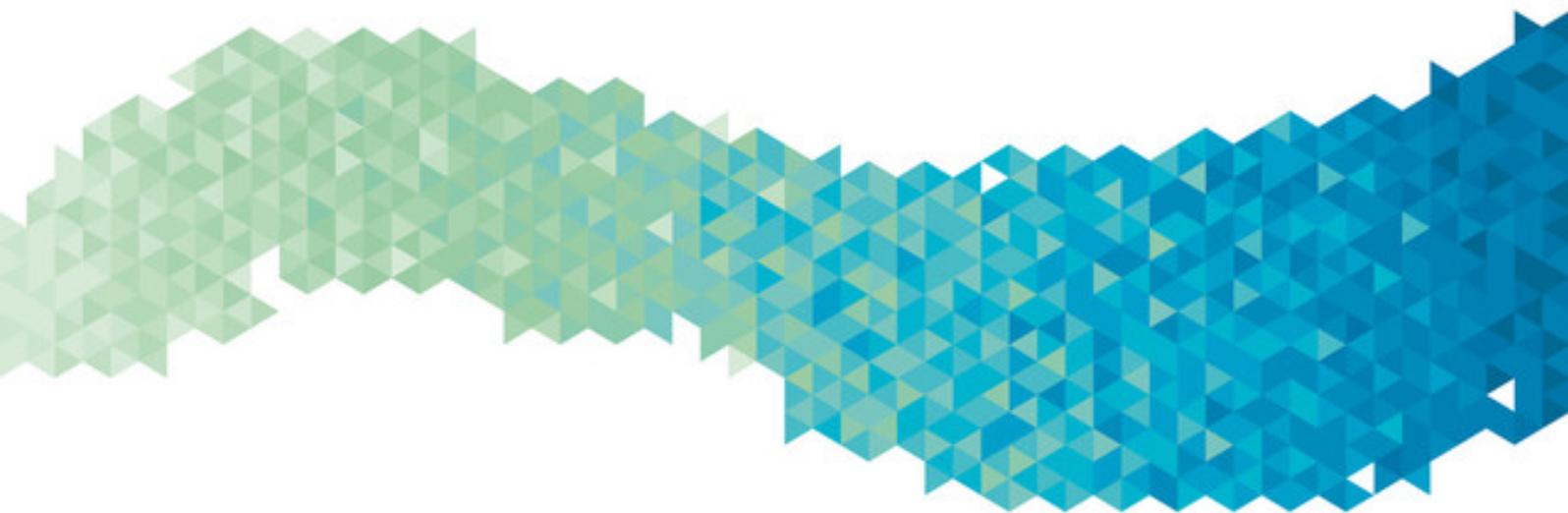


# Financial resilience of Kenyan smallholders affected by climate change, and the potential for blockchain technology

CCAFS Flagship Climate-Smart Technologies and practices  
Incentives and innovative finance for scaling Climate Smart Agriculture up and out

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## Introduction

This study is part of the project 'Incentives and innovative finance for scaling Climate Smart Agriculture (CSA) up and out' which as part of the flagship 'Climate-Smart Technologies and Practices'. Through case study research, the project aims to develop context-specific knowledge on the factors and conditions which constitute an effective technical and financial package to scale up and scale out CSA practices and businesses. The impact of these packages on the adoption of CSA and the resilience of farmers and Small to Medium Enterprises to climate change will be assessed by means of three case studies.

The first case aimed at upscaling CSA with small scale food producers who were organised in village savings and loans in Tanzania. The second case study focused on climate smart villages using climate-smart financial diaries for scaling in Kenya.

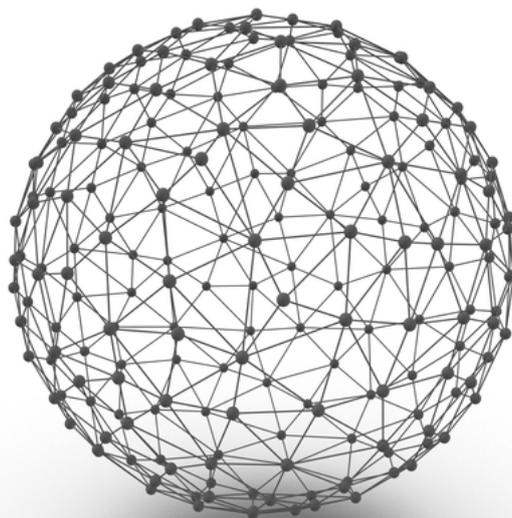
This third study focuses on the financial resilience of smallholder farmers in Kenya who are affected by climate change. We will use blockchain technology as a lens to discuss the potential impact provided through this innovative technology. In the next year we envisage to run a small pilot with blockchain technology in Kenya. Kenya is particularly interesting considering blockchain, as mobile payment systems are well and widely adopted. This enhances possibilities for linking blockchain technology.

## Financial resilience of Kenyan farmers adapting to climate change

Although the role of agriculture is becoming smaller with regards to the Kenyan economy, it is still vital in rural economy, providing livelihood to more than 80 percent of the Kenyan population (FAO, 2018). Most farmers in Kenya are semi-commercial farmers combining subsistence farming (producing food for the family) with commercial farming (profit maximisation) (Nyikai et. al., 2003). Subsistence farming is fundamental in facing challenges concerning food insecurity. The main staple food crops in Kenya are maize, together with rice, wheat, Irish potato and beans. All these crops are highly threatened by global climate change (Muthoni & Nyamongo, 2009). In 2018 the State Department of Agriculture announced harvests of crops such as maize and cowpeas below the five-year average. They also stated that total long rains maize production amounted to 10 percent below the five-year average production.

In 2018, most rain-fed crops were affected by a shortage in rain, leading to crop failures (FEWS, 2018). These farmers of rain-fed systems are pushed into areas where they become more vulnerable to both drought as the uncertainty resulting from climate change (FAO, 2018). Farmers face climate variability and extreme weather events; increasing temperatures, heavy rainfall and drought leading to severe crop and livestock losses, famine, and displacement (USAID, 2018).

Financial resilience is the ability to withstand events impacting income or assets. Climate change related risks and impacts are imposing on this resilience, particularly on smallholder farmers. Different solutions are available to strengthen their financial resilience. Farmers may protect themselves financially from future risks by insurance, they could obtain credit or loans to adapt to climate change by purchasing proper input supplies for climate smart agriculture. They could also pool resources by cooperating more with other farmers. Such pooling could help with access to financial services, decreasing of costs, negotiation of interest rates, pooled sales of produce etc. This chapter will delve further into some of these solutions that were mentioned by various stakeholders for this study, and their current challenges and developments.



## Crop insurance

Insurance of crops can help farmers in hedging against possible negative externalities of climate change such as increase drought, an increasing number of floods, or hail. According to a study by Falco et.al (2013), considering climate change, the demand for insurance products is likely to increase and the extent of risk exposure is reduced with insurance. Farmers diversifying their income generating activities are better protected against financial risk, and less likely to adopt an insurance scheme.

However, insurance procedures can be tedious to the point where farmers who are enrolled, might not collect their insurance at all. Insurances are not always accessible or affordable, and the process of insurance pay-out is not always transparent so that trust issues can play a role. At the side of the insurer the costs of processing large numbers of small farms and the increasing frequency of climate related crop failure inhibit its commercial success.

## Current developments

From the stakeholder interviews (#9, #10, #17, #18) we found that crop insurance is limited offered by Kenyan insurance providers. One insurer mentioned claims were growing excessively due to bad farming practices and as a result they had decided to stop crop insurances by 2015. The main challenge for an insurer is to determine proper terms and conditions of the policy. In case of an indemnity-based insurance scheme, an insurer would for example need to employ an agronomist, for a specific crop, who would have to test the soil of the farmer and monitor crop growth. The results would lead to measurements that need to be undertaken by the farmer to reduce risks of damage or loss. Farmers furthermore lack irrigation plans so that the impact of weather extremities are severe, farmers are not ready for disaster management. This further decreases the interest of insurers.

A Kenyan insurer has started with agri insurance from 2009 onwards where they cover products for livestock, poultry, crop insurance, horticulture, floriculture, and forestry for small, medium or large farmers. These are offered through three major product lines; multi-peril cover, high yield index, and weather index insurance. For commercial products they look at landscape farmers from 100 to 150 acres and above. It is generally more attractive to insure large famers as insuring small-scale farmers is subjected to different challenges;

- They require to supply a great deal of background information and these farmers often do not have a history. It is difficult to determine the amount that should be insured;
- They do not have a standardised input use, not all farmers use manure for example;
- Trust of these farmers is minimal; there is a knowledge gap of how insurance works;
- They often do not read the insurance policy to understand their coverage, this may result in negative connotation.

Other insurers also mentioned a negative attitude of Kenyan farmers towards insurance where they think crop insurance is:

- Expensive/unaffordable (particularly for subsistence farming);
- Meant for the elite;
- Intangible, thus unreliable;
- Irrelevant as they have nothing worth insuring.

Therefore, insurers mostly target corporates. The interviews show mistrust from insurance providers towards farmers, but also from farmers to the insurer. Insurers mention conditions where farmers would not be able to sell their produce and would thereupon maliciously destroy their produce to receive a claim. They are furthermore worried about farmer practices; "Although insurance is meant for weather related perils, the farmer is responsible for generating good crops". To do so, farmers need inputs but are vulnerable to falsified inputs. Examples are when farmers buy seeds that are not certified or are not supplied with the proper chemicals.

Synthesis of current challenges in crop insurance for small holders in Kenya:

Farmers	Insurers
<ul style="list-style-type: none"> <li>Do not have required background information</li> </ul>	<ul style="list-style-type: none"> <li>Do not have insight into the history/status of many farmers</li> </ul>
<ul style="list-style-type: none"> <li>Feel insurance is too expensive</li> </ul>	<ul style="list-style-type: none"> <li>Find it difficult to determine the insured amount</li> </ul>
<ul style="list-style-type: none"> <li>Do not feel addressed by insurance</li> </ul>	<ul style="list-style-type: none"> <li>Experience high costs, it becomes too expensive to undertake (field work)</li> </ul>
<ul style="list-style-type: none"> <li>Do not like that insurance is intangible</li> </ul>	<ul style="list-style-type: none"> <li>Experience that claims are not always reliable</li> </ul>
<ul style="list-style-type: none"> <li>Do not trust insurance/insurers</li> </ul>	<ul style="list-style-type: none"> <li>Find that farmer practices are inadequate leading to too many claims</li> </ul>
<ul style="list-style-type: none"> <li>Do not feel insurance is relevant</li> </ul>	<ul style="list-style-type: none"> <li>Find that farmers are susceptible to buying falsified inputs from unreliable input suppliers</li> </ul>
<ul style="list-style-type: none"> <li>Require more knowledge on how insurance works</li> </ul>	

An insurer explained how small-scale farmers may still be commercially viable to an insurer. Not for multi-peril crop insurance, but an index insurance could be interesting or when farmers decide to aggregate. Combined, these farmers may consequently insure 30 to 40 acres. For an insurer a minimum of 20 acres is required to make it commercially viable as the insurer will need to do crop inspections, visiting more farmers with lower acreage will increase the administrative costs and thus the premium. Livestock insurance can be applied per individual animal (i.e., cow).

Some farmers are insured. They were reached through SACCO's or financial institutions where they apply for financial aid for farming inputs. This is then where the crop insurance is introduced to them. An insurer mentioned that an agri insurance is considered a type of micro finance or should be tied to micro finance. To make that work, stakeholders mentioned it is vital to keep informing farmers to clarify policies and coverage. Insurers work together with the Kenyan government to reach farmers and attract interest. They simplify their policy documents and avoid insurance jargon.

At times insurers work together in programs with barley producers, breweries, banks where different products as inputs, lending, insurance may be combined. However, a systemic approach towards climate resilience is still missing. The interviewed insurance companies recognized that "climate smart agriculture is the way to go", but it is not yet part of their approach. They mention that drought occurs every 2.5 to 3 years. As the occurrence increases, the premium does as well. Including climate resilience in the overall method, could help increase both climate and financial resilience of farmers.

## Access to credit

The International Finance Corporation (IFC) estimates less than 10 percent of small holder farmers have access to finance and those who do, are primarily engaged in higher value cash crops (IFC, 2014). Most farmers do not have a bank account, but many farmers in Kenya for example are familiar with a mobile payment system such as M-Pesa. Different sources (interviews #8, #13, #17) have mentioned that in the assessments of providing finance to a farmer they consider three elements:

1. The ability to pay and the willingness to pay;
2. Collateral (what assets does the receiver of credit have that could give the bank more security);
3. Character (the credit status of the receiver).

In Kenya, a credit scoring system does not yet exist in a structured way. TransUnion can check the credit history of people who have loaned money from a bank through mobile platforms (interview #13). ACRE Africa (interview #13) is looking into a risk assessment of ability to pay versus the willingness to pay. For financial institutions it can be difficult to lend to farmers. Agriculture is considered a high-risk sector with limited information available, in particular with regards to farmers with food crops. Information about cash crops such as coffee, tea, and sugarcane can often be accessed through Saving and Credit Cooperative Organisations (SACCOs). But for other crops financial institutions find it challenging that farmers often do not keep records, for instance about the type and amount of inputs (Interview #17). Kenya and South Africa are the only African countries with independent regulators and regulations for SACCOs. In many rural areas, such a SACCO is the sole provider of financial services. SACCO's can offer loans for lower prices compared to banks, and higher interest on savings. They can attract higher capital when their number of members increases. SACCO's are also important for government economic strategies and for ICT project which lean on the demands of the SACCO members to scale up operations.

## Current challenges

During the interviews, financial institutions have mentioned several challenges with financing farmers:

- The administrative costs outweigh the benefits for the bank (micro finance is most expensive);
- The ability to pay back the loan is an issue;
- Some farmers forward their credit to a friend or family, it can be difficult to keep track;
- Small holder farmers pose higher risks;
- Farmers have no credit status;
- Many farmers do not have a bank account;
- Information with regards to credit history is not exchanged, there is no interoperability of data.

Farmers mention other challenges:

- In rural areas there are not enough banks (or not the right banks);
- It is difficult to obtain credit/a loan;
- Interest rates for a microloan are usually quite high;
- They feel financial institutions can be too strict or traditional;
- They have limited information/access to look for other forms of finance.

## Collaboration/Pooling of resources

According to a paper by Valentinov (2007), cooperation in agriculture allows for its organisation while avoiding transaction costs. This adds to the general advantages of cooperative organisations; economisation of transaction costs and development of a power balance (Valentinov, 2007). When working together, farmers can pool their lands, profits, resources, creating an economy of scale. Pooled together, farmers can act as large-scale farmers benefitting from lower prices for inputs (bulk quantities) and a better position for negotiation of prices. This method of working also has significant impact on the time of the workers who can expand their efforts in other (economic) activities. On an individual level it is challenging for farmers to obtain credit, as a cooperative they might be better equipped to attract larger amounts of finance. A cooperative might furthermore have administrative benefits with regards to taxes, subsidies and efficiency (Agroplexi, 2018).

## Current challenges

Although there are several benefits of working together, many farmers in East-Africa do not yet cooperate with similar farmers. The first cooperative set up in Kenya was a dairy cooperative in 1908 where after the government was committed to enable and expand cooperative development (Kenyan Ministry of industrialization and enterprise development, 2014). By 1997 the involvement from the government was removed completely which led to the essential collapse of the movement of cooperation in Kenya (Kenyan Ministry of industrialization and enterprise development, 2014). By now, this movement has picked up again, especially in the form of SACCOS, which is the fastest growing sub-sector within the realm of the cooperative movement in Kenya. However, SACCOS may be more significant in the field of savings, credits and loans and less in practical cooperation for agriculture. Agricultural cooperatives mostly target coffee or dairy.

NGOs, input suppliers and innovative implementers in the realm of IT understand the importance of cooperatives. They generally use cooperative as a mechanism for scaling their solutions and business propositions. AgUnity (interview #2) has mentioned that many NGO's such as the Bill and Melinda Gates Foundation have considerable focus on enabling and creating cooperatives. However, many of these initiatives disintegrate shortly after, when small disagreements ensue between farmers and the people running the cooperative or the administration of the cooperative. These may occur for example when farmers are illiterate and have less control over the information that is put into the ledger of the cooperative, for instance with regards to the yields that they have supplied to the organisation.

Interviews with stakeholders show that farmers find it difficult to work together in Kenya. An insurance company (interview #17) mentioned farmers will only work together if they are familiar with the market already. When a common market is not present, farmers consider each other as competitor. A group of farmers in the Mara river basin was confronted with the idea of buying a common good together which would benefit all of them (Mamase, 2017). When confronted with the proposition to buy a car with a group of farmers from the same area, the farmers preferred not to buy a car at all as they could not be sure who would use the car at what time and whether it would be used for private purposes.

## Blockchain technology

Bitcoin is a financial peer to peer transaction system developed by Satoshi Nakamoto in 2008. Bitcoin enables direct financial transactions without intermediary parties. Blockchain is the emerging digital technology which forms the basis of bitcoin. Or vice versa; bitcoin can be considered the financial incentive system of blockchain. In the meantime, many other coins have emerged, called 'cryptocurrencies'. In essence blockchain is a new evolutionary phase of database technology. Where internet enables communication of different databases, blockchain enables attestation of the data. The data continues to be stored in the relevant databases, but the verification/attestation process occurs decentralised, comparable to the decentralised nature of the internet. Blockchain can be considered a decentralised governance system that could transform current structures for citizenship, authority and democracy (Atzori, 2015).

Adam Smith, considered a father of modern economics, has described virtues as trust to be essential characteristics for a flourishing economy. In reality trust is rarely present, resulting in transaction costs in the form of search and information costs, costs of drafting, negotiating and concluding contracts, and monitoring and enforcement costs (Groenewegen, 2010). In the blockchain system, the nodes in the network attest the data necessary for a transaction (Kirkman, 2017). By this service of attestation, we can eliminate a large part of conventional transaction costs. Implying that blockchain becomes a substitution for trusted intermediaries. This may change our current economic system and its institutions and infrastructures (Tapscott, 2016).

The first generation blockchains offered true immutability of recorded data in the digital realm for the first time – a feature that enables transactions to be settled without the need for intermediary parties such as banks or notaries. It could be interesting to employ blockchain in situations where transactions are being hampered by distrust or unreliable governance.

The second generation of the blockchain uses this immutable feature for automated execution of business logic, using small programs called 'smart contracts', software which provides certainty on what exactly has transpired. A smart contract is an automated self-executing agreement between parties (Swan, 2015). Through these contracts it is possible to create requirements that a small program executes. With a smart contract, parties involved in the transactions only execute when all conditions are met. This makes it impossible to conduct the transaction without meeting the set requirements. This offers what is called 'up-front compliance'. In centrally governed systems this certainty would be provided only after the transaction is settled. For example, by an auditor, notary or accountant. Thus, the blockchain can offer a solution where the governance poses trust issues.

Blockchain is a relatively new technology (just beyond the peak of the Gartner Hype Cycle) created for the financial sector, for which applications are still being developed and discovered. Most of its implemented innovations seem to be predominantly technology-driven with a primary focus on the financial sector (Catallini, 2017). The adoption of blockchain in agriculture is still relatively new and more examples and research are needed to study its use and implications.

## (Crop) Insurance

Finding out what exactly has transpired is fundamental in the field of insurance. An insurance company wants to be sure of the true events and losses before paying out can take place. At times this process can be tedious and long for the receiving parties, such as smallholder farmers. A development of the past years has 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 in the verification of the used data. With blockchain, predefined requirements can be set in place, for example through smart contracts. This leads to advantages in efficiency, cost saving and reliability benefitting both farmers and the insurance company.

Scientific research on blockchain (in insurance) is, due to its innovative character very limited. Numerous articles do mention blockchain as an interesting innovation, even disruptive, for the insurance branch. Swan (2017) has written a fundamental book on blockchain and its possible applications where she describes the proof of insurance as a type of attestation. Attestation is one of the core functions of blockchain. Pricewaterhouse Coopers (PwC) published an article (Crawford, 2017) explaining ways in which insurance can be improved through blockchain; through increased customer engagement, fraud detection, automation, and new product development. McKinsey & Company (2016) describe blockchain for the insurance sector and highlight several challenges with regards to compliance. For instance; the importance of securing data as, according to them, between 5 to 10 percent of all insurance claims are fraudulent. They add that blockchain could facilitate trust, transparency and stability through the security of its public ledger, its ability to manage, share and monetize large amounts of data, its ability to deal with the (number of) third party transactions, smart contracts, and its ability to ensure exposure against specific risks (in the realm of reinsurance). B3i is a blockchain insurance industry initiative which explores this technology to understand its potential for this sector. B3i is started by Swiss Re, Aegon, Allianz, Munich Re and Zurich among others. IBM, EY, Deloitte, Accenture also explore the use of blockchain technology for the insurance sector and have published several blogs and articles to inform the sector.

Haveson et al. (2017) have written a report on 'protecting farmers in emerging markets with blockchain'. They acknowledge the challenges in the operational processes of a crop insurer, but also the hinderance for farmers looking for coverage. It can take several months for claims to be verified due to the unpredictable nature of weather events, discrepancy in reported damages compared to actual damage etc. Haveson et al. (2017) go as far as stating blockchain could play a significant role in improving the crop insurance industry. Specific rules and thresholds can be set in place to automate payments for claims. This would improve the process for both the insurer and the insured.

## Credit/Input

Blockchain is a peer-to-peer network that is incentivised through the cryptocurrency Bitcoin (later joined by various other cryptocurrencies). Through these systems it is possible for peers in the network to interact with one another without a third party. An example of such a third party could be a bank; whenever two people undertake a financial transaction, this is enabled/facilitated by a bank. With blockchain, two people can make a decentralised payment. Naturally, this is interesting when transactions costs of a bank become significant, for example when conducting international payments. Or when making a large number of particularly small payments.

When a farmer needs to have access to finance, they would need to find a bank willing to provide a loan. Most banks are not willing to do so due to reasons mentioned in the previous chapter. When borders do not exist, such as in a digital world, a farmer could access anyone willing to invest. Any person with a connection to the internet could make a transfer from one cent to a million dollars in a crypto currency of their choosing towards this farmer. This transaction could be executed faster, oftentimes cheaper, and at times safer compared to a bank or money transfer office.

Developments with blockchain for finance also occur within the financial sector. With blockchain in combination with objective and reliable data, more certainty can be given about the origin of information. This can enable farmers to look for forms of collateral which was previously unavailable to them, the case studies in next chapter will show some examples. Banks can have more certainty about the credit status of farmers which enables payments. This is called the 'unlocking' of financial potential; due to new data, business models and technology; farmers can get access to finance which was previously 'locked' to them.

Lastly, it is possible for anybody with internet access to create their own cryptocurrency. A cryptocurrency can be compared to a digital coin where the difference is that this crypto coin, or 'token' can be programmed. An example is that a token can physically only be spent on a specific goal. This could be useful for farmers as well. Climate Smart Agriculture requires from farmers to apply proper farmer practices for instance through buying input supplies from vetted agro dealers. A token system could be set up compared to an e-voucher scheme. Such a token system could further unlock additional credit for farmers as is shown in one of the use cases (Agri-wallet). A programmed token could increase investments as it gives more certainty to the donor or investor that money will be spent on agreed goals. It would seem this is less attractive for the receiver. During two meetings one with social entrepreneurs in Kenya and one with citizens in Kenya we had discussed several scenarios where they could only spend the invested amount on what had been agreed, for instance specific stores or things. The citizens mentioned that this would confine their freedoms and would give a sense of distrust. The entrepreneurs were positive about the idea; they would be ensured of proper inputs and felt it would help them to better achieve their business goals.

## Cooperation

Where people do not trust each other, it becomes difficult to engage in business/transactions together. In East Africa this could hamper development of farmers. This is limiting them as climate change forces them to adopt new technologies, apply new practices and safeguard valuable resources. As blockchain can deal with transactions from small to large amounts, it might enable pooling of resources. Etherisc is an organisation working with crop insurances for farmers through blockchain technology. Etherisc explained that their platform stimulates risk pools; risk sharing is controlled by the beneficiaries of the insurance instead of centralised by large central corporations.

Internet of Things (IoT) in combination with blockchain could enable new types of business models where 'things' may receive payments or become actual autonomous organisations. An example could be a machine or a car that solely functions when payment has been received; comparable to a dispenser of soda drinks. Rabobank is looking into pay per use systems to explore whether this could be used in agriculture. In this scenario farmers would not need to physically cooperate, but as the required machine or tool receives payment, farmers could share machinery. It is comparable to a soda machine; if a refrigerator at an office would be open, colleagues would need to trust each other to take a fair amount of soda cans from the fridge. With a paid soda can dispenser, this does not matter. A soda can dispenser can be compared to a smart contract; once payment has been received, the can will be released without intermediary party.

Some developers on blockchain go further. A blockchain that is expected to have enormous transformative potential is Tauchain. This blockchain is aiming to create 'an internet of knowledge'; a tool to interpret any information and deduce any consensus. Such a tool could be used in different fields from academic, to a social setting with friends, judicial, political etc. What would make this unique is that Tauchain promises to make consensus scalable from 2 people to a million people. If it lives up to its promise it would be a tool that could be used for cooperation.

## Case studies

Some blockchain applications are still in development where others have been implemented. In 2018, the World Economic Forum published a report where they highlighted 65 usecases of blockchain for a better planet. One of the challenges they had considered was climate change (see below image). This chapter describes various use cases in the realm of insurance, credit and input, and cooperation which could assist farmers in East-Africa.

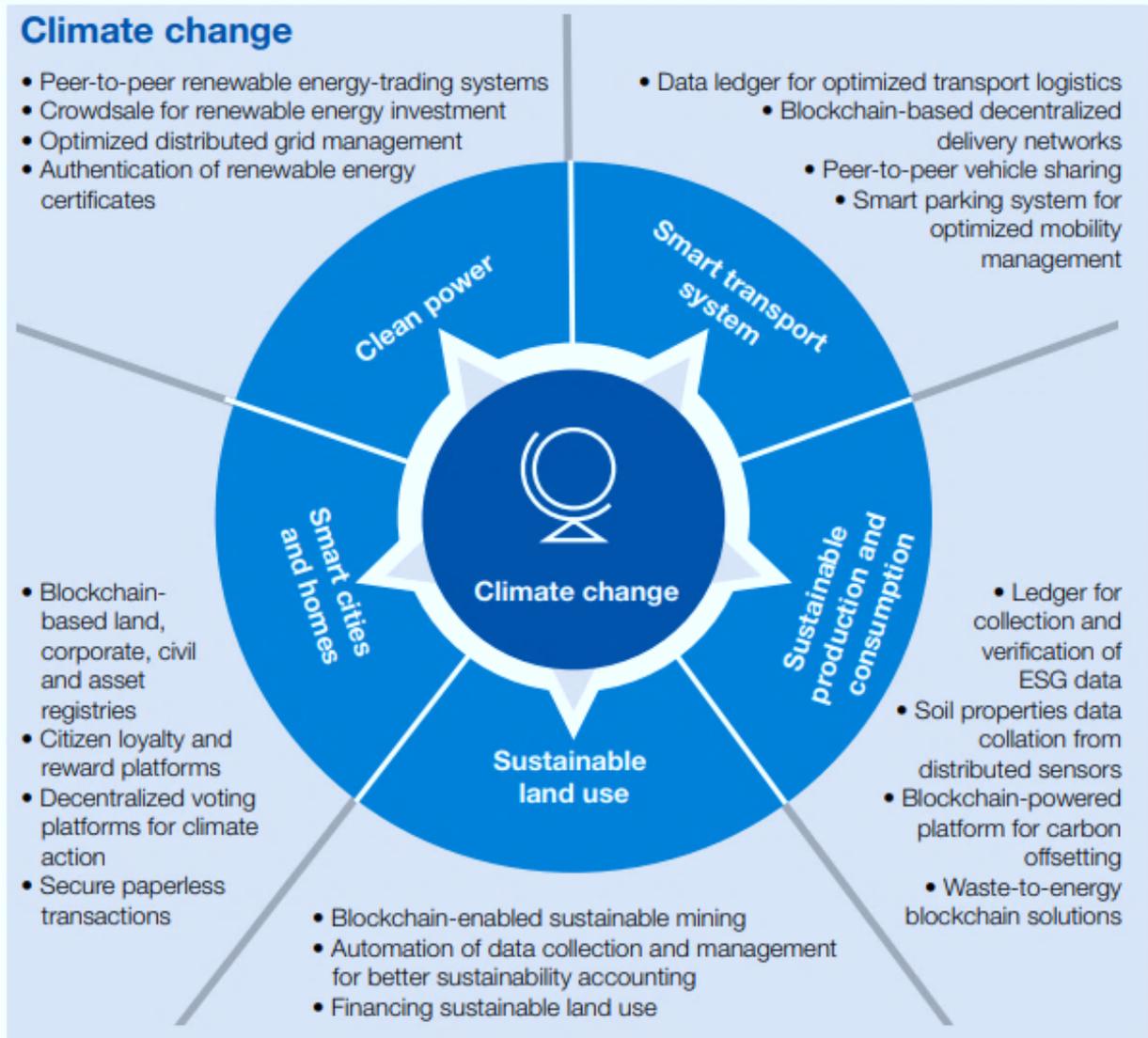


Figure 1: Blockchain for Climate change (source: WEF, 2018)

## Crop insurance

### Etherisc | Crop insurance

Applied in	India
Based in	Munich, Germany
Type	Tech start-up – Private and for profit
Founded	2016 (active)
Status	Not yet applied

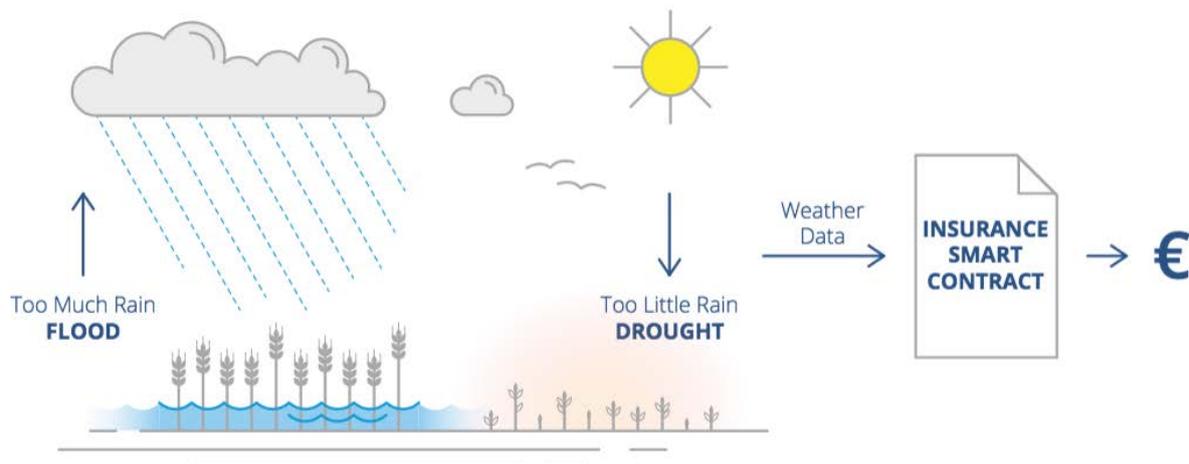


Figure 2: How parametric insurance works (source: Etherisc 2017)

[Etherisc](#) is building a platform for decentralized insurance applications, for example for crop insurance for smallholder farmers. They aim for a peer-to-peer risk platform that enable groups building their own insurance risk pools and insurances on the platform. Through smart contracts they enable automated pay-outs (crop insurance) triggered by drought or flood events reported by government agencies. They also want to offer more affordable and accessible protection against risk of death or disability 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 the data and the used technology autonomously. This creates trust along all participants.

### SmartCrop | Crop Insurance

Applied in	China (not implemented yet)
Based in	United States
Type	University project (Cornell)
Founded	2017
Status	Unclear

[SmartCrop](#) is an Android-based mobile platform to help farmers hedge against crop volatility through the use of smart contracts and intelligent weather predictions. They target farmers in rural areas in China between the age of 24 and 56. They aim to create earlier pay-outs to mitigate risks for natural disasters. They give an example: “10 days prior to a hurricane striking, a consumer can initiate an early pay-out beginning with a 90% reduction in the overall sum of the policy coverage. With each day inching closer to the hurricane striking, that 90% will increase by 1% until it reaches the incident date in which the consumer can collect 100% of their insurance policy up to 30 days following the hurricane, which serves as the standard terms for today’s weather-related insurance coverage. While the opportunity cost of choosing to be paid 10 days prior to an event occurring is the difference between receiving 90% - 99% of the policies coverage as opposed to 100%, the ability to salvage the harvest prior to an event striking is a far bigger gain in the long run. SmartCrop’s mission is that preparation always prevails” (Haveson et al., 2017).



Figure 3 : Features of the SmartCrop Solution (source: Haveson et al. 2017)

### Credit/Input

#### **Agri-wallet (by Dodore) | Verified inputs and collateral**

Applied in	Kenya
Based in	Amsterdam, The Netherlands and Nairobi, Kenya
Type	Foundation in the Netherlands, Company in Kenya
Founded	2010 (NL) 2013 (KE)
Status	Piloted and running

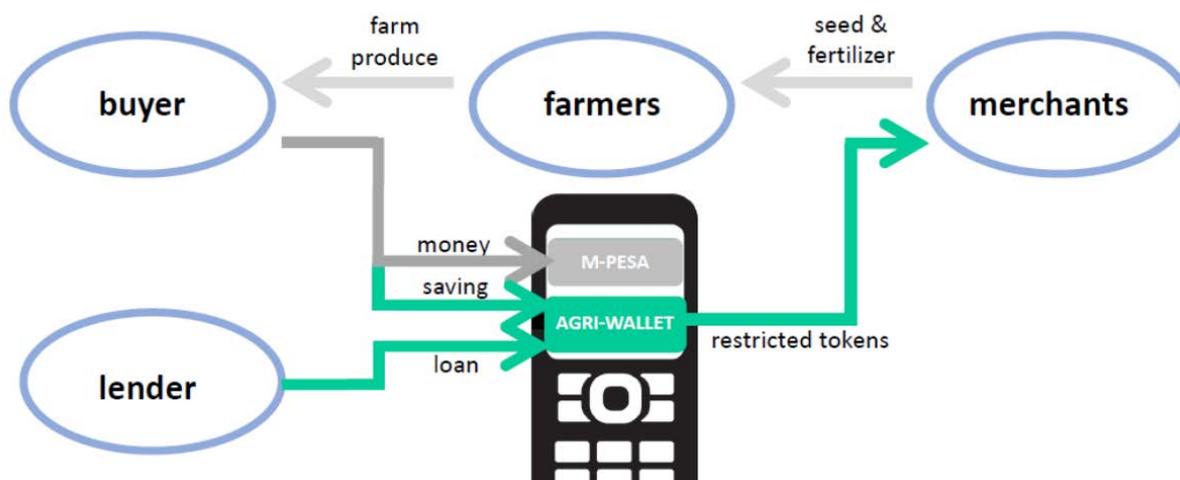


Figure 4 : Agri-wallet ecosystem (source; Dodore 2018)

[Agri-wallet](#) by Dodore is a mobile digital wallet for the agricultural sector. Farmers are provided with a free business account which can be used to save, buy, and sell. When farmers earn revenue through sales, they can choose to be paid in money through M-Pesa (a Kenyan mobile payment system) or (partly) in tokens for their wallet. Tokens are then earmarked for purchasing input supplies such as seeds or fertilizers from merchants that have been vetted by Dodore. These tokens can be used to purchase inputs for the next cropping season. Furthermore, because credit takes the form of tokens rather than currency, lenders are more willing to provide farmers with loans. As part of an ‘ecosystem’ with earmarked credit, Agri-wallet helps farmers to save and in turn enables them to access short term loans through Rabobank – without the conventional stack of paperwork. This kind of credit ecosystem is comparable to a voucher system, combined with a savings element. Currently 35% of the farmers who use the wallet, save. Farmers gain access to finance, but if they do not use it, there are no costs involved. Defaults in loans that have been provided by this system occur rarely.

Opinion from Dodore on blockchain technology:

- Disruptive and interesting for countries without (proper) banks;
- Enables transparency and auditability in costs, also for farmers.

Lessons learned by Agri-wallet:

- Avoid jargon, avoid mentioning 'bitcoin' or 'token' in Kenya (confusion and distrust);
- Trust is key, use cooperatives as a scaling mechanism.

### EthicHub | Access to finance

Applied in Mexico, scaling to Africa  
Based in Mexico  
Type Tech start up  
Founded 2018  
Status Piloted

[EthicHub](#) is a transnational peer-to-peer crowdlending platform using blockchain for the benefit of unbanked or marginalised small holders. EthicHub crowdlending platform enables peer-to-peer transactions, where individual investors act collectively as lenders who can be connected to producers; borrowers. EthicHub aims to “democratise finances, making credit and investment opportunities available to everyone” (Interview #21). Investors are free to choose their own projects where they gain direct insight on the impact of their investment. The selection of projects is decentralised. Lenders are offered a portfolio of profitable and below 3% default risk projects. Producers (the borrowers) benefit from lower interest rates because there are no financial intermediaries. Furthermore, these loans provide borrowers with a documented immutable credit history on the blockchain. Investors lend money through smart contracts and generate a guarantee and exchange risk fund through smart contracts as well. The final aim is to create a decentralized governance by using blockchain. Up until now, EthicHub has enabled 40,000\$ USD to 60 farmers on 3 communities (Las Delicias, San Rafael and La Boquilla in Chiapas, Mexico) and all of them are paying back their loans on time, plus a 15% annual interest.

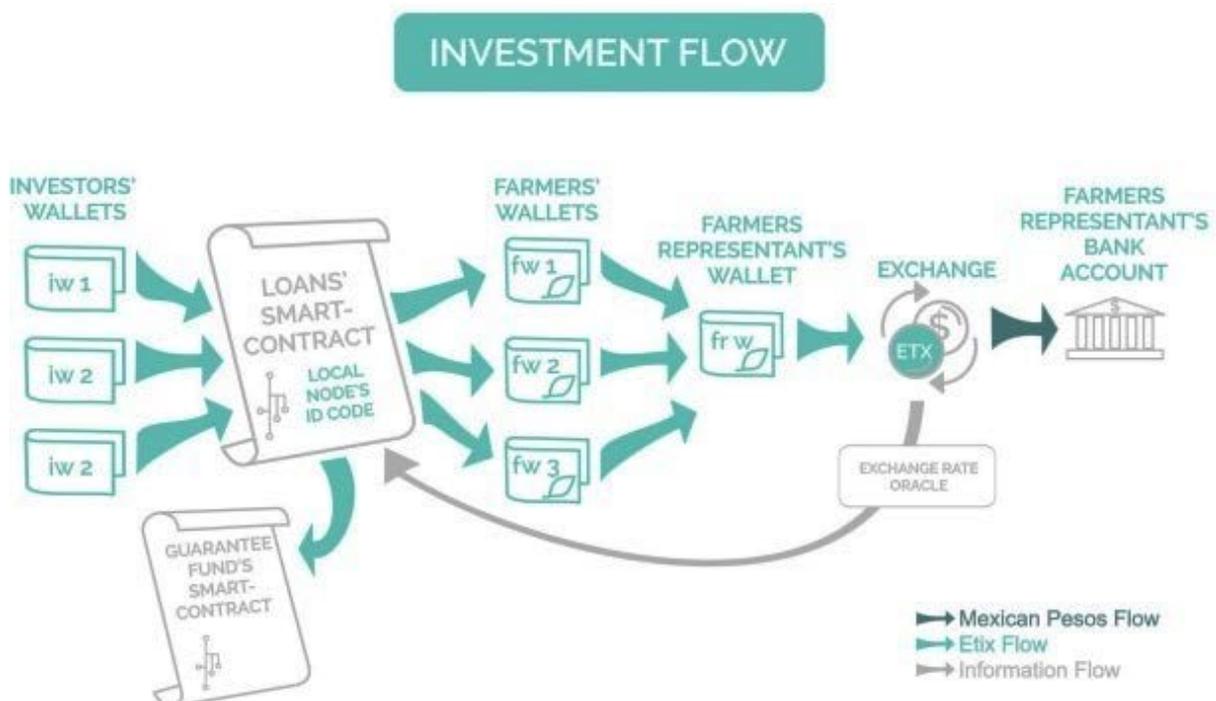


Figure 5 : Investment flow of EthicHub (source: ICO Deal Deck 2018)

Opinion from EthicHub on blockchain technology:

- A digital currency without borders could be used to transfer money across nations much faster, easier, and cheaper compared to conventional methods;

- Ethereum blockchain provides a solid protocol for Smart Contracts, it has a strong community and strong administration.

Lessons learned by EthicHub:

- With blockchain projects it is paramount to build a strong and solid community around common values and a shared vision;
- Blockchain projects take time and requires hard work to win the confidence and support from the stakeholders;
- It is best to start local and grow global.

### **SunExchange | Access to energy**

Applied in	South Africa, scaling in Ghana and Kenya
Based in	South Africa
Type	Tech start up
Founded	2015
Status	Running

Through a platform, [The Sun Exchange](#) connects investors of solar energy with receivers in rural areas. “Rural communities in Kenya working on coffee need to go to a local market and/or wholesaler, which requires significant time and effort to undertake. But through our grids, they now have internet access which they can use for e-commerce, more efficient value chains and better negotiation (Interview #24). The Sun Exchanges uses a platform and digital wallets where investors can choose to finance solar projects from micro payments to large amounts in national currencies or Bitcoin. Solar energy is then purchased and collected by mobile phone payment which is then switched to a local bitcoin exchange aligned with their system. Local users are leasing the solar panels for 20 years for which they pay the cost of electricity through M-Pesa (African mobile payment system) for example. Through its solar micro-leasing platform, The Sun Exchange connects investors of solar energy with receivers in emerging markets, and through a partnership with Powerhive the company will soon be able to facilitate funding for solar projects in rural Kenya.

Opinion on blockchain technology:

- Blockchain technology offers frictionless cross border payments;
- It enables global payments on micro scale, and in high frequency.

Lessons learned by SunExchange:

- Focus on how blockchain can be used now, not what it could do in the future;
- The simplest application at the moment is international payments.

## **Binkabi | Access to finance**

Applied in	Nigeria and Vietnam (expanding to South Africa and East Africa)
Based in	United Kingdom
Type	For Profit start-up
Founded	2017
Status	Active

[Binkabi](#) is a fintech start up that works on the global agrifood trade. They have created a platform on Ethereum connecting farmers, warehouses, and buyers of produce. Farmers can choose to connect with the market place or with a warehouse and/or bank. Farmers can sell their produce to buyers on the market place. They can also await better prices by stocking their produce in a warehouse, reducing post-harvest loss. The warehouse will grant them with a receipt which can be used as collateral for obtaining loans at the involved banks. Blockchain is used for reconciliation of the trades; automatic balancing. Traders can use the platform to trade internationally within their local currencies. Farmers are able to earn more profit as they gain access to a higher number of buyers, they can also access funding at lower costs compared to conventional banks, and through the warehouse option, farmers can reduce their risks from price fluctuations.

Binkabi uses three applications:

1. Barter Block                      Enabling physical trading
2. BinkabiLEND                      For collateralised lending
3. Commodity exchanges      Settlement technology and hedging product innovation

Opinion on blockchain technology:

- It is new and exciting and can potentially help to decrease costs and improve efficiency;
- It is interesting to consider blockchain for tokens and reconciliation;
- In ten years we will not talk about blockchain anymore; it will be part of the background comparable to email protocols which run in the background.

Lessons learned:

- It is important to start with a concrete problem, blockchain will not solve everything;
- To help farmers, it is important to take practical steps and recognise the status of technologies and resources.

## Land LayBy | Unlocking finance/collateral

Applied in	Ghana and Kenya
Based in	Kenya, Ghana, UK, Australia, US
Type	Tech start up
Founded	2017
Status	Active

[Land LayBy](#) is a platform for (verification of) land transactions. Their solution makes landownership more transparent in Sub-Saharan Africa and other developing nations by recording land ownership. Land LayBy highlights where large landowners are, which also helps to raise questions about the inequality of landownership. The application adheres to land commission procedures and details the transaction history of the land. They use an Ethereum based, shared ledger to keep records of land transactions. These records can never be altered, corrupted, forged or erroneously replicated. “We take legally verified land, with traceable histories, and place this information on the application. Users can then access the platform and add extra information about the land” (interview #5). Land LayBy will verify this information and announce the land as certified, or Land LayBy listed. A person looking to buy land can log-in to interact with the current owner. For example, they can ask to purchase the land or rent it to grow crops on. Details about a user can be shared but specific permission settings can be changed by the account holder. Verified landownership can help farmers in obtaining credit by using this land as collateral.



Figure 6 : Impact of blockchain on Land LayBy Holdings (source: Land LayBy 2018)

### Vision on Blockchain:

- Blockchain facilitates us in making land more transparent and affordable;
- Blockchain enables incorruptible solutions.

### Lessons learned:

- People are less willing to support entrepreneurs from Kenya compare to western entrepreneurs;
- working with governmental organisations can hamper development by creating burdens through extensive audits;
- It is challenging to find investors.

## Agroplexi

Applied in	Nigeria (scaling to the Caribbean)
Based in	Nigeria
Type	Tech start up
Founded	2016
Status	Active

[Agroplexi](#) offers a platform for Agriculture value chains in emerging markets. Through the platform farmers in cooperatives or other agri organisations, can gain access to finance. Cooperatives can submit a request for funding to the platform where project managers will first select the most viable projects. Then funds get release from smart project escrow (this means that investors can use their Agroplexi tokens, called 'XAG' to support the farm projects). Investors, also called 'backers' receive return on investment from the sale of agricultural produce.

Vision on blockchain:

- Blockchain breaks national barriers;
- Settlements becomes easier for farmers;
- It enables financial inclusion;
- The simplest application for now is international payments.

Lessons learned:

- Do not get caught up with speculations on the technology in the future, but how it can be used now;
- Education is an important aspect of working on the adoption of the application. We worked with cooperatives which was very helpful.
- It is important to engage regulators in the process.



Figure 7 : Ecosystem of Agroplexi (source: Agroplexi 2018)

## Cooperation

### AgUnity | Cooperation / Micro finance

Applied in	Indonesia, Papua New Guinea, Ethiopia
Based in	Unknown
Type	For profit start-up
Founded	2017
Status	Unknown

[AgUnity](#) enables restoration of trust between smallholder farmers and farming cooperatives by recording transactions via blockchain technology. This is comparable to a digital handshake between a farmer and cooperative, which no entity (including AgUnity) can amend. When farmers and cooperatives trust each other and collaborate, they see a substantial increase in efficiency and a dramatic increase in their income. “Farmers were willing to participate in a cooperative when they believe they are not more likely to be cheated compared to anyone else.” AgUnity started with projects in Kenya and Papua New-Guinea where the technology led to an average threefold increase in income during one season. The solution enables agreements on amounts delivered and sharing of equipment (such as a tractor or combine harvester). The app itself is a blockchain-based smartphone app which lets farmers schedule various farming activities – such as sharing farming equipment and recording transactions when buying and selling with cooperatives and other third parties, as well as managing their incomes using the in-built digital wallet. AgUnity is also in the process of facilitating access to micro-loan services from their online ‘Marketplace’ within the app.

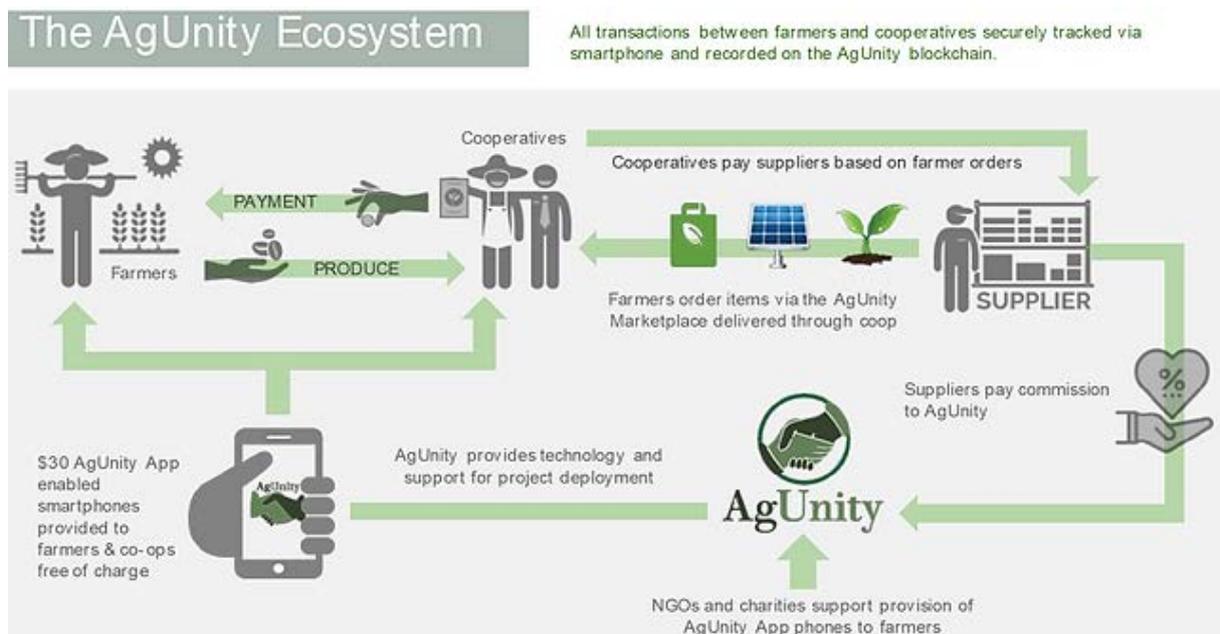


Figure 8 : The AgUnity Ecosystem (source: Steemit @cryptowezz)

### Lessons learned;

- Take time to find the blockchain that is the best fit;
- Engage with people behind the technology (e.g. via social media as Telegram);
- Set up a proper development team that understand and can build with quality blockchain technology.

## Synthesis of technology in the use cases

Most organisations mentioned they had chosen for [Ethereum](#) as, according to them, it is easy to build on. It is also a decentralised system; a permissionless blockchain like [Bitcoin](#). Organisations working on democratising finance often consider a decentralised system so that it is open to all. For these organisations it is often important to consider the distribution of power between the implementing parties, the beneficiaries and the other stakeholders in the system. Stellar is a permissioned blockchain; or centralised. AgUnity explained that [Multichain](#) has both characteristics. Not all organisations are yet able to work with decentralised systems, so in order to pilot and test with blockchain, they will use a centralised database solution such as [Stellar](#). Below table summarises this information:

<b>Name</b>	<b>Protocol</b>	<b>App</b>	<b>Solution for farmers</b>
Etherisc	Ethereum	Platform	Insuring farmers from crop losses and price fluctuations
SmartCrop		Mobile app	Crop insurance for farmers
Agri-wallet	Ethereum	Digital wallet	Access to finance and verified inputs
EthicHub	Ethereum	Platform	Access to finance
SunExchange	Bitcoin	Platform	Peer to peer system for solar energy in rural areas
Binkabi	Ethereum	Platform	Collateral for finance, access to buyers and warehouses
Land LayBy	Ethereum	Platform	Administration of land ownership and ensued collateral/business model
Agroplexi	Stellar	Platform	Access to finance
AgUnity	Multichain	Mobile app	Reliable agreements between farmers (and cooperatives), and access to micro-loan services

The highlighted organisations mention advantages with blockchain, but also challenges. It is quite a new technology, so regulatory frameworks are lagging. The implications and true effects of the technology are not yet well known, so we are still in the experimental phase. The World Economic Forum (2018) mentions six important current risks and challenges;

1. Challenges with adoption;
2. Technology barriers;
3. Security risks;
4. Legal and regulatory challenges;
5. Interoperability risks;
6. Energy consumption challenge.

They describe that the challenges relate to the maturity of the technology, trust of the stakeholders in the technology and its network, and their willingness to invest. This is comparable with the answers from the interviews. Generally, the worry of the energy consumption is often less of a consideration with the start-ups, unless they are actively working in the field of energy or sustainability. WEF concludes that stakeholders will need to collaborate to develop solutions that are “effective, holistic, relevant, and deployable”.

## Conclusion and outlook

The nature of the study is highly explorative looking into a very innovative technology. The report demonstrates the possible value that blockchain technology could offer in current challenges that farmers in particular are facing in Kenya. Several initiatives have started to use blockchain for solving some of these difficulties. Knowledge institutes, NGO's, financial institutions, and insurers might learn from the value blockchain can(not) add in this regard. Blockchain developers may learn from an actual context in a developing country facing food security issues and climate change. Currently these different worlds have not yet established clear channels to enable exchange of information.

Within blockchain technology several choices can be made with regards to its application. For example, whether to use a token, to build on a permissioned versus a permissionless ledger, to consider the consensus protocol, to involve all stakeholders or to start building fast and small etc. The technology in itself poses characteristics and challenges which initiatives might want to consider when implementing a solution. The objectivity and accuracy of data that is used to inform the application remains vital, therefore management of data and information should be in order before starting with a blockchain application.

Within Kenya, blockchain initiatives are being employed where a national blockchain taskforce has been created and where the Kenyan government is partnering with IBM to develop blockchain solutions. For example, to counter academic credential fraud. On the other hand, the interviews show that both the population and government have a critical attitude towards Bitcoin, and sometimes cryptocurrencies in general. The Kenyan economy is significantly impacted by agriculture where farmers are highly affected by climate change. However, the insurance market is still particularly small in this field for different reasons. Blockchains and smart contracts could offer new solutions to existing problems and might allow for new business opportunities to arise.

During the field work; insurers, financial institutions, social Kenyan entrepreneurs and input suppliers seemed positive towards exploring the possibilities of applying blockchain for increasing the financial resilience of farmers in value chains vulnerable to climate change.

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#### Other sources

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- Meeting with Kenyan social entrepreneurs about blockchain
- Reports from Mau Mara Serengeti Sustainable Water Initiative from 2014-2018

#### Websites

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- AgUnity - <https://agunity.com/>
- Crunchbase - <https://www.crunchbase.com/>
- Etherisc – [www.etherisc.com](http://www.etherisc.com)
- EthicHub - <https://ethichub.com/>
- Land Layby - <https://hrbe.io/>
- Tauchain - <http://www.idni.org/>
- The Sun Exchange - <https://thesunexchange.com/>

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## Overview of interviews

Additional interviews in 2019:

Date	Location	Who	Subject	Code #
2019	Utrecht	Rabobank	Blockchain for farmers in East Africa	25
2019	Skype	SunExchange	Blockchain use case	24
2019	Skype	Agroplexi	Blockchain use case	23
2019	Skype	Binkabi	Blockchain use case	22

Date	Location	Who	Subject	Code #
16-11-18	Den Haag	Ethic Hub	Micro financing for small holder farmers through blockchain	21
14-11-18	Skype	Syngenta Nairobi	(Climate Smart) Agriculture, finance and blockchain	20
1-11-18	Wageningen	Emiel Zwarts	His thesis on climate change & agriculture in Kenya	19
22-10-18	Nairobi, Kenya	ICEA Insurance	Crop insurance and blockchain	18
22-10-18	Nairobi, Kenya	CIC Head office	Crop insurance & agriculture	17
19-10-18	Nairobi, Kenya	National Bank, Kenya	Agriculture & finance	16
18-10-18	Nairobi, Kenya	SNV	Climate change & agriculture in Kenya	15
18-10-18	Nairobi, Kenya	Tensenses through SNV	Blockchain for food value chains in Kenya	14
16-10-18	Nairobi, Kenya	ACRE Africa	Blockchain & Agriculture	13
15-10-18	Nairobi, Kenya	Dodore on Agri-wallet	Blockchain solution for smallholder farmers	12
15-10-18	Nairobi, Kenya	Potato farmer	Climate change & insurance	11
12-10-18	Kampala, Uganda	ICEA Insurance	Crop insurance	10
12-10-18	Kampala, Uganda	ACRE Africa	Blockchain for crop insurance	9
10-10-18	East Africa	Rabobank	Access to finance for farmers	8
5-10-18	Skype	Fairfood	Blockchain in food value chains	7
4-10-18	Utrecht	This side up	Blockchain in food value chains in Africa	6
3-10-18	Skype	Land LayBy	Their experience with blockchain in Kenya	5
2-10-18	Skype	Etherisc	Crop insurance for small holder farmers though blockchain technology	4
1-10-18	Skype	Farmerline	Farm inputs and blockchain	3
27-09-18	Skype	AgUnity	Blockchain and farmer cooperation	2
25-09-18	The Hague	Dutch chain	Blockchain for food and for nature	1