PROTECTING FARMERS IN EMERGING MARKETS WITH BLOCKCHAIN

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CURRENT AGRICULTURE TECHNOLOGY LANDSCAPE

In the field of agricultural production, a vast ecosystem of systems has cropped up to serve consumers and institutions on a global scale. The landscape is diverse and ranges from global agribusiness to smallholder farms to crop insurers to Ag Tech startups. Modern precision technologies empower farmers by identifying and preempting disaster. For example, soil mapping provides geo-referenced information on growing conditions while automated guidance systems utilize GPS to self-steer application of water, pesticides, and other crop treatments. However, the agricultural sector as a whole remains conservative and monopolized by large-scale agribusiness.

80% of American corn and 90% of American soybeans are grown using Monsanto’s patented seed traits. Additionally, in a study measuring digital adoption and usage for 22 industries, McKinsey and Company ranked the agriculture sector in last place. In an increasingly digital world, farmers are being left behind with less influence on their circumstances.

In an effort to feed their rapidly growing populations, emerging markets have fueled global growth in agriculture. GSMA estimates an agricultural market of $515 billion in developed economies versus $2.4 trillion in emerging markets. Likewise, agriculture is a major economic driver in emerging markets, contributing 11% to GDP versus only 2% in developed economies. This growth is due in no small part to smallholder farmers, who represent up to 80% of the food supply in Sub-Saharan Africa and Asia.

However, agriculture is still a resource-intensive sector with high externalities - it accounts for 70% of global freshwater use, 38% of global land area, and 14% of total greenhouse gas emissions. With growing concerns around climate change and economic uncertainty, there is a greater need for platforms that protect farmers from volatility yet also protect the environment from anthropogenic destruction. Blockchain technology possesses a potential solution that can sustainably unlock greater agency for farmers.
BLOCKCHAIN TECHNOLOGY OVERVIEW

Blockchain and Bitcoin Origins

The concept of the Blockchain was first discussed in a paper published by a mysterious cryptographer named “Satoshi Nakamoto” in 2008. The paper was thought to be part of the international response to the 2008 financial crisis when a large number of banks failed and lost consumer trust. Satoshi wanted to create a peer-to-peer payment system without the need of transacting through a third party financial institution. The system has become the basis of the digital currency bitcoin in which payment transactions are recorded on a public ledger managed on the blockchain. Figure 1 provides a more detailed view into the blockchain ledger mechanism. The bitcoin use case is the first of many use cases of the blockchain technology. Today in 2017, there are close to 600 blockchain startups listed on AngelList ranging from government (electronic voting) to healthcare (patient records).

Figure 1. Blockchain Technologies Overview

Source: Blockgeeks - What is Blockchain Technology
Smart Contracts Origins

The term smart contracts can be traced back to a term coined by “Nick Szabo” in 1994. Smart contracts are automated contracts that execute certain contractual clauses when a condition is triggered. Behind the scenes, they are converted to computer code and stored on a system supervised by a blockchain network. They can be used to track ownership for anything of value such as money, property, physical asset without a middlemen. Figure 2 provides an overview of how the technology works.

Figure 2. Smart Contracts Technology Overview

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<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
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<tbody>
<tr>
<td>An option contract between parties is written as code into the blockchain. The individuals involved are anonymous, but the contract is the public ledger.</td>
<td>A triggering event like an expiration date and strike price is hit and the contract executes itself according to the coded terms.</td>
<td>Regulators can use the blockchain to understand the activity in the market while maintaining the privacy of individual actors’ positions.</td>
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Source: Blockgeeks - Smart Contracts

AGRICULTURE USE CASES

In exploring the applications of blockchain solutions in the agricultural sector, we explored the potential of three specific use cases: 1) supply chain traceability, 2) smart contracts and crop insurance, and 3) micro-financing and bitcoin payments.

Supply Chain Traceability

With the advent of the Industrial Revolution, machine-intensive technologies began to enable production processes operating on an unprecedented scale. Young economies in Europe and North America propped up never-ending rows of
factories to support food production for their rapidly growing populations. Today, in the race to serve consumers food ever-faster and ever-cheaper, food producers have fine-tuned their supply chains into highly complex yet systematized networks that traverse borders and terrains. However, as supply chains have extended their reach, they have also become more entangled.

**Figure 3.** The Complex Food Chain

The number of stakeholders across the value chain continues to multiply - Figure 3 aptly illustrates the complexity of the modern food supply chain. As a consequence, consumers have largely become disconnected from their food. It has become more difficult for consumers to trace their food back to its provenance, or origin, and ensure hygienic, sustainable, and humane production. Numerous scandals have dogged the food industry in developed and emerging markets alike. To counter this information deficit, consumers are increasingly demanding transparency from food suppliers.

One growing movement is local consumption, which consumers perceive to be more transparent than consumption through traditional agribusiness. Local consumption has gained significant traction in the US, where local foods are expected to nearly double from 2014 to 2019. A report from Packaged Facts showed that half of Americans are currently willing to pay 10% more for locally grown and produced foods while a third would be willing to pay a premium of 25%. Yet, similar to the “all natural” and “organic” labels, “local” also suffers from fraudulent practices by corrupt stakeholders in the food value chain. Ironically, consumers face a widening information gap as most other areas of their lives become more digitized.
Meanwhile, digitization offers solutions to consumers concerned about provenance. TraceRegister, ThisFish, and m-Fish are examples of ongoing projects that capture and convert physical components into digital data along the food supply chain, all the way from first-mile (product origination) to last-mile (final delivery to consumer). They have given consumers and suppliers the ability to triangulate the flow of food products. However, since each relies on a centralized entity for accountability, fundamental flaws exist in ensuring that those entities themselves will remain accountable.

**Figure 4. Certification Access Models**

As a form of digitization, blockchain technology builds on the utility of other data capture tools but also provides a secure and transparent model for food traceability. Provenance.org, a UK-based technology platform, conducted a pilot in early 2016 using blockchain, along with mobile and smart tags, to track tuna from catch to consumer. Their pilot enabled Indonesian fishermen to convert physical tuna into codified assets linked to a digital identity that can be verified on an open registry. As a result, suppliers along the value chain as well as consumers can freely access a suite of proofs that certify a product’s quality standards. In December 2016, Everledger applied similar provenance tracking technology to wine bottles.
to counter fraudulent sales. With the rise of proven use cases by programs developed in industrialized markets, blockchain may garner even greater attention in emerging markets.

**Smart Contracts and Crop Insurance**

Since the advent of agriculture, farmers have confronted unpredictable weather conditions in their work. One way that farmers protect themselves from weather and commodities risk is through crop insurance. However, processing these claims is often a slow process and hinders farmers when they need coverage the most. It might take months or, in the extreme, years before these claims are verified.

From an insurance provider perspective, processing large amount of claims for each weather crisis puts tremendous operational burden on its workforce. Weather patterns are often unpredictable, making it extremely difficult to efficiently scale the workforce to accommodate for weather events. Furthermore, once an event happens, farmers processing claims may engage in fraud and report losses larger than the actual damage. Insurance providers are unable to accurately verify the validity of such claims and incur losses due to fraud.

Farmers and insurance providers have been using inefficient claims processing systems built on legacy technologies. Traditionally, the agricultural industry has been slow to adapt with technologies and innovation. However, with the introduction of Blockchain technologies and Smart Contracts, the crop insurance industry is now facing major disruption and has tremendous opportunity for improvement.

Smart Contracts will create major improvements in the claims processing system. In the event of a natural disaster, weather data will be proactively used to trigger conditions and rules to begin issuance of capital for claims. In this case, farmers are able to receive the resources that they need to mitigate the risk of a weather crisis. The operational volatility of running an agricultural business due to unexpected weather is greatly reduced.

The insurers are able to avoid the operational burden of processing a large volume of claims because of the automated processing afforded by smart contracts. Also, Internet of Things (IoT) devices can be used on major equipment possessions to feed data back to the smart contracts in the event of disaster for verification purposes.
Microfinancing and Bitcoin Payments

Many individuals in emerging markets have cell phones but do not have bank accounts. To address this, mobile solutions have been implemented to help these underbanked populations participate in the mainstream financial system. In Kenya, many businesses are incorporating M-Pesa, a top mobile payment platform in Africa, as part of their entrepreneurial business model. One small business uses it to help parents make more timely tuition payments, while another uses it to establish informal savings groups. Bridge International Academies, a low-cost, for-profit educational franchiser, found that it was able to improve trust and reduce record keeping when it obtained real-time financial data with the M-Pesa platform from its franchisees.

Small and medium-sized business owners living in emerging markets are particularly sensitive when it comes to financial literacy and gaining access to financial resources. The inability to microfinance business needs has left many businesses in the dark. Zeroing in on the agriculture industry and the farmers living in rural emerging markets provides a great opportunity to improve financial inclusion and transparency. Through blockchain technology, underbanked populations will have the opportunity to receive payments and micro-financing, as well as to access transparent transactions that are tamper-free.

Atlas is a startup launching a mobile peer-to-peer application to give to communities in the developing world access to savings and credit through a decentralised solution built on blockchain technology. The rise of mobile penetration in developing countries has enabled these markets to bypass traditional financial infrastructures, resulting in the emergence of microfinance and mobile solutions for the general public.

The app aims to create a network of people from local communities, which in turn will create and cultivate trust while boosting financial inclusion. In addition, access to capital through savings accounts and loans are offered through the Atlas platform. The blockchain shows proof of origin for the money and all transactions, ensuring users know exactly where their money is and the latest transactions on their account.
Solution Deep Dive Selection - Smart Contracts in Crop Insurance

After evaluating the three blockchain use cases, we further investigated the smart contract solution for crop insurance. We found the crop-insurance-use case to be most compelling because of both its potential feasibility and impact. The resulting product can help farmers mitigate risk before a natural disaster happens. The natural disaster trigger event would automatically create payouts for the parties most in need. Also, the insurance companies would benefit by significantly reducing the number of resources needed to process claims, which in turn boosts huge back office cost savings.

MARKET SELECTION

Evaluation Methodology and Results

For our analysis, we wanted to systematically evaluate the opportunity size for a crop insurance solution in key emerging markets. To do so, we first identified top emerging markets (primarily comprised of BRIC nations), as well as other markets with anecdotal evidence of success for other financial programs. Then, we applied our selected markets against evaluative criteria assembled from a combination of industry indices and proxy measures. Cells with a full harvey ball indicate strong potential while an empty harvey ball suggests poor potential. Overall, China represents the best opportunity for a smart contract-powered crop insurance solution based on our evaluative criteria.

Figure 5. Analysis of Emerging Markets against Crop Insurance Opportunity Factors

<table>
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<tr>
<th>CROP INSURANCE OPPORTUNITY MATRIX</th>
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<tbody>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>China</td>
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<tr>
<td>Russia</td>
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### Harvey Balls

![Harvey Balls](https://example.com/harvey-balls.png)

### Opportunity Matrix Glossary:

1. **National Significance of Agriculture Industry Size** - Indicator demonstrating agriculture’s importance relative to the national economy (revenues as % of GDP)

2. **Appropriate technical infrastructure** - Ability to leverage prior implementation of technical infrastructure for a smart contract solution

3. **Government Cooperation** - Level of regulation levied on new entrants (can be found on Ease of Doing Business report)

4. **Maturity of Crop Insurance Sector** - The crop insurance market is more mature with a competitive number of players, which provides more leverage for a partnership

5. **Likelihood of User Adoption** - User familiarity with technology and financial solutions that would make them more likely to adopt a smart contract solution; as measured by smartphone penetration, bank account ownership, Internet usage
China

Agricultural industry accounts for only 12% of Chinese GDP - however, China is one of the largest producers of food in the world. The country is a strong exporter of a variety of goods (wheat, rice, peanuts, tea etc.) and the industry employs more than 300 million people in China. China ranks at 78th for doing business overall and 5th globally for contract enforcement.

China’s government is incentivising innovation with Blockchain solutions by permitting some exchanges to operate without licenses. The government is building blockchain parks in certain regions to entice talent around the world. The private industry is embracing Blockchain as well as Chinese banks are hiring blockchain experts to partner with the government to increase transparency and combat fraud in financial sector.

64% of Chinese consumers have an account at a formal financial institution while roughly 40% of consumers own a smartphone, accounting for 28% of worldwide smartphone adoption. The Chinese agricultural insurance market is also the 2nd largest in the world.

Russia

The Federal Assembly of Russia State Duma, the Ministry of Finance and the Federal Financial Monitoring Service, known as Rosfinmonitoring, are set to review a proposal drafted by the Association of Financial Innovation (AFI) regarding regulatory improvements to the National Payment System. One of the main provisions of the proposal was a roadmap that entailed the utilization of Blockchain technology to create an immutable and transparent client identification system. In essence, the Russian government is cautiously planning the usage of Blockchain to identify clients of the National Payment System. The government is also highly conducive to business, with an overall Ease of Doing Business ranking of 40th and a strong contract enforcement ranking, at 12th in the world.

Agriculture is not a critical input into GDP, only contributing 4%. In general, farmers appreciate the value of crop insurance, with 69% of farmers purchasing multi-peril crop insurance. User adoption tendencies are mixed: 48% of Russians have an account at a formal financial institution while only 11% of Russians have a smartphone.
Kenya

Despite vehement resistance to Bitcoin as an accepted currency, the Kenyan government is now partnering with IBM to develop a blockchain solution to counter academic credential fraud. Kenya overall under-indexes as the 92nd most business-friendly country, but ranks #3 for Ease of Getting Electricity and #8 for Ease of Enforcing Contracts. These conditions suggest that the resource-intensive computational needs of permission-less blockchains, upon which smart contracts could sit on top, would be more viable in a low-cost energy environment. Kenya’s favorable attitude towards rule of law would also be conducive to supporting smart contract-based programs. Additionally, government estimates place the tally of NGOs at 330 suggesting a robust proxy of financial inclusion resources.

Agriculture heavily impacts Kenya’s economy, representing one third of national GDP. Of Kenyan farmers, 75% are smallholder subsistence farmers who are highly vulnerable to the economic effects of natural disasters such as drought and flooding. However, the agricultural insurance market is small with less than 1% of Kenyan farmers covered by some form of crop insurance. Consumer awareness of modern digital and financial tools is also relatively low - 42% of Kenyans own an account with a formal financial institution while only 26% of the population reports smartphone ownership. Together, these measures suggest that user adoption would likely be low as well.

Mexico

Agriculture only plays a small role in Mexico, contributing only 4% of the national GDP. 27% of Mexicans have an account at a formal financial institution while 18% of consumers have a smartphone. Mexico performs moderately well on the Ease of Doing Business index, ranking 47th overall, 93rd for starting a business, and 40th for enforcing contracts. Dating back to 1926, crop insurance is a relatively mature market in Mexico, with 37% of cropped land covered by insurance. Mexico also has a thriving fintech market, however infrastructure needed to support blockchain technology is underdeveloped.

India

In India, agriculture and supporting industries do not constitute a high share of GDP, with contributions expected to reach 17% of GDP in 2017. However, 58% of households in rural India rely on agriculture for their livelihood, which is
indicative of its regional influence. Businesses also have a difficult time operating. India under-indexes as a business unfriendly market, ranking 130th overall and 172nd for contract enforcement. Financial access and smartphone adoption are low - 35% of Indians own an account with a formal financial institution while only 14% of the population, or 30% of mobile subscribers, has a smartphone. Crop insurance coverage is relatively low as well, with only 20% of all cropland in India covered by some form of insurance. Lastly, India has traditionally been known for its strong reputation as a global technology hub. Blockchain technology is in a nascent stage in India, but has observed a slew of recent blockchain implementations with banking partners around fintech, which will increase the nation’s blockchain knowledge base in the years to come.

**SOLUTION DEEP DIVE**

**SmartCrop**

Introducing: SmartCrop, an Android-based mobile platform leveraging smart contracts and intelligent weather prediction to help farmers hedge against crop volatility. Through the use of weather APIs, SmartCrop provides farmers with the option to initiate crop insurance payouts before natural disasters strike. The solution is a win-win for all stakeholders in the value chain.

**Figure 6. Features of the SmartCrop Solution**

- **Predefined Crop Insurance Contract**
- **Intelligent Weather Predictions Alert Scenario/Event**
- **Option to initiate an earlier payout through smart contracts from insurance company to policyholder**
- **Settlement happens automatically and digital assets are recorded on the blockchain**

**Users**

The target user is a progressive farmer living in the rural regions of China, between the ages of 24 and 56. This user has access to a smartphone, bank account and has a demonstrated need for weather insurance.
Insurance Companies

Insurance companies will be keen on partnering with SmartCrop in order to provide a competitive offering in the marketplace to consumers. Users will be keen on signing up for SmartCrop to enjoy the benefits of receiving an earlier payout as a form of risk mitigation for natural disasters. SmartCrop remains transparent by informing the consumer that a percentage of the policy will be given up and in turn the insurance company will salvage the resulting amount. For example, 10 days prior to a hurricane striking, a consumer can initiate an early payout 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.*

Product Interface

SmartCrop’s mobile solution enables users to purchase insurance policies for their valuable crops and monitor weather conditions for proactive insurance payouts.

*Figure 7. Mobile Insurance Policy Purchase*
Figure 7 shows the ability users have to purchase insurance policies on the SmartCrop mobile platform. The user selects the policy type that best fits their needs and enters basic details of the assets to be insured. SmartCrop will then deploy an on-field agent to visit the target location and appraise and confirm the asset value before finalizing the terms of the insurance contract.

**Figure 8.** Proactive Payout Event
Once the contract of the insurance policy is finalized and initiated, SmartCorp uses intelligent weather monitoring technologies to detect events that may trigger an advance payout. Figure 8 illustrates a user scenario where a hurricane has been detected in the region and a notification is pushed to alert the user: the user is now eligible for a proactive payout to prepare for upcoming losses. The user can receive up to 90% of the insured policy amount 10 days prior from the estimated event strike date. Once the user decides to receive the payout, the payment will be immediately initiated through the SmartCrop’s Smart Contract system and deposited into the user’s designated bank account. The policy premium will increase accordingly based on the frequency of the event occurrence.

Architecture

Figure 9. Architecture of the SmartCrop Solution


SmartCrop uses a Smart Contract architecture to power the claims process. Smart contracts are computable legal contracts that automatically execute when a set of pre-programmed conditions set forth in the contract are satisfied. They can be stored in the blockchain ledger and are secured using cryptographic key pairs to make them tamper resistant. Smart contracts will trigger automatic payments upon the occurrence of certain weather trigger events. If SmartCrop detects that there is a 90% chance that a natural disaster will occur within a certain timeframe, a Smart Contract condition is triggered to give the user the option of an early payout under the insured amount.

The insurance claims process is dramatically streamlined by reducing the staff needed to verify and distribute the claims. As a result, insurance companies save on back office expenses. Also, insurees will receive immediate payment of the policy value through the blockchain infrastructure, enabling them to quickly use the capital to plan for the upcoming natural disaster.
GO-TO-MARKET

China’s mature financial services sector, technologically savvy demographics, and government interest in blockchain position the country as a viable point of arrival for our solution. China represents the world’s second largest agricultural insurance market, based on premium income, serving 129 million rural households. The market is also valuable: agricultural insurance premiums are valued at $2.3 billion while effects from climate change cost the Chinese economy $32 billion in 2014. However, the market is unique in that there are currently no private insurers in the space and the sector is supported entirely by the government.

Currently, the Chinese government subsidizes up to 80% of insurance packages for farmers. As such, it will be important for SmartCrop to partner with key government entities, such as state-owned enterprises, to power our blockchain-enabled solution. Several use cases around blockchain are currently underway in China with support from the government. Specifically, the government has joined forces with multinational organizations such as Walmart and IBM to develop new solutions that improve transparency and counter fraud. However, applications for agriculture are nascent, providing an opportunity for SmartCrop to disrupt the sector with government buy-in.

The agricultural insurance market is highly centralized and mature. 21 state-owned providers compete in the market, yet 3 players (People’s Insurance Company of China, China United Property Insurance, and An-Hua Agricultural Insurance) represent 80% of the market. Insurance providers in China are incentivized to shield farmers from adverse weather events in order to minimize claims. Examples of cross-selling tactics include training farmers to manage erratic weather patterns and through marketing artificial hail suppression services.

On April 26, 2017, the Chinese government launched a plan to promote agricultural insurance programs in 200 local counties across China’s 13 main grain-producing provinces. The plan targets “family farms, large scale growers and farmers’ cooperatives, covering the costs of agricultural materials, fertilizers, and land use fees for planting rice, wheat and corn.” Working with the government, the local counties will develop custom plans that suit their agricultural risk profiles. In the current system, insurance programs are suboptimal in light of the lack of timely and sufficient reimbursement to farmers and exorbitant cost of disaster-related claims.
With SmartCrop, all stakeholders in the value chain win. Smart contracts provide the flexibility for farmers to fulfill insurance payouts in preparation for upcoming weather-related calamities. Insurers benefit by reducing the value of claims that get processed, while instantaneous smart contract execution generates back-office operational cost savings.

SmartCrop will plan to build relationships with a top 3 Chinese insurer, pilot with farmers currently covered through that provider, and then target a co-branded launch with our partner following the pilot period to distribute our solution. Following the success of our China launch, we will revisit commercialization prospects in other moderate-to-high potential markets, such as Russia.

IMPLEMENTATION PLAN

In order to successfully launch SmartCrop in China, the following implementation plan will be executed:

**Figure 10. SmartCrop Timeline of Activities**

<table>
<thead>
<tr>
<th>3 months</th>
<th>6 months</th>
<th>9 months</th>
<th>12 months</th>
<th>15 months</th>
<th>18 months</th>
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<tbody>
<tr>
<td>Complete initial prototype of product</td>
<td>Implement field product with existing technology partners in China</td>
<td>Launch product</td>
<td>Complete onboarding of initial customers</td>
<td>Complete testing of product with potential users</td>
<td>Begin marketing campaign and complete sign-up of initial customers</td>
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<tr>
<td>Develop initial list of partners in China and begin outreach (insurance, technology etc.)</td>
<td>Complete hiring of local operations team in China</td>
<td>Complete post-product launch fixes</td>
<td>Gather feedback from initial customers for future product releases</td>
<td>Complete upgrades from user testing for final product</td>
<td>Complete training of local operations team in China</td>
</tr>
<tr>
<td>Complete outreach to partners and select go-to-market insurance and technology vendors</td>
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Development activities will be primarily divided into three workstreams: product development, infrastructure partnerships, and marketing and operations. The goal is to launch SmartCrop after 12 months, and complete and onboard our initial set of customers by the 15 month mark. Any post-production launch fixes and feedback solicitation will be completed by the end of 18 months. The key for the product launch is to partner with local stakeholders in China, and distribute the product through channels that best reach target agriculture customers.

CONCLUSION

The advent of scalable technologies in the digital age, such as blockchain and smart contracts, has given rise to new solutions for ancient problems in emerging markets. Agriculture, the world’s least digitized sector, is a prime candidate for disruption. We see this need heightened in crop insurance, an area where farmers have low agency over their fate. With our solution SmartCrop, farmers make informed insurance decisions powered by smart contracts to anticipate and prepare for natural disasters. China presents a promising opportunity for our launch given the country’s strong commitment to blockchain development, their mature agricultural insurance market, and their reliance on agriculture.

It is difficult to prevent disasters, but it is always possible to prepare. We believe that preparation always prevails.