Indonesia Agro-Value Chain Assessment

Background Paper 2
Issues and Options in Promoting Digital Agriculture

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Agriculture and Food Global Practice

Contents

1 Introduction

To inform the preparation of a proposed World Bank project that aims to support agriculture value chain development in Indonesia, a comprehensive study on agriculture value chains was planned during March and April 2020. The study was expected to be conducted in partnership with the Ministry of Agriculture and FAO and contain the following parts:

1. Value chain constraints analysis: to identify opportunities for improvement and possible project interventions, based on the examination of performance of selected key value chains
2. Agriculture finance overview: to identify private and public providers of agriculture and agribusiness finance, highlighting constraints regarding access to finance by farmers and other value chain participants and identifying entry points for project interventions.
3. Digital agriculture overview: to identify entry points for project interventions through assessment of issues and options for promoting digital agriculture and mapping the landscape of digital service providers.
4. Human resource development in agriculture: to assess how agriculture extension, training and education will need to be adapted to attract a new generation of farmers and agro-entrepreneurs, and bring about agriculture modernization.

Due to COVID-19 related travel restrictions, the full set of activities under this ASA could not be undertaken as planned. Only the agriculture finance overview (2) and the digital agriculture overview (3) were completed, within the limitations imposed by the inability to organize physical meetings or field work. Hence, these reports offer an initial assessment which can be further supplemented during 2020/21.

This background paper aims to provide an assessment of the issues and options in promoting digital agriculture in Indonesia, within the broader technology landscape of the country, with the primary aim of informing the design of the proposed World Bank investment project. The study considers global best practices as well as the status of Indonesia in product traceability, e-commerce, agriculture fintech service providers, weather index insurance providers, and precision farming technology providers. Although digital agriculture is cross-cutting across all commodities, the focus was on the horticulture and small ruminant value chains as those were identified as priority commodity categories by the Ministry of Agriculture. The study also offers high-level recommendations for policymakers on reforms and programs that can accelerate the adoption of digital agriculture.

In the first section, the national context and the importance of ICT technology in agriculture are summarized. Section 2 presents the current landscape of digital agriculture in Indonesia, followed by section 3 that suggests key areas where ICT can play a role in agriculture, based on global experience. As scaling up the digitization of the agriculture sector involves a complex set of policy, investment, innovation, and capacity-building measures, a number of high-level recommendations are provided for policymakers and practitioners in the fourth and last section.

2 Sector context

2.1 The Agriculture Sector in Indonesia

Indonesia is the fourth most populous country in the world. With its vast land endowments and abundant fertile soils, it is a major global producer of a wide variety of agricultural tropical products,

which provide income for the majority of Indonesian households today. Moreover, with an agricultural area of 60.2 million ha, Indonesia still has significant untapped agriculture potential. Agriculture retains an important role in the Indonesian economy, even though its share of the country's gross domestic product (GDP) has declined, as is typical in the process of economic growth and structural transformation. The share of the agriculture sector declined from 30% in 1975 to about 12.8% in 2018. The structural transformation is also reflected in employment patterns, with the share of agricultural labor in the country's total labor force decreasing from 62% in 1975, to 29.7% in 2017 (BPS 2018). The slower decline in the share of agricultural labor compared with agricultural GDP indicates the relatively slow absorption of labor outside agriculture. As the service sector is less labor-intensive than the agriculture and manufacturing sectors, and the GDP share of the manufacturing sector has declined, excess agricultural labor has remained in the agriculture and rural sectors, often as disguised unemployment.[1]

The vision of the Indonesian Ministry of Agriculture (MoA) in the medium-term development 2020-2024 is to achieve an independent, developed, and prosperous agricultural sector by increasing food security and agricultural competitiveness. It involves: (1) achieving farmer welfare through protecting and empowering farmers; (2) obtaining food security by increasing availability, affordability, and utilization of foods, fulfilling community consumption; and (3) improving added-value and competitiveness of agricultural commodities by enhancing competitive advantage and improving production, storage, processing and distribution.[2]

The major priorities of the MoA are:

- Improving infrastructure (irrigation, agricultural markets, and farm roads).
- Increasing investments (agricultural lands, livestock population, agricultural tools and machineries, and working capital).
- Promoting innovations (high yielding seed/seedlings, cultivation technology/ integrated technology packages, and cropping patterns).
- Improving access to inputs (supplies, and input access assurance).
- Strengthening incentives (appropriate inputs and output prices and risk protection/insurance).
- Promoting inclusion (equitable distribution of aid and food barns in border regions); and
- Strengthening institutions (farmer institution, cluster development and governance improvement).
- Promoting digitat agriculture (ICTs to boost development through use of relevant devices, networks, services and applications)

With a population of 273 million as of 2020, food security continues to be one of the national development priorities. In 2019, Indonesia ranked 62nd out of 113 countries in the Global Food Security Index[3].

Consisting largely of smallholder farmers (defined as having landholding less than two hectares) and large plantations, millions of Indonesians depend on this sector to earn their everyday livelihoods. Smallholder farmers, who typically come from agriculture-dependent households, are also part of the

[1] https://www.adb.org/sites/default/files/publication/534336/indonesia-food-agri-development-2020-2045.pdf
[2] http://ap.fftc.agnet.org/ap_db.php?id=1107
[3] https://foodsecurityindex.eiu.com/Index

segment of SMEs in Indonesia. Information nonetheless regarding SMEs (in the case of smallholder family farmers) that contribute to the agriculture sector remains limited.[4]

Limited education, declining land holding sizes, complex and insecure tenure arrangements, together with low access to appropriate technologies, infrastructure, financial services and input and output markets, have resulted in sub-optimal use of landholdings and has led to low labor productivity.[5]

With almost 119.8 mobile-cellular telephone subscriptions per 100 inhabitants, and mobile-broadband subscription of 87.2%, and less than 40% of the adult population using the internet, Indonesia ranks 72nd out of 141 countries in the ICT adoption rating. Indonesia has about 193.4 million mobile connections. According to forecasts, the smartphones penetration rate in Indonesia will rise from 26 to 33 percent between 2018 and 2023. The number of smartphone users in Indonesia could reach as high as 89.86 million by the year 2022.[6]

According to the Global Competitiveness Index 4.0 2019, released by the World Economic Forum (WEF), Indonesia scored 64.6.[7] Indonesia scores better than the global average in terms of technology adoption related to implementation of the legal framework, adapting to digital business models (e.g. e-commerce, sharing economy, FinTech etc.,).

Digital literacy remains a main obstacle to provide digital agriculture advisories or services to rural communities directly. Increased use of digital technologies for advisory services would involve strengthening the access to knowledge of the intermediary agents (i.e. public and private extension agents) and improving women's access.

Indonesia leads the South-East Asian startup ecosystem and with the Fintech, especially peer to peer (P2P) lending-based startups, it is expected that cumulative fintech lending in Indonesia will reach US$16 bn by end of this year[8]. This has led the Indonesian Financial Services Authority (OJK) to tighten regulations on P2P lending. Farmer advisory (e.g. eFishery, KARSA, NeuraFarm), mechanization platforms (e.g. Sentragro, AgroDrone), digital marketplace (e.g. TaniHub, Chilibeli, Kedasayur), traceability (e.g. HARA, Koltiva) and peer-to-peer lending (e.g. Crowde, iGrow, Tanijoy) are some areas where startups are active in the country.

According to The Global Competitiveness Report 2019, Indonesia boasts of a vibrant business culture (scoring 69.6, ranked 29th) and a stable financial system (scoring 64.0, ranked 58th)—both of which are improvements over 2018—and a high rate of technology adoption (scoring 55.4, ranked 72nd), considering the country's stage of development. However, the quality of access remains relatively low. Innovation capacity remains limited (scoring 37.7, ranked 74th), but is increasing.[9]

Connected services for agriculture will help build business cases as well as encourage investment and startups to develop solutions to benefit the rural community and/or connect producers to consumers in a more efficient and transparent manner. The primary challenges to digital agriculture in Indonesia still

[4] https://www.unglobalpulse.org/2019/08/mapping-smallholder-farmers-in-indonesia-to-inform-agriculture-policies/
[5] https://webapps.ifad.org/members/eb/127/docs/EB-2019-127-R-26-Project-Design-Report.pdf?attach=1
[6] https://www.statista.com/statistics/274659/forecast-of-mobile-phone-users-in-indonesia
[7] http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf
[8] Indonesia's Fintech Lending: Driving Economic Growth Through Financial Inclusion <https://www.pwc.com/id/en/fintech/PwC_FintechLendingThoughtLeadership_ExecutiveSummary.pdf>
[9] The Global Competitiveness Report 2019

remain to be infrastructure development, digital literacy, an enabling policy environment and a cohesive strategy to link dispersed agriculture services.

The horticulture and livestock value chains have potential to grow and become competitive. Horticulture is important in Indonesia. Indonesian consumers currently pay high prices for fresh produce and do not consume sufficient nutritious foods. Local production is insufficient to meet domestic demand and import restrictions cause high market prices. Creating market opportunities for producers while reducing costs, including through the use of digital technologies, within the value chain would create significant opportunities for producers and downstream value chain actors. Although 30% of the country's labor force is involved in agriculture, only 11% of agricultural workers are in the horticulture sector. Indonesian horticultural products currently suffer from poor product quality due to the lack of knowledge on post-harvest management, inconsistent supply and poor infrastructure.

Indonesia's livestock sector is becoming an increasing contributor to the overall Indonesian agriculture industry. About 70% of the population are involved in the livestock, feed and fisheries industry. In terms of production cost, Indonesia was ranked third for sheep and goat and fourth for broiler production per kilogram live weight compared to other member ASEAN countries. Indonesia has seen a major boom in demand for livestock products such as red meat, milk, and eggs in recent years. The livestock market in Indonesia needs to develop more efficient marketing channels, including digitally enabled channels and food safety systems, in order to create more opportunities to export to international markets.

2.2 Digital Agriculture Transformations

Digital agriculture is a pervasive game-changer. Digital agriculture, understood as applying information and communication technologies (ICTs) through relevant devices, networks, services and applications with a primary focus on agriculture, can help agricultural stakeholders to make the best possible decisions and use the resources available in the most productive and sustainable manner. As such, it can boost on-farm productivity (through improved both technical and allocative efficiencies), off-farm profitability, equity, and environmental sustainability of agri-food systems. It does so by potentially impacting every stage along an agricultural value chain as well as influencing the incentives and behaviors of the various players involved at each step of the chain.

With respect to boosting on-farm productivity, use of digital approaches can improve generation, dissemination and absorption of technical knowledge and good practices; measured application of water, fertilizer, feed and other inputs in relation to specific crop, soil, climatic and animal-breed types; more effective use of physical capital, including tractors, machinery and equipment, on the farm; improved farmer decision-making and mitigation through provision of more accurate, timely, and location-specific weather, agronomic and livestock data; and better alignment of production decision with broader market conditions, trade opportunities and storage options. Individually, and cumulatively, these can significantly improve the output-mix (allocative efficiency) and input-mix (technical efficiency) as well as dynamic growth prospects, together measured as Total Factor Productivity (TFP) growth. And TFP growth is, ultimately, the basis of rising incomes and living standards in agriculture.

With respect to enhancing profitability of off-farm (post- production) activities, digital approaches essentially facilitate myriad transactions across different links (players) of a value chain, fundamentally through generating and transmitting massive amounts of information at virtually zero marginal cost. Illustrative examples include:

- Reducing search costs to match potential buyers and sellers
- Improving "price discovery" (i.e., more stable and predictable prices) by pooling potential buyers and sellers through virtual markets
- Reducing riskiness through provision of greater and more reliable/verifiable information about insurable risks (e.g., weather conditions, pests, diseases, localized disasters)
- Facilitating coordination amongst parties involed in inter-connected transactions through more transparent sharing of relevant information and scenarios
- Enabling trade in "quality" (or reputational products) by allowing digital verification and certification, thus allowing additional value capture in niche markets
- Raising efficiency and robustness of supply chains by allowing multiple players to participate (rather than vertically integrate).

Through these and related ways, adoption of digital approaches enhances the profitability of value chains, thus creating incentives for their further growth and innovation.

With respect to boosting equity, digital agriculture can help narrow economic, spatial and social divides in rural areas. Economic divide – systematic differences between large and small farmers - can be narrowed through increasing productivity of small farmers through digitally-enabled methods, improved access to markets (including financial) and their integration into more extensive and profitable value-chains. Spatial divide – remoteness from markets, infrastructure and public services - can be narrowed though use of digital technologies that offset these disadvantages through lowering hurdles to market information, connectivity and technical goods and services. Finally, social divide – unequal access to resources or markets of particular disadvantaged groups - can be narrowed through digital technologies that create opportunities to integrate disadvantaged groups into society, including through social media and changes in social interaction.

Finally, with respect to environmental sustainability, digital agriculture can have potentially beneficial societal impacts in three ways:

• Direct effects: adoption of improved technologies and practices, greater production control (e.g., as precision agriculture), greater alignment of production and consumption/market, and reduction in waste can reduce pressure on natural resources as well as GHG emissions.

• Enabling effects: digital technologies that can better measure, model, and communicate the environmental impacts of agri-food systems can assist in better inventorying and stewardship of natural resources at national and global levels, and ensuring compliance with relevant environmental regulations (thus addressing the issue of environmental externalities)

• Behavioral effects: as digital technologies enable the rise of sustainable production practices and their awareness among consumers through traceability and certification, they can drive the trend for more environmentally responsible consumption, thus creating additional momentum for more environmentally friendly production practices and waste management.

2.3 Promoting digital agriculture: entry points for public action

As mentioned above, digital innovation in the agriculture sector can be at the core of improving efficiency in crop production, aggregation, quality assurance, logistics and marketing, thus reducing cost, enhancing connectivity and increasing competitiveness. Of course, agriculture is being "digitized" all over the world

in various ways. However, how extensive, how deep, how fast and how transformative this process will be depends to a considerable extent on public policies and actions for the following reasons:

- First, digital information and digital products (software, apps, videos etc.) typically involve high set-up costs but nearly zero marginal costs to replicate, store and transmit/share. They are also be non-rivalrous and non-excludable in consumption. These techno-economic characteristics may cause a "market failure" which significantly distorts incentives for the private sector to provide appropriate amounts of digital information/goods - especially in dispersed rural settings -, causing a severe under-investment in an enabling digital environment for producing the desired deep-seated agricultural transformations. Hence, public actions (discussed in more detail in Chapter 5) to correct these market failures may be necessary.
- Second, international evidence suggests that the development and ownership of digital systems and data lead to a concentration of knowledge, power, and revenue. The cost of infrastructure (telecommunications, security protocols, ledgers, clouds) and the advantage of accumulated data tend to favor big actors and first-movers in the development of new digital technologies, while creating barriers for new entrants. As a result, a few powerful companies dominate markets, including the market for digital solutions in agriculture. Robust public policy and regulatory systems are needed in this regard to ensure that the huge information and power asymmetries do not hurt consumers and impede the digital transformation of agriculture. Third, digitalization of agriculture can also perversely create conditions for a "digital divide": differences in the capacity to access and use ICTs among socioeconomic/ethnic groups, geographic areas and so on. Since the capacity to access and use ICTs requires investment in physical and digital assets (devices, apps, subscription services) as in "digital literacy", inequality in this regard can stem from and reinforce the same economic, spatial, and social divides that already prevail in rural areas. Hence, proactive public actions to ensure inclusion become essential in this regard.
- Finally, the adoption of digital approaches and technologies tends to be skill- and knowledge-biased, tilting labor demand in favor of skilled workers and creating losers among the ranks of the unskilled. Appropriate public policy measures are needed to ensure to mitigate the negative effects of the digital transformation, through smarter safety nets, income and training support.

The next two sections survey the digital landscape in Indonesia and the state of digital services and solutions in the agriculture sector. Building on these, section 5 presents options and next steps for promotion of digital agriculture in Indonesia.

3 Current landscape of digital tools and policies in Indonesia

3.1 Digital infrastructure, availability and access

The mobile sector in Indonesia has experienced massive growth, with 176 million Indonesians now subscribing to a mobile service. Mobile phones have been instrumental in connecting millions to the internet, particularly in the areas that are hardest to reach. In the next five years, the forecasted number of mobile subscribers will reach 199 million, with 177 million using their mobile services for internet access (Figure 1).[10] The essential ingredient behind this growth has been the smart use of ICT to spur progress in all sectors.

[10] https://www.gsma.com/newsroom/press-release/gsma-indonesia-on-brink-of-becoming-digital-economy-giant/

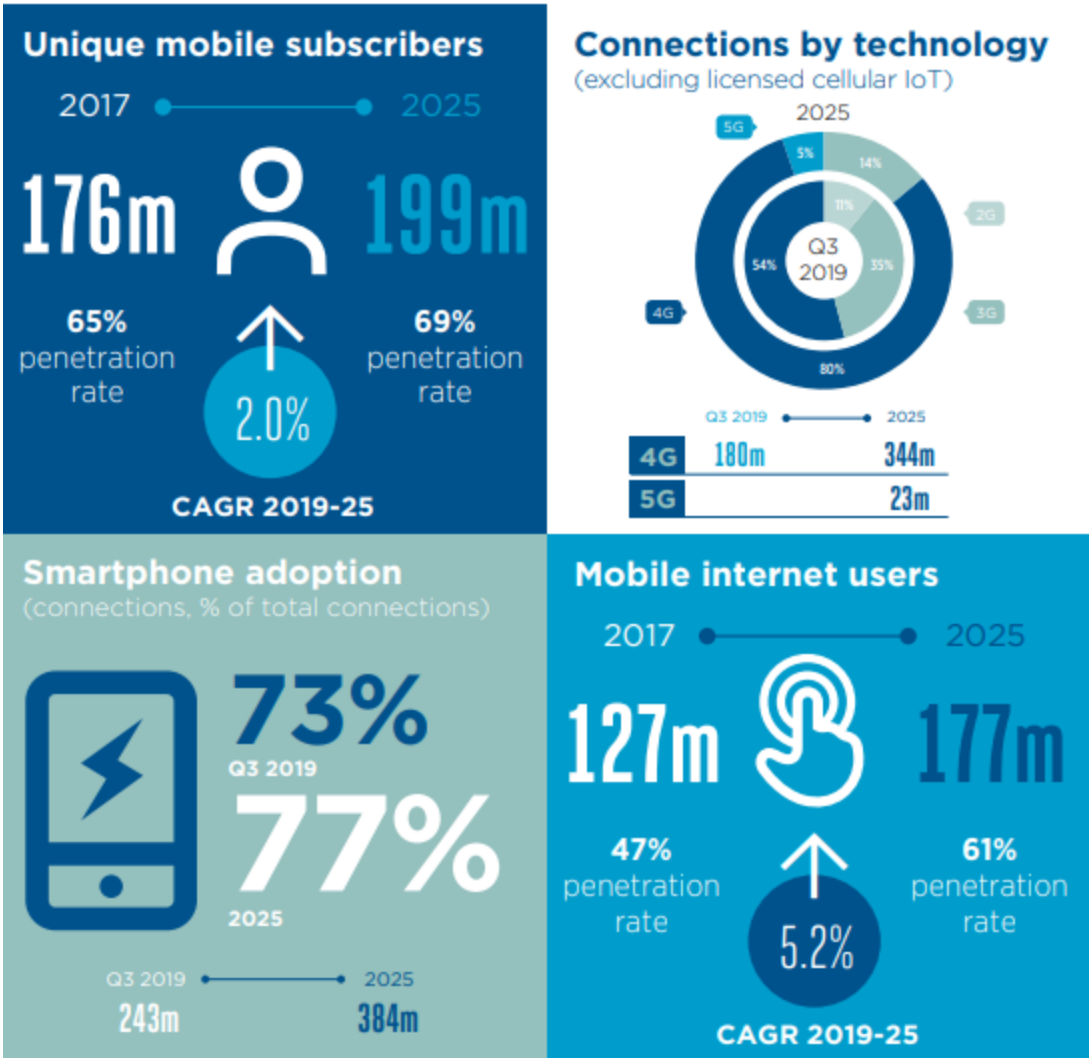

Figure 1: Indonesian mobile market at a glance[11]

While Indonesia is the third largest mobile services market in the Asia Pacific (APAC) region, the main barriers identified by non-mobile owners included: affordability, literacy and network coverage and quality (Figure 2). In Indonesia, 12 per cent of men and women who do not use mobile internet both cited the latter as the main barrier.

[11] Source: GSMA Intelligence

	Barriers to mobile ownership	AFFORDABILITY		LITERACY AND SKILLS		RELEVANCE		SAFETY AND SECURITY	
		M	W	M	W	M	W	M	W
ASIA	Bangladesh	23%	20%	39%	30%	16%	23%	0%	3%
	India	30%	24%	26%	35%	8%	11%	23%	12%
	Indonesia	37%	28%	24%	36%	11%	12%	16%	10%
	Myanmar	26%	25%	33%	37%	31%	28%	7%	5%
	Pakistan	27%	15%	46%	37%	1%	10%	8%	3%

Figure 2: Barriers to owning a mobile phone[12]

Mobile phones are essential in the digital transformation of traditional industries such as agriculture and manufacturing and in stimulating innovation among domestic start-ups. Indonesia has produced five 'unicorns'[13] such as GoJek, Tokopedia etc. However, a lack of spectrum is limiting operators' ability to expand network coverage, hindering future adoption.

3.2 E- Governance, data, policies and regulations

E-governance: The Presidential Regulation Number 95 of 2018 on Sistem Pemerintahan Berbasis Elektronik or e-Government (e-Gov) works "To increase integration and efficiency of an electronic-based system of governance in order to achieve clean, effective, transparent and accountable governance as well as to improve quality and reliability of public services."

Indonesia has made concrete commitments to champion open data and the country has seen slow but steady improvement supported by strong regulatory frameworks concerning public access to information. Yet, the need to improve data policies, strategies, and data management practices, as well as to strengthen data protection framework and implementation, remain. [14]

Open data: Indonesia passed the Public Information Disclosure Act in 2008, in order to improve transparency. In 2011, the country was among the founders of the Open Government Partnership. Indonesia launched its Open Data initiative to promote open government. Initiatives using the Open Data platform (https://data.go.id/) are improving good governance at the national and local level. It is currently hosting close to 43,486 datasets and encourages policymaking based on data.

The basic principles of One Indonesian Data are One Data Standard, One Standard Metadata, Data Interoperability, and Data Reference. Thus, the use of government data is not only limited to internal use between agencies, but also as a form of meeting public data needs for the community.

Agricultural War Room (AWR): The Indonesian AWR is a strategic command centre for national agricultural development, established in the MoA. It collects and analyses different types of information

[12] Source: GSMA Intelligence Consumer Survey, 2018
[13] privately held start-ups valued at over $1 B
[14] https://labs.webfoundation.org/why-is-the-new-e-gov-policy-in-indonesia-critical-for-open-data/

such as rainfall intensity, wind movement to assess the hazard, crop calendar using sentinel 2, fertilizer allocation, information about cattle birth and slaughtering, crop yield, machinery monitoring and flood risk area that inputs into the MoA policy and decision making. In addition, the AWR offers the possibility to have videoconferences with Kostrawil, Kostrada, Kostratani and CCTV for monitoring. MoA plans to procure of 1000 CCTV in the field for monitoring crop growth.

3.3 Challenges for digital agriculture

The primary barriers to digital agricultural solutions in Indonesia includes the lack of an enabling environment, generally low digital literacy rates, limited access to technology, unfavorable policies, limited information integration across value chains, and inability to build agriculture services that generate revenue due to lack of ecosystem and regulatory standards and in some cases cultural barriers.

Policy, Framework and Strategy. Many stakeholders around the world have acknowledged the need for national e-agriculture strategies for some time; however, many countries have not yet adopted a national strategy for use of ICTs in the agricultural sector. In most countries, there are many elements to e-agriculture, but all are part of the existing ICT strategy or embedded as small projects within e-government strategies (mostly OECD countries). Indonesia does not yet have an ICT strategy for the agriculture sector. In Asia-Pacific, FAO together with the International Telecommunication Union has worked in Afghanistan, Pakistan, Bhutan, Sri Lanka, Fiji, Philippines, Mongolia and Papua New Guinea with national governments and partners to develop their national e-agriculture strategy, based on the FAO-ITU E-agriculture Strategy Guide[15].

IT Infrastructure in rural areas. The 2014 Village Law significantly increased financial resources for Indonesia's 74,954 villages to invest in rural infrastructure, human capital and job creation. The law also expanded the roles and responsibilities of villages on administration, infrastructure, basic service delivery, and community empowerment.[16] Globally, IT infrastructure is critical to the growth of digital agriculture, Indonesia also has large gaps in IT infrastructure, especially in far flung islands and efforts are needed to fill that gap through the private sector and if regulations allow through the village grant under the village law. Typically, millions of people live and work in rural communities, but mobile network operators (MNOs) focus on cities, in which required investment in infrastructure is usually lower and purchasing power of consumers is higher, thus creating a spontaneous gap and leaving a technological vacuum between urban and rural areas .

Digital literacy in rural communities. Educational systems and attainment must keep pace with the process of digital transformation and the new administration in Indonesia has repeatedly highlighted the importance of education to spur the digital economy. The nature of the target audience of the modern educational system, mostly youth who are digitally connected, means that teachers must possess appropriate digital skills and education must adapt to accommodate expectations of future generations.

Institutional Linkages/Strategy. Enhanced communication and coordination between stakeholders, institutions and individuals using information and communication technologies is paramount to realize the potential of digital technologies especially in agriculture domain.

[15] For more details: FAO-ITU E-agriculture Strategy Guide http://www.fao.org/3/a-i5564e.pdf
[16] https://www.worldbank.org/en/news/press-release/2019/06/26/indonesia-boosting-rural-government-capacity-infrastructure-and-citizen-engagement-to-accelerate-poverty-reduction

There are many organizations – government, private and some private working with the various government divisions implementing many agricultural services. One key service is agricultural extension advisories. Given that there is no strategy to identify, develop and sustain key digital agriculture services in the country, there is a lot of 'reinvention of the wheel'. To capitalize on the potential benefits of digital technologies, there is a need for the Ministry of Agriculture, supported by the Ministry of Communication and Information Technology, to develop a national e-agriculture strategy.

This digital agriculture strategy will help to rationalize resources (financial and human) and address holistically the ICT opportunities and challenges for the agricultural sector in a more efficient manner while generating new revenue streams and improving the livelihoods of rural communities as well as ensure the goals of the national agriculture master plan are achieved.

The existence of a digital agriculture strategy and its alignment with other government plans will enable e-agriculture projects and services to be implemented with greater coordination and synergies. The way forward is to facilitate effective coordination between the Ministry of Agriculture, Ministry of Communication and Information Technology, Indonesian Telecommunication Regulatory Authority (BRTI) and other private sectors such as the mobile network operators in contributing to a strategic roadmap for identification, development and sustaining digital agriculture services. The role of insurance, banks and value-added service providers and innovators/incubators such are also key to developing and sustaining ICT for agriculture services in the country.

Services. Improved market access, risk mitigation, disaster management, and logistics have the potential of enhancing agriculture incomes and improving profitability. Emerging technologies can provide actionable information to communities and governments on disaster prevention, in real-time, while also providing advice on risk-mitigation techniques. Linking markets, inputs and trade in a variety of ways can also help with complying with international standards for traceability by providing reliable data.

In the agriculture value chain, producers look for information to improve their productivity, yields and profitability. Digital agriculture services and solutions offer a vehicle to achieve this through better access to productivity enhancing information and technologies and market access. Information on pricing of agricultural products (inputs and outputs) and markets, providing logistics, storage information services and in some cases access to virtual trading floors are much needed. Financial inclusion plays a key role for rural producers, digital agriculture solutions for payments, credits, savings and facilitating transactions including micro-loans and insurance are very essential for smallholder farmers in Indonesia.

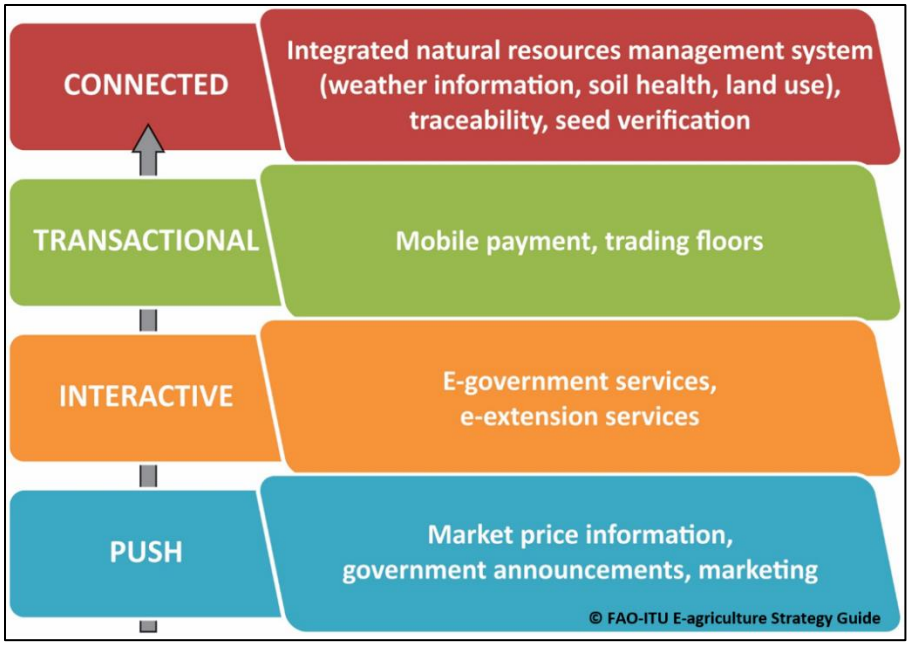

Figure 3: Service delivery categorizations

Digital services can be classified into categories such as push, interactive, transactional and connected. The higher the service category, the better the opportunity to build business models and thereby ensure sustainability (financial) of the service (see Figure 3).

4 Enabling digital agriculture services and solutions

4.1 Agricultural Extension Services

The information seeking behavior of rural communities have traditionally been influenced by the existing structures in the rural areas where the neighbor, a big farmer in the village or in most cases the input dealer plays a major part in providing knowledge and information on agriculture. These linkages have traditionally worked but with the increasing impact of climatic variabilities, the opportunity exist for technology to help strengthen these linkages with more current and reliable advisories. A summary of digital technologies in agriculture is provided in Figure 4.

In Indonesia, there are three types of extension workers: public, private, and self-help/voluntary. The input suppliers usually employ private workers and the last category of voluntary or self-help workers are lead farmers whom the Government train and provide with certificate of competency.[17]

However, the public extension service, the main extension provider, is lacking in terms of reach and capacity. Severely constrained by the decentralization process in Indonesia, the public extension workers are dwindling in numbers and they suffer from low morale and poor capacity. The private extension workers who are an important source of information for the farmers is the input suppliers' agronomists. Unfortunately, these private agronomists' reach is even more limited due to cost constraints. A third category that we can see emerging is for villages to hire "extension workers" at the village level. These people will not be agriculture-trained, but through the support of application and

[17] https://aip-prisma.or.id/data/public/uploaded_file/2018-03-10_07-34-48am_16._17._Extension_and_ICT_Services-GSD_2017_v2.pdf

technology, they could provide extension services at the village level. As the usage of mobile phones, particularly smartphones, is increasing in rural areas, developing mobile services can be a useful complement to the existing multi-modal extension systems.

Weather information is an important input to farmer decision making and is useful to include in agriculture extension services. For farmers to understand weather parameters and its relevance to their crop cycle, it is important to provide decision-support system for automating the generation and dissemination of climate information-based agro-advisories for farmers. Scaling-up and mainstreaming agro-meteorological early warning systems, as done by Agrometeorological Field Unit (AMFU) to be accessible to rural communities through various access points (mobile, web, community centres, etc.,) could be facilitated by the National Center for Agricultural Extension Development (NCAED) in coordination with Provincial Agricultural Extension Coordination Offices and the District Agricultural Extension Offices. The involvement of private extension workers using digital technology (e.g. PISAgro, Nestle, Danone with Cargill, Syngenta) as well as NGOs and farmer producer organizations (FPOs) are also important to improve the breadth of agriculture extension services in rural areas.

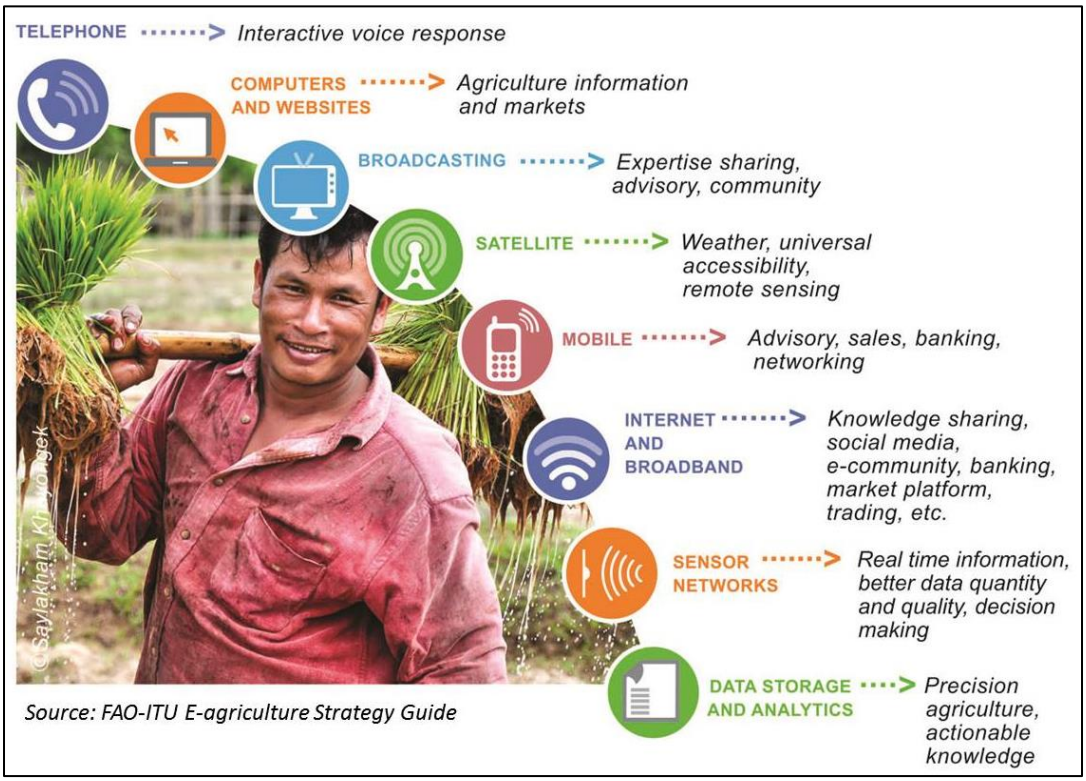

Figure 4: Digital technologies in agriculture

4.2 Market Linkages

Smallholder farmers in the uplands of Indonesia generally have good resource potential and a demonstrated willingness to produce marketable surpluses that would increase their incomes and reduce poverty. There is a strong demand for diversified higher value crops, however, supply chains are underdeveloped, and sustainable commercial relationships have failed to emerge. Smallholders face several technical and organizational constraints that keep them from realising their potential, while off-

takers face other constraints that keep them from sourcing from upland areas. Investment in ensuring a more enabling environment for effective business relationships with better access to improved inputs, technologies, and public and private sector investment in market infrastructure, has great potential for increasing the income levels of upland smallholder farmers. [18]

However, payments and logistics continue to be a major bottleneck to the growth of e-commerce especially in dealing with perishable produces. The public sector can help boost market access by removing barriers to digital trade by introducing legal, regulatory and institutional reforms to accommodate electronic business, facilitate access and connectivity, and enable e-payments for agriculture products.

Foster an enabling environment for digital businesses and innovative startups, like GoJek 8Villages, through complementary investments will ensure sustainability.

4.3 Financial services

For Indonesia, Digital Financial Services (DFS) may well be the next big thing, combining existing mobile phone usage and the countries increasing appetite for financial services. Digitizing the value chains and actors is a pre-requisite to developing and implementing focused DFS services and solutions. The prospective entry of millions of unbanked and underbanked consumers into the financial system is the result of the increasing prevalence of mobile devices.[19] While the growth of mobile is increasing among rural communities, mobile money and e-wallets are just a small part of the entire DFS ecosystem.

Digital innovation can shape financial services for agriculture in many ways. This will also help in offering greater accessibility, affordability, and more tailored products that meet the distinct needs and capabilities of rural customers.

Digital credit scoring could potentially increase the scale and scope of lending to smallholder farmers by complementing or augmenting existing value chain finance programs and informal lending from the farmer's local community. Currently, most value chain finance programs lend funds based on the dynamics and relationships within specific structured value chains, rather than on data about those relationships. Informal credit, the only choice for many smallholder farmers, is widely perceived to be expensive and a barrier to increasing small farmer productivity and use of digital technologies can improve access and bring down costs.

In Indonesia, geographical fragmentation represents an unavoidable challenge for banks that plan to expand their presences or reach to the unbanked market segments. Without any access to financial services, the bankable unbanked currently use the following alternative financial services and products to fulfil their needs:

Deposits and loans: The majority of the bankable unbanked Indonesians fulfil their savings needs via Arisan, an interest-free financing provided during social gatherings, or the traditional way of self-saving at home. Others resort to borrowing from friends and relatives or cooperatives when there is a need for loan. The banks are slowly encroaching into this product segment.

[18] https://webapps.ifad.org/members/eb/127/docs/EB-2019-127-R-26-Project-Design-Report.pdf?attach=1
[19] https://www2.deloitte.com/th/en/pages/financial-services/articles/digital-financial-indonesia.html

Bill payment and remittances: Indonesians have traditionally preferred to pay their bills at Perusahaan Listrik Negara (PLN) and Perusahaan Daerah Air Minum (PDAM) branches rather than through the networks of financial institutions. Remittances companies such as Western Union have gained a strong foothold in serving the remittances market, especially for transactions across neighboring countries such as Singapore and Malaysia.

Airtime top-up: With 99% of the 282 million mobile subscriptions in Indonesia being prepaid customers, there is immense potential in capturing the voluminous transactions of airtime top-up via DFS. Currently, traditional top-up counters, minimarkets and mom-pop grocery stores are amongst the first choices used by the unbanked Indonesians for airtime top-up.[20]

Some of the innovative start-ups in the fintech space are given in Annex 1.

The biggest challenge has been for various DFS players to be able to show tangible benefits to switching to digital finance is behavior change. It has been quite difficult and hence innovative incentives are needed.

Several innovative funding mechanisms such as Peer-to-Peer lend money to individuals or businesses through online services that match lenders with borrowers. Technologies like blockchain makes it transparent and trustworthy. However, an appropriate P2P lending regulatory framework will need to be developed. As seen in other countries, a key player in bringing DFS is the mobile network operators (MNOs) and telecom regulators – including the banking regulator and connected public sector in countries. To manage such diverse partnerships building inter-sectoral leverage opportunities is important to address some of the challenges and bringing in new regulations or relaxing existing regulations on software systems such as Know Your Customer (KYC).

4.4 E-commerce

There is a need for Indonesia's logistics sector to adopt a more integrated approach that ensures efficiencies across the entire supply chain. Indonesia's logistics sector is currently recording strong double-digit growth due to the continuous development of the Indonesian economy driven by the resilient domestic demand. However, Indonesia's logistics performance in international rankings remains weak.[21]

More than 50% of Indonesia's economy in GDP is comprised of micro, small and medium enterprises, and Java has been the beneficiary of big commerce marketplace platforms such as Tokopedia. But for the rest of the 17,000 islands, it is also crucial to narrow the gap, and the country's focus on building the ICT infrastructure and its goal to connect all regions of Indonesia by broadband is important.

Regulation and incentives on promoting e-commerce such as the Presidential Decree No. 74/2017 on e-Commerce Road Map in which skills development is included and tax incentives for start-ups and venture capital (KMK No. 1251 Year 1988 and KMK No. 250 Year 1995) are key to supporting e-commerce in Indonesia.

[20] https://www2.deloitte.com/th/en/pages/financial-services/articles/digital-financial-indonesia.html
[21] http://www.gbgindonesia.com/en/services/article/2016/indonesia_s_logistics_sector_making_connections_11383.php

4.5 Capacity Development

To participate in the digital ecosystem, capacity development at all levels is necessary. With the improvement in digital infrastructure, Indonesia has a good potential to harness the power of digital technologies to accelerate its human resource development. While TVET in Indonesia has been improving and helping youth to gain skills and find jobs; regional disparities still exist due to the geographical dispersion of Indonesia.[22]

The government of Indonesia has invested in several initiatives, notably in improving access through digital infrastructure through the Palapa Ring Project, Pipa Bersama, BTS Provision for Telecommunication Blankspot Area Project, and Wireless Connectivity Pilot Project for Rural Areas. Several Government to Consumer services and online services have been implemented in the last few years. Human resources are strengthened by providing capacity development through the Nongsa Digital Park program in Batam, improving skills of workers, creating jobs in technology-based entrepreneurship and revamping of vocational education institutions.

5 The way forward: options for promoting digital agriculture

For the promise of digital transformation to be realized in Indonesian agriculture to boost productivity, profitability, equity and environmental sustainability and to mitigate downside risks, it is essential to have proactive public actions (policy and investments) that can coordinate and leverage relevant private sector investments, stimulate both supply of and demand for digital agricultural solutions, facilitate their widespread and equitable adoption and use and ensure "open", competitive environment that fosters innovation and growth. This chapter presents a framework for promoting digital agriculture which comprises actions at three distinct levels:

(i) Specific actions at a "project" (or, more generally, a scheme or territorial unit) level
(ii) Enabling-condition actions at sectoral level, to enhance supply of and demand for digital agricultural solutions
(iii) Cross-cutting foundational actions, to deepen and extend digital transformation

Level One: Specific actions at a "project" (or, more generally, a scheme or territorial unit) level

A key interest of this report is to contribute to the design and formulation of the proposed World Bank-assisted project to support agriculture value chain development in Indonesia. The project mode (more generally, the operational mode of a public sector scheme or a program implemented over a defined geographical area) provides unique opportunities to promote more granular digital solutions to specific problem types in defined geographical space and socio-economic setting. As such, it allows for piloting of good practices and innovations, scaling-up of recent successes, and experimenting with bottoms-up solutions to various problems. As a form of public (financed) action, the project mode therefore represents a very flexible and customized form of support towards promoting digital transformation

Working from this perspective, this study has identified seven candidate technologies for consideration for a project-mode operation. These technologies have been drawn from international and national

[22] Mahatmi Parwitasari Saronto, Director of Employment and Job Opportunity Expansion of Bappenas

experience, especially with regard to their impacts on the key development objectives of efficiency, equity and employment, and environmental sustainability. Table 1 below presents the relevant details.

Table 1: Potential Digital Technologies and Impact

Impact of Technology on:		
Efficiency	Equity and employment	Environmental sustainability
Technology 1: Satellite Imagery (On-Farm)		
More rational use of natural resources including soil (organic content monitoring) and water (evapotranspiration monitoring) leading to reduced production cost. Improved farm management pest management capacity through drones	To the extent that the technology is made accessible to small farmers through tailored applications supported by public interventions, satellite imagery could contribute to improved small-scale agriculture through yield forecast, irrigation water management, weather forecast and natural hazard prevention. Food security could be enhanced through better yield prediction.	More rational use of water and soil in cropping and livestock activities Better adaptation to climate change if improved weather forecast is made accessible to producers (tailored smartphone-based weather advice could be considered - see below). Ecosystem services could be enhanced through satellite imagery
Technology 2: Digital Communication Tools – mobile, tablets, broadband (On-Farm)		
Increased efficiency will come from digital communication tool-based services such as e-agricultural extension, weather forecast, E-payment system and sourcing management systems	To the extent that barriers of entry are lowered, combined cost reduction and yield increase from tailored smartphone-based services will generate increased income for small farmers These services are likely to retain/attract youth in agriculture Job creation within digital startups can have a high youth content	Better adaptation to climate change through more accessible and tailored weather forecast
Technology 3: Precision Agriculture – combining drones, IOT, low power Wide Area Networks, LPWAN, GPS, precision soil sampling, big data, cloud computing, machine learning, variable rate technology (On- & Off-Farm)		
On-farm: Precision agriculture is about optimizing farm and livestock management. The efficiency of all factors of production including labor, soil, water and capital will be enhanced. Incidence of pests will be reduced. Mechanized labor will be enhanced (UBER tractor services). Off-farm: through IOT, GPS and cloud computing, possible efficiency improvements can take place on post-harvest losses; storage management for both inputs and	On-farm: To the extent that barriers of entry are lowered for small producers, equity gains can be significant. In particular, precision agriculture combined with smartphone-based services could have a strong impact on smallholders. Precision agriculture is likely to retain/attract youth in agriculture To the extent that artificial intelligence will be adopted in agriculture, labor will be displaced by machine work	On-farm: Optimization of agriculture practices will bring about environmental benefits in the form of reduced use of unnecessary chemical inputs, more rational use of irrigation water, improved soil management and fertility. Climate change adaptation will be improved through Off-farm: IOT will improve climate change mitigation thorough improved energy and material use in processing, storage and

outputs; cold chain management and transportation.	Job creation within digital start-ups can have a high youth content.	transportation especially for products requiring cold chains.
Technology 4: Fintech – digital solutions for finance and insurance markets (On- & Off-Farm)		
Time and labor savings will occur because of E-payment system through the value chains. These savings will find more efficient uses both on-farm and off-farm	Big data will improve access to rural finance for smallholders through (i) improving their credit history (access to databases providing additional information on potential clients); and (ii) improving insurance products that could be used as de-risking factors for small scale agriculture investment	Time and labor savings will occur because of E-payment system through the value chains. These savings will find more efficient uses both on-farm and off-farm
Technology 5: Blockchain (On- & Off-Farm)		
Blockchain will have undeniable efficiency gains along the whole value chain through registration of holdings, animal, plant and transactions; smart contracts; transfer of import and export certificates; traceability and food safety	*Smart contracts* combining blockchain and IOT technologies will generate equity impacts in terms of (i) higher producer prices following exclusion of intermediaries; (ii) lower cost crop insurance and improved access to finance; (iii) savings associated with pay-per-use agricultural services; (iv) blockchain will allow traceable products from small farms getting better market conditions; and (v) Social transfer mechanisms and E-voucher system will see their targeting efficiency increased when blockchain is adopted	Accurate traceability will allow for improved certification of low environment/ energy/ material content products Improved food safety will allow savings in health public expenditures
Technology 6: E-commerce (Off-Farm)		
By directly linking producers and consumers, E-commerce allows to make rural supply more responsive to market requirements	Higher producer prices are likely to be generated through E-commerce linkages	Environmentally friendly products are likely to be promoted through E-commerce

Further details on the "how-to" of promoting these technologies in any socio-economic and geographical setting will need to be scoped out as part of the detailed project design.

Level Two: Enabling-condition actions at sectoral level, to enhance supply of and demand for digital agricultural solutions

While the development, provision and utilization of digital agricultural technologies are intrinsically private sector activities, there is an important role for public policies and actions to create the right enabling conditions (adequate investment incentives, complementary infrastructure and capacities) in order to correct the market failures discussed in section 2 above. Entry points for sector-level public

actions can be grouped into supply-side actions, demand-side actions and actions to ensure environmental sustainability (i.e., offset environmental externalities).

With respect to the supply-side of promoting digital agricultural solutions, four kinds of public action are relevant:

- Reducing private sector investment risks – e.g., through clear digital property rights and patent protection, stable (agricultural) policy regimes, encouragement for equity/venture-capital financing
- Fostering innovation ecosystems – e.g., , innovation hubs to lower entry and establishment costs for new competitors, incubation centers for agri-entrepreneurs, public provision of technical training and advice
- Enabling access to and use of data in agriculture – e.g., public-led 'open-data" initiatives, creation of (or support for private initiatives) for standards of consistency and inter-operability in handling agricultural data, ensuring transparency and accountability of agri-food system data (especially for quality assurance and certification)
- Aligning agricultural policies – e.g., review legacy policies and subsidies – like water and fertilizer subsidies – that undercut precision farming that economizes on water and fertilizers, expanding public agriculture R&D to support digital transformation.

With respect to the building up the demand side for digital agricultural solutions, the following public measures need to be considered:

- Strengthening digital knowledge and skills development – e.g., promotion of digital literacy among farmers and target disadvantaged groups, digital extension and advisory services to enable farmers to undertake on-line transactions and link up through e-platforms.
- Supporting customization of digital tools – e.g., incentivise/mandate development of digital tools in local languages, with user-friendly designs, and addressing specific problems faced by particular communities or areas.
- Building trust in digital applications – e.g., laws and regulations to strengthen data security and privacy or ownership rights, transparent protocols for data collection, storage and processing, overall digital governance arrangements to build trust in digital transactions.

With respect to public actions to enhance environmental sustainability through use of digital technologies, the following entry points need to be considered:

- Strengthening digital environmental monitoring in agri-food systems -e.g., incentivizing and resourcing use of modern agroecological monitoring systems (remote sensing and ground-based monitoring systems with real-time, smart, wireless, internet-connected sensor webs) to the cataloguing, interpreting, forecasting and dissemination of data about the status and trends of agroecosystems to ensure that agricultural products are delivered with smaller environmental footprints and their prices reflected the life-cycle costs of production.
- Incorporating environmental sustainability goals into agricultural policies – e.g., using stronger monitoring of environmental impacts to provide incentives for creating and integrating environmental and production data streams and directing them to decisionmakers. This could lead to evolution of policy goals and targets that reduce environmental footprint while enhancing efficiency

- Influencing consumer behaviour and agri-food markets – e.g., supporting information and communication initiatives to achieve voluntary shifts in consumer choices toward more sustainable production, transportation and waste disposal modes.

Level Three: Cross-cutting foundational actions, to deepen and extend digital transformation

Establishing the foundations for a long-term and successful digital transformation requires complementary actions in related areas. Of these, three are particularly important:

- Availability of digital infrastructure: The set of digital solutions applicable across farms, value chains, and public services require different levels of mobile phone and internet connectivity. Good quality, accessible mobile and internet networks are essential to maximize the efficiency, equity, and environmental sustainability gains from digital agriculture in agri-food systems. Especially in remote and sparsely populated rural areas, creating an enabling environment for telecom sector activity for expanding network coverage can be a challenging pre-condition. Supportive measures in this regard can include a regulatory environment that is stable, flexible, predictable, and low cost; tax policies crafted to reduce investment risks and support expansion in rural areas without creating inappropriate incentives; subsidies and other support policies to try to encourage companies to expand coverage to underserved areas.
- Availability of non-digital enablers: Lack of complementary rural infrastructure—such as roads, energy, post-harvest storage, and logistics—can limit the adoption and impact of digital technologies in agriculture. For example, it is difficult to sell products on e-commerce platforms if there are no roads to markets, or to sell high-quality fruits to online customers if there is no storage to preserve their freshness. Beyond access and storage infrastructure, policy and regulatory framework need to evolve to support e-commerce to legitimize and encourage transactions. Similarly, as transactions shift to e-platforms, trade policies need to adapt to streamline the import process and reduce transaction costs. Finally, private sector investments in agro-logistics and cold-chain capacity should be encouraged to fuel growth of e-commerce.
- Development of an overarching vision, strategy and action plan: In the medium term, it will be helpful to develop a cross-cutting National Digital Agriculture Vision, which can harmonize actions across different areas and stakeholders and prevent costs and mis-steps from more ad hoc initiatives. The vision should be translated into a multi-stakeholder roadmap for digital agriculture, spanning various government ministries, including those dealing with ICTs, food production and processing, rural development, irrigation and water management, disaster management, telecommunication, governance, transportation, finance and commerce.

Annex 1: Agri-Tech Startups in Indonesia

Source: https://tracxn.com/explore/AgriTech-Startups-in-Indonesia

TaniHub | App-based online marketplace to trade agriculture commodities

TaniHub is an app-based online marketplace to trade agriculture commodities. It allows farmers and producers to sell the products to retailers, wholesalers, and individual customers. It allows buyers to buy fruits, vegetables, grains, meat, seafood, etc. It delivers products through an in-house delivery team Tani-Express. The mobile platform is available for Android users.

Investors: Tenaya Capital, Intudo Ventures, Vertex Ventures and 7 Other Investors

Chilibeli | Online community-based platform for agricultural products

Chilibeli is an online community platform for agricultural products. It connects farmers and manufacturers with agents through instant-messaging tools.

Investors: AltoPartners, Golden Gate Ventures, Kinesys Group and 2 Other Investors

eFishery | Provider of an IoT based automatic fish feeding solution

eFishery is an Indonesia-based company offering a smart fish feeding solution for commercial aquaculture. It comprises of a feeder that can sense the fish's appetite through motion sensors, and if the fishes feel agitated or hungry, the machine feeds them automatically. It also provides a data platform that allows fish farmers to monitor and schedule feeding times in real-time on their phones, and control the system if needed.

Investors: Unreasonable Capital, 500 Durians, Ideosource and 6 Other Investors

Crowde | Online platform for connecting farmers with retail investors

Crowde is an online platform for connecting the farmers with retail investors for obtaining capital for their farming operations. The farmers can get their project listed upon registration. Investors can choose among the listed projects for making their investments. There is no lower limit of investment on the platform.

Investors: Mandiri Capital Indonesia, Instellar, Crevisse and 3 Other Investors

8Villages | Marketing solution for companies in agribusiness

8villages product comes in the form of a mobile phone subscription service called LISA (Farmers' Information Service). By subscribing to LISA, users will be put into corresponding community groups based on their crops and location. It connects the farmers directly with the companies engaged in

agribusiness. These companies can push through targeted marketing and advertising messages to farmers via 8village's platform.

Investors: IMJ Investment Partners

iGrow | Crowdfunding platform for farming

iGrow partners with farmers and agribusinesses and allows users to invest in and take ownership (Productive farm ownership) of farms by allowing them to buy seeds. The proceeds are utilized by farmers to carry out the entire farming operation and the farmers share the revenue generated by selling the harvest in proportion to the seed investment with the users.

Investors: Rekanext, East Ventures, 500 Durians

InFishta | Online platform connecting investors with fish farmers

inFishta is an online platform connecting investors with fish farmers. It allows investors to choose the cultivation method, determine the funds to be invested, and invest in fish farming projects. Users can receive real-time updates on the projects they invest and earn from profits.

Investors: Mandiri Capital Indonesia

Jala | IoT enabled solution for monitoring water condition in the shrimp farm

Jala is an IoT device for monitoring water condition in the shrimp farm. The device can be submerged in the pond and is equipped with multiple sensors for monitoring parameters like dissolved oxygen, temperature, humidity, pH, salinity, and TDS (total dissolved solids). It collects the above-mentioned data and sends the same, in real-time, to the cloud. The company additionally provides a web-based portal wherein the collected data is processed and uses decision-making algorithms to produce actionable insights for the farmers. Also provides a companion application enabling the farmers to access data in case there is no internet connectivity. Claims that in March 2015, it won a grant from ASME. One of the clients includes Shrimp Club Indonesia.

Investors: brinc, Conservation, Instellar and 3 Other Investors

Habibi Garden | IoT-based precision farming platform

Habibi is an IoT-based precision farming platform. They deploy a central device which connects to a number of sensors to record data related to light intensity, humidity, moisture, nutrients and send it to the central cloud platform. The information is processed and used to control on ground devices like water pumps to supply water to the field when it is required. All the information is processed and is available in a dashboard like an interface for farmers to monitor their fields.

Investors: brinc, Instellar, Indigo Creative Nation and 1 Other Investors

Eragano | Mobile application for effective farming

Eragano is a mobile application for smallholder farmers for effective farming. The application's features include AI generated farm schedule, integrated with e-commerce farm supply and crop protection program. The application is available on Google Play Store. Notable customers include PISAgro, Agrina, Paskomnas, and others.

Investors: East Ventures

Gojek | Wallet for consumer payments

Go-Jek provides a wallet for consumer payments. Its services include utility bill payments, travel reservations, money transfers, online/offline payments, and more. It also enables businesses to accept online payments via credit/debit cards. Its mobile app is available for iOS and Android devices.

Investors: Golden Gate Ventures, Shunwei Capital, JD.com and 40 Other Investors

Lemonilo | Marketplace for healthy grocery items, snacks and food

Lemonilo is a marketplace platform for healthy food and grocery items. Sellers or merchants can list their products on the platform under appropriate categories. Lemonilo offers delivery from the merchants to the customers and also collect CoD payments. In addition to health grocery and snacks items, users can also place orders for ready to eat healthy food and salad.

Investors: East Ventures, Alpha JWC Ventures