Digital AgTech in Indonesia's Transforming Smallholder Agriculture Sector

Potentials and Policy Options

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Australian Centre for International Agricultural Research

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Executive Summary

The Australian Centre for International Agricultural Research (ACIAR) commissioned Beanstalk AgTech to lead a project with the Indonesian Center for Agriculture Socio Economic and Policy Studies (ICASEPS) and Universitas Brawijaya to help the Government of Indonesia to sharpen its focus on actions that will drive the impactful deployment and advancement of Digital AgTech.
This report is an output of that project, which centred on two key objectives:

1 Assess the current and potential impact of Digital AgTech in smallholder farming and value chains in Indonesia.

2 Identify actions that Indonesian Government agencies could take over the next 5-10 years to unlock and maximise potential impacts.

This resulted in an end-to-end 'benchmark' of Indonesia's Digital AgTech ecosystem as well as a prospective policy and investment 'roadmap' for a whole-of-government approach to Digital AgTech advancement in Indonesia.

There is a growing base of research and community of practice supporting the proliferation and adoption of Digital AgTech in Indonesia, in the Southeast Asia region and around the globe. This study was structured to highlight critical knowledge gaps and to identify how to best enable meaningful and collaborative 'action' to advance the sector. As such, four principles were central to this undertaking:

Focus on Government
Centering analysis and insights on the potential for Indonesian public sector agencies to positively contribute to the Digital AgTech ecosystem

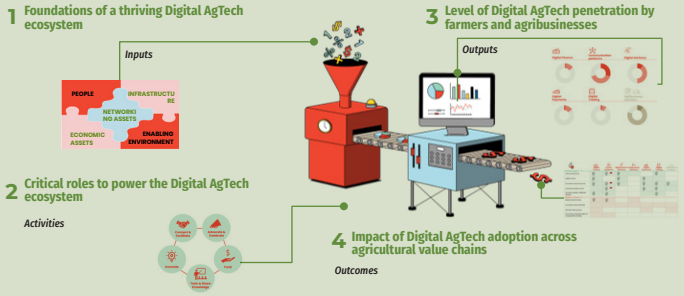
'Full-Spectrum' AgTech
Considering the breadth of Digital AgTech solutions across smallholder agricultural value chains – whether used by farmers, agribusinesses or others

Ecosystem Orientation
Recognising the myriad roles and actors who collaborate, complement and even compete with one another to influence Digital AgTech innovation, uptake and impact

Innovation 'Life Cycle'
Independently evaluating the separate components of an innovation ecosystem – from 'foundations' to 'impact'

Conducting a benchmark across the innovation 'life cycle' allowed us to have a more comprehensive view of challenges, gaps and successes in Indonesia's Digital AgTech ecosystem. As such, we sought to independently understand Digital AgTech ecosystem **foundations**, **roles**, **penetration** and **impact**. Collectively, this benchmark helped us to isolate **10 major challenges** constraining Indonesia's Digital AgTech sector today.

Our Approach to the Benchmark Assessment



The 10 Most Significant Challenges

- Lagging rural digital literacy
- Universities largely untapped
- Advisors' shallow depth of Digital AgTech knowledge
- Concentration of Digital AgTech penetration and support
- Limited understanding of impact from Digital AgTech
- Lack of effective government coordination
- Shallow talent pool for Digital AgTech
- Lack of public–private sector engagement
- Poor information and data infrastructure
- Misfit of startup and agriculture ecosystems

Digital AgTech ecosystem

Identified standout challenges and opportunities to strengthen Indonesia's Digital AgTech ecosystem

40+ interviews
50+ datasets, reports and other resources consulted

Stakeholder-Driven Ideation

Gathered perspectives from across and outside of the Digital AgTech ecosystem on highest-potential 'actions' to take

3 industry roundtables convening
>55 industry changemakers

Global Industry Roadmap Review

Built a 'long list' of initiatives, pulling new ideas and structure from other countries' Digital AgTech policy frameworks and other industry roadmaps (e.g. healthcare and transport technology)

5 key 'programs' for government action
>50 impactful initiatives

Initiative Prioritisation

Determined and classified highest-potential actions for the Indonesian Government to take in the next five to 10 years

12 13 'quick wins' and transformational investments'
6 to take on TODAY

Develop a whole-of-government development plan for an independent AgTech sector.

Support the creation of a public–private AgTech association.

Roll out a decentralised, farmer-focused digital literacy training program.

Upskill advisors in Digital AgTech use, deployment and impacts.

Increase talent supply for the Digital AgTech ecosystem.

Build a comprehensive, publicly accessible agri-data warehouse.

What Is Digital AgTech?

Digital AgTech refers to the integration of contemporary digital tools and technologies within the agricultural realm, aiming to enhance diverse facets of farming practices, communication, financial operations and the overall landscape of agribusiness operations.

Within this context, we have categorised eight distinct forms of Digital AgTech solutions:

01

DIGITAL FINANCE

Digital tools enabling and expanding access to credit and associated services (e.g. digital microcredit, peer-to-peer (P2P) lending, digital insurance, alternative credit scoring, and digital origination and servicing tools)

02

FARMER COMMUNICATION PLATFORMS

Digital tools used by farmers to connect, learn and share (e.g. use of phone/SMS for business, leveraging social media, online search and streaming services)

03

DIGITAL FARMER ADVISORY

Digital tools providing weather, market and technical advisory services (e.g. phone-based, web-based or app-based advisory tools)

04

FARMER EQUIPMENT AND HARDWARE

Automation and Internet of Things (IoT) tools used on farms for increased efficiency (e.g. Equipment as a Service (EaaS), software packages for core equipment, drones, sensors and IoT devices)

05

DIGITAL PAYMENTS

Digital tools and platforms that enhance financial transactions for farmers and value-chain actors (e.g. digital bank transfers, e-wallets and Quick Response Code Indonesian Standard (QRIS))

06

DIGITAL TRADING

Digital marketplace solutions enabling and enhancing agriculture value-chain transactions (e.g. social media marketing, general e-commerce, and output and input marketplaces)

07

AGRIBUSINESS SOLUTIONS

Digital tools and advanced analytics solutions used across the agriculture value chain to improve performance and strengthen supply chains (e.g. traceability systems, supply chain management, land mapping and GIS, and advanced processing technologies)

08

E-GOVERNMENT SOLUTIONS

Digital tools built to improve the reach, capability and efficiency of government services (e.g. e-tax filing, digital ID systems, web-based government services and e-subsidy platforms)

Digital AgTech Holds Major Promise for Indonesian Agriculture

Economic Value

Improves product quality and prices for farmers

Improves farm productivity and increased farmer profitability

Improves access to new markets (including exports) and financial products

Societal Value

Improves farmer safety and working standards

Greater food security

Greater farmer incomes and livelihood for millions of farmers

Creates a culture of innovation for the next generation of Indonesian agripreneurs

Environmental Value

Improves product shelf life and storage, and avoids crop loss

Increases biodiversity; less food waste and 'net zero' pathway

Every step of the farmer journey could potentially be transformed...

	Current: A Typical Farmer Journey	**Future: A Digitally Native Farmer Journey**
Finance	Obtains loan from local trader or village lead with high interest rates and short tenure	Uses a mobile app to receive a three-month P2P low-interest loan from commercial investors
Input	Purchases the seeds, fertiliser and chemicals that are available at local kiosks and pays advertised price	Browses seed, fertiliser and pesticide prices through an online shop; orders quality inputs at low prices
Communication	Talks to other farmers (who grow the same crops in the village) about challenges	Reads post in WhatsApp group about how a fellow farmer in another region solved crop challenges
Advisory	Talks to extension workers in person about planting issues and hears about market prices from the local traders	Uses a weather forecast app to target planting time and an app to identify disease pressure more quickly; searches online to identify market prices in different markets
Equipment	Relies on family and local labour for cropping activities, imprecise water and fertiliser application, heightened cost, and impact yields	Hires a pesticide drone service via an app; uses IoT sensors to identify the optimal amount of water and fertiliser to use for higher yields
Payments	Gets paid in cash by the local trader, who takes a portion of the payment for loan and interest costs	Pays for inputs and receives payment from customers online or via mobile e-wallets
Trading	Relies on the local trader to purchase produce at low prices that are sensitive to market supply and demand in local markets	Uses an online marketplace to find buyers across the region who are willing to pay higher prices
Data	Records transactions; however, very few farmers do so due to a lack of financial literacy	Data regarding the farmer's land and produce are collected to help coordinate the supply of produce and tailor services for farmers
Off-Farm	Produce aggregated through manylayers with little traceability, then sold to end consumers	Farm information, off-farm distribution logistics and processes highly automated with transactions recorded
Government Solutions	Available government solutions not known and found out through government extension workers	Pays taxes via e-tax filing; digital ID allows immediate access to services such as e-subsidies

Indonesia: a 'Success Story' for Digital AgTech

The convergence of several forces has paved the way for the development of a robust and dynamic Digital AgTech sector in Indonesia...

Public Investment in Digitisation	Maturation of Venture Capital & Startup Ecosystems	Growth and Modernisation of Agriculture Sector
Transformative investment in **rural infrastructure** to increase digital readiness and connectivity across the nation (e.g. submarine cable network expansion and base transceiver stations) **Policies and regulation** purpose-fit to power a growing digital economy Public investment in **data and digitally enabled governance initiatives** Longstanding prioritisation of **financial inclusion and literacy** Partnerships and public investment in the development of **digital skills** in the workforce (e.g. Digital Talent Scholarship Program, Google for Indonesia and Microsoft YouthSpark)	**>160** venture capital (VC) funds active in Indonesia, including **~60 VC funds with exposure to the AgTech** sector (Tracxn, 2022) **>2,450** active startups across Indonesia (Startup Ranking 2023), with a particularly sustained rapid growth of investment and innovation in the **fintech and healthtech sectors** Startup Genome (2022) ranked Jakarta as the **#12 emerging startup ecosystem globally**, with its ecosystem value estimated at $62B **$6.4B** in total private equity / VC investment in Indonesia in 2021 (Statista 2022)	Major federal investment in **input and technology intensification** for staple crops, livestock and horticultural enterprise production Renewed **partnerships with multilateral institutions** increasingly focused on **digitisation and modernisation** **Sustained annual growth in agriculture sector** GDP for over past decade

...with major achievements and successes to date:

#2 agrifoodtech investment market in the Association of Southeast Asian Nations ASEAN (behind Singapore), counting over **$800M** in capital raised in 2021

>80 Digital AgTech startups operating in Indonesia today

>100 unique organisations playing a role in Indonesia's Digital AgTech ecosystem

An Emerging 'AquaTech' Hub

Home to the world's second-largest seafood industry, Indonesia houses several business model & technology pioneers bringing digital capabilities to shrimp and finfish producers – from water-quality monitoring and digital advisory tools to financing and marketplace solutions.

eFishery, aruna, DELOS, Crustea, JALA

Indonesian AgTech Pioneers Going Global

Early leaders in Indonesia's Digital AgTech sector are leveraging relationships with multinational agribusinesses, using international 'landing pad' programs and investing in organic growth to new frontiers, across Southeast Asia and the world at large.

GROW AGRIFOOD TECH ACCELERATOR, GRAFT POWERED BY BEANSTALK, KOLTITRACE, Nestlé

A Budding 'Ecosystem'

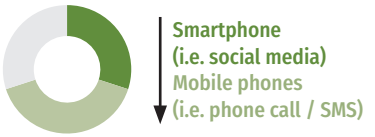
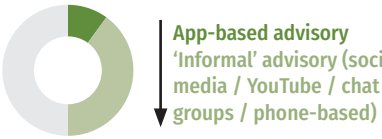
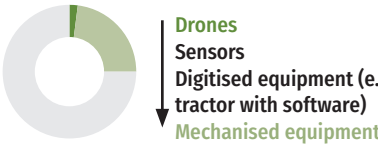
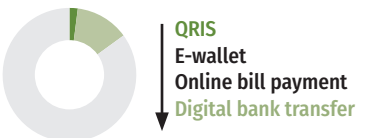
International development programs, technology enterprises, investors and other ecosystem enablers are increasingly bringing both focus and investment to cultivate a new generation of Digital AgTech innovators and corporate innovation partnerships.

GK PLUGANDPLAY INDONESIA, Cultivhacktion, Coffee Innovation Fund – Indonesia, INAGRITECH, AGRINNOVATION CONFERENCE

Room to Grow: Penetration Across Digital AgTech Solutions

The measurement of the penetration of Digital AgTech services across both farmers and agribusinesses (e.g. processors and distributors) is crucial to understanding the current state of AgTech in Indonesia and how fast transformation is occurring. This view will help the government and businesses pinpoint where the major gaps are occurring and devise actions to address them. Increasing the adoption of Digital AgTech solutions by actors across the supply chain – not just farmers themselves – will be critical to maximising positive impact across the smallholder agriculture sector.

Indonesia Current AgTech Penetration (2022)

CATEGORY	DEFINITION	PENETRATION ESTIMATE	COMMENTARY
Digital Finance	Digital tools enabling and expanding access to credit and associated services (e.g. digital microcredit, P2P lending, digital insurance, alternative credit scoring, and digital origination and servicing tools)		Standout growth in P2P lending, but limited digitisation in formal and microcredit settings; scale of advanced digital offerings hindered by regulatory challenges and rural financial literacy
Digital communication platforms	Digital tools used by farmers to connect, learn and share (e.g. use of phone/SMS for business, leveraging social media, online search and streaming services)		The large majority have mobile phones, but smartphone penetration still limited by cost; social media platforms are far more popular for dialogue than business
Digital Farmer Advisory	Digital tools providing weather, market and technical advisory services (e.g. phone-based, web-based or app-based advisory tools)		Informal advisory preferred via social media, WhatsApp chat groups and YouTube videos; low uptake of formal tools such as app-based advice
Farmer Equipment and Hardware	Automation and IoT tools used on farm for increased efficiency (e.g. EaaS, software packages for core equipment, drones, sensors and IoT devices)		The use of IoT and sensors is quickly increasing in the fishing industry; however, usage elsewhere is far from being commercial; the penetration of basic tractors sits at ~25%
Digital Payments	Digital tools and platforms that enhance financial transactions for farmers and value-chain actors (e.g. digital bank transfers, e-wallets, QRIS system)		~50% of agricultural workers own a bank account; however, they are slow to adopt digital payments; transactions are still largely conducted via cash
Digital Trading	Digital marketplace solutions enabling and enhancing agriculture value-chain transactions (e.g. social media marketing, general e-commerce, and output and input marketplaces)		Many startups are disrupting agriculture e-commerce, with changes in consumer behaviour due to COVID seeing an increase in demand for farm-to-door produce

(continued)

Indonesia Current AgTech Penetration (2022) *(continue)*

CATEGORY	DEFINITION	PENETRATION ESTIMATE	COMMENTARY
Agribusiness Solutions	Digital tools and advanced analytics solutions used across the agriculture value chain to improve performance and strengthen supply chains (e.g. traceability systems, supply chain management, land mapping and GIS, and advanced processing technologies)	 Traceability platform Data management platform Food processing / quality control / supply chain software Land mapping and GIS	The majority use digital supply chain management tools and land mapping; traceability and advanced data analytics still nascent
E-Government Solutions	Digital tools built to improve the reach, capability, and efficiency of government services (e.g. e-tax filing, digital ID systems, web-based government services and e-subsidy platforms)	E-tax filing	Farmer use of e-tax filing is low; further development is needed, for example for e-subsidies and digital solutions for extension workers; Indonesia ranked 77th in the UN E-Government Development Index (EGDI; 2022)

Penetration of: Highest-sophistication solutions Lowest-sophistication solutions

NOTE: Penetration estimates are based on a combination of team analysis and estimates from literature and key informants. Note that penetration varies based on type of service, which has been recorded as '% of total smallholder farmers', except for 'agribusiness solutions' (instead, '% of total corporate agribusinesses').

Key Takeaways

- **AgTech adoption is a journey:** Technology leapfrogging takes time, as farmers and businesses need to familiarise themselves with Digital AgTech services and integrate them into their practice. Even within Digital AgTech service categories, there are spectrums of tools and services offering varying degrees of sophistication and value propositions.
- **Early success stories 'a step away' from the farmer:** Solutions with the highest level of growth and investment are largely enterprise and marketing tools – more squarely targeting the needs of agribusinesses, distributors and input suppliers than smallholder farmers.
- **AgTech penetration is concentrated:** It is concentrated by region (for example, in Java and western provinces) and commodity (for example, in aqua and plantation sectors).
- **The level of AgTech uptake remains unclear:** Little empirical data is available to know how many farmers and agribusinesses are using AgTech, especially when disaggregating by types of services.
- **Informal tools still dominate:** Farmer use of tools such as WhatsApp and YouTube goes far beyond that of formal apps and services.
- **Perception that AgTech is solving 'secondary' problems:** Without managing primary challenges such as affordable finances and inputs, farmers have limited appetites and limited ability to invest in AgTech solutions; they face significant challenges in scaling their operations.

10 Major 'Gaps' in Indonesia's Digital AgTech Ecosystem

Where can action from the Indonesian Government be most impactful?

	1	**Lagging rural digital literacy** significantly inhibits uptake and the ability to benefit from Digital AgTech. By all available measures, rural digital literacy and penetration remain low. This gap pertains not only to agricultural producers, but also to those who train, support and advise them. For example, it is estimated that only half of farmers own mobile phones, and those who do generally do not see their phone as a tool to help them conduct business.
	2	**Advisors' shallow depth of Digital AgTech knowledge** inhibits producers' abilities to effectively access, use and benefit from AgTech solutions. Extension agents, farm business advisors, channel partners and farm support program staff (such as from development programs) are generally limited in their understanding of the breadth of solutions available, how to use them and how/when they are most impactful.
	3	**Limited understanding of impact from Digital AgTech solutions**, both in nature and magnitude, limits the ability of public officials, advisors and agricultural producers themselves to invest and advocate for highest-impact Digital AgTech solutions effectively. Globally, but especially in Indonesia, there are very few verifiable studies of the impact of Digital AgTech solutions, and the focus has been on a few – mainly economic – variables of concern. Discrepancies between solution providers' claims and 'observed' impact are often significant.
	4	**A shallow talent pool** fit to power Indonesian Digital AgTech solutions is a limiting factor on pace, quality and diffusion of innovation. Digital AgTech is playing from behind (relative to other industry tech sectors thriving in Indonesia – such as fintech and healthtech). The sector suffers from a 'perception problem' through association with agriculture, generally reputed as slow-growing and unattractive. In addition, the share of graduates and workforce sufficiently trained on the intersection of 'agri' and 'tech' is restrictively slim.
	5	**Poor information and data infrastructure** is a particular drain, rather than foundation, for Digital AgTech innovators and decision-makers. A lack of basic agricultural statistics at the local level limits the ability to 'benchmark' Digital AgTech impact, and an inability to 'share' common data translates to severe duplication of effort. Even when data is available, a lack of trust, usability and understanding by its users limits its impact. Government data and dashboards are not robust enough to offer meaningful decision-making support.

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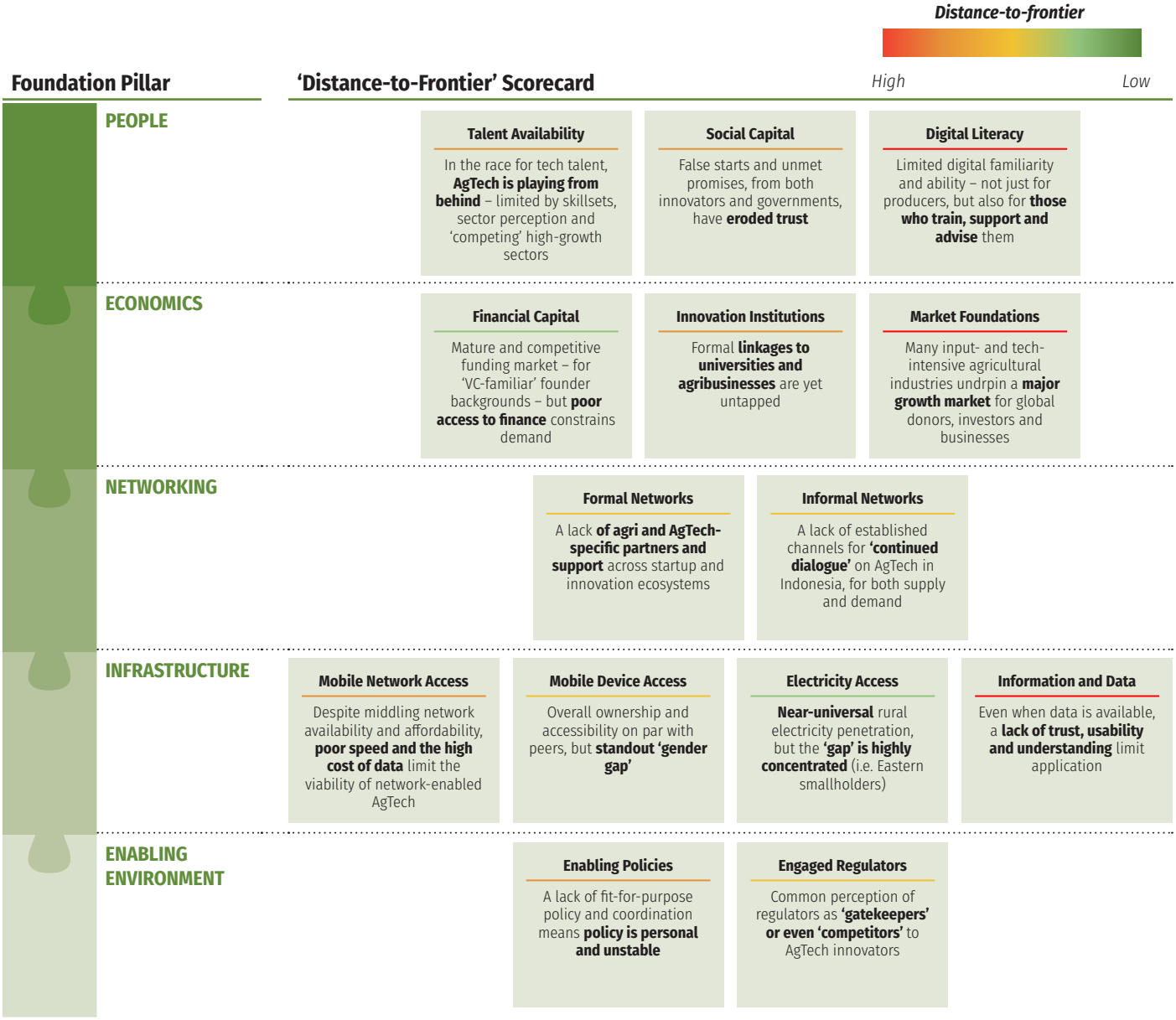
	6	**Universities are largely 'untapped' –** underutilised by, and only loosely linked to, the Digital AgTech ecosystem in Indonesia. Whereas universities have served as springboards and stewards of Digital AgTech innovation in peer markets, Indonesian universities have remained relatively distant. University capabilities, IP and assets have played little role in the sector to date, constrained by a lack of incentives, trust and practice on behalf of universities and a lack of 'navigability' from the side of innovators.
	7	**Digital AgTech penetration and support is relatively concentrated,** both by region and domain. The greatest attention, investment and level of penetration has been focused in Java, while a relatively small proportion of – especially VC-funded – Digital AgTech solutions in Indonesia is regionally based. The greatest 'successes' have been seen downstream in the agricultural supply chain – in marketplace solutions, for example – which have limited demonstrated linkage to and benefit for farmers. The common perception is that Digital AgTech is often solving 'secondary' challenges and widening, rather than minimising, gaps in productivity and innovation.
	8	**A lack of effective coordination at and between all levels of government** results in persistent conflict, gaps and inconsistency of public investment in and support for Digital AgTech. A lack of coordination down to the regional level and up to multilateral organisations results in a significant duplication, lack of synergy and perceived unreliability of public sector support for AgTech. There remains no single overarching roadmap and set of KPIs for Digital AgTech as an independent, positively impactful entity. As a result, Digital AgTech policy is largely 'personal'. This has caused conflicting policies, creating a complex regulatory environment for Digital AgTech players and investors to navigate.
	9	**A lack of direct engagement between the public and private sector** on topics of innovation – especially with innovators themselves – limits the responsiveness and relevance of public policy and investment in Digital AgTech. Government investment in the development of Digital AgTech solutions has often competed with or eroded trust in private sector innovation. Existing regulation presents various barriers to digitised agriculture solutions. There is no central advocacy body for Digital AgTech, and those for 'agriculture' are ill-equipped to do so. Those in Digital AgTech noted great difficulty in connecting with both government and others in industry, often working in a segregated manner.
	10	**The misfit of startup ecosystem support for agriculture** results in a thinner pipeline of sustainable, adaptable and farmer-oriented Digital AgTech innovators. Particularities of the customer base, seasonality and (low) tech intensity are just a few of the factors that make traditional startup infrastructure often ill-equipped to support Digital AgTech. There are few startup support services and programs (such as incubators and accelerators) specific to Digital AgTech innovators, and there is a lack of such support available for rural innovators – especially from non-corporate backgrounds.

Foundations of the Indonesian Digital AgTech Ecosystem

Considerable limitations persist in terms of available research and the depth of (especially internationally) comparable 'like-to-like' data regarding sector-specific agricultural systems development and tech ecosystems. While there has been increasing attention on the barriers to, level of and impact of Digital AgTech uptake to date, we found that the question of what capabilities and conditions spur Digital AgTech innovation – and how they are performing at the national level – has been largely unexplored.

To address this void, we employed analytical frameworks that span the realms of agricultural development and innovation ecosystems, enabling the construction of a scorecard evaluating the 'foundations' of Indonesia's Digital AgTech ecosystem, thus identifying areas of maximum impact for investment and intervention by Indonesia's public sector and its collaborative partners.

Through the examination of five 'foundational pillars' and 14 'sub-pillars', our assessment has brought into focus the areas of '**digital literacy**' and '**information and data**' as pivotal domains where targeted attention and investment could propel the advancement of Indonesia's Digital AgTech ecosystem. Other promising domains include '**talent availability**', '**social capital**', '**innovation institutions**', '**mobile network access**' and '**enabling policies**', which present a significant opportunity for improvement. Conversely, the country demonstrates relative strength in '**market foundations**', '**financial capital**' and '**electricity access**', providing avenues for strategic leveraging.



NOTE ON METHODOLOGY: *'Distance-to-frontier' reflects the gap between performance and a measure of 'best practice', based on the observation and comparative assessment of >40 categorised and independently assessed qualitative and quantitative indicators, combined with >40 expert perspectives throughout this engagement. With a semi-structured questionnaire and procedure for the weighting of available indicators, the process was designed for repeatability – in Indonesia and elsewhere.*

Improving Intergovernmental Coordination and Collaboration

Feedback from industry players revealed how a lack of coordination and collaboration has become a substantial pain point, stifling the growth and transformation of the agricultural industry. There was a unanimous view that lack of proper coordination within governments is one of the single largest challenges that need to be tackled to enable actors to better innovate, develop and scale their programs. Rather than being a barrier, the government needs to focus on how to best accelerate national efforts towards delivering on a unified Digital AgTech vision and mission.

There is a major opportunity for government to improve across three main areas: (1) improved inter-ministerial role in coordination and support, (2) better vertical governance communication and cooperation between federal and provincial, and (3) the government playing a greater coordination role across the whole ecosystem.

What we heard from the industry:

INTER-MINISTERIAL

On improving coordination...	*Different ministries are very segregated and have too many conflicting regulations. There needs to be one roadmap to govern AgTech. With at least three coordinating ministries, none are taking the lead on AgTech. Major institutional silos also exist – between public and private, within the ministries, between DGs, and then within layers of management.*
On sustainability of support...	*AgTech programs held by ministries are always one-off. AgTech businesses cannot depend on government funds that are volatile and lack continuity. Ministry budget cuts negatively disrupt industry development and growth.*
On setting a common objective...	*Singapore's '30 by 30' strategy has helped to catalyse and force the separate ministries that work across food security, innovation and research to organise quickly.*

VERTICAL GOVERNANCE

On federal–provincial alignment...	*The national government's influence is overly dependent on the will and capability of provincial governments. Today, there are no synergies between national and provincial [AgTech] policies.*
On inter-regional consistency...	*Traceability schemes are extremely different from one province to another. Government extension staff are under-resourced.*
On building pathways to the global ecosystem...	*The influx of cheap and high-performing tech from China is unlocking more potential. Current regulations in Indonesia are too difficult and non-transparent for foreign entrepreneurs to bring products in. Singapore uses grant programs to attract accelerators into the market, who then directly co-invest in the sector.*

CROSS-ECOSYSTEM

On alignment with multilateral initiatives...	*There is mixed messaging from international agencies, government agencies and apps even on simple management practices, making it hard to listen. We should be better leveraging 'ASEAN Access' and other international network partners for data layers and bespoke services. International donors are also behind, as the current focus is on governance instead of more important metrics such as productivity and livelihood outcomes.*
On leaving space for others to operate...	*The government tends to build its own solutions, and is openly hostile towards external new technology, which hurts farmer trust in technology. The biggest challenge is that the government does not know when to stop intervening.*
On connecting critical ecosystem players...	*I see India as the 'aspirational competition', and we are only just five years behind. They have immense depth in innovation infrastructure that plays a critical role connecting universities, corporates and investors together.*

Examples of Effective Coordination and Collaboration in Other Countries

Indonesia will benefit by learning from how other countries have navigated coordination and collaboration efforts.

Leveraging innovation to improve national food security

Setting a national mission:
In 2019, the Singapore Food Agency (SFA) announced its '30 by 30' initiative with the objective of producing 30% of its nutritional needs by 2030 by transforming the agrifood industry to one that is highly productive, innovative and sustainable.

Providing adequate financial support:
The government also recognised the importance of providing sustainable financial support to the sector to boost research and development (R&D) and tech adoption. The SFA established a $23M Singapore dollar (SGD) fund for R&D in sustainable urban food production, and a $60M SGD co-funding scheme for local farmers to improve capabilities, adopt innovation and upscale technology.

Creating a strategic approach:
A three-pronged strategy ('The 3 Food Baskets') was identified to provide a focused approach to improving Singapore's food security. It includes: (1) ***Diversify import sources*** *to reduce reliance on any single food supply source, (2)* ***grow local*** *to provide buffer supply in the event of overseas supply disruption and (3)* ***grow overseas*** *to help local companies expand abroad and export food back.*

Setting up an enabling ecosystem for AgTech development

Setting a clear mission statement:
The Israeli Ministry explicitly outlines its support for AgTech in its mission statement: '... to leverage the relative advantage of Israeli agriculture'. Volcani Institute, Israel's unique research center run by the government, is recognised here as a key engine for AgTech development.

Clear government role in promoting cross-sector partnerships:
In 2016, the senior position of Deputy Director-General for Agricultural Innovation was created to bolster AgTech in the Ministry of Agriculture. The role works closely with the chief scientist – however, with a focus on commercialising and scaling AgTech ideas into profitable businesses through partnerships with corporate, venture capital firms and private investors. A $2.6M USD fund was established to encourage the development of solutions that are innovative *and* can create a large impact in agriculture.

Establishing a government layer to support innovation:
The Ministry of Economy recognised its role in providing investment to the agriculture sector. The Israel Innovation Authority was established to channel R&D financing into enterprises at different stages, which has built a highly entrepreneurial culture in Israel.

Evidence of Impact from Digital AgTech

Research measuring the impact of Digital AgTech services is critical to understanding how tools and solutions are improving farmer livelihoods and the agriculture sector, so government and non-government organisations can focus efforts on policies and solutions that can make the most significant positive impact while reducing negative ones. We undertook a global literature review of impact 'studies' undertaken by universities, development programs and Digital AgTech solution providers; and we found that there is a great deal of headroom for further studies to improve our understanding of Digital AgTech's impact – not only in Indonesia, but across the globe.

The Impact of AgTech on Agriculture, Smallholder Farmers and Broader Society

Theoretical outcomes*
Global-studies-observed outcomes
Indonesian-studies-observed outcomes

	Digital Finance	Comm. Platforms	Digital Farmer Advisory	Equipment and Hardware	Digital Payments	Digital Trading	Agribusiness Solutions
Farm productivity	●	● ●	●			●	
Higher prices	●		●		●		
Increase in farmer income	●	● ●	●		●	●	●
Enhanced market access		● ●			●	●	
Increased uptake of adjacent AgTech	●	●				●	
Negative impact							
Reduced on-farm employment	●	●					
Increased social exclusion							
Decreased data privacy							
Increase in misinformation and irresponsible lending							

*'Theoretical outcomes' defined as outcomes that research and articles have postulated, but have not measured

From this literature review and substantiated through our broad-based stakeholder engagement, our team took away several additional learnings regarding the breadth and depth of Digital AgTech's global impact:

Digital Finance and Advisory Tools Demonstrate Meaningful Impact for Farmers

- **Digital finance** tools help smallholder farmers access loans and purchase inputs just when they need them, which is critical to ensuring that they grow enough to generate an income – but are dependent on designs specific to smallholder farmers' needs.
- **Digital advisory** tools prove effective in strengthening knowledge in using the right inputs in the right amount at the right time, which is critical to improving farm productivity and income.

Access to Information Does Not Always Empower the Farmer

- Access to information, such as prices and new farming practices, is not enough to empower farmers to change their behaviour. Farmers are constrained by the 'familiar', for example existing relationships with local traders and greater trust from other farmers vs. online advice.

Empirical Research on 'Impact' Is Limited in Number, by Economic Dimensions Measured and by Short-Term Nature

- Globally, the focus has been on measuring the impact of 'digital farmer advisory' and 'information communication technologies' on farmers with limited studies in other types of Digital AgTech services. Studies in Indonesia are lacking across all Digital AgTech.
- The primary focus of empirical research is on yield, prices and farm incomes; there is far less attention on social, environmental and value-chain outcomes. Few perspectives consider potential negative outcomes and the ways to best manage them.
- Project activities and impact measurement need to occur over 5+ years as changes in farmer behaviour happens gradually over time. Many projects only last a few years.

Research Examples:

Research across different Digital AgTech services, industry sectors and regions is critical to propelling Indonesia and developing nations forward in the agriculture industry – to understand what works, what does not and what lessons can be taken.

Influence of WhatsApp on Fish Farmers (Indonesia)

A research study by Apresia et al. (2020) analysed how the use of WhatsApp improved Semarang City fish farmers' financial conditions and aquaculture knowledge. A questionnaire was distributed to 60 farmers (both WhatsApp users and non-users). Farmers in the WhatsApp group received farming information faster, and were able to share information and problems and find solutions via discussions.

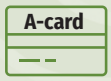
The results showed that the participation in the WhatsApp group had a positive impact on improving financial conditions and aquaculture knowledge:

- **Higher aquaculture knowledge:** Versus the non-user group, the WhatsApp group showed a 5%+ higher result in farming technique, a 5%+ higher result in problem-solving skills and an 8%+ higher result in new information received.
- **Better financial conditions:** The WhatsApp group showed a 2%+ higher result in financial prosperity, a 2%+ higher result in marketing ability and a 13%+ higher result in social network size.

Micro-Credit Project (Bangladesh)

As part of the Agricultural Extension Support Activity (AESA) project funded by USAID, in 2016, a new model was designed to re-engineer microfinance involving rice farmers across three districts in Bangladesh to solve challenges: (1) a lack of reach by banks and collateral needed for loans, (2) high interest rates by microcredit programs with short and inflexible repayment periods, and (3) cash-based loans used for non-farming activities.

A special debit card (A-card) was developed in a four-way partnership with farm input retailers, commercial banks, microfinance institutions and smallholder farmers.



Features of the A-card

- Low interest rate credit (10%)
- No collateral needed
- Flexible payback period
- Only purchase seeds, fertiliser, agrochemicals and irrigation fuel

Mahalder et al. (2018) reported the following results for the 53 farmers involved:

- **Increased input purchases:** 23%+ seed purchases; 20%+ in fertiliser purchases
- **Higher rice yield:** 17%+ in kilograms of rice produced
- **Higher prices and profit:** 21% increase in prices received; 59% increase in profitability
- **Increased access to financial services:** 33% of farmers opened a bank account; 11% opened a loan account

A Comprehensive and Coordinated Strategy for the Development of an Independent AgTech Sector in Indonesia

A clear, specific and coordinated Digital AgTech strategy – aligned to Indonesia's **National Development Priorities** – could help to mobilise a long-term collaborative transformation of the agriculture sector through Digital AgTech. The diagram below outlines what an aspirational Digital AgTech strategy could look like (as summarised on a single page). This starts with a **mission statement** to set a clear goal for Indonesia to lead the Digital AgTech innovation space in Southeast Asia; **priority outcomes** laying out the key outcomes of increased economic, societal and environmental value; a proposed set of five **Digital AgTech industry development programs** comprising a set of priority initiatives to achieve priority outcomes; the **key enablers** required to support growth and transformation in Digital AgTech; and lastly the eight identified **Digital AgTech solutions** that set the foundation for a digitally enabled transformation.

National Development Priorities[1] (2020–24)

- ✓ **Strengthening economic resilience for quality and equitable growth**
- ✓ **Developing regions to reduce inequality and to ensure equity**
- ✓ **Increasing the quality and competitiveness of human resources**
- ✓ **Mental revolution and cultural development**
- ✓ **Strengthening infrastructure to support economic and basic services development**
- ✓ **Strengthening the environment and resilience against natural disasters and climate change**
- ✓ **Strengthening the stability of political, legal and regulatory affairs**

Mission Statement

Lead Southeast Asia in Digital AgTech innovation and adoption by 2030, enabling millions of farmers to increase livelihoods and developing a culture of innovation for a rising generation of agripreneurs.

Mission Statement

Economic Value	Societal Value	Environmental Value
More productive land, more efficient systems, greater exports and greater incentives for actors	Greater farmer incomes,food security, and gender and equity inclusion,including young farmers	Increased biodiversity, less food loss and waste, and 'net zero' pathway

Digital AgTech Industry Development Programs

Support Key Players			Strengthen Enabling Environment	
Strengthen producers	Empower advisors	Equip innovators	Effective governance and coordination	Data-driven feedback loops

Key Enablers

Build people's capability and capacity	Revise regulations	Strengthen infrastructure	Catalyse funding	Partnership and collaboration

Digital AgTech Solutions

Digital finance	Communications platforms	Digital advisory	Equipment and hardware
Digital payments	Digital trading	Agribiz solutions	E-government services

1. Extracted from Indonesia's *National Medium-Term Development Plan for 2020-24* (see References)

Policy and Investment Roadmap

The 'roadmap' below is a deeper dive into the 'Digital AgTech Industry Development Programs' denoted in the Digital AgTech strategy on the previous page. This roadmap synthesises our recommendations for the 25 highest-priority actions for Indonesia's government to take forward to maximise the potential impact of Digital AgTech in Indonesia over the next five to 10 years. Of the 25 actions, we classified 12 as 'quick wins' (more rapidly and 'unilaterally' implemented; '**[QW]**' below) and 13 as 'transformational investments' (long-term complex initiatives requiring multilateral alignment and collaboration). We identified six in particular as priority investments to take on first, starting with the development of a **whole-of-government plan for an independent AgTech sector**.

The initiatives prioritised below reflect relative strengths and areas for growth within Indonesia's Digital AgTech ecosystem today, with a focus on addressing the 10 major 'gaps' in Indonesia's Digital AgTech ecosystem. An initial inventory of potential initiatives was developed with the support of stakeholders from across and outside of Indonesia's Digital AgTech ecosystem, generated from both direct interviews and the three industry roundtables we conducted. Additionally, we consulted similar 'roadmaps' and exemplary high-impact initiatives from several analogous industries and geographies. The final set of prioritized initiatives reflects a consideration of the breadth and depth of the need addressed, exemplary 'success' in other settings, and assessed fit and feasibility within the Indonesian context.

PROGRAM		WAVE 1 (within 2 years)	WAVE 2 (within 5–10 years)
1 Strengthen Producers	Upskill farmers digitally and empower them to use information and solutions.	Upskill farmers digitally and empower them to use information and solutions.	Develop and deploy 'Digital AgTech' learning module(s) into public school curriculums (at all levels).
	Help strengthen financial access and manage risk for farmers.		Pioneer deployment of farmer-centred digital financial services **[QW]**. Review and revise financial regulation to lessen the burden on digital financial solution providers **[QW]**. Review and revise financial regulation to ensure protection against predatory (digitally enabled) loans **[QW]**.
	Provide infrastructure to link farmers to markets and solutions.		
2 Empower Advisors	Improve quality, expertise and efficiency of extension services.	Upskill advisors in Digital AgTech use, deployment and impacts.	Develop a Digital AgTech 'knowledge bank' showcasing best practices (i.e. via video and multimedia) **[QW]**.
	Build effective e-extension systems for rapid knowledge dissemination.		Build a comprehensive, usable and feedback-driven e-extension platform.
3 Equip Innovators	Foster digital entrepreneurship.	Increase talent supply within the Digital AgTech ecosystem.	Strengthen university offerings in and support to Digital AgTech. Launch Indonesia's first Digital-AgTech-specific startup incubator/accelerator **[QW]**. Build Digital AgTech 'innovation hubs' for cross-ecosystem collaboration.
	Incentivise the private sector to fund, deploy and commercialise.		Reduce the cost of private R&D for Digital AgTech. Invest in a dedicated bridge between the local industry and the global Digital AgTech innovation ecosystem **[QW]**.
	Strengthen research and development capability.		Review and revise public (research) incentives to support Digital AgTech innovation development, uptake and impact **[QW]**. Commission and increase funding for new Digital AgTech impact research studies **[QW]**.
4 Effective Governance and Coordination	Create a synergy between government agencies and ministries.	Develop a whole-of-government development plan for an independent AgTech sector [QW]. ★	Establish Digital AgTech key performance indicators (KPIs) to improve coordination with and accountability to/for regional governments **[QW]**.
	Provide greater communication and collaboration with the private sector and multilateral/inter-national organisations.	Support the creation of a public–private AgTech association [QW].	Review and rationalise a government portfolio of Digital AgTech solutions (to avoid crowding out the private sector) **[QW]**. Prioritise and invest in strategic (i.e. thematically aligned) bilateral partnerships in Digital AgTech.
5 Data-Driven Feedback Loop	Create a usable centralised database platform that unlocks value for the entire ecosystem.	Build a comprehensive, publicly accessible agri-data warehouse.	Complete the development of agri 'tech stack' (a foundational tech platform) by building tracking and analysis functions on top of a central data warehouse. Foster a data-driven culture within the government to support a focus on positive impact (of Digital AgTech).
	Build e-government services to accelerate adoption.		Build technology infrastructure for e-government services.

Policy and Investment Roadmap (Wave 1: First 2 Years)

PROGRAM		INITIATIVE	DESCRIPTION
1  **Strengthen Producers**	Upskill farmers digitally and empower them to use information and solutions.	Upskill farmers digitally and empower them to use information and solutions.	**Lead Actor(s):** Line ministries directly engaging with primary producers, rural financial infrastructure, and rural training and education **Key Gap(s) Addressed:** **Lagging rural digital and financial literacy**; relative concentration of AgTech penetration and support **Detail:** Fund and design a nationwide rural digital literacy training program to deliver a structured curriculum of basic training regarding the use of digital devices, internet, cashless transactions and government e-services. This would include strategically deploying physical, farmer-dedicated Digital & Financial Literacy Centres across rural regions specially aimed at increasing rural farmers' digital and financial literacy.
	Help strengthen financial access and manage risk for farmers.		
	Provide infrastructure to link farmers to markets and solutions.		
2  **Empower Advisors**	Improve quality, expertise and efficiency of extension services.	Upskill advisors in Digital AgTech use, deployment and impacts.	**Lead Actor(s):** Line ministries engaging directly with agricultural sector advisors **Key Gap(s) Addressed:** **Shallow depth of AgTech knowledge** held by agricultural extension advisors, farm business advisors, channel partners and other smallholder support (such as development program staff) **Detail:** Improve extension advisors' abilities to support producers and farmers in the use of AgTech solutions by improving their own digital skillsets and AgTech knowledge, and by fostering a best-practice digitally enabled extension system leveraging real-time and continuous information flows from innovators and research institutes to put into practical application.
	Build effective e-extension systems for rapid knowledge dissemination.		
3  **Equip Innovators**	Foster digital entrepreneurship.	Increase talent supply within the Digital AgTech ecosystem.	**Lead Actor(s):** Line ministries engaging directly with education and vocational training ecosystems; public education institutions **Key Gap(s) Addressed:** **A shallow talent pool fit to power Digital AgTech solutions**; relative concentration of AgTech penetration and support **Detail:** Shift the narrative of 'agricultural' employment by promoting the opportunity within Digital AgTech independently, such as championing success stories to high school and university students – as well as a national Digital AgTech campaign to influence attitudes towards agriculture and technology – and supporting universities to uplift Digital AgTech as a national priority through programs, events and competitions.
	Incentivise the private sector to fund, deploy and commercialise.		
	Strengthen research and development capability.		
4  **Effective Governance and Coordination**	Create a synergy between government agencies and ministries.	 Develop a whole-of-government development plan for an independent AgTech sector [QW].	**Lead Actor(s):** Coordinating ministries and agencies **Key Gap(s) Addressed:** **Lack of effective coordination at and between all levels of government** **Detail:** Develop a comprehensive national roadmap with clear roles and responsibilities for each ministry and government agency to make AgTech and the impact it creates a national focus. *This is instructive and instrumental to all initiatives that come to support the Digital AgTech ecosystem thereafter.*
	Provide greater communication and collaboration with the private sector and multilateral/inter-national organisations.	Support the creation of a public–private AgTech association [QW].	**Lead Actor(s):** Line ministries engaging directly with agribusinesses, farmers/co-operatives and innovation ecosystems **Key Gap(s) Addressed:** **Lack of direct engagement between the public and private sector**; lack of effective coordination at and between all levels of government **Detail:** Create a Digital AgTech association with public and private stakeholders to act as a holistic task force to identify key challenges across the sector and collaborate with the ecosystem to develop solutions. The Digital AgTech association can also act as a sounding board to provide feedback and suggestions on effective government policy and interventions.
5  **Data-Driven Feedback Loop**	Create a usable centralised database platform that unlocks value for the entire ecosystem.	Build a comprehensive, publicly accessible agri-data warehouse.	**Lead Actor(s):** Line ministries involved in the collection and processing of agriculture value-chain data; national extension advisory networks **Key Gap(s) Addressed:** **Poor information and data infrastructure**; advisors' shallow depth of Digital AgTech knowledge; limited understanding of impact from Digital AgTech solutions **Detail:** Develop a centralised open database platform collecting data inputs from relevant stakeholders across the ecosystem such as on-farm data (i.e. farm information, farmer ID and crops grown), agri-climate zone and weather data, and supply-chain data. A robust database enables public and private sectors to better identify challenges and solutions, and to effectively monitor programs and assist in national planning.
	Build e-government services to accelerate adoption.		

Collaborators

This research effort has been a collaborative bilateral partnership between **Beanstalk AgTech**, the **Indonesian Center for Agricultural Socio Economic and Policy Studies** (ICASEPS), and Universitas **Brawijaya (UB)** – funded and supported by the **Australian Centre for International Agricultural Research** (ACIAR).

Australian Centre for International Agricultural Research | Australian Aid

Canberra, Australia

ACIAR is the Australian Government's specialist agricultural research-for-development agency.

Since 1982, ACIAR has supported research projects in four regions: Eastern and Southern Africa, East Asia, South and West Asia, and the Pacific. Their research projects focus on agribusiness, climate change, crops, fisheries, forestry, horticulture, livestock systems, social systems, soil and land management, and water. They deliver specific development outcomes.

To date, ACIAR has commissioned and managed more than 1,500 research projects in 36 countries, partnering with 150 institutions along with more than 50 Australian research organisations.

BEANSTALK

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Beanstalk is a group of innovation, strategy and industry experts who aim to transform the global food and agriculture industry. We exist to support corporations, startup innovators, investors and government bodies to advance sustainable, ethical and responsible food systems. Our core competency is in helping our clients to navigate and adopt leading practices and technologies with purpose and clarity. Our advantage lies at the intersection of our deep domain expertise, our open innovation mindset and our global network. Beanstalk is headquartered in Australia and Singapore, but leverages a network of specialists and advisors from across the globe. Established in 2018, its core team counts nearly 200 years of collective experience in various corners of the agrifood establishment, with high-profile commercial engagements spanning everywhere but Antarctica.

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University of Brawijaya (UB), established in 1963 and located in Malang, is a state university in Indonesia. UB is a leading university in Indonesia with more than 30,000 students in degrees ranging from diploma programs (one- and two-year) to bachelor's degree programs, master's degree programs, doctoral degree programs and medical specialist programs in 16 faculties.

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ICASEPS is officially a part of the Ministry of Agriculture's Secretariat-General, but its technical matter is managed and supervised through the Indonesian Agency for Agricultural Research and Development (IAARD). ICASEPS performs formulation programs, implementations, technical and public consultations, and evaluations and reports on investigations of socio-economic and policy analyses. It carries out agricultural program and policy reviews, and cooperates and makes efficient use of agriculture socioeconomic and policy analyses and research results.

To provide feedback, request clarifications, seek advice or partnership on Digital AgTech initiatives, or learn how you can be more involved in engagements to come, reach out to Justin Ahmed (Director, Beanstalk AgTech) at justin@beanstalkagtech.com

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