blockchain. Find out for yourselves... goo.gl/qP6yLQ

Transforming subsistence farmers into market-connected entrepreneurs

Chris Mimm

Chris Mimm explains how Farmshine is attempting to rebuild the value chain infrastructure in East Africa. Farmshine connects actors in the value chain on a fully transparent blockchain platform, providing them with a digital identity and fully traceable record of transactions.

In many developing world countries, the agriculture value chain is aligned with smallholder farmers. Access to credit, inputs and trade is largely controlled by middlemen, who extract a disproportionate amount of income while providing little value in return. They charge exorbitant interest rates on small loans, hoard the limited market information to which they have access, and offer farmers below-market prices for their crops.

Large commodities buyers are likewise affected by value chain inefficiencies. Because they lack a direct connection with individual farmers, many buyers are unable to influence which crops the farmers plant in a given season. In East Africa alone, this disconnect results in hundreds of thousands of tonnes of unmet demand for commodities each year. Similarly, seed producers have little indication of which crops smallholder farmers will plant in the coming seasons, resulting in seed shortages for those crops in highest demand.

Trust

In order to connect and align the interests of each actor in the value chain, such as farmers, buyers, banks, seed suppliers and other service providers, the value chain infrastructure must be redesigned for the modern economy. The price that buyers will pay for a crop should be conveyed before the planting season, directly from the

In order to connect and align the interests of each actor in the value chain, its infrastructure must be redesigned for the modern economy.

buyer to the farmer. Loans and other services should be offered to farmers with complete transparency. And farmers should become entrepreneurs – market-connected traders who can choose which service provider or buyer to work with based on their reputation and history of trade.

The essential component of this improved infrastructure is trust. Farmers must trust that buyers will pay them the

agreed price, and buyers must trust that farmers will grow the quantity and quality of crops they require. Likewise, banks must have confidence that individual farmers are creditworthy, and farmers must believe that the crop insurance they purchase will pay out following the occurrence of drought or flooding.

Based on the above ideals, Farmshine is rebuilding the value chain infrastructure in East Africa. We connect each actor in the value chain on a fully transparent platform, beginning with the farmers, who are provided with a digital identity and fully traceable record of transactions. Each activity is recorded, including the quantity and quality of the crops delivered at harvest as well as the successful repayment of loans. Much like a CV or credit score, this enables farmers to build a reputation among buyers and service providers, and thereby increase their access to better market opportunities.

Our strategy is to identify each broken link in the agriculture supply chain – the points where smallholder farmers are underserved or even exploited – and replace them with beneficial processes and service providers. Without such a comprehensive solution, farmers are unlikely to escape from the middlemen or, ultimately, from the cycle of poverty perpetuated by the current system.

Recording activities on the blockchain

The activities of each actor are recorded on an underlying blockchain layer, providing a traceable history of the entire value chain. In this way, accountability is built into the platform. The reputation score of each actor signifies their reliability to potential clients or suppliers, and builds trust among unknown parties. We also use blockchain technology to record the provenance and physical condition of crops after harvest. As crops are aggregated in the field, each bag is given a QR code, which is scanned at a series of checkpoints. The weight, quantity, humidity and other information is recorded on the blockchain. This provides the buyer with a comprehensive record of each harvest, while enabling farmers to establish their reputations as reliable suppliers.

Although we believe this model represents the future of the agriculture value chain, technology can solve only part of the problem. In order to optimise the quality and quantity of farmers' production, field agents are needed to provide support, such as training in conservation agriculture. To this end, we employ our own agents while also partnering with NGOs and UN organisations. These partnerships are mutually beneficial, as development agencies generally provide training to farmers but do not connect them with buyers. Moreover, their projects are finite and often lack a sustainability component. By connecting farmers to our platform, development agencies can provide their farmers with sustainable trading opportunities among trusted value chain actors.

By providing farmers with a digital identity, traceable production history and direct access to buyers and service providers, our platform helps to transform subsistence farmers into market-connected traders. This transition is the essence of sustainable development. ●

About the author



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