AgTech Innovation Unlocks Economic Identities for Smallholder Farmers in Indonesia

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1. Executive summary

Digital technologies in the agricultural last mile[1] can benefit all stakeholders involved in the production and trade of crops. Crop buyers experience new efficiencies when sourcing from smallholder farmers, and real-time visibility in the supply chain enables operations to be monitored more efficiently. Meanwhile, producers benefit from more transparent transactions and better access to markets, which allow them to sell their produce at competitive prices and improve their livelihoods. Crucially, the digital footprints these tools generate can help develop economic identities for smallholders. Digital identities provide banks and other financial institutions with a range of relevant data points to assess a farmer's credit risk and ability to repay loans.

Over the last few years, Indonesia has benefitted from a strong AgTech presence that has been driving technological innovation in the agricultural sector. AgTech innovators are playing a vital role in digitising processes in the last mile and supporting the creation of digital identities for farmers. In contrast to AgTechs, the participation of mobile network operators (MNOs) in digitisation initiatives has been mainly peripheral, largely because of a restrictive regulatory environment that prevents non-banks from offering mobile money and promoting rural financial inclusion. Beyond digitising processes in the agricultural last mile, AgTechs are disrupting and reshaping long-established relationships across value chains and building entirely new ecosystems. Although Indonesia's digital transformation is nascent and has by no means reached significant scale, three main paths have emerged in AgTech innovation:

- **Digital tools for monitoring last-mile operations.** These tools replace manual data gathering with digital data collection to support sustainability and traceability and streamline monitoring of field operations. By recording a breadth of farm and farmer data, they can support farmers in developing an economic identity.

- **Digital tools for market access.** Driven by AgTech innovation, digital marketplaces in Indonesia aim to formalise last-mile procurement which, in the absence of strong cooperative structures, depends largely on the intermediation of informal traders. These tools generate a significant volume of digital transactional data, and when shared with financial institutions, can inform more accurate assessments of the creditworthiness of farmers and their ability to repay loans.

- **Digital tools for centralised data collection**. These tools are at the forefront of disruptive innovation in Indonesia and highlight the need for intermediation and aggregation in agricultural data sharing. By centralising the collection of farm and farmer data, they are making it more accessible to interested stakeholders, facilitating rich analytics and enabling data-driven decision making.
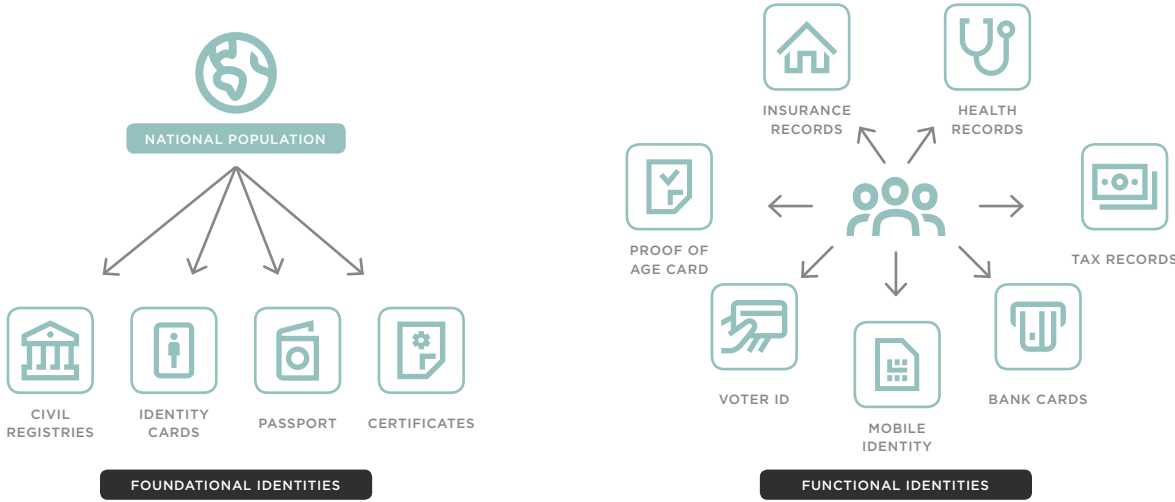
2. Introduction

The use of digital technologies in the last mile of agricultural value chains has the potential to address various pain points crop buyers experience when sourcing from smallholder farmers. For example, lack of transparency in the supply chain can impede successful roll-out of traceability programmes; operational inefficiencies can increase costs of production; and limited opportunities to engage with farmers can restrict the knowledge, inputs and tools buyers provide to boost production. Digital tools can help to make production more transparent, operations easier to monitor and supply chains more efficient. Farmers entering the digital ecosystem can also benefit from better access to formal markets, adoption of the latest agricultural practices and the empowerment that comes from clear terms of trade and transparent transactions.

This report provides a window into Indonesia's digital agriculture ecosystem by presenting the most common use cases of digital interventions and the roles of various stakeholders in driving digital disruption (see section 5). AgTech start-ups are at the centre of this ecosystem, piloting technological innovations that aim to address the challenges buyers and producers face with crop procurement. Although the challenges vary and demand a range of digital tools with different features and capabilities, digital footprints are a common denominator. Generated by both farm and farmer data, a digital footprint can help farmers forge an economic identity[2] and provide a path to financial inclusion. In contrast to foundational identities[3] — government-issued documents like identity cards, passports or birth certificates — economic identities are a form of functional identity[4] that enables access to a specific set of services, such as credit, insurance and saving accounts. For Indonesian farmers, an economic identity could help lenders predict income and assess credit risk more accurately, providing a clearer path to digital financial inclusion. This report examines three paths of AgTech innovation guiding the creation of economic identities for smallholder farmers in Indonesia.

Figure 1

Foundational and functional identities

3. Agriculture in Indonesia

Agriculture has historically been a pillar of the Indonesian economy, making a significant contribution to the country's strong economic growth following the Asian financial crisis of the late 1990s. Agriculture employs more than 30 per cent of the total working age population, the third highest of the Asia-Pacific Economic Cooperation's (APEC) 21 member economies. According to the World Bank, agriculture, forestry and fishing accounted for 13.1 per cent of Indonesia's Gross Domestic Product (GDP) in 2017.[5,6]

Figure 2   Source: The World Bank

Relevance of agriculture in select APEC member economies, 2017
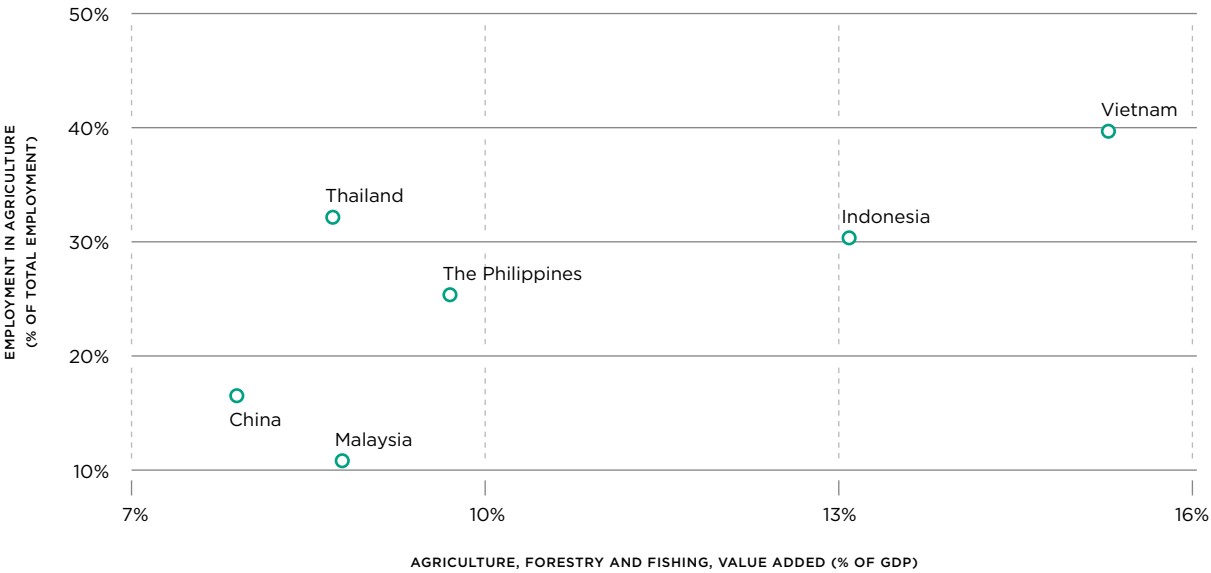
Note

Only Far East Asian countries where agriculture, forestry and fishing employ over 10 per cent of the total working age population have been considered.

The sector remains a key driver of economic growth in Indonesia despite the impact of several recent weather events, including the 2014–16 El Niño and 2016 La Niña weather patterns. Within the agriculture, forestry and fishing sub-sectors, cash crops and food crops jointly represent over half the sector's contribution to GDP.[7]

Figure 3   Source: BPS-Statistics Indonesia

Contribution of agriculture, forestry and fishing to Indonesia's GDP, by sub-sector, 2017

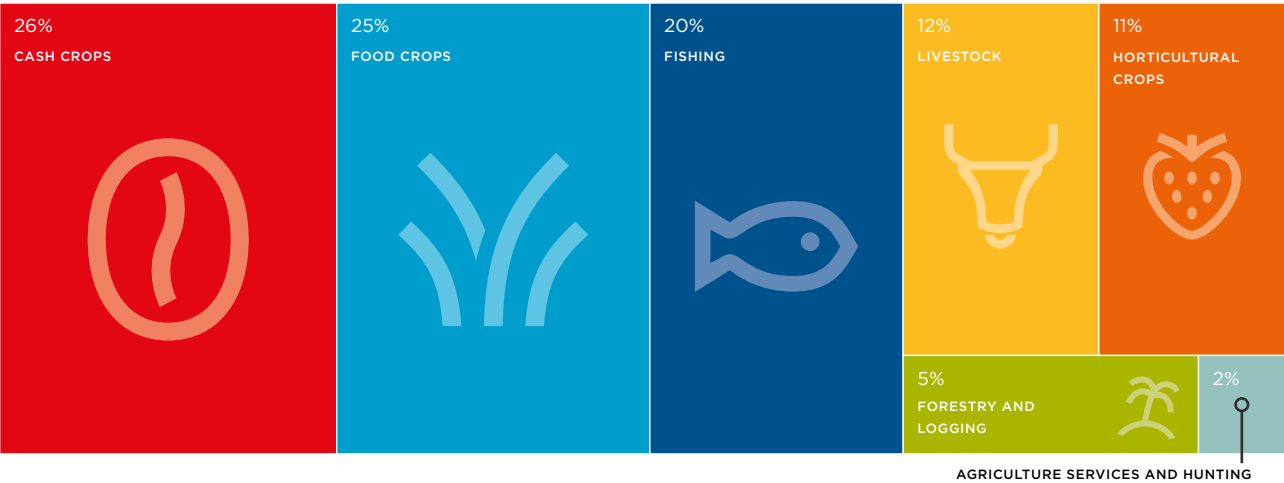Indonesia's agriculture sector is made up of four sub-sectors: cash crops, food crops, horticultural crops and livestock.[8] The country is one of the world's largest producers and exporters of cash crops, such as palm oil, rubber, coconut, cocoa and coffee. These high-value crops dominate the agricultural landscape attracting interest from large agribusinesses in the global supply chain, with 98 per cent of the total value of Indonesia's agricultural commodity exports coming from cash crops (export value of cash crops at $31,815 million).[9] Major food crops, ranked by export value, are rice, wheat, soybean, mung bean and peanuts. The total annual export value of Indonesia's food crops is $171 million. Horticultural crops include vegetables (e.g. chilli, shallot, cabbage, potato), fruits (e.g. pineapple, banana, mangosteen, mango), ornamental plants (e.g. orchid) and medicinal plants (e.g. ginger, turmeric), with a combined export value of $442 million.[10]

5.   APEC's 21 member economies are Australia, Brunei Darussalam, Canada, Chile, China, Hong Kong, China, Indonesia, Japan, Republic of Korea, Malaysia, Mexico, New Zealand, Papua New Guinea, Peru, Philippines, Russia, Singapore, Chinese Taipei, Thailand, United States and Vietnam. Available at: https://www.apec.org/About-Us/About-APEC/Member-Economies
6.   The World Bank, 2017. Available at: https://data.worldbank.org/country/indonesia

7.   Statistical Yearbook of Indonesia, 2018. Available at: https://www.bps.go.id/publication/2018/07/03/5a963c1ea9b0fed6497d0845/statistik-indonesia-2018.html
8.   Agricultural statistics 2018, Ministry of Agriculture. Available at: http://epublikasi.setjen.pertanian.go.id/download/file/438-statistik-pertanian-2018
9.   The total area of palm oil plantations in Indonesia is currently around 14 million hectares, with most located on the island of Sumatra. Indonesia is also home to approximately 1.7 million hectares of cocoa plantations. The island of Sulawesi is Indonesia's main cocoa-producing region.
10. Crops are listed by export value.

Export value of agricultural commodities, by sub-sector, 2017

- 1.3% | HORTICULTURAL CROPS
- 0.5% | FOOD CROPS
- 1.9% | LIVESTOCK
- 96.3% | CASH CROPS

Export value of cash crops, by crop type, 2017

- 3.5% | COCOA
- 5.6% | OTHER
- 3.7% | COFFEE
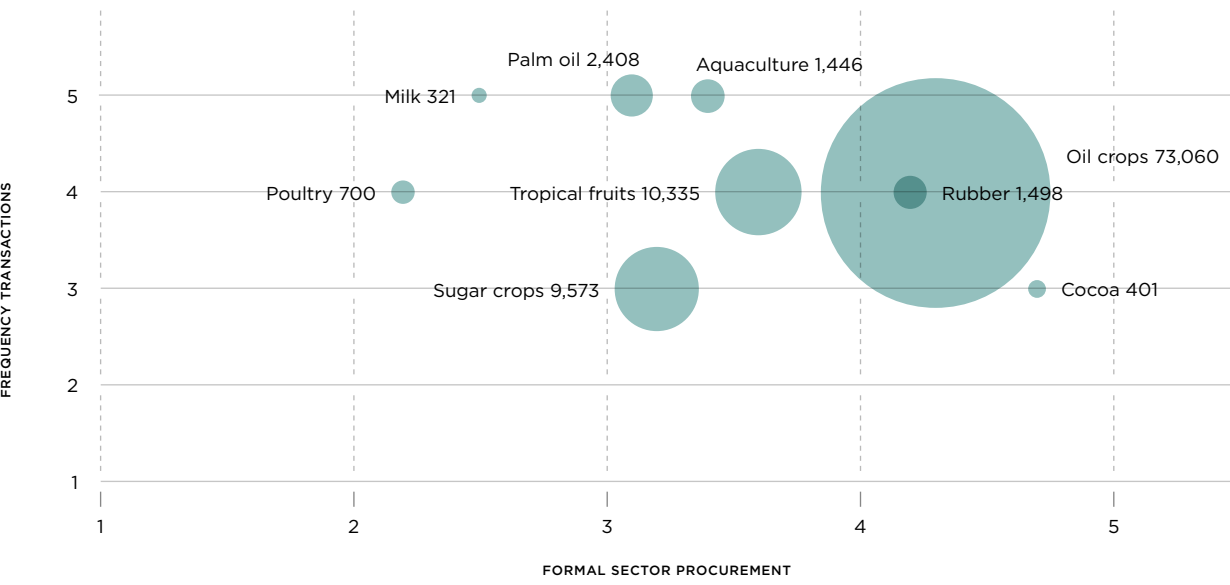- 4.3% | COCONUT
- 16% | RUBBER
- 66.8% | PALM OIL
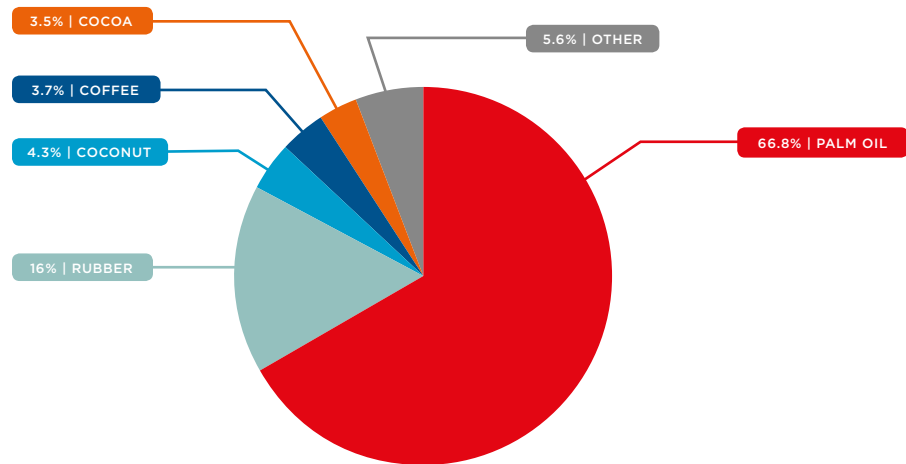
To help identify priority value chains for digital intervention in the agricultural last mile, the GSMA mAgri programme and GSMA Intelligence have

developed a model that categorises the most attractive value chains for digitisation in 71 emerging countries, including Indonesia (see Figure 6).

Priority value chains for digital intervention in Indonesia

Milk 321 · Palm oil 2,408 · Aquaculture 1,446 · Oil crops 73,060 · Poultry 700 · Tropical fruits 10,335 · Rubber 1,498 · Sugar crops 9,573 · Cocoa 401

FREQUENCY TRANSACTIONS (vertical axis)
FORMAL SECTOR PROCUREMENT (horizontal axis)

Note

Bubbles indicate the size of the value chain (volume of formal production in tonnes, 2013)

Using a proprietary model developed by GSMA Intelligence and GSMA mAgri, this figure displays the 10 most attractive value chains for digitisation. Factors considered include, among others: size of the value chain (volume of formal production in tonnes, FAO data, 2013), which is shown by the teal bubbles; formal sector procurement by value chain (horizontal axis); and frequency of transactions by value chain (vertical axis). Formal sector procurement is a metric calculated as the weighted average of three sub-indicators: Commercial Activity in the Value Chain (subsistence crops versus cash crops); Structure of the Value Chain (localised traders versus institutional buyers); and Share of Exports (consumed locally versus exported). The assumption is that formal value chains with established structures and well-defined roles and economic relationships between stakeholders offer mobile money providers greater opportunities for digital payments. Each value chain has been given an aggregate score (1 to 5) for the sub-indicators; the higher the score the stronger the potential for digitisation. Frequency of transactions is a major factor when assessing the viability of a value chain for digitisation, as regular transactions ease liquidity management for a mobile money provider and provide stable revenues to its mobile money agents. Similar to formal sector procurement, agricultural value chains receive a score of 1 to 5 depending on the estimated number of transactions per year: 1 transaction (scores 1); 2 to 5 transactions (2); 6 to 20 transactions (3); 21 to 50 transactions (4); 50+ transactions (5).

Major foreign exchange generators in the agricultural sector, such as palm oil and rubber, have attracted attention from digital agriculture implementers; not for digitisation of procurement payments, but last-mile traceability systems suited for monitoring supply chain operations. Both these cash crops belong to formal value chains with established structures and well-defined roles and economic relationships, and are likely to offer suitable entry points for digitisation.

In addition to palm oil and rubber, Indonesia is the third-largest producer of cocoa beans in the world after Côte d'Ivoire and Ghana. Some early initiatives in digital agriculture have therefore focused on the cocoa value chain, which is one of the country's leading cash crops and has attracted interest from large buyers, such as Barry Callebaut, Cargill, Olam, ECOM, Mondelēz International and others.

3.1. Characteristics of last-mile procurement

Crop procurement is still largely informal

In Indonesia, the process by which buyers source crops from farmers (last-mile procurement) still depends largely on the intermediation of informal traders (or middlemen or brokers). Although large institutional buyers control the processing and export of cash crops in Indonesia, informal traders still play a critical role with these high-value crops, and most buyers and producers take their ubiquitous presence for granted. There are often several layers of traders between institutional buyers and producers, fragmenting the supply chain. Farmers sell their crops directly to local traders at the farm gate or at nearby warehouses, while traders connect farmers to markets and informally address their financing needs by offering credit, either in cash or in kind.

Unlike other emerging markets, like Kenya and Tanzania in East Africa or India in South Asia, where cooperatives or farmer associations play a vital role in value-chain development and help producers address challenges with informal last-mile procurement, in Indonesia, cooperative structures play a less prominent role. This partly explains the informal nature of agricultural procurement. One of the main issues affecting the long-term viability of the cooperative model in Indonesia is the low rate of member activity. Although about 15 per cent of the country's population belongs to a cooperative, 30 per cent of cooperatives have been inactive, in part due to declining membership rates, low levels of professionalisation in management and governance of activities.[11]

Lack of collateral restricts farmers' access to credit

The 2017 Global Findex database shows that, of the 199.9 million Indonesians aged 15 and older,[12] 48.9 per cent own an account with a financial institution or through a mobile money provider. For Indonesians living in rural areas, this share drops only marginally to 47 per cent in the same period. Interestingly, for the vast majority of Indonesians, financial inclusion means having a bank account at a financial institution.[13]

Most financially excluded rural residents are farmers at the bottom of the economic pyramid (living on less than $2.50/day) who need access to financial services to fund their core agricultural activities and improve their livelihoods. A farmer's ability to access credit leads to both higher quality crops and higher yields, which can unlock rural development and stimulate further economic growth. While Indonesia is one of the leading producers and exporters of coffee worldwide, the productivity of coffee farms is significantly lower than neighbouring Vietnam.[14] Better access to financial instruments could enable Indonesian coffee farmers to access better quality inputs and equipment and expand their farming activities to boost per hectare yields and profits.
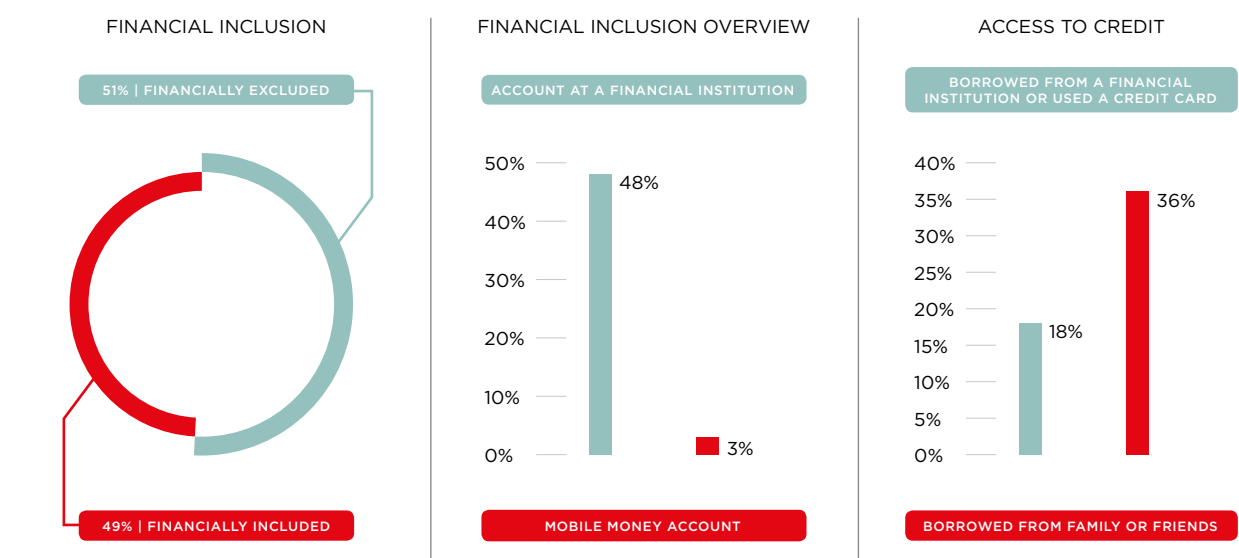
The high perceived risk of lending to the agricultural sector is the main reason for the lack of interest in smallholder financing in the formal financial sector. As a result, the brick-and-mortar network of formal financial institutions is very thin in rural Indonesia. The bank branch network is sparse in parts of the archipelago outside densely populated Java, for example, in the rural areas of Sumatra and Sulawesi islands, which produce a substantial share of high-value crops. Where bank credit is available, it generally requires collateral, but according to an IFC report, up to an estimated 90 per cent of smallholders in Indonesia do not have a formal title to their land.[15] Without regular salaries and sufficient collateral, financial institutions do not have the information necessary to offer credit, let alone in a smart and meaningful way tailored to the crop calendar and the problems and realities of agricultural production.

To address the challenge of smallholder farmer financing, Indonesia's central bank, Bank Indonesia, established the Kredit Usaha Rakyat (KUR) programme ("Business Credit for People"), a credit guarantee scheme for microfinance institutions (MFIs) lending to micro, small and medium enterprises (MSMEs).[16] Agriculture is one of two sectors with the highest number of eligible MSMEs.[17] A recent OECD study concluded that although the programme has met its objective to increase credit flows to micro and small enterprises, the programme's high operating costs cast doubts on its long-term sustainability.[18]

Figure 7 — Source: The World Bank

Financial inclusion, population aged 15+, 2017

FINANCIAL INCLUSION
- 51% | FINANCIALLY EXCLUDED
- 49% | FINANCIALLY INCLUDED

FINANCIAL INCLUSION OVERVIEW
- ACCOUNT AT A FINANCIAL INSTITUTION: 48%
- MOBILE MONEY ACCOUNT: 3%

ACCESS TO CREDIT
- BORROWED FROM A FINANCIAL INSTITUTION OR USED A CREDIT CARD: 18%
- BORROWED FROM FAMILY OR FRIENDS: 36%

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11. International Journal of Humanities and Social Science Invention, 2017, "The Role of Cooperatives in the Indonesian Economy". Available at: http://www.ijhssi.org/papers/v6(10)/Version-3/F0610034346.pdf
12. The World Bank, Findex 2017. Available at: https://globalfindex.worldbank.org/sites/globalfindex/files/countrybook/Indonesia.pdf
13. In November 2016, the Indonesian Government announced a National Strategy for Financial Inclusion (SNKI). One of its goals is to expand bank account ownership to 75 per cent of the adult population by 2019.

14. In Vietnam, the average size of a coffee farm is similar to Indonesia (about one hectare per household), but average yields are more than three times higher. See IDH, Technoserve (January 2014) "Indonesia: A business case for sustainable coffee production". Available at http://exchange.growasia.org/indonesia-business-case-sustainable-coffee-production
15. Available at: https://www.ifc.org/wps/wcm/connect/443a6f00408d25feb13ab1cdd0ee9c33/EAP-Indonesia+Agri-finance.pdf?MOD=AJPERES
16. Under the new KUR programme, farmers can borrow money from a select number of banks without collateral at a current annual interest rate of seven per cent. There are two components of the programme: 1) Micro KUR, which has a maximum loan of IDR 25 million ($1,756) and 2) Retail KUR, which has a maximum loan of IDR 500 million ($35,129).
17. The other sector is wholesale and retail trade.
18. OECD, 2018, "SMS and Entrepreneurship Policy in Indonesia 2018". Available at: https://doi.org/10.1787/9789264306264-en

4. The mobile ecosystem landscape

Five licensed MNOs dominate Indonesia's mobile market: Telkomsel, Indosat Ooredoo, XL Axiata, Tri and SmartFren. Telkomsel is a 65 per cent-owned subsidiary of Telkom Indonesia in which the government is the majority shareholder. The Indonesian Government also retains a minority stake of about 14 per cent in Indosat. As of H1 2018, Telkomsel holds a 46 per cent share of total connections, followed by Indosat (23 per cent), Tri (15 per cent), XL (13 per cent) and SmartFren (two per cent).[19]

By the end of 2018, the total number of mobile connections represented a market penetration of 132.6 per cent, a 32.5 percentage point drop year on year. This sharp decline in mobile connections was due to a new government regulation requiring new and existing pre-paid connections to be registered with a valid national identity card (KTP) and family card (KK). This blocked nearly 101 million SIM cards after the 1 March 2018 registration deadline had passed.[20] As of mid-2018, smartphone adoption stood at 65 per cent, but is expected to reach almost 90 per cent by 2025 (396 million connections). The vast majority of smartphone users are located in urban areas and smartphone penetration in remote rural areas is significantly lower.

Mobile money was first introduced in Indonesia by Telkomsel in 2007, with subsequent roll-outs by other bank- and non-bank entities.[21] Currently, Telkomsel's mobile money offering, LinkAja, and XL Axiata's service, XL Tunai, are the only mobile money services offered by MNOs. Despite the potential of mobile money to promote financial inclusion among unbanked Indonesians, consumer adoption of these mobile money services has been slow due to regulatory limitations that restrict MNO participation in financial services.

While there are interoperability regulations that allow mobile money users to transact with others across networks, mobile money providers are only allowed to partner with registered legal entities as agents for the provision of cash-in and cash-out services.[22] Consequently, these services are restricted to MNO customer stores and institutional retailer outlets (such as Indomaret and Alfamart), which are present mainly in urban and peri-urban areas. An additional challenge to driving adoption of mobile money in rural regions is low wallet and transaction size limits.[23] These limits make mobile money's value proposition less compelling for business-to-person (B2P) payments to farmers, as a single transaction for high-value crops like cocoa and coffee would typically amount to hundreds of dollars. Overall, mobile money services in Indonesia tend to focus on use cases such as online shopping, utility bill payments and ticket payments that are more relevant for the urban customer segment.

Largely because of a restrictive mobile money regulatory framework, the participation of local MNOs in digitisation initiatives has been mostly peripheral. Digital agriculture implementers may use an MNO's core assets, such as mobile connectivity and IoT technology, to develop their own digital solutions and market them directly to rural stakeholders like agribusinesses and farmers.[24] Although forming deeper and more strategic partnerships between MNOs and digital agriculture implementers could help to transform the sector by unlocking commercial opportunities for both parties while also delivering socio-economic benefits for local populations and businesses, progress has been rather slow.[25]

19.   GSMA, 2018, "Accelerating Indonesia's digital economy: Assigning the 700 MHz band to mobile broadband". Available at: https://www.gsmaintelligence.com/research/?file=906683ed02157aa8b18af03e213e7abf&download
20.   GSMA, 2018, "Indonesia blocks 101M prepaid SIMs". Available at: https://www.mobileworldlive.com/asia/asia-news/indonesia-blocks-101m-prepaid-sims/
21.   GSMA, 2019, Mobile Money Deployment Tracker. Available at: https://www.gsma.com/mobilemoneymetrics/#deployment-tracker
22.   Examples of registered legal entities include MNO customer stores, supermarkets and retail stores. Examples of unregistered entities include airtime agents, mobile money agents and pop-up stores.
23.   For Basic Service, wallet and monthly transaction limits are $142 and $1,422, respectively. For Full Service, wallet and monthly transaction limits are $711 and $1,422, respectively.

24.   GSMA, 2017, "Opportunities in agricultural value chain digitisation: Learnings from Uganda".
       Available at: https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/01/Opportunities-in-agricultural-value-chain-digitisation-Learnings-from-Uganda.pdf
25.   eFishery offers a recent example of a strategic partnership between an Indonesian start-up and an MNO. More information is available at:
       https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/12/Start-ups-and-Mobile-in-Emerging-Markets-Issue-4.pdf

5. Digital agricultural interventions in Indonesia

Indonesia has been a hotbed for agricultural innovation in recent years, driven mainly by AgTech start-ups focussed on creating opportunities to optimise fragmented value chains and connecting crop producers and buyers in more efficient and profitable ways. A growing number of Indonesian start-ups have developed solutions that optimise the value chain by addressing pain points faced by both producers and buyers. For crop producers, poor land practices result in high production costs and sub-optimal yields, while the dominant role of traders leads to low prices at the farm gate. For crop buyers, such as those in the palm oil, cocoa and coffee value chains, ever-growing demand for sustainable agriculture practices and traceable production creates the need for improved systems and processes.

AgTech start-ups are at the centre of this digital transformation, and local and international venture investment are helping to drive technological innovation in the agricultural sector and improve its long-term sustainability. The value proposition of AgTech innovators revolves around the need for more cost-effective and efficient ways to produce food, fuelled by the country's population boom, changing food consumption patterns and land scarcity.

This section explores the three main paths of AgTech innovation in Indonesia, led by start-ups focussed on three types of solutions:

- Digital tools that support commercial agribusinesses in optimising last-mile operations and developing reliable supply chains;

- Digital tools that improve producers' access to markets and enhance supply chain efficiency by formalising last-mile procurement activities; and

- Digital tools for centralised farm and farmer data collection that make data more accessible, facilitate rich analytics and allow better data-driven decisions for any interested stakeholder (e.g. agribusiness, financial institution, insurance company).

These digital tools can deliver a range of benefits to crop buyers and producers in agricultural value chains. A common output across all types of digital tools is data. Data generation is a by-product of a digital tool's value proposition for solutions that address inefficiencies in the agricultural last mile (see sections 5.1 and 5.2), and tools that centralise data collection and enable sharing between interested parties (see section 5.3). The digital footprint created by AgTech innovation also gives smallholders the potential to develop an economic identity that provides financial institutions with a range of relevant data points to assess a farmer's risk and ability to repay.

Figure 8

Source: GSMA

Digital tools that generate farm and farmer data
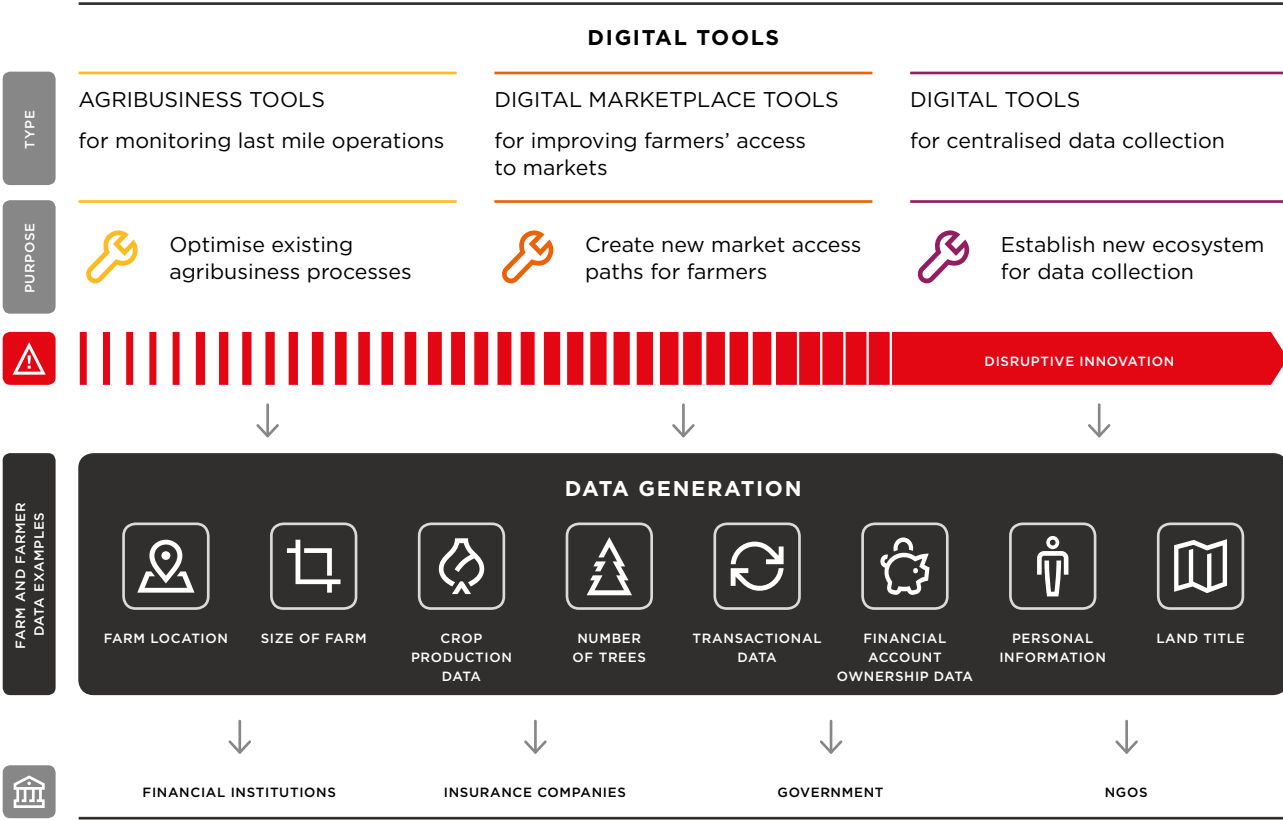
5.1. Digital tools for monitoring last-mile operations

The deployment of digital tools in the last mile allows agribusinesses in Indonesia to address an array of business challenges they face when sourcing from farmers. These challenges are often inherent in local agricultural production systems and prevent farmers, crop buyers and other value-chain actors from realising their full potential. For example, using manual systems to capture data, following inefficient processes in the last mile, lacking transparency in transactions with farmers or having poor visibility in the supply chain. These challenges create inefficiencies and bottlenecks in the supply chain, increase the cost of sourcing raw materials and managing operations, and have a negative impact on agribusiness revenue and profitability. These effects can be felt across a range of agribusiness activities in the agricultural last mile, such as farmer registration and profiling, crop procurement or the development of transparent and traceable supply chains.

The scale of these challenges becomes apparent when considering the multitude of dimensions, systems and processes of last-mile activities. For example, in direct procurement, farmer registration and profiling often involves recording a variety of data points across numerous categories from several agribusiness stakeholders, such as field agents, extension agents and others. However, agribusiness field staff are often spread across vast procurement catchment areas that extend to remote parts of less-populated Indonesian islands, such as Sulawesi. In this context, recording and sharing farmer registration data to facilitate procurement becomes a challenge.

Agribusinesses may benefit from farm and farmer data in several ways. First, data can enable an agribusiness to design and direct customised products and services that provide specific and timely support to

farmers. Data can also drive value-chain development programmes and facilitate communication with farmers. Customised support to farmers is particularly important in Indonesia's cocoa, coffee and other competitive value chains where farmers are less dependent on a specific buyer and agribusinesses compete to procure crops from the same farmer.

Farm and farmer data can also support farmers in building an economic identity and benefitting from the products and services offered by formal financial institutions. However, traditional pen-and-paper data collection is time consuming and expensive, compromises data quality and makes operations management less efficient.

Figure 9   Source: GSMA

Examples of farm and farmer data captured in the registration and profiling of farmers

Farm and farmer data categories	Example data points
PERSONAL INFORMATION	Name, gender, family size, ID number
COMMUNICATION	Mobile number, native language
FARM	Farm location, field size, land title, soil conditions
CROP	Crops grown over time, varieties grown, plant spacing
PRODUCTION	Cultivation and production data, use of agrochemicals, historical sales data
FINANCIAL	Account ownership, credit and savings, insurance data

In Indonesia's highly formal value chains, such as palm oil and cocoa, which are significant to the country's economic development, the requirement for data capturing widens. This is primarily due to the need to provide smallholder finance, but there is also growing pressure to meet the needs of sustainability and traceability initiatives. Demand for traceable products is steadily growing from downstream supply chain actors increasingly alarmed by reported cases of deforestation and habitat and biodiversity loss from crop cultivation. With last-mile procurement still largely informal in many value chains, non-digital data collection methods are inadequate at scale.

In this environment, the deployment of digital tools could benefit agribusinesses in two main ways: optimising last-mile operations and developing more reliable value chains. For an agribusiness, greater

transparency in the supply chain translates into more effective management of supply chain operations and allows activities to be expanded in an environmentally and socially sustainable way. In Indonesia, there are two dominant models for last-mile digital tools targeting agribusinesses:

○ A tech provider-led model in which a growing number of providers with different skill sets and capabilities, mainly start-ups, use core MNO assets like cellular connectivity to develop their tools; and

○ An agribusiness-led model for last-mile digitisation in which an agribusiness may draw on resources from a specialist software firm and lead the development of an enterprise digital tool that meets organisational objectives.

The first model benefits from a tech provider's agility and highly specialised skill set, which often drive innovation in AgTech. However, its success depends on a provider's ability to tailor digital tools to a variety of agribusiness client needs, so achieving scale through roll-out across multiple clients could become challenging. On the other hand, digital tools developed under the agribusiness-led model are designed to address the specific challenges an agribusiness faces when interacting with crop producers. Yet, relying on external resources for digital tool development could slow the development process and create risks that are more difficult to predict and manage.

Indonesian start-up, Koltiva, has been developing digital tools under a tech provider-led model. The company offers a suite of cloud-based mobile and web applications (apps) for project and supply chain management that target commodity buyers operating in a range of value chains. Koltiva offers six commodity management platforms that empower sustainability and traceability management from farm to processing facilities and factories. Each platform consists of multiple modules, including smallholder farm profiling, impact monitoring and result measurement and producer training administration, among others.

Figure 10   Source: Koltiva

Koltiva's commodity management platforms

Value-chain actors can access a commodity platform via one of Koltiva's tailored mobile apps. The FarmXtension app is operated by field agents and used to collect and update farm and farmer data. The FarmGate app is used by collectors, traders, buying

stations, warehouses and processing factories to record post-farm gate transactions. The FarmRetail app is used by seedling nurseries and farm input kiosks in rural areas for stock management, cash flow and customer relationship management.

The Koltiva supply chain ecosystem

Koltiva has also developed the FarmCloud mobile app, which gives farmers access to all the information (stored on the cloud) collected on them by traders, input suppliers, field agents and agribusiness extension officers using one of Koltiva's commodity platforms. To login to FarmCloud, farmers request a password linked to their user profile on the commodity platform. The smartphone-operated app also connects farmers to agribusiness collectors to

access price and quality information and schedule procurement activities. It also gives farmers access to inputs and procurement transaction notifications. FarmCloud's link to Bank Rakyat Indonesia permits farmers applying for credit to authorise sharing of their data by text message. The bank can then use the data to conduct risk profiling, offer loans to farmers or recommend bank account opening.

Koltiva's FarmCloud farmer app
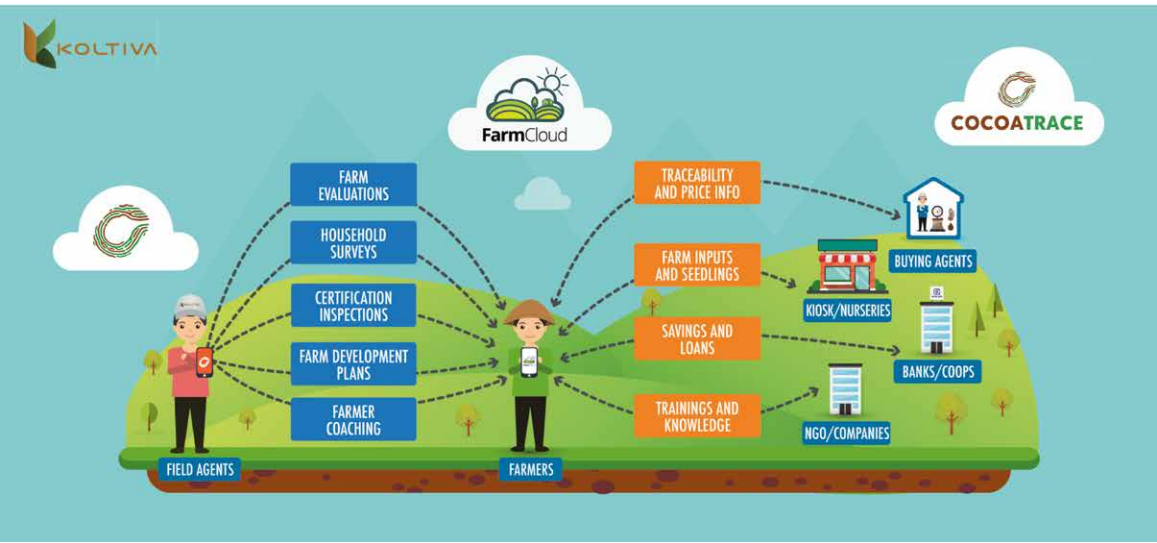
This FarmCloud functionality allows farmers without credit history to access formal financial services by authorising their digital footprint to be shared with a financial institution. For farmers cut off from the formal financial system, FarmCloud has the potential to become a stepping stone to digital financial inclusion.
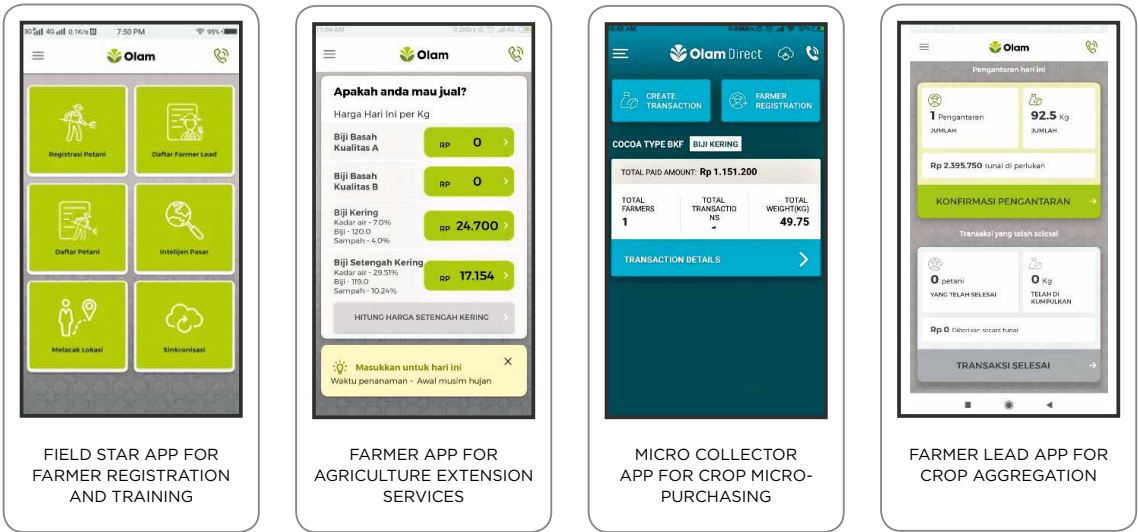
To date, Koltiva's digital tools have collected and processed data from over 215,000 independent smallholder farmers and 280,000 smallholder farms and plantations, and recorded over 265,000 traceability transactions. Koltiva is now targeting partnerships in markets outside Indonesia.

There is a growing need for these types of digital solutions, and AgTech start-ups are only addressing a fraction of agribusiness demand. Some of the largest buyers in agricultural value chains aim to develop digital tools in-house that support monitoring and

overall visibility of last-mile operations. For example, global agribusiness Olam began deploying the Olam Digital Origination platform in Lampung Province in August 2017, which consists of a suite of apps (see Figure 13) within Olam Direct Digital Solutions. Developed by the Digital Olam team, the platform connects farmer suppliers and rural entrepreneurs with the company's cocoa business teams, which can coordinate procurement and warehousing more efficiently and allocate resources when and where they are needed. Additionally, Digital Origination's Farmer app allows farmers to check cocoa prices online, access tips on Good Agricultural Practices (GAP)[26] and indicate their intent to transact with Olam. With this digital platform, Olam aims to establish a transparent sourcing process and improve traceability in the supply chain. To date, Olam's Digital Origination has been deployed to 40,000 cocoa farmers in Indonesia.[27]

Olam Digital Origination suite of apps

| FIELD STAR APP FOR FARMER REGISTRATION AND TRAINING | FARMER APP FOR AGRICULTURE EXTENSION SERVICES | MICRO COLLECTOR APP FOR CROP MICRO-PURCHASING | FARMER LEAD APP FOR CROP AGGREGATION |

26. The Food and Agricultural Organization of the United Nations (FAO) describes the concept of Good Agricultural Practice (GAP) as a collection of principles to apply to on-farm production and post-production processes, resulting in safe and healthy food and non-food agricultural products, while taking into account economic, social and environmental sustainability. See http://www.fao.org/3/Y5224E/y5224e04.htm

27. For more information on Olam digital tools, see the GSMA report, "Opportunities in agricultural value chain digitisation: Learnings from Côte d'Ivoire". Available at: https://www.gsma.com/mobilefordevelopment/resources/opportunities-agricultural-value-chain-digitisation-learnings-cote-divoire

Given the breadth of farm and farmer data it records, this type of holistic digital tool has strong potential to support the creation of an economic identity. While no single data point is likely sufficient to support a farmer's credit risk profile, a combination of data may be. The face-to-face relationships agribusinesses have with farmers could play a key role in efforts to build economic identities and facilitate access to formal credit. In addition to digital tools that are optimising last-mile operations and transparency in the value chain, GSMA research in Indonesia has found evidence of last-mile digitisation in digital tools that improve producers' access to markets and enhance supply chain efficiency by formalising procurement activities (see section 5.2).

5.2. Digital tools for access to formal markets

Implementing digital technologies in the agricultural last mile can ease the challenges Indonesian farmers face operating in predominantly informal local markets with weak links between crop producers and buyers. Fragmented or inadequate access to formal markets, including supply chain partners, off-takers and wholesalers, prevents farmers from selling their produce at a competitive price and generating substantial cash flow. Instead, farmers may take an opportunistic approach and sell to cash-rich traders at reduced prices that are often negotiated on an ad hoc basis. Informal transactions like these can lead to low returns, volatile cash income and vulnerability to financial shocks.

One-to-one interactions based on unstructured economic relationships are not conducive to building economic identities and gaining access to formal financial services, such as credit and insurance. Despite the efforts of the Indonesian Government to support those excluded from the formal financial system with its credit guarantee scheme, KUR, the relatively low maximum loan amount for applicants without collateral keeps it restrictive. As a result, farming activities that require significant upfront capital investment, such as aquaculture,[28] cannot rely on credit from KUR.

Without enough liquidity, farmers cannot purchase inputs such as pesticides, fertilisers and seedlings to replace ageing trees, invest in farming equipment or expand their activities to boost agricultural production and transform their livelihoods. The impact of this is grave for crops like cocoa since yields decline drastically as trees age. When exclusion from formal markets accompanies poor access to formal financial

services, it leads to income insecurity, which in turn discourages farmers from producing high-value cash crops. Cut off from formal markets, farmers can be forced into subsistence farming.

Digital tools can also benefit commodity buyers by formalising the last mile. Institutional buyers favour robust market structures that support sourcing of higher crop volumes, predictable revenue streams and traceability in the supply chain. To make procurement more predictable, agribusinesses continuously look for opportunities to strengthen relationships with farmers to promote farmer loyalty (farmers returning to sell their crops to the same buyer) and ensure a steady supply of high-quality crops (which traders often cannot provide as their procurement strategy is geared towards volume rather than quality). With cooperatives in Indonesia largely absent or disempowered to organise farmers, aggregate crops or secure access to markets, crop buyers must look elsewhere for support in formalising last-mile activities. Digital tools can help to address the market gaps that make it difficult to match demand to supply.

In Indonesia, AgTech innovation is supporting the development of digital tools that improve farmers' access to markets and formalise the agricultural last mile. These kinds of solutions help build trust and benefit farmers and crop buyers alike. Two main models for these digital tools have emerged. The first is a basic implementation model in which an AgTech provider develops a digital marketplace and markets it directly to farmers and buyers who become responsible for matching demand to supply. In the second model, an AgTech provider builds on the basic

implementation model to become directly responsible for the marketing and distribution of crops, in charge of logistics, warehousing and the identification of producers and buyers. It also takes responsibility for outreach activities in rural areas for farmer acquisition and education, integrating online payments on its

platforms and exercising quality control and identifying defects. Through this process, AgTech providers become stakeholders in the agricultural value chain, taking on the role of formal commodity buyers that procure crops from farmers that they subsequently sell to institutional buyers or consumers.[29]

Figure 14   Source: GSMA

Levels of value chain control by digital marketplace tool owners
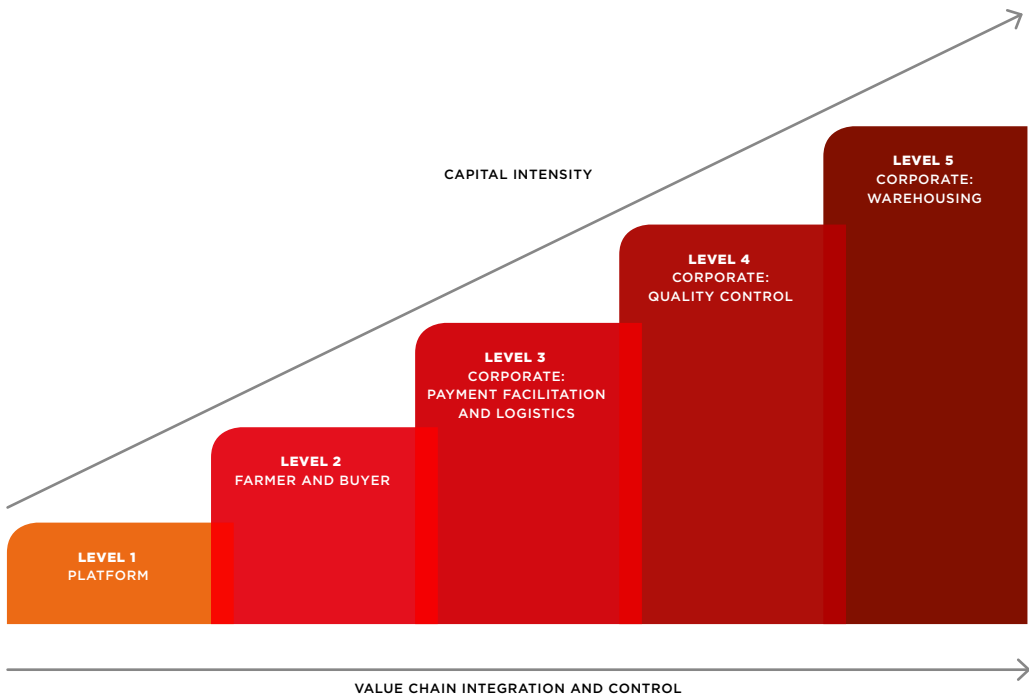
Indonesian AgTech start-up, Tani Group, has developed a holistic solution (see Level 5 in Figure 14) that encompasses a digital marketplace and marketing and distribution functions. Tani Group's

business model is divided into two main lines: a digital marketplace under the name TaniHub and a peer-to-peer lending platform called TaniFund.

28. GSMA interviews with aquaculture farmers in Indonesia revealed that the cost of a single fish pond can exceed $2,000. Micro KUR's maximum loan amount is IDR 25 million ($1,756).

29. GSMA, 2019, "E-commerce in agriculture: new business models for smallholders' inclusion into formal economy". Available at: www.gsma.com/mobilefordevelopment/e-commerce-in-agriculture

Figure 15　　　　　　　　　　　　　　　　Source: Tani Group

TaniHub's business model

Figure 16　　　　　　　　　　　　　　　　Source: Tani Group

TaniHub's digital marketplace app

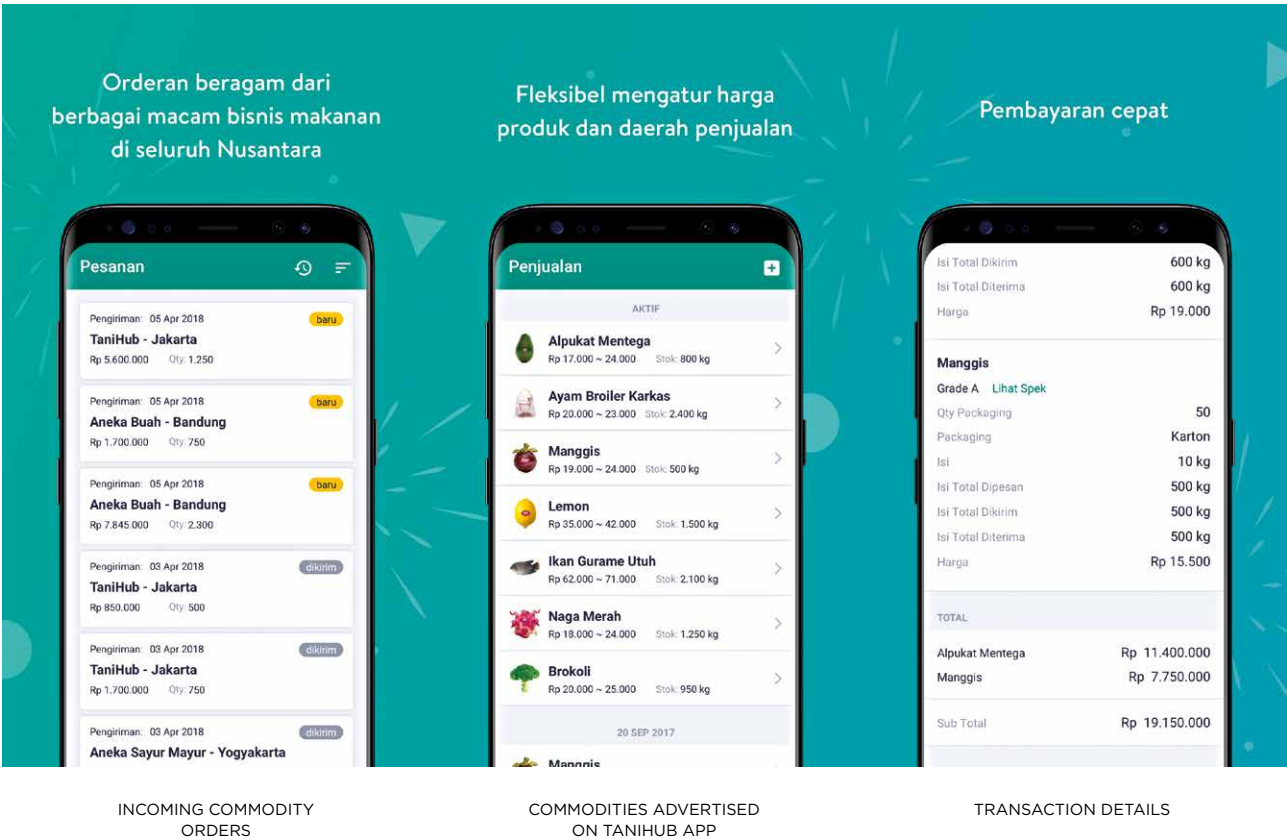| INCOMING COMMODITY ORDERS | COMMODITIES ADVERTISED ON TANIHUB APP | TRANSACTION DETAILS |
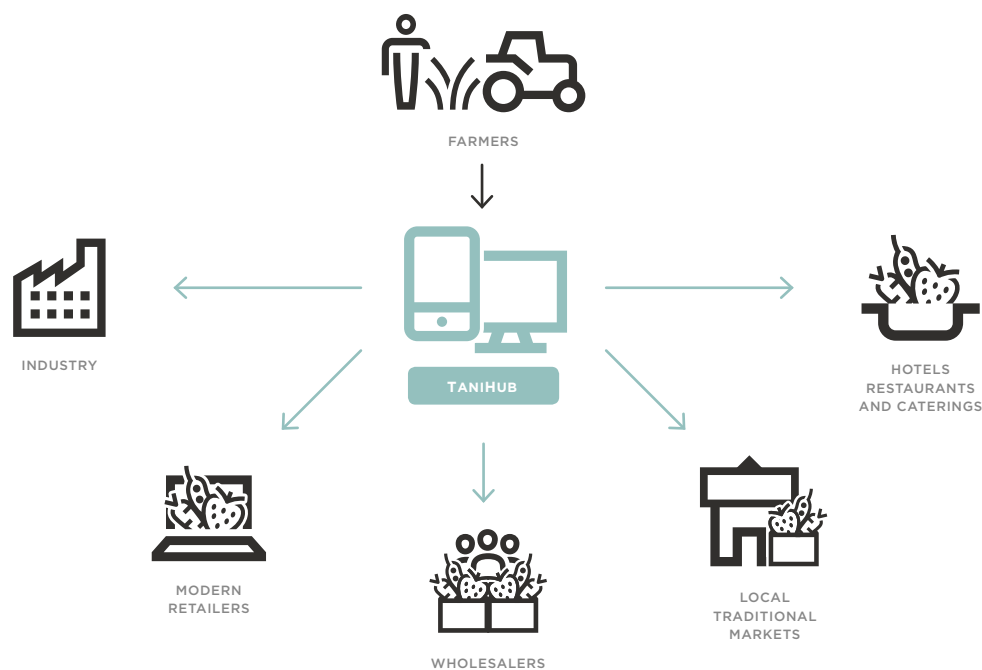
With its smartphone-operated app, TaniHub creates direct links between crop producers and buyers by eliminating the need for multiple traders and formalising last-mile procurement. In doing so, TaniHub aims to secure a fair price and reliable payment service while also cutting the cost of a buyer's internal marketing or sourcing team. Staff checks the quality and grade of the produce to meet buyer requirements, and Tani Hub uses a mix of third-party delivery services and its own vehicles to distribute produce to customers. Examples of buyers that use TaniHub to source crops include commodity buyers seeking to supplement procurement volumes; supermarket chains, such as Lottemart, Giant and HERO; and hotels. TaniHub also operates TaniXpress, its own logistics service that collects and distributes crops across a network of producers and buyers.

Through its lending platform, TaniFund, Tani Group invites lenders to invest in agricultural programmes. While some programmes may crowdfund to meet the capital requirements for marketing and selling agricultural produce, other programmes request lending to fund the establishment of new plantations. Farmers in TaniFund are selected and recommended by TaniHub based on their trading track record. TaniHub integrates transactional records from the sale of crops in the marketplace with other farm and farmer data that TaniFund collects as part of its due diligence process. These records are used to assess the viability of a farmer's business plan and their ability to sell crops and repay the loan at the end of the funding period. Transactional records generated by a last-mile digital tool therefore become a vehicle for assessing a farmer's awareness of financial planning and financial planning ability, and for addressing their need for credit.

For undersubscribed programmes, TaniHub becomes the programme guarantor and partners with banks for supplementary lending. To control risk, TaniFund monitors and supervises farmer activity during the cultivation process and delivers on-farm education and training. The company disburses funds to farmers periodically when programme milestones are reached and shares monthly updates with lenders. At harvest, all crops are sold through the digital marketplace, TaniHub. TaniFund then applies a profit-sharing system whereby lenders, farmers and TaniFund share the profit 40:40:20. Returns are distributed monthly or annually depending on the programme, with initial capital investment disbursed when the programme ends.

Figure 17

Source: Tani Group

Example of a cultivation programme on TaniFund

Dana Terkumpul
Rp 243.200.000

Tenor
3 bulan
01 Maret 2019 - 31 Mei 2019

Imbal Hasil (p.a)
12% ?

Jangka Pengembalian
Bulanan

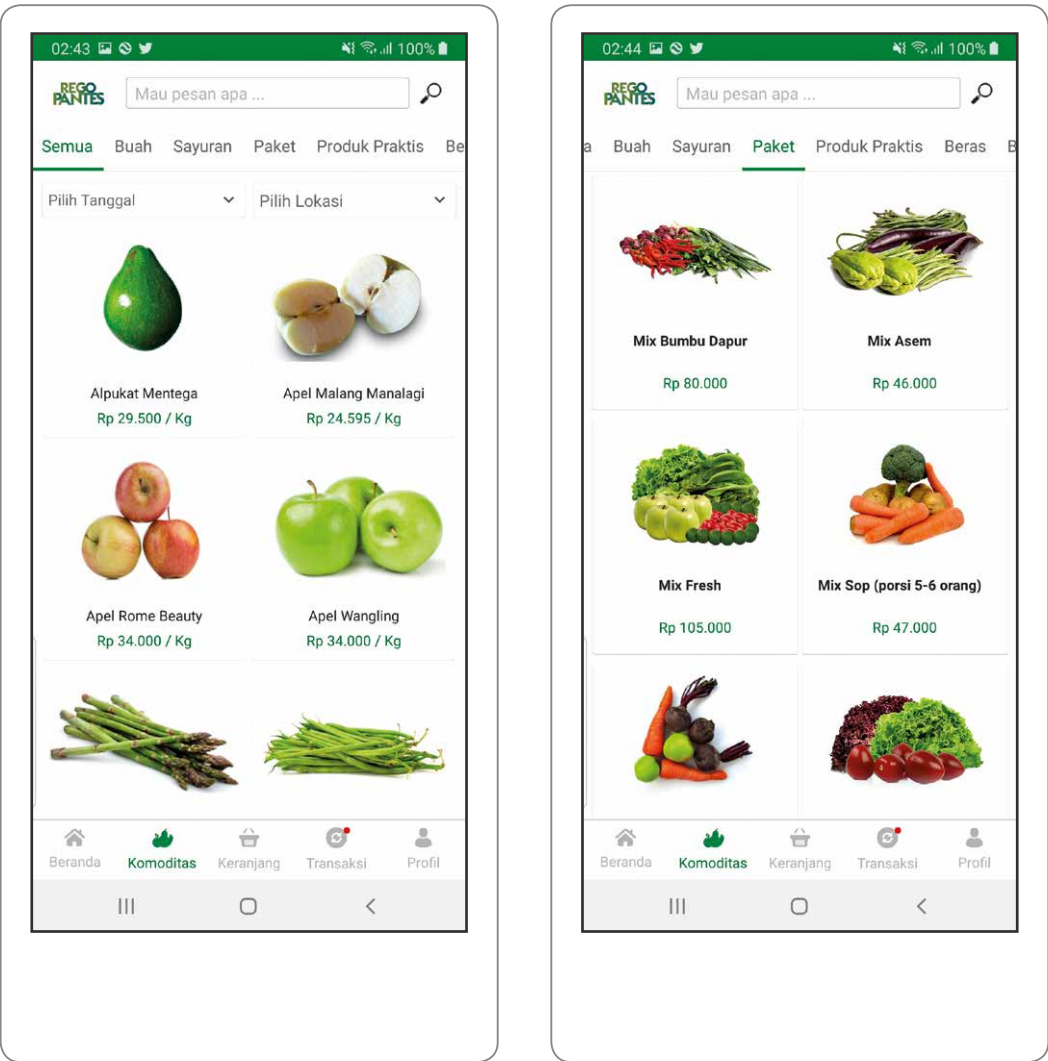Nilai per Unit
Rp 100.000

bagikan program ini

To date, TaniHub has helped more than 17,000 farmers sell their crops on its digital marketplace by listing over 60 kinds of fresh produce and over 60 institutional buyers. It has also supported about 900 cultivation programmes that receive funding through its crowdfunding platform, TaniFund, by engaging more than 1,150 lenders. Each cultivation programme represents one or more farmers while the total value of investments raised to date exceeds IDR 45 billion ($3.16 million) distributed across 61 projects.

Figure 18

RegoPantes digital marketplace app

RegoPantes is a digital marketplace in Indonesia designed and operated by AgTech start-up, 8villages. This smartphone app aims to offer guaranteed quality of farm produce and fair prices for farmers. It connects producers and buyers directly for the procurement of a wide variety of crops. Although the app was launched as an e-commerce platform to connect farmers and consumers, it is currently expanding its coverage to channel fresh produce to institutional buyers, including commercial agribusinesses.

In addition to offering farmers new sales channels to connect with the right buyers efficiently and receive competitive prices, digital marketplaces like TaniHub and RegoPantes also generate a significant volume of digital transactional data. This digital footprint can allow banks and other financial institutions to more accurately assess the creditworthiness of farmers and help previously unbanked farmers relying on informal credit to secure formal financing or gain access to savings or insurance products.

The next section presents the third use case for last-mile digitisation in Indonesia, which builds on the power of digital tools to centralise data collection. It creates opportunities for data-driven decision making and the possibility to leverage data sets from various sources to build sophisticated credit scoring models for untapped consumer segments.

5.3. Digital tools for centralised data collection

With the rise of AgTech in Indonesia, an increasing amount of agriculture-related data has become available in digital form. Data points such as farm and farmer records (see section 5.1), as well as transactional data from the procurement of crops, are proving useful to value chain actors, for example, to gain visibility in the last mile or to ensure traceability and certification of crops. These data points are also becoming valuable for stakeholders outside the agricultural sector, such as financial service providers targeting the rural segment. Crucially, this digital data can enable farmers to establish a functional economic identity (see section 2) and enable them to access a range of services, including financial services.

As mentioned in previous sections, the smallholder financing gap is due to two main factors. On one hand, financing suffers from the high perceived risk of lending to the agricultural sector at large, with smallholder farmers particularly affected by their inability to offer collateral to lenders. On the other hand, financing suffers from a lack of farm and farmer data points (e.g. formal documentation, economic transactions) that lenders need for credit risk profiling. Combined with traditional data points, digital farmer data creates an economic history that becomes part of a farmer's broader digital identity, opening access to formal financial services.

The digital tools presented in this report all generate data that can be used in innovative credit scoring models to assess the creditworthiness of smallholder famers. For example, transactional data from the sale of crops on TaniHub (see section 5.2) can build the economic history of farmers who sell their crops on this platform. Similarly, Koltiva has built links with the financial sector to allow farmers to share data generated through its platforms and allow banks to perform credit risk assessments (see section 5.1).

The growing number of agricultural Internet of Things (IoT) solution providers entering the market are also generating valuable data points. eFishery, for example, is an IoT solution that monitors livestock behaviour via sensors, allowing farmers to schedule feeding times for fish via a smartphone app. The feeding, production

and fish behaviour data obtained through eFishery is valuable for credit scoring, especially for a sector like aquaculture that suffers from severe climatic and market risks. The monetisation of data is in the company's strategic roadmap.

While more and more data is becoming available, the challenge of sharing and aggregating data between interested stakeholders remains. So far, there have been one-to-one agreements for data sharing between individual entities, as exemplified by the Koltiva partnership with Bank Rakyat Indonesia, where farmers using the FarmCloud mobile app can authorise sharing of their data when applying for credit (see section 5.1). Potentially any AgTech company or digital solution provider with relevant agricultural data could form similar partnerships with financial institutions, or with value chain actors interested in improving smallholders' access to finance, such as agribusinesses or cooperatives.

However, data ownership is still a significant issue, as is sufficiently incentivising farmers and other institutional actors that collect and own farm and farmer data, such as agribusinesses and NGOs, to share this data. Farm and farmer data represent a key asset for agribusinesses in formal value chains, especially when companies operate in environments where farmers may have access to multiple buyers and where last-mile digital tools are used to build farmer loyalty.[30]

Effective data sharing is another key challenge even with the use of blockchain technology. While distributed ledgers offer significant scope to address the issue of data sharing effectively and securely across networks of interested stakeholders, consistent and standardised data collection is still a challenge, even for single stakeholders collecting data for their own purposes. For example, agribusinesses collecting farm and farmer data to boost visibility and efficiency in the last mile often encounter internal challenges using the data when the unique identifiers for farmers are not used consistently. This problem is exacerbated when different stakeholders exchange their own independently generated data.
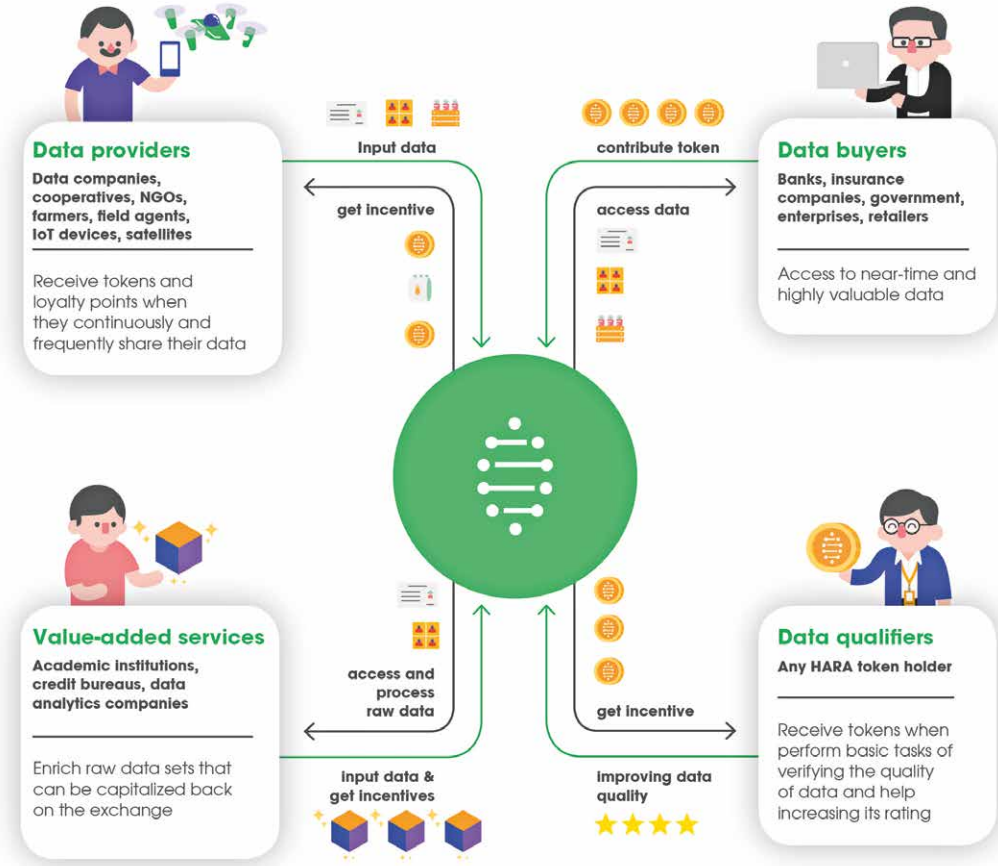
Given the lack of aggregated data for credit scoring and the challenge of incentivising data sharing with the financial sector, new AgTech providers in Indonesia are aiming to develop an entire ecosystem for effective data sharing. HARA is a Dattabot-owned start-up that has developed a suite of data acquisition apps powered by blockchain, which ensures decentralised storage and security of agricultural data. HARA aims to make the agricultural value chain more sustainable by connecting smallholder farmers with financial institutions, off-takers and input producers through data.

Data providers, such as crop and livestock farmers, as well as NGOs, agribusinesses, cooperatives and companies with IoT and satellite solutions,[31] supply data to the HARA data exchange platform via a mobile and web portal. To enable farmers to share

their data, HARA deploys a network of field agents (collection agents), typically tech-savvy individuals who are underemployed, whose role is to assist farmers with registering their profiles on the HARA app and collecting agricultural data. An incentive system based on tokens awards both farmers and field agents with discounts on fertilisers and seeds through local partners engaged with the HARA ecosystem. To enable data sharing from companies with relevant data, including agribusinesses and cooperatives, HARA uses the same tokens as a reward. This allows data providers to reinvest tokens in the system or convert them into local currency, after HARA data exchange has verified the quality and consistency of data through a rating system powered by artificial intelligence (AI) and machine learning.

The HARA ecosystem

In the HARA ecosystem, agribusinesses or cooperatives can share their own data or encourage the farmers they work with to share data. The objective is to open access to credit from financial institutions or to allow providers of agriculture-related content to develop services that are more accurate, localised and tailored to farmer needs. Agribusinesses can opt to invest their tokens to access data through the system to formulate better harvest predictions, improve the quality of outputs and traceability of crops or enable better stock management decisions.

While the HARA ecosystem is still in early phases of development,[32] the emergence of this kind of digital tool highlights the need for intermediation and aggregation in agricultural data sharing. It also showcases the value data aggregation and analytics can offer to actors leading these activities. To sustain the token ecosystem, HARA issues tokens to all corporate and institutional providers listed on the HARA data exchange that share data, with a share of these tokens allocated to receive basic ratings on data quality and compensate for the work that goes into validating data. As a result, HARA has a revenue stream from both data providers and data buyers.

In Indonesia, solutions like HARA can help the formal financial sector reduce the cost of data acquisition and, crucially, de-risk smallholder financing through new and critical data points. For example, one of the key data points HARA's field officers collect from farmers via the HARA mobile app is the actual size of the farm. In Indonesia's national land registration system, the only data available is the average farm size at the

district level.[33] In addition to land size, transactional data on crop sales is another sought-after data point by financial institutions. However, the lack of available digital financial services, especially mobile money, makes it challenging for financial institutions to access this kind of data at scale and in digital form.[34] So far, HARA has collaborated with two banks, Bank Negara Indonesia (BNI) and Bank Tabungan Pensiunan Nasional Syariah (BTPN-S), to enable disbursement of microloans to farmers.[35]

From a technological standpoint, HARA's use of blockchain in agriculture supports a secure, traceable and transparent exchange of data. However, ensuring farmers are aware of data sharing, and understand the purpose of it, remains a challenge. To address this issue, HARA has an electronic authentication system that sends one-time passwords to farmers via SMS to request consent every time they share data.

From a business model viewpoint, incentivising stakeholders through tokens is a way to stimulate adoption and provide value to all stakeholders. However, like any digital solution that requires intermediation from field agents, HARA faces a challenge in scaling this approach. To expand the system over time, extensive field agent onboarding and training will be required, with the associated operational costs. Strengthening collaboration with agribusinesses in formal value chains and using agribusiness field officers (i.e. purchasing clerks) for farmer enrolment and data collection, could be a way to build up the network of field agents over time.

6. Learnings

A restrictive regulatory environment for digital financial services hinders the use of mobile money for rural financial inclusion

In Indonesia, the significant smallholder financing gap calls for new and innovative approaches on the supply side, including the intervention of non-traditional players from the FinTech sector.[36] However, restrictive regulation prevents digital financial services offered by non-banks from becoming a tool to support digital interventions in agriculture and advance financial inclusion for rural populations, including smallholder farmers who are the backbone of the country's economy. GSMA research has found that the current regulatory framework blocks mobile money providers from deploying a traditional agent-based distribution network that facilitates cash-in and cash-out services. Another challenge is low mandated limits on transactions and wallet size.

The implementation of mobile money interoperability in Indonesia, which has enabled transactions across different networks, was made possible through collaboration between MNOs. This has been a step in the right direction, but current rules defining non-bank mobile money distribution networks and limits on account and transaction size merit regulatory intervention to allow non-traditional entities, such as MNOs and AgTechs, to leverage their widespread reach for the benefit of users. These regulatory limitations are felt most acutely in rural areas, where most unbanked users are receiving cash payments for the sale of agricultural crops. Low transactional and wallet size limits, in fact, make digital B2P payments unviable for the sale of certain high-value cash crops, arguably the main cash inflow for Indonesia's smallholder households.

Indonesia's agricultural sector is ripe for digital transformation, but without the participation of the FinTech sector it will be challenging to achieve scale in rural areas

The structure of Indonesia's agricultural sector makes it a suitable ground for digital tools in the last mile, which aim to deliver efficiencies for agribusinesses and smallholder farmers and strengthen smallholders' access to finance. Commercial agribusinesses operating in cash value chains have clear incentives to establish direct procurement models with farmers and to disintermediate middlemen.

At the same time, the limited role of cooperatives and farmer organisations in Indonesia means that, for commercial agribusinesses, it is more viable to establish direct procurement models in which last-mile digital tools, such as those described in section 5, can strengthen farmer relationships, especially in value chains where agribusinesses compete to procure crops from the same farmer.

On the demand side, the comparatively higher mobile penetration in rural Indonesia and the wider availability of smartphones make digital interventions relatively less challenging than in other developing markets. However, significant obstacles remain in rural regions in terms of access (availability and cost of cellular connectivity) and use of technology (tech and digital literacy). The AgTech innovators featured in this report all support the use of smartphone-based solutions in the agricultural last mile. To expand their reach, especially to poorer rural households, and support scalable solutions, it is important that Indonesia's AgTech providers back a

32. By February 2019, HARA had collected agricultural data from about 17,809 farmers across Indonesia. The company has an ambitious target to collect data from one million farmers by the end of 2020.

33. As mentioned in section 3, up to an estimated 90 per cent of smallholders in Indonesia do not have a formal title to their land. See also: https://govinsider.asia/innovation/how-can-indonesia-solve-its-land-certification-problem

34. Via field officers, HARA can collect self-reported data from farmers on the ticket size of crop sales. When available, farmers' physical or e-receipts can provide additional transactional data on the sale of crops.

35. According to Dattabot, these partnerships have so far enabled over 800 farmers initially deemed unbankable to access formal microloans. The company states that the partnerships with BNI and BTPN-S resulted in a total of IDR 573 million ($ 40,248) and IDR 1.162 billion ($ 81,619) in disbursed microloans, respectively, with a repayment rate of 100 per cent.

36. The term "FinTech" denotes companies or representatives of companies that combine financial services with modern, innovative technologies. FinTechs generally aim to attract customers with products and services that are more user friendly, efficient, transparent and automated than those currently available.

range of delivery channels via 2G (e.g. voice and text-based technologies) as well as 3G and 4G networks.

As new digital data becoming available to support and expand smallholder financing, the agricultural sector is ripe for digital transformation. However, regulatory barriers to the full participation of FinTechs are preventing mobile money transactional data from being generated at scale. If available, this data (particularly transactional data from agricultural payments) would provide key added value to building an economic identity for farmers and assessing their creditworthiness.

In the absence of MNO-led mobile money services, Indonesian AgTech providers are generating three main types of transactional data: digital procurement records for agribusinesses and farmers (i.e. digital receipts); marketplace transactional data (i.e. TaniHub, RegoPantes); and self-reported transactional data from farmers (i.e. HARA). While these data sets can support the creation of an economic identity for farmers, and are relevant for financial service providers, the digitisation of agricultural transactions (i.e. B2P payments) and non-agricultural transactions via mobile money services offers much greater scope to generate transactional data at scale and support financial inclusion for farmers.

AgTech innovators in Indonesia are not just digitising existing processes in the agricultural last mile; they are building entirely new relationships and ecosystems

A growing number of Indonesia's AgTech providers are bringing digital tools to market that support agribusinesses in monitoring last-mile operations and address an array of business challenges for both agribusinesses and farmers. The demand for these solutions is rising, especially due to the dominance

of formal cash crops and a growing opportunity to implement direct procurement models in agricultural value chains. Digital agriculture in Indonesia is also increasingly focussed on the use of digital tools to disrupt existing and long-established relations across value chains, offering farmers an opportunity to access new buyers and new providers of financial services, and to improve their livelihoods.

The use of digital solutions to improve farmers' access to markets and formalise the agricultural last mile is not unique to Indonesia. New digital marketplace tools that connect buyers and sellers of crops, and disrupt intermediaries, are emerging in different regions of the developing world, as shown by the examples of Twiga Foods in Kenya and AgroCenta in Ghana. In Indonesia, digital marketplace service providers are assuming the role of aggregators and distributors in the agricultural last mile, taking charge of logistics, warehousing and the identification of producers and buyers. In doing so, AgTech companies have brought innovation to the digital and agricultural sectors alike, becoming emerging players in agricultural value chains as they take on the traditional role of agribusinesses, from procuring and selling crops to enabling farmer access to finance.

The emergence of digital tools for centralised data collection aim to connect parties with different motivations, such as farmers, agribusinesses and financial institutions, in an entirely new data sharing ecosystem and represent another step in digital disruption. Like digital marketplaces, these tools are forming entirely new ecosystems of stakeholders and related processes and relationships. Rather than trading physical products, as in a digital marketplace, these types of solutions trade valuable farm and farmer data. Motivation to use these digital tools nevertheless remains high, as it enables access to finance for farmers and reduces inefficiencies in the last mile for agribusinesses. This kind of digital transformation is nascent and by no means has reached significant scale,

but it highlights just how valuable farm and farmer data has become for stakeholders both inside and outside the agricultural value chain.

Data ownership and sharing are becoming critical issues as digital tools make more farm and farmer data available

As AgTech provider-led digital agriculture tools generate digital footprints that can build farmers' economic identities, data generation is only the first step on the path to financial inclusion. Once new agriculture-related data becomes available, questions about data ownership and use, and the implications and processes for sharing that data between interested parties arise.

Data ownership is primarily an issue with personal data on farmers and their economic lives. In the case of agribusiness tools that monitor last-mile operations, agribusinesses own or operate these tools and may assume implicit ownership of all data sets produced, including personal farmer data. In the case of digital marketplaces that allow farmers to access formal markets, these tools generate significant volumes of digital transactional data. The providers of digital marketplaces may also assume implicit ownership of the data generated through their platforms. In Indonesia, farm and farmer digital data, including transactional records, are already used to address farmers' needs for credit. While this is a positive development, it is vital that farmers are aware of how their data is used by third parties and for what

purposes, particularly when data sets are exposed to stakeholders outside the agricultural value chain, such as financial service providers.

It is worth highlighting that the digital tools for centralised data collection presented in this report (i.e HARA), operate under the principle that data is owned by data providers. For example, farmers proactively share their personal data in the HARA ecosystem via field agents (data collectors) and in exchange for incentives (tokens), and consent to entering their own data in the ecosystem via an SMS-based electronic authentication system. When it comes to sharing data with third parties, such as banks and agribusinesses, farmers are still able to authorise data buyers to access their data using the same authentication system.

Even though technology can reinforce data ownership and support effective and secure data sharing via distributed ledgers, the question remains whether farmers enrolled on such complex centralised data collection systems are able to fully understand how their data is shared and for what purposes. To empower farmers to understand data use by third parties, digital tool providers will have to make considerable investments into farmer awareness and education. Not only can these efforts support informed decision making, they can also promote greater participation by farmers in the digital ecosystem and reach new farmer communities.