



Landscaping New Opportunities for Digital Agriculture in Papua New Guinea

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1. Executive summary

Agriculture is central to Papua New Guinean society, with 85 per cent of the population depending on it for their livelihoods. Although the sector currently accounts for less than 20 per cent of Papua New Guinea's GDP, the government is pursuing several initiatives through its Vision 2050 strategic plan to help raise agriculture's share significantly over the next 30 years. Mobile-enabled digital tools can play a significant role in helping the government reach its objectives.

Recognising the positive impact that digital technologies can have in raising production levels and reducing inefficiencies, agriculture-sector stakeholders in Papua New Guinea are implementing a range of tools aimed at easing pain points and delivering benefits to supply and demand-side actors. Most of the tools implemented thus far fall into one of the following two use cases:

- **Agricultural extension support:** Mobile-enabled digital tools, such as PacFarmer and FARMIS, are focused on the dissemination of information to farmers, including agronomic advice, weather, market prices and certification standards, among others. Armed with this information, farmers can improve on-farm practices, reduce inefficiencies and increase per hectare yields, thereby improving incomes.
- **Last-mile digitisation:** Digital enterprise tools, such as Farmforce (used by PNGAC and SP Brewery) and OFIS (used by Olam), enable agribusinesses to control and monitor their operations better, perform more transparent transactions and communicate more effectively, both internally and with smallholder suppliers. Farmers can also benefit from the transparency and market access that these tools afford.

Morobe Province is one of Papua New Guinea's most important agricultural areas. Recently, the province has attracted significant investment from government, donor organisations and the private sector, such as agribusinesses, due to its proximity to the Port of Lae, which offers access to Port Moresby and international markets; ongoing modernisation of the region's infrastructure; and availability of fertile land suitable for the cultivation of crops. In March 2019, the GSMA met with executives from seven agribusinesses operating in Morobe Province in a variety of value chains, including coffee, cocoa, rice, palm oil, fresh produce and spices. At the same time, the GSMA met with farmers supplying cocoa beans to Olam, an agribusiness in Morobe Province. These meetings aimed to understand the challenges agribusinesses and farmers confront in their agricultural activities and to identify opportunities for digital interventions.

Although Papua New Guinea's digital transformation is in an early stage, four main areas of opportunity have been identified:

- **Weather monitoring and forecasting tools.** Climate change represents an ongoing threat to the people of Papua New Guinea and other islands in the Pacific region. Mobile-enabled digital tools can play a pivotal role not only in the dissemination of weather forecasts and early warning information, but also in the provision of agro-economic advice that can help agricultural stakeholders act on the data they receive.
- **Agricultural payment digitisation.** Digitising payments using mobile money offers significant opportunities for key agricultural stakeholders in the broader payments ecosystem. Mobile network operators (MNOs) are in a unique position to leverage their extensive distribution network to

reach the agricultural last mile and expand rural financial inclusion.

- **Digital enterprise solutions.** Ensuring end-to-end traceability and certification and improving visibility in the supply chain are two of the main pain points for agribusinesses in Morobe Province. For local MNOs, supporting the commercialisation of digital enterprise tools for the last mile provides a compelling new opportunity to diversify their offering for the rural customer base beyond a B2C value proposition.
- **Agricultural extension support through information dissemination and access to markets.** Farmers lack relevant information, from crop prices to demand for crops in local markets to agronomic advice on best practices. MNOs can play any number of roles in the provision of information services to farmers, from a relatively passive role whereby third parties leverage their network connectivity to market information services to end users, to owning the service, with full responsibility for design, implementation and maintenance.



2. Introduction

Agriculture is the most important economic activity in Papua New Guinea, dominating rural areas where over 85 per cent of the country's population resides.¹ Subsistence farming provides most of the food consumed in Papua New Guinea, while the sale of crops such as coffee, cocoa and palm oil, brings cash income to farmers. The agricultural sector faces significant challenges that limit its potential and affect the livelihoods of farmers. These challenges include inadequate agricultural extension services that leave farmers vulnerable to pests and diseases; fragmented or inadequate access to markets; more frequent and extreme weather events like droughts, frost and flooding; risks and costs related to handling physical cash; and lack of access to financing for agricultural inputs and capital investments. On the other hand, private sector actors involved in the procurement of crops confront a variety of business inefficiencies in their day-to-day activities, from dealing in cash to lack of visibility in value chain activities, end-to-end traceability and certification of crops.

Digital agriculture solutions (AgriTech) can help to address some of these challenges and deliver an array of benefits to supply and demand-side actors across a range of use cases. On the supply side, the provision of agricultural extension services empowers farmers and enhances their knowledge and skills to improve yields. Better access to markets allows farmers to sell

their produce at competitive prices and improve their livelihoods. Localised, granular weather forecasts and extreme weather advisories can provide immense value to farmers who depend on rain for their agricultural activities.

The shift from cash transactions to mobile money provides farmers with more secure, timely and potentially less costly payments. Digital payments, in turn, can help farmers develop an economic identity² via transactional records from the sale of agricultural crops. In conjunction with other farm and farmer data, this can open the door to financial inclusion. For women in Papua New Guinea, financial inclusion can translate into greater economic independence and better livelihoods for themselves and their children.

Digital technologies can benefit other agricultural stakeholders too, such as agribusinesses and cooperatives, by addressing gaps in the value chain and creating opportunities for agricultural sector development. For instance, digitisation of the last mile³ improves visibility in the value chain, enabling demand-side stakeholders to control and monitor operations more effectively. Digital solutions can address the needs of the agriculture sector more holistically, providing a range of use cases that benefit stakeholders throughout the value chain.

1. The World Bank, 2018. Available at: <https://data.worldbank.org>

2. An **economic identity** is a dynamic citizen profile that captures an individual's life events, assets and transaction history. For farmers, digitising the procurement of crops helps to establish an economic identity through transactional data from the sale of agricultural produce. In combination with other farm and farmer data, this data opens up full financial inclusion to farmers, including access to credit, savings and insurance products.

3. In agricultural value chains, the last mile is the web of relationships and transactions between buyers of crops, such as agribusinesses, cooperatives and intermediaries, and the farmers who produce and sell their crops. Most of this activity takes place in the developing world, where about 1.3 billion people are employed in agriculture and involved in the production of the majority (at least 70 per cent) of the world's food. Source: GSMA, 2018, "Prerequisites to digitising the agricultural last mile." Available at: <https://www.gsma.com/mobilefordevelopment/resources/prerequisites-to-digitise-the-agricultural-last-mile/>



Figure 1

Source: GSMA

Digital agriculture use cases enabled by mobile technology

	LAST-MILE DIGITISATION	AGRICULTURAL EXTENSION SUPPORT ⁴	WEATHER MONITORING AND FORECASTING ⁵	AGRI E-COMMERCE ⁶	SMART FARMING ⁷
DEFINITION	Last-mile digitisation refers to the use of digital technologies in the agricultural last mile that enable the transition from paper to a range of digital systems and processes.	Agricultural extension support refers to mobile-enabled dissemination of information to farmers, such as agronomic advice, market prices and certification standards.	Weather monitoring and forecasting refers to the provision of localised forecasts enabled by improved weather modelling techniques; weather adaptive agronomic advice; and climate-smart agronomic advice related to climate adaptation, climate change mitigation and food security.	Agricultural e-commerce refers to the buying and selling of agricultural produce online. Although most agri e-commerce businesses sell domestically, agri e-commerce also enables farmers to reach international buyers.	Smart farming refers to the use of digital channels like the Internet of Things (IoT), which can include machine-to-machine (M2M) and pay-as-you-go (PAYG) systems via mobile money or airtime, to automatically and remotely access essential farm equipment and farming assets and track key parameters, such as soil temperature, water consumption, water pH and humidity.
BENEFITS	Last-mile digital solutions allow agribusinesses to control and monitor operations more effectively; make transactions more transparent; and establish effective communication channels, both internally and with smallholder suppliers. Farmers benefit from more transparent transactions and improved access to markets.	Farmers are able to improve on-farm practices, reduce inefficiencies and increase per hectare yields, thereby improving their incomes. Underserved populations also benefit from the dissemination of nutrition-sensitive agricultural content that can improve overall health.	The availability of localised, granular weather forecasts allow smallholder farmers, who depend on rain, to better plan farming activities and protect against the impacts of climate change. The digitisation of weather index insurance presents an opportunity for MNOs to use core capabilities (geo-location and mobile money) to enable agricultural mobile financial services.	Agri e-commerce provides an opportunity to streamline the agricultural value chain and make the distribution of farm produce more efficient. It represents a new way for farmers to sell their produce to an array of buyers, including agribusinesses, retailers, restaurants and consumers. Agricultural e-commerce also increases farmers' access to new markets and makes the value chain more transparent.	Smart farming empowers farmers to increase productivity, incomes and overall resilience. It also enables agribusinesses to create efficiencies in the value chain, improve the use of natural resources and boost overall productivity.

The deep-seated structural challenges facing farmers and agribusinesses in Papua New Guinea makes the agricultural sector particularly well suited to digital interventions. Over the last few years, stakeholders have been looking for innovative ways to alleviate various pain points in agricultural supply chains, with private sector organisations and government introducing a range of digital solutions, often with the support of donor agencies. This report outlines some of the findings associated with these early interventions, and what agribusinesses, farmers, AgriTechs, MNOs and donors should consider as they move forward with their digitisation initiatives. The report also takes a deep dive into the opportunities for digitisation in

Morobe Province on the northern coast of Papua New Guinea. This is an area with vast natural resources that, until recently, has been underdeveloped. Infrastructure improvements, proximity to one of the largest ports in the Pacific islands, government commitment to the region, numerous donor projects helping to revitalise the area and the presence of several agribusinesses eager to invest, make Morobe Province attractive for digital interventions. Taking into consideration the needs of local farmers and agribusinesses, this report offers recommendations for future engagements in the AgriTech space that could address many of the pain points of producers and buyers in Papua New Guinea in a sustainable way.

4. GSMA, 2017, "Creating scalable, engaging mobile solutions for agriculture." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/create-scalable-engaging-mobile-solutions-agriculture.pdf>
 5. GSMA, 2016, "Weather Forecasting and Monitoring: Mobile Solutions for Climate Resilience." Available at: <https://www.gsma.com/mobilefordevelopment/resources/weather-forecasting-and-monitoring-mobile-solutions-for-climate-resilience/>
 6. GSMA, 2019, "E-commerce in agriculture: new business models for smallholders' inclusion into the formal economy." Available at: <https://www.gsma.com/mobilefordevelopment/resources/e-commerce-in-agriculture-new-business-models-for-smallholders-inclusion-into-the-formal-economy/>
 7. GSMA, 2018, "The Future of Farming: How Mobile IoT technologies can help agriculture feed the world." Available at: https://www.gsma.com/iot/wp-content/uploads/2018/09/201809_GSMA_Mobile_IoT_Agriculture_Case_Study.pdf

3. Agriculture in Papua New Guinea

3.1. A country-level snapshot

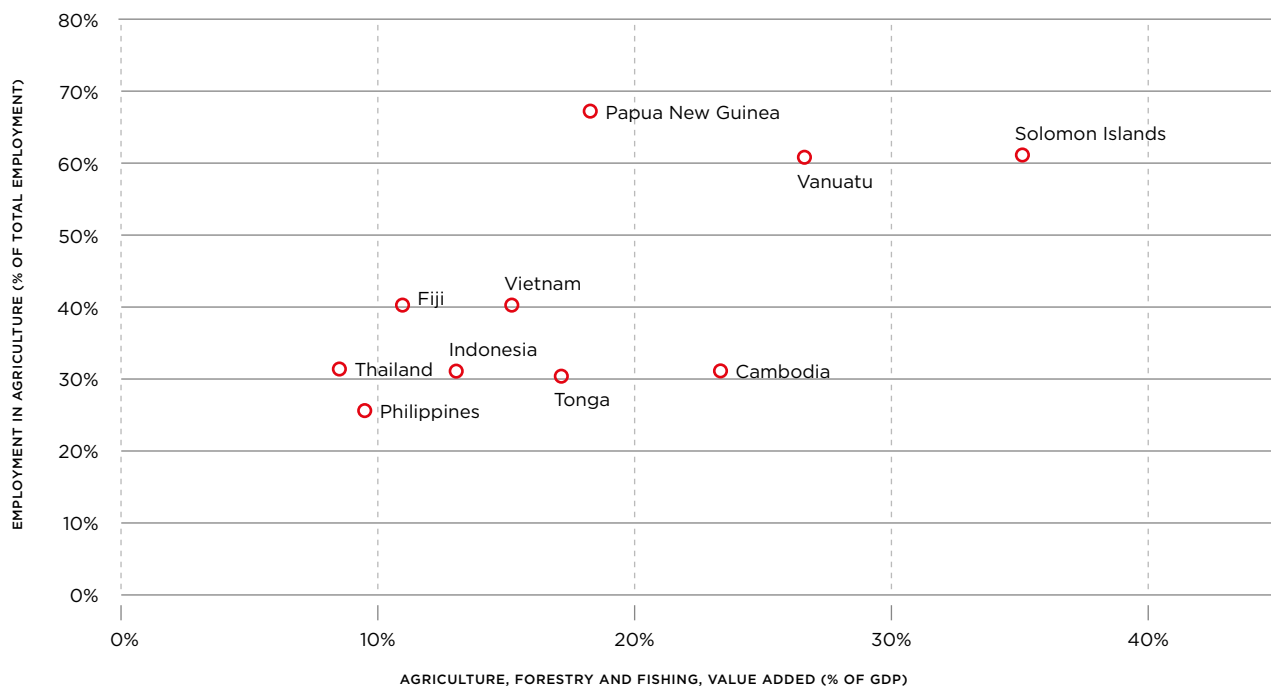
Agriculture is central to Papua New Guinean society, with 85 per cent of the population depending on agriculture for their livelihoods.⁸ The majority of Papua New Guinea’s farmers operate in the informal sector, growing their food on small-scale farms to sell, barter or consume. A mere five per cent of farmers are employed in commercial farming activities.⁹

According to the International Labour Organization (ILO), agriculture employs 67 per cent of the country’s working age population, one of the highest ratios in Asia Pacific. The World Bank put the agricultural sector’s contribution to Papua New Guinea’s Gross Domestic Product (GDP) at 18.4 per cent in 2017, a slight decline from previous years.

Figure 2

Source: ILO, The World Bank

Relevance of agriculture in select Asia Pacific countries, 2017¹⁰



8. Department of Agriculture and Livestock (DAL). Available at: <https://www.agriculture.gov.pg/>

9. Market Development Facility (MDF), 2016, "Papua New Guinea Country Engagement Strategy" p. 8. Available at: <http://marketdevelopmentfacility.org/wp-content/uploads/2017/07/PNG-Country-Strategy-Web.pdf>

10. The ILO is the source for agriculture employment statistics (<https://www.ilo.org>). The World Bank is the source for agriculture, forestry and fishing value-added (% of GDP) statistics (<https://data.worldbank.org>). All data presented is for 2017 except agriculture, forestry and fishing value added (% of GDP) figures for Fiji (2016), Tonga (2016), Vanuatu (2015), Papua New Guinea (2015) and Solomon Islands (2006).



Papua New Guinea’s agricultural sector is made up of crops, livestock, forestry and fisheries. The main cash crops include palm oil, coffee, cocoa, copra,¹¹ rubber and tea.¹² Sweet potato, yam, taro, banana and sago¹³ make up the bulk of Papua New Guinea’s staple crops,¹⁴ while fresh fruits and vegetables (referred to locally as fresh produce) and vanilla are among the fastest growing crop categories from a production perspective. The country’s livestock market is largely comprised of cattle, poultry and pigs while its extensive fishery zone (2.4 million

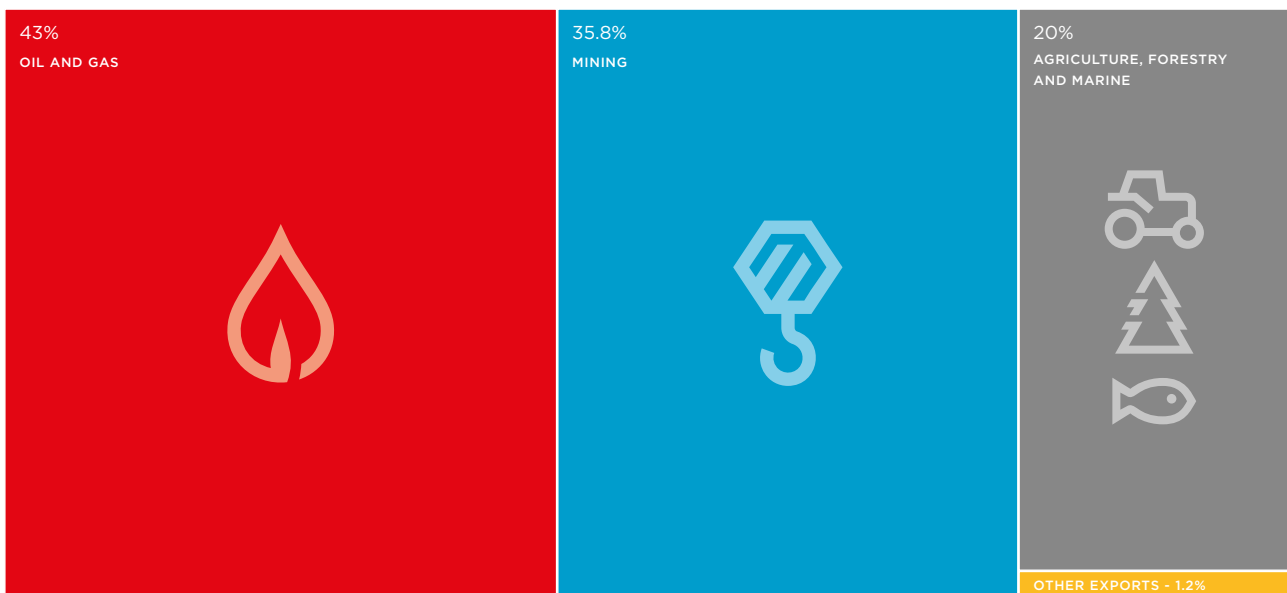
square km) has helped Papua New Guinea develop into one of the world’s leading sources of tuna.¹⁵

Agriculture, forestry and marine products account for 20 per cent of Papua New Guinea’s commodity exports, behind oil and gas¹⁶ (43 per cent) and mining (35.8 per cent).¹⁷ Within the agriculture, forestry and marine products category, forestry and marine products make up just over a third of export totals, with agricultural products making up the remainder.

Figure 3

Source: Bank of Papua New Guinea

Distribution of Papua New Guinea’s commodity exports, 2017

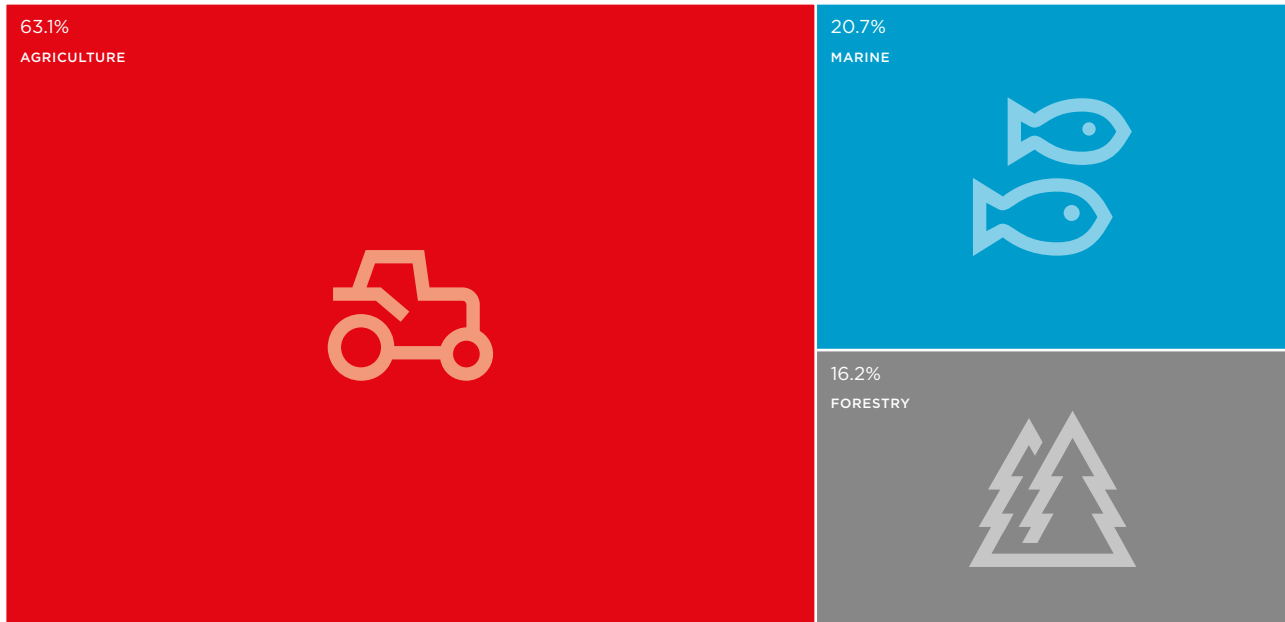


11. Merriam Webster defines copra as “dried coconut meat yielding coconut oil.” Available at: <https://www.merriam-webster.com/dictionary/copra>
 12. Bank of Papua New Guinea. Available at: <https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/>
 13. Merriam Webster defines sago as “a dry granulated or powdered starch prepared from the pith of a sago palm and used in foods and as textile stiffening.” Available at: <https://www.merriam-webster.com/dictionary/sago>
 14. Australian National University (ANU), 2009, “Food and Agriculture in Papua New Guinea” by Michael Bourke and Tracy Harwood. Available at: <https://press.anu.edu.au/publications/food-and-agriculture-papua-new-guinea>
 15. The National Fisheries Authority (NFA) states “[Tuna] catch from PNG waters accounts for 20–30% of the regional catch and is about 10% of the global catch.” Available at: <http://www.fisheries.gov.pg/FisheriesIndustry/TunaFishery/tabid/104/Default.aspx>
 16. Includes crude oil, liquified natural gas (LNG) and condensate.
 17. Bank of Papua New Guinea. Available at: <https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/>

Figure 4

Source: Bank of Papua New Guinea

Distribution of Papua New Guinea’s agriculture, forestry and marine exports, 2017



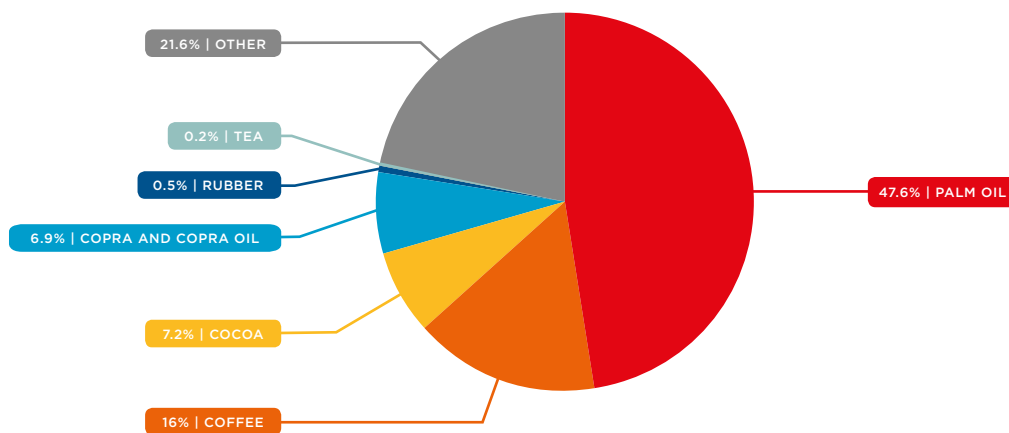
Palm oil is the leading export crop within the agriculture category, generating USD 401 million (PGK 1.3 billion) in export revenue in 2017. This represents 47.6 per cent of total agriculture export values, compared with 41 per cent the previous year. Palm oil is distantly followed by coffee and cocoa,

which generated \$135 million (PGK 450 million) and \$61 million (PGK 202 million) in export revenue, respectively, in 2017.¹⁸ Coffee and cocoa have both been negatively affected by declining international commodity prices, shrinking their contribution to Papua New Guinea’s export market in recent years.

Figure 5

Source: Bank of Papua New Guinea

Distribution of agricultural exports by crop, 2017



18. Bank of Papua New Guinea. Available at: <https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/>



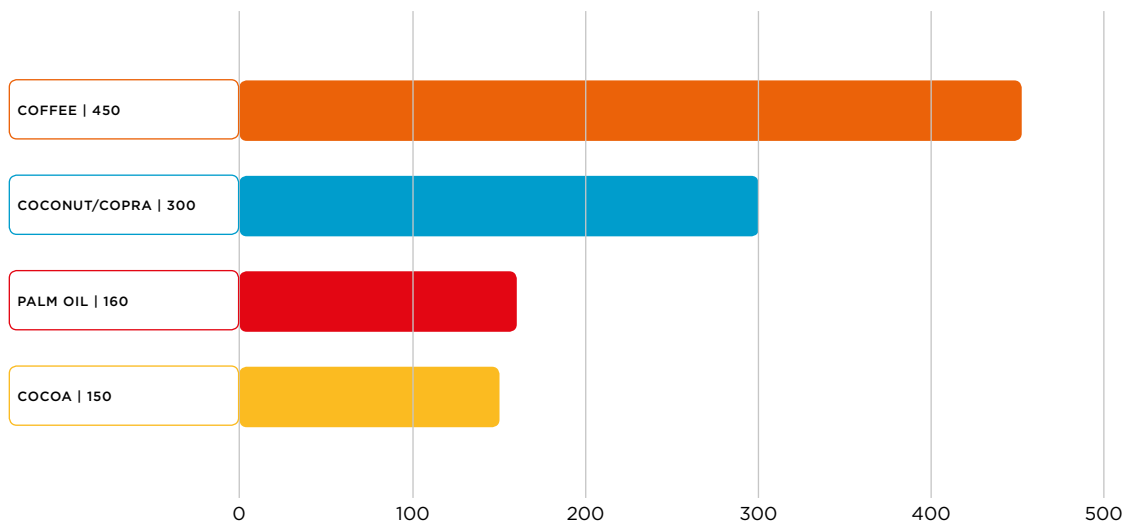
Although the palm oil sector generates more revenue, the coffee and coconut/copra industries engage more households. Estimates from the Coffee Industry Corporation (CIC) put the total number of households

involved in the coffee industry at approximately 450,000, benefitting as many as three million people¹⁹ across different geographic regions of Papua New Guinea.

Figure 6

Source: Department of Agriculture and Livestock (DAL) and Industry Boards

Households (thousands) engaged in different cash crops in Papua New Guinea



The country is divided into four administrative regions, each encompassing four or more provinces. Coffee, fruits and vegetables are grown predominantly in the Highlands region while palm oil, coconut and cocoa are prevalent on the Islands.

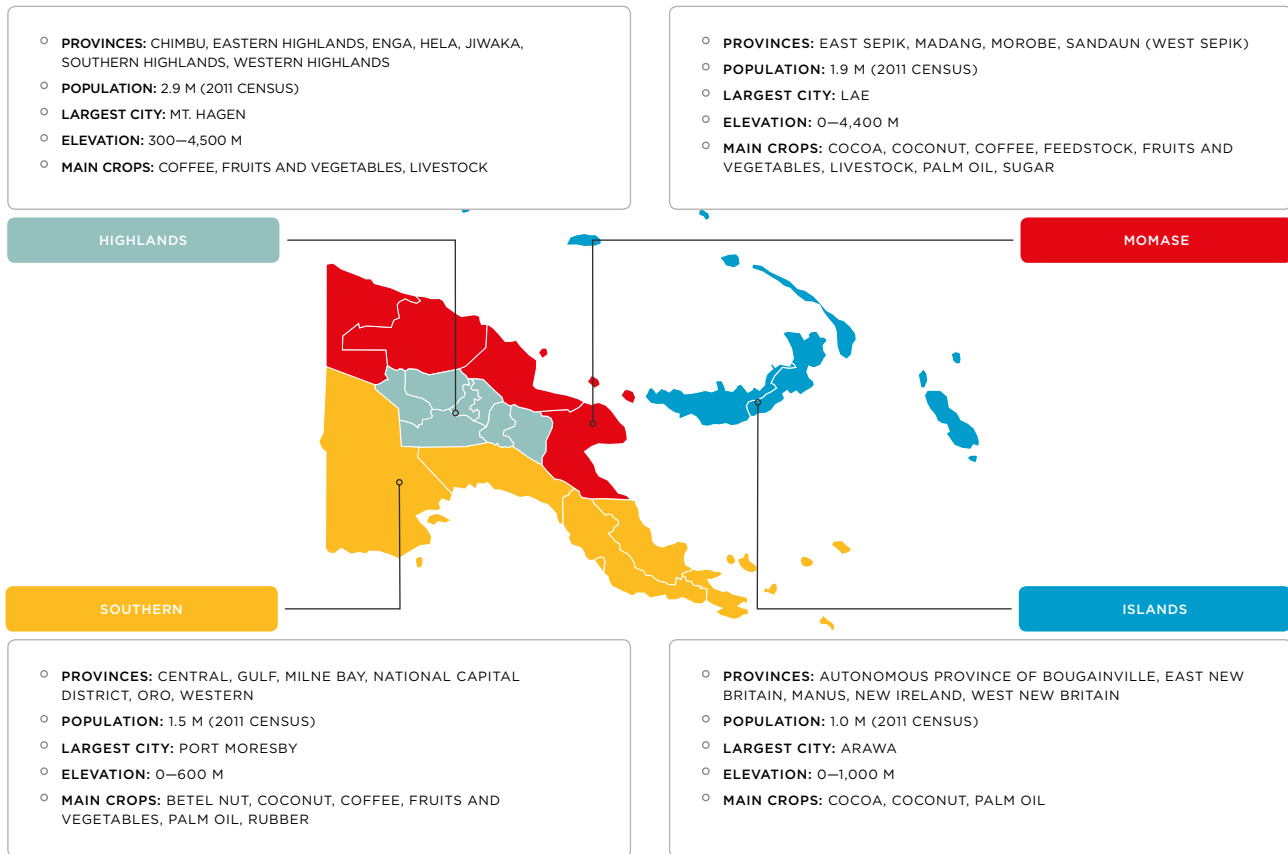
The region known as Momase, which encompasses Morobe, Madang and Sepik Provinces, is the most agriculturally diverse of the four regions and has been the recent focus of donor and private sector investment.

19. Coffee Industry Corporation (CIC). Available at: <https://www.agriculture.gov.pg/coffee/>

Figure 7

Source: Bank of Papua New Guinea, GSMA, DAL

Papua New Guinea's four administrative regions



Although Papua New Guinea's economy is currently dominated by extraction industries, these employ only a small fraction of the population, largely exclude women and have a finite project life span. As a result, the government has been shifting toward renewable sectors (agriculture, forestry, fisheries and tourism) — a key objective of its Vision 2050 strategic plan.²⁰ In Vision 2050, the government has called for renewable sectors to account for 70 per cent of GDP by 2050, compared with the current 20 per cent. It has also outlined four key areas for development in the agricultural sector: food production for the domestic market, high-value export crops, import-competing industries and plantation forestry.²¹

Vision 2050 also calls for the development of one large-scale impact project and one major downstream project each in agriculture, forestry and fisheries, and tourism, in each of Papua New Guinea's four regions²² (see Figure 7). It also calls for large-scale projects in non-renewable sectors, such as mining, to set resources aside for agricultural sector development.²³

The government is aware that several obstacles stand in the way of achieving its goals. As stated in Vision 2050, Papua New Guinea's ability to leverage its vast natural resources to generate economic growth depends on the country's ability to address key challenges, including weak governance and management, unsustainable farming practices, extreme climate events and pest infestations.²⁴

20. Department of Treasury Papua New Guinea, 2011, "Papua New Guinea Vision 2050." Available at: http://www.treasury.gov.pg/html/publications/files/pub_files/2011/2011.png.vision.2050.pdf

21. Ibid.

22. Ibid.

23. The \$2.8 billion Wafi-Golpu mining project (WGJV), has pledged to invest in infrastructure and support local agribusinesses as a means of engaging the local community and garnering its support. WGJV has already invested \$297,000 (PGK 1 million) in support of 1,000 cocoa families in the area.

24. Department of Treasury Papua New Guinea, 2011, "Papua New Guinea Vision 2050." Available at: http://www.treasury.gov.pg/html/publications/files/pub_files/2011/2011.png.vision.2050.pdf



3.2. The agricultural sector in Morobe Province

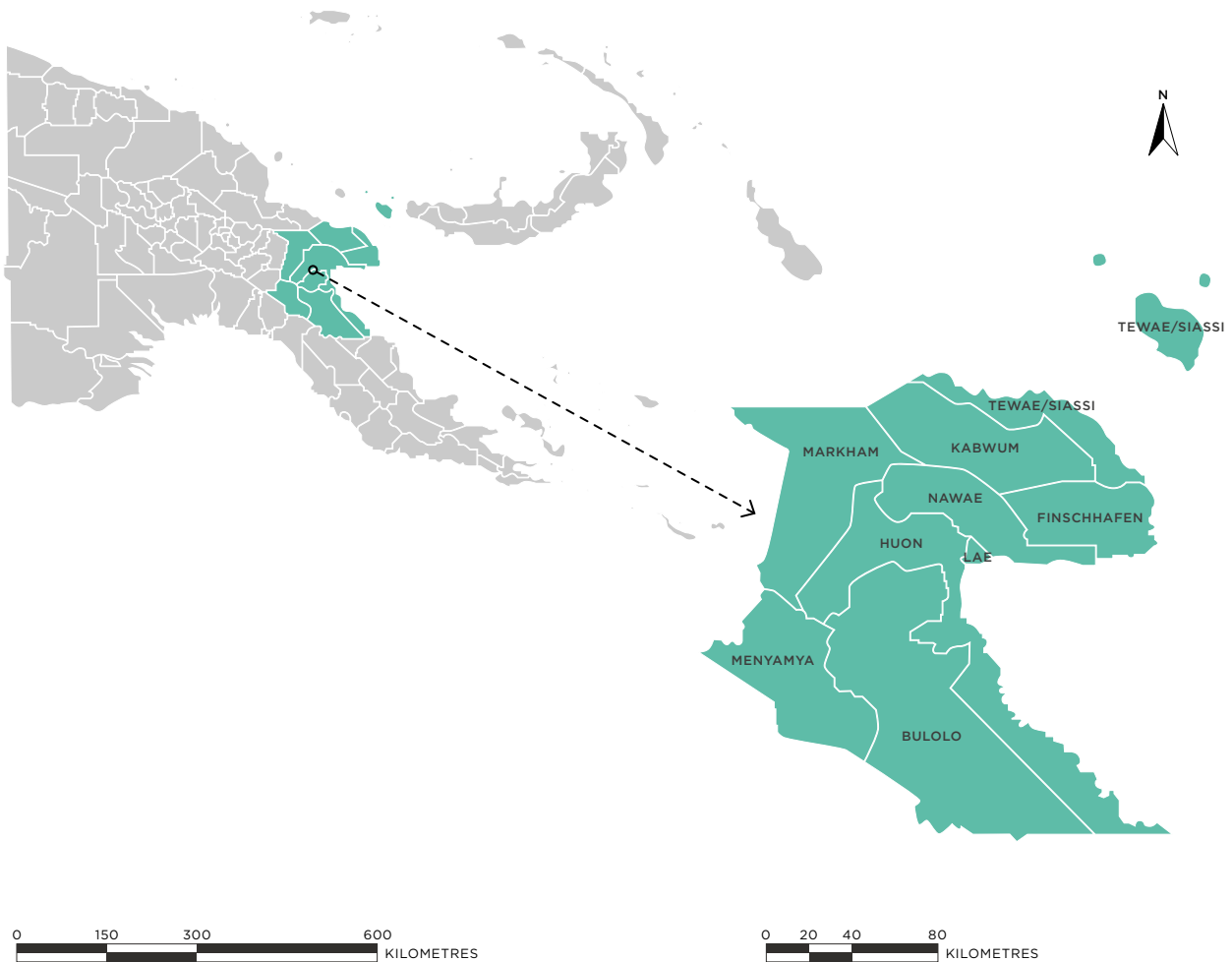
Morobe is the largest province in Papua New Guinea by population, home to approximately 9.3 per cent (674,810) of the country's people (2011 census). Morobe's provincial capital is the port city of Lae, Papua New Guinea's second largest metropolitan area and home to over 150,000 people (2011 census).

Lae sits at the mouth of the Markham River. Most of the cash crops and produce grown in the Highlands and Momase regions travel to the port of Lae via the Highlands or Ramu Madang Highways. From Lae, crops are exported to international destinations or to Port Moresby for domestic consumption.

Figure 8

Source: International Journal of Engineering Research and Applications (IJERA)²⁵

Map of Morobe Province



25. Gouri Sankar Bhunia, Sailesh Samanta and Babita Pal, 2012, "Deciphering prospective ground water zones of Morobe province, Papua New Guinea." Available at IJERA: https://www.ijera.com/papers/Vol2_issue3/EA23752766.pdf

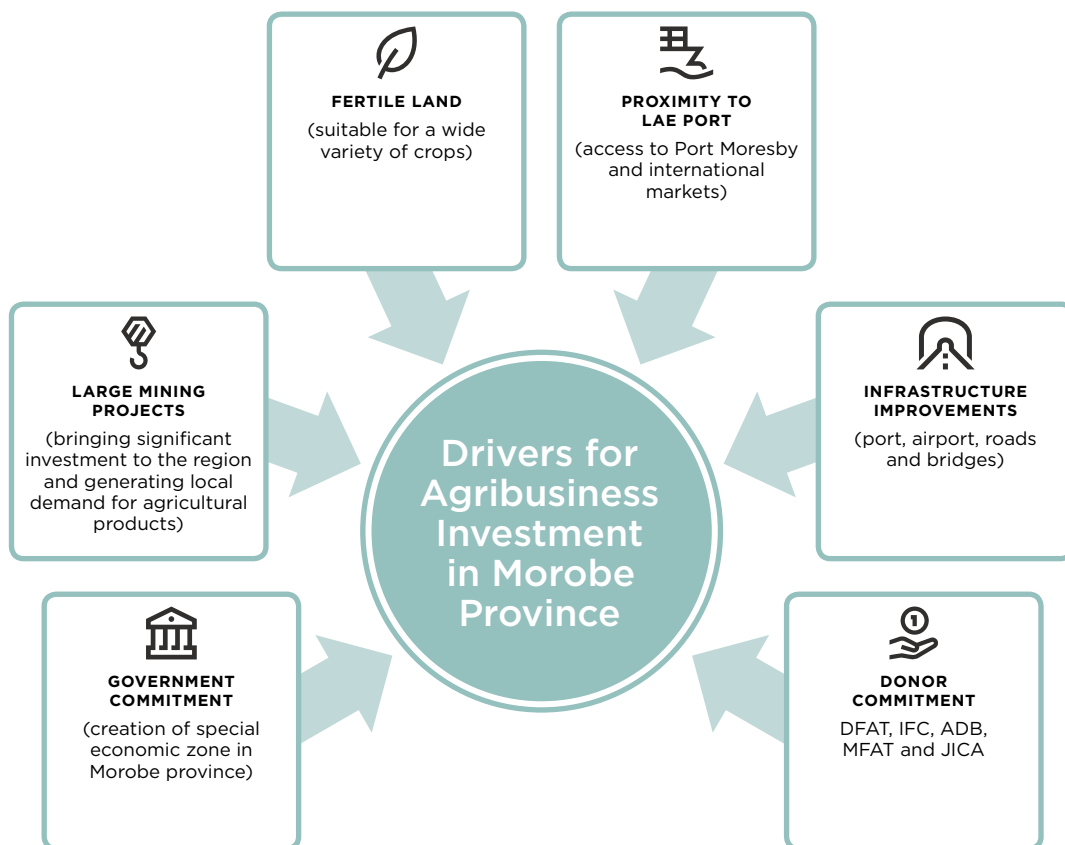
Morobe Province is one of the most culturally, geographically and economically diverse parts of the country. Spread over nearly 34,000 square kilometres, the province includes mountainous areas that rise 4,400 metres above sea level, as well as island regions, coastal regions and fertile valleys with rainfall that ranges from 2,500 to 5,000 millimetres per year. This geographic diversity lends itself to the development of many different industries and agricultural value chains. Forestry and logging are prevalent both in the mountainous and coastal regions while commercial fishing has developed along the coast. Cocoa and

copra are grown on the islands and coastal regions while coffee, the province’s main cash crop, is grown in the mountains alongside vanilla and fresh fruits and vegetables. Markham and Ramu valleys, which together include 400,000 hectares of arable land,²⁶ have until recently been largely underdeveloped from a commercial agriculture perspective. In recent years, however, agribusinesses have been investing in expanding plantations that grow palm oil, sugar, cassava, rice, trees for feedstock and tea. Markham Valley has also attracted agribusinesses that produce cattle and poultry to meet domestic demand.²⁷

Figure 9

Source: GSMA

Drivers contributing to the development of agriculture in Morobe Province














26. Interview with IFC.

27. The World Bank, 2015, "Financial Inclusion and Financial Capability in Morobe and Madang Provinces, Papua New Guinea." Available at: <http://documents.worldbank.org/curated/en/704801471496337675/pdf/105185-REVISED-WP-P145131-PUBLIC.pdf>

Figure 10

Source: Agribusinesses, GSMA

Selected agribusinesses operating in Morobe Province and their primary value chains

AGRIBUSINESS	VALUE CHAINS	
NKW Fresh	Fresh fruits and vegetables	
SP Brewery	Cassava	
Mainland Holdings	Poultry, eggs, stock feed (sorghum, soya bean), flour, crocodiles	
Olam	Coffee, cocoa	
New Britain Palm Oil	Palm oil, sugar, beef	
NGIP Agmark	Coffee, tea, spices	
Trukai Industries	Rice	
Goodman Fielder	Flour	
Rumion	Pigs, cattle, stock feed (maize)	
PNG Biomass	Trees (feedstock for power plant)	
Paradise Foods	Cocoa, spices	

The World Bank estimates that about 50 per cent of the population in Morobe Province is engaged in subsistence agriculture activities, slightly below the national average.²⁸ As is the case nationally, slightly more women than men are involved in subsistence activities, although men handle the bulk of the buying and selling of the Province's cash crops.

According to the Bank of Papua New Guinea, Morobe is one of the fastest growing provinces in the country, with employment increasing by nearly 150 per cent between 2002 and 2017.²⁹ Commercial projects, primarily in mining and agriculture, are drawing workers from neighbouring provinces, contributing to the employment boom. Morobe Province's government has been working with a number of donor

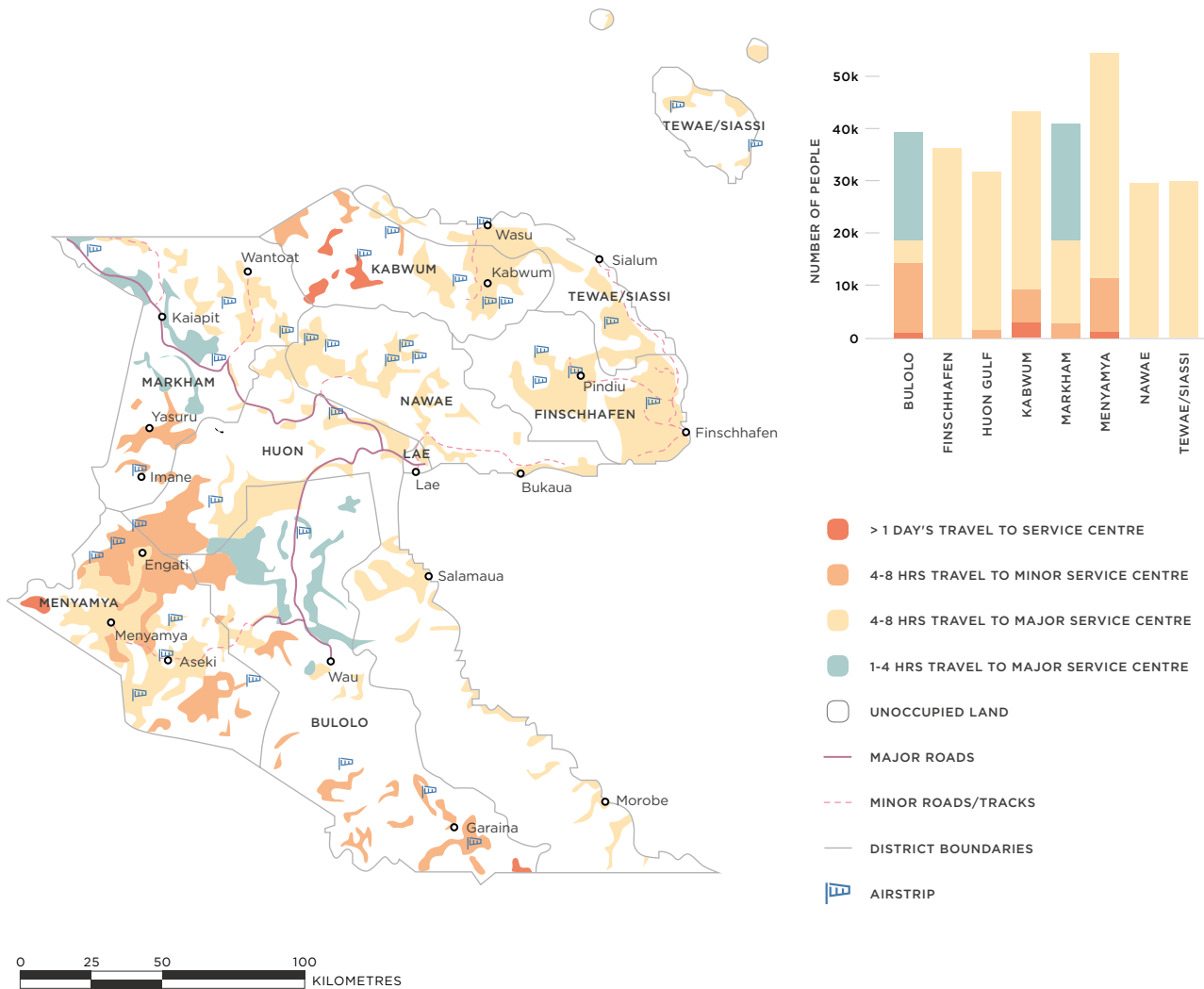
organisations in an effort to transform the province into a key industrial hub in the Pacific region. Key to this transformation is the modernisation of the region's infrastructure. The province has just a handful of major roads, including the Highlands Highway (connecting the Highlands to Lae), the Wau-Bulolo Road (connecting gold and copper mines in the Bulolo district to Lae) and the Ramu Madang Highway (connecting Morobe and Madang). Many of these roads have fallen into disrepair, increasing transportation times of crops from production areas to the Port of Lae. Among the major infrastructure projects currently underway are the expansion of the Port of Lae's export/import capacity, the modernisation of the Nazdab International Airport and the construction of several new highways, secondary roads and bridges.

28. Ibid.

29. Bank of Papua New Guinea. Available at: <https://www.bankpng.gov.pg/statistics/quarterly-economic-bulletin-statistical-tables/>

Figure 11 Source: The World Bank, 2015, "Financial Inclusion and Financial Capability in Morobe and Madang Provinces, Papua New Guinea"

Roads and travel times to minor and major service centres in Morobe Province



In August 2018, the Papua New Guinea government signed a \$25 million (PGK 82 million) International Fund for Agriculture Development (IFAD) project aimed at improving the fresh produce value chain. The Fresh Produce Development Agency (FPDA) will take the lead on the project, building a network of cold storage and warehousing facilities throughout the country, including in Lae. The goal is to alleviate the burden on farmers who often see the quality of their produce decline during the transportation process,

while making the produce pick-up process more efficient for agribusinesses as the number of pick-up locations will be reduced.³⁰

The government is also working toward the creation of a special economic zone (SEZ) in the Finschhafen district in Morobe Province. The SEZ will focus on driving innovation and foreign direct investment through blockchain technology, which will be used to develop solutions that tackle challenges around land registration,

30. The National, May 2019, "K2.03 billion agri-park boost for farmers." Available at: <https://www.thenational.com.pg/k2-03-billion-agri-park-boost-for-farmers/>

identification and financial exclusion, among others. The government is hoping to build on some of the blockchain pilots it tested ahead of the establishment of the SEZ, such as IDBox and Coin-sure.³¹

Although not located in Morobe Province, the new \$600 million Papua New Guinea-China Integrated Agriculture Park Project in the Highlands Region will

likely open up additional markets for fresh produce in adjoining districts, including Morobe. The Agriculture Park, part of China's Belt Road Initiative (BRI), seeks to establish a market for fresh products in Eastern Highlands for export to China, which is now looking for new sources of organic food. The plan also calls for the development of the Highlands Agriculture Training Institute (HATI) to improve agricultural education.³²



31. GSMA, 2019, "Digital Transformation, the Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/03/Digital-Transformation-The-Role-of-Mobile-Technology-in-Papua-New-Guinea.pdf>

32. The National, May 2019, "K2.03 billion agri-park boost for farmers." Available at: <https://www.thenational.com.pg/k2-03-billion-agri-park-boost-for-farmers/>

4. Key challenges facing the agricultural sector in Papua New Guinea

Government stability and the introduction of numerous reforms in recent years have helped Papua New Guinea rise from 141st out of 190 countries on the World Bank's 2014 Ease of Doing Business Index to 108th in 2018.³³ Papua New Guinea's improved ranking reflects a streamlining of the process associated with starting a business, as well as the introduction of a new private

credit bureau that makes it easier for agribusinesses and entrepreneurs to access credit. Despite these positive developments, agribusinesses and farmers continue to confront a significant number of challenges, some of which can be addressed through targeted digital interventions.

4.1. Climate change poses a risk to farmer livelihoods and public health

In a 2011 report, The World Bank concluded that ecosystems in the Pacific can be radically altered in the coming decades as a result of the climate crisis, pointing to cases of devastating crop failures that have already impacted several island nations. Like other countries in the region where strategies for climate change adaptation and mitigation are becoming a priority, the Government of Papua New Guinea has identified environmental sustainability and climate change as one of seven pillars critical to achieving its Vision 2050 objective of being an upper middle-income country by 2050.³⁴

The effects of weather events like El Niño and La Niña can be devastating for Papua New Guinea.³⁵ In 2015, El Niño-related droughts caused widespread food shortages as well as higher reported deaths from famine and malnutrition.³⁶ Frost in the Highlands caused a nearly 85 per cent loss in sweet potato production, which was devastating to the 81 per cent of the population that consider sweet potato a key element of their diet.³⁷ Sago-producing streams dried up while drought-related wildfires caused loss of livestock, forcing many rural people to turn to famine foods for survival.³⁸ The droughts also affected many cash crops, negatively impacting farmer incomes. Total agricultural exports declined by 16.4 per cent in 2015.

33. Ease of doing business ranks economies from 1 to 190, with first place being the best. A high ranking (a low numerical rank) means that the regulatory environment is conducive to business operation. The World Bank, 2018, Ease of Doing Business Index. Available at: <https://data.worldbank.org/indicator/ic.bus.ease.xq>

34. Department of Treasury Papua New Guinea, 2011, "Papua New Guinea Vision 2050." Available at: http://www.treasury.gov.pg/html/publications/files/pub_files/2011/2011.png.vision.2050.pdf

35. An estimated three million people in Papua New Guinea were affected by El Niño in 2015. Oxfam, "Powerful el Nino brings droughts and food insecurity to millions in Papua New Guinea." Available at: <https://oxf.am/2FKbBgL>

36. According to The World Bank, "The economic cost of undernutrition is high, in 2015-2016, it was estimated to have cost the economy 2.81 per cent of annual GDP (equivalent to USD 508 million)." The World Bank, 2018, "PNG Agriculture Commercialization and Diversification Project (P166222)." Available at: <http://projects.worldbank.org/P166222?lang=en>

37. Australian National University (ANU), 2009, "Food and Agriculture in Papua New Guinea" by Michael Bourke and Tracy Harwood. Available at: <https://press.anu.edu.au/publications/food-and-agriculture-papua-new-guinea>

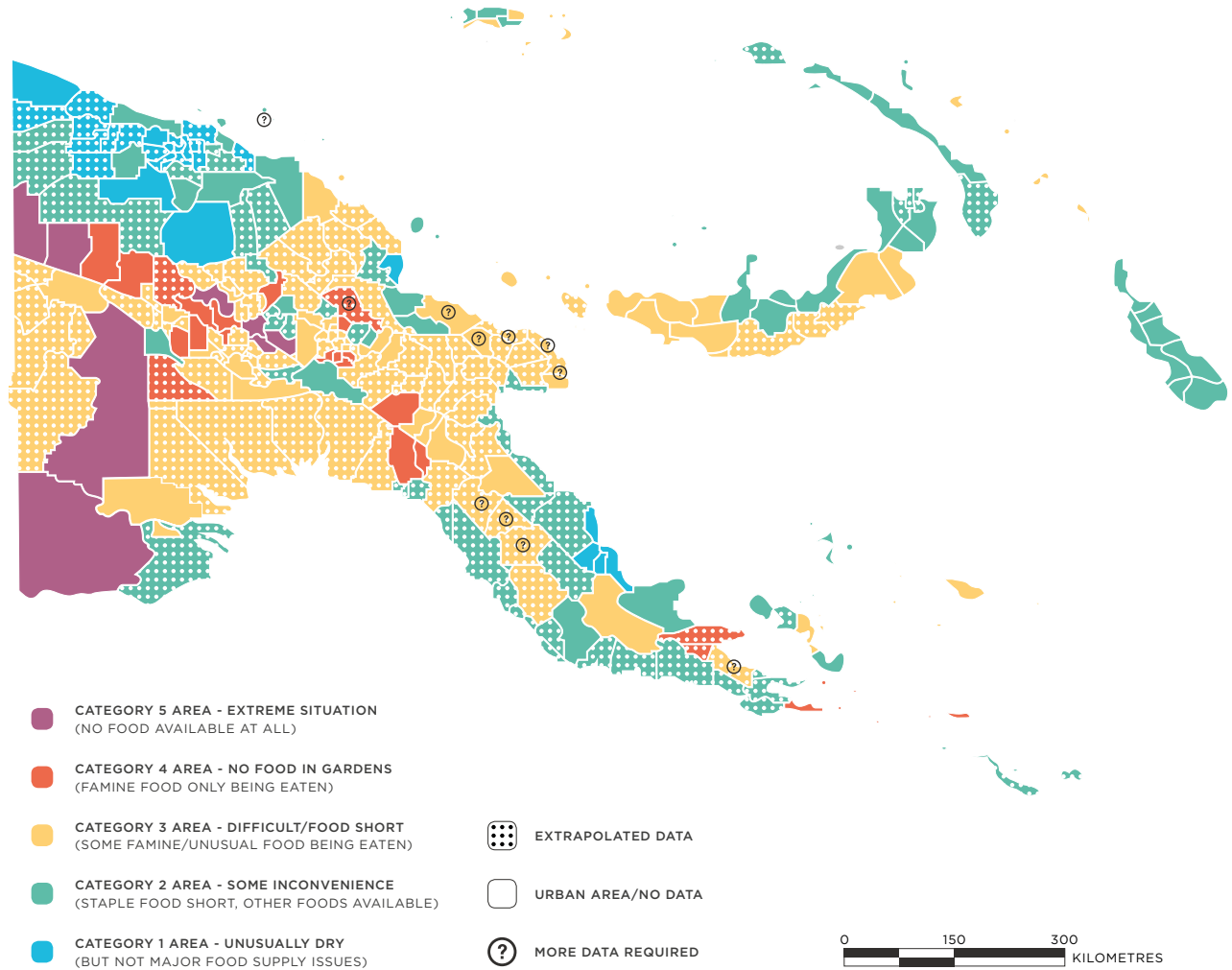
38. Australian Centre for International Agricultural Research (ACIAR), 2017, "Engaging agricultural communities in climate resilient food production adaptation: a PNG highlands case study." Available at: <https://www.aciar.gov.au/project/ASEM/2016/041>



Figure 12

Source: Michael Bourke³⁹

Impact of 2015 drought on crops in Papua New Guinea



39. Michael Bourke, 2015, "Impact of frost and drought in Papua New Guinea: Update Mid-December 2015." Available at: http://www.inapng.com/pdf_files/Bourke%20drought%20POM%20Dec15%20Ver2.pdf

Extreme weather events tend to exacerbate the nutrition-related challenges Papua New Guinea is already facing. According to the World Health Organization (WHO), approximately half of all children under the age of five are impacted by stunting, the fourth highest stunting rate worldwide.⁴⁰ The main causes of stunting include the introduction of foods other than breast milk in the first six months of life; the lack of a balanced diet; and diseases, specifically malaria and diarrhea.⁴¹ There is also a high prevalence of underweight and wasting among children under five, particularly in the Highlands region.

Families are adapting to food shortages by moving from the Highlands areas, which are prone to drought and frost, to lowland or urban areas, purchasing more imported goods like rice and wheat, slaughtering livestock, scavenging from neighbouring gardens or dipping into savings. These strategies are not generally effective and can exacerbate other societal

challenges, such as high urban unemployment and poverty and security levels.

There are concerns about a potential return of El Niño in 2019 (experts put the probability at 70 per cent) and the potential impact of the associated droughts, floods and landslides, not only on agricultural production, but also on income generation and public health.

The climate crisis is also having an impact on agricultural production, altering the harvesting cycle for crops like coffee.⁴² As farmers adjust to climate-related changes or enter new value chains, they require access to accurate, timely and highly localised weather forecasts and extreme weather advisory. While weather forecasts are readily available for larger metropolitan areas, such as Port Moresby, Lae and Mt. Hagen, they are not available for more remote agricultural and rural areas. Given the significant topographical diversity of Papua New Guinea, weather forecasts for a city cannot serve as a proxy within the same province.

4.2. Financial exclusion is especially acute in rural farming areas

Papua New Guinea has one of the highest unbanked rates in the world, a consequence of a geographically dispersed population that speaks over 800 different languages and limited banking infrastructure (bank branches and ATMs). High banking fees have generated a lack of trust in formal banking institutions. There is also a strong culture of cash in Papua New Guinea — even those with accounts at a formal financial institution tend to fully cash-out payments immediately to cover their everyday expenses. Savings often take the form of hiding money in the house. The Pacific Financial Inclusion Programme (PFIP) estimates that, among Pacific Island nations, only Solomon Islands has a lower rate of financial inclusion than Papua New Guinea.⁴³ Whereas nationally, 37 per cent of adults have an account at a formal financial institution,⁴⁴ in

rural areas this can be as low as five to 10 per cent.⁴⁵ According to The World Bank, Papua New Guinea has one of the lowest levels of bank branch density globally, ranking 169 out of 179 countries measured in 2014.⁴⁶

Despite poor access to the formal financial sector outside large cities, Papua New Guinea's rural population has an acute need for financial services, particularly credit. Without operational capital, farmers are unable to acquire seedlings to replace ageing trees, or the pesticides, fertilisers and farm equipment that can boost crop production and income. The International Monetary Fund (IMF) estimates that approximately 70 per cent of Papua New Guineans take out loans, but less than five per cent of these loans are with formal financial institutions. The vast majority

40. World Health Organization, 2018. Available at: <https://www.who.int/nutgrowthdb/estimates2018/en/>

41. Global Citizen, 2018, "Nearly 50% of Papua New Guinea's Children are Malnourished." Available at: <https://www.globalcitizen.org/en/content/papua-new-guinea-children-malnourished/>

42. National Weather Service, Papua New Guinea, 2019.

43. Pacific Financial Inclusion Programme (PFIP), 2018, "Papua New Guinea Financial Inclusion Country Profile." Available at: <http://www.pfip.org/our-work/performance-dashboard/countries/papua-new-guinea/>

44. Ibid.

45. The World Bank, 2015, "Financial Inclusion in Papua New Guinea Status Report." Available at: <https://www.bankpng.gov.pg/wp-content/uploads/2015/03/Financial-Services-Sector-Review-Financial-Inclusion.docx>

46. The World Bank, 2015, "Financial Inclusion and Financial Capability in Morobe and Madang Provinces", p. 14. Available at: <http://documents.worldbank.org/curated/en/704801471496337675/pdf/105185-REVISED-WP-P145131-PUBLIC.pdf>



are with relatives and *wantoks*⁴⁷ or moneylenders who charge interest rates as high as 20 to 50 per cent per fortnight. Informal loans tend to be small, averaging \$121 (PGK 405),⁴⁸ making them costly to service for formal financial services providers.

To address low financial inclusion, Papua New Guinea's government became a signatory to the Maya Declaration⁴⁹ in 2013 and subsequently issued the First National Financial Inclusion and Financial Literacy Strategy 2014–2015 with the support of the PFIP. The initiative succeeded in adding 1.2 million new deposit accounts in the first two years.⁵⁰ Although this figure exceeds the original target of one million new deposit accounts, the government found that the majority of new accounts belonged to individuals living in urban areas. After reviewing the results of the First National Financial Inclusion and Financial Literacy Strategy, the government refined its goals for the Second National Financial Inclusion Strategy 2016–2020 (NFIS), focusing on groups that remain disproportionately excluded from

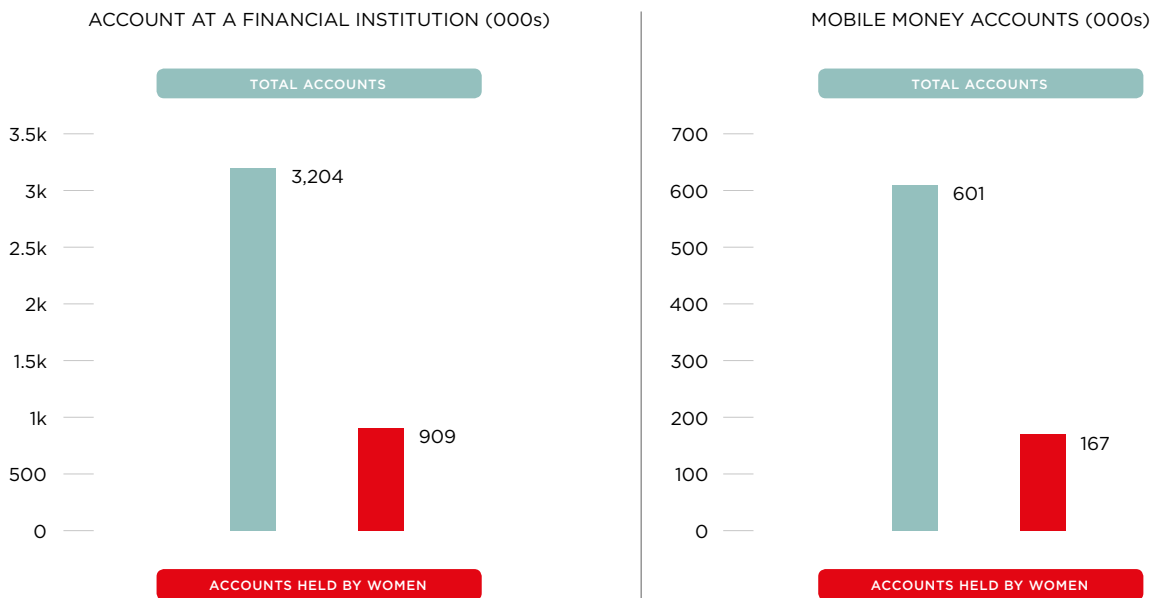
financial services, namely, women, people living in rural areas, micro and small businesses and those making a living from agriculture. For agriculture specifically, the government has outlined two key objectives: increasing private-sector credit to agriculture-sector entrepreneurs and developing insurance products for farmers. The government has established a working group to look into these areas, which is focusing on identifying best practices and establishing new metrics for tracking the success of any programs that are implemented.

The target of the NFIS is to open an additional two million financial services accounts by year-end 2020, raising the proportion of financially included adults to 75 per cent. Of these two million new accounts, the NFIS expects a million to be opened by women. Thus far, the NFIS is falling short of its target, particularly with respect to the goal of signing on more women. Only 21 per cent of new financial services accounts added between year-end 2016 and year-end 2018 are held by women.

Figure 13

Source: Centre for Excellence in Financial Inclusion (CEFI)

Financial Inclusion in Papua New Guinea, 2018



47. The term "wantok", meaning "one talk" in Tok Pisin, is related to a powerful cultural social bond that links people of the same ethnic group who speak the same language. The wantok system is a traditional social welfare system that emphasises the responsibilities group members have to care for each other and to help each other with food, shelter, clothing, monies, work, bereavement, etc. The definition is derived from the International Finance Corporation (IFC), 2018, "Papua New Guinea Financial Consumer Protection Diagnostic" p. 7. Available at: <http://documents.worldbank.org/curated/en/541911540390928999/Papua-New-Guinea-Financial-Consumer-Protection-Diagnostic-2018>

48. Joint publication of the Pacific Financial Inclusion Programme (PFIP) and the International Finance Corporation (IFC), 2017, "Building a Mobile Money Distribution Network in Papua New Guinea." Available at: <http://documents.worldbank.org/curated/en/102471501139355363/Building-a-mobile-money-distribution-network-in-Papua-New-Guinea>

49. The Maya Declaration is a platform that enables Alliance for Financial Inclusion (AFI) member institutions to make concrete financial inclusion targets, implement in-country policy changes, and regularly share progress updates. A public commitment to the Maya Declaration is a means to champion financial inclusion and contribute to the range of UN Sustainable Development Goals, but specifically Goal 1 – No Poverty. AFI, available at: <https://www.afi-global.org/maya-declaration>. Papua New Guinea's commitment to the Maya Declaration is available at: http://www.afi-global.org/sites/default/files/publications/maya_declaration_bank_of_papua_new_guinea.pdf#targetText=The%20Bank%20of%20Papua%20New,Guinea%20under%20the%20Maya%20Declaration

50. CEFI, "(Second) National Financial Inclusion Strategy 2016–2020." Available at: <http://www.pfip.org/wp-content/uploads/2017/01/2-PNG-NATIONAL-FINANCIAL-INCLUSION-STRATEGY-2016-2020-final.pdf>

4.3. Poor infrastructure poses substantial access-to-market challenges, and costs for both agribusinesses and farmers

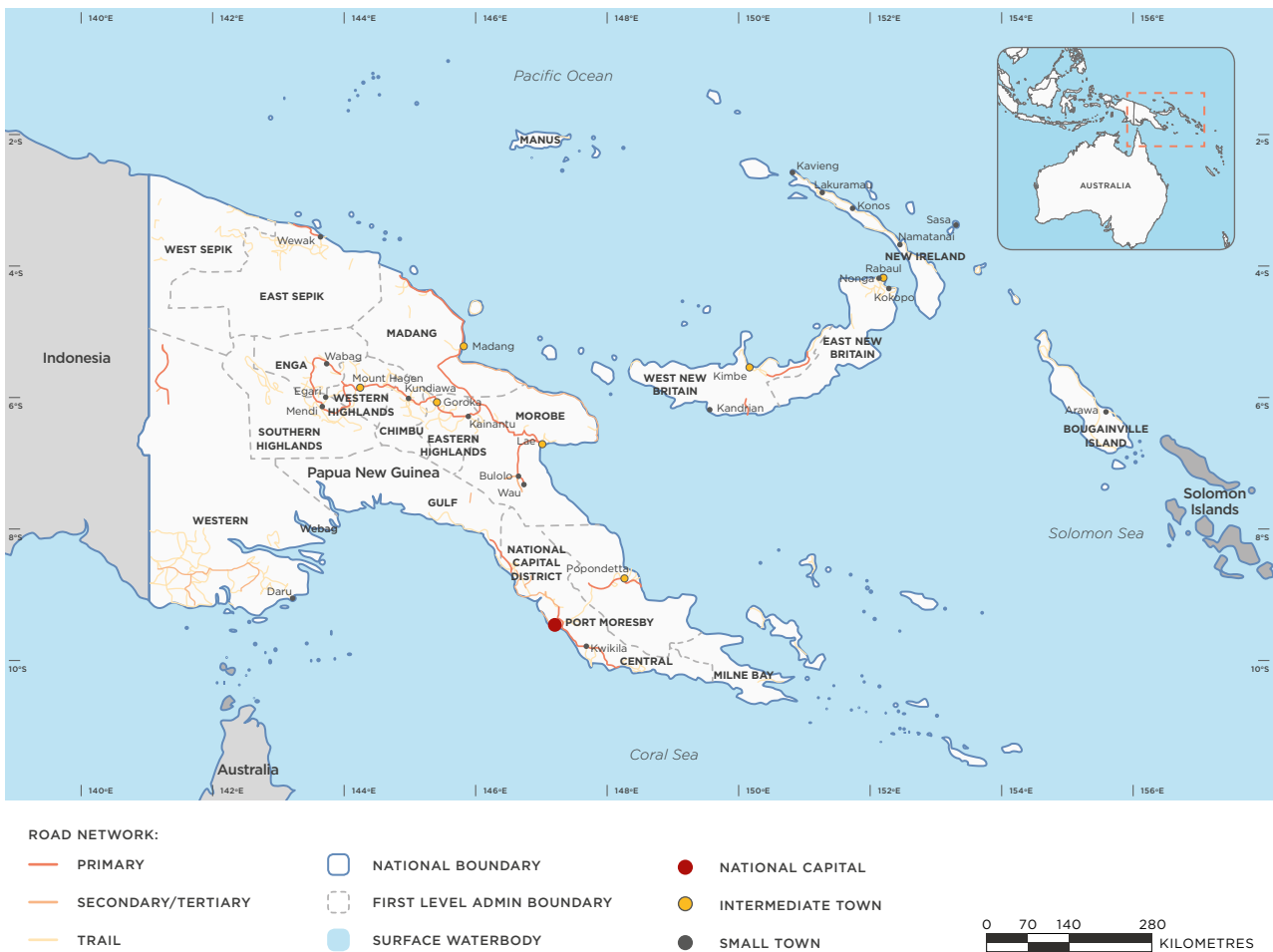
For most agribusinesses and farmers, Papua New Guinea’s poor infrastructure ranks first or second on the list of challenges standing in the way of higher productivity. An estimated 75 per cent of roads are

impassable at some point during the year due to adverse weather, primarily rain or flooding. Limited government funds for infrastructure investment means that standard maintenance is not taking place as required.

Figure 14

Source: Logistics Capacity Assessment⁵¹

Road infrastructure in Papua New Guinea



51. Available at: <https://dlca.logcluster.org/display/public/DLCA/2.3+Papua+New+Guinea+Road+Assessment>



There are no roads connecting the Highlands and Momase regions to the capital of Port Moresby due to the mountain range running through the middle of the country. Most crops grown in these regions are transported to Port Moresby via air or ship, adding time and cost to the process. The CIC estimates that 40 per cent of coffee produced never actually reaches the market due to wastage and transport challenges.⁵² Due to the lack of proper refrigeration at various points in the journey, wastage rates in fresh produce are at 30 to 50 per cent. The cost of transportation and lack of a reliable supply of fresh produce and livestock to Port

Moresby's markets are the main reasons why Papua New Guinea imports an average of \$900 million to \$1.2 billion (PGK 3–4 billion) in food every year despite the country's vast agricultural resources.⁵³

The cost of transportation is felt acutely by farmers. Of the \$1.20–\$1.80 (PGK 4–6) per kilo coffee beans earned by a farmer, for example, \$0.30 (PGK 1) is paid to transport it to the buying point.⁵⁴ To avoid this fee, farmers often travel the distance to the buying point on foot, risking theft or violence and taking time away from productive activities on their farms.

4.4. Insufficient agricultural extension affects crop yields and quality

Extension services in Papua New Guinea have been insufficient to meet the needs of farmers and agribusinesses. In 2010, the government allocated \$31.5 million (PGK 105 million) for agricultural extension and employed roughly 850 extension officers,⁵⁵ resulting in an extension officer-to-farmer ratio of over 5,000, which is well above the recommended ratio and significantly higher than in other developing markets. According to The World Bank, improved farming techniques and more tailored extension support could raise yields for most cash crops by 30 to 50 per cent in Papua New Guinea.⁵⁶ In the case of coffee, the CIC blames an ageing tree stock, poor management of pests and diseases and poor financial management for declining coffee production that could be addressed through targeted extension services. In the cocoa market, extension support that promotes the planting of cocoa pod borer (CPB)-tolerant varieties, the use of insecticides, optimal harvesting techniques and proper use of fermenteries is required for the industry to reach pre-CPB production levels.

Many private agribusinesses have taken it upon themselves to directly fund and deliver extension services to help farmers increase productivity levels. Hargy Oil Palms, for instance, has been providing agricultural extension to its smallholder farmers since 2014. Visits to farms revealed poor harvesting/skip harvesting, lack of fertiliser use and lack of tools as some of the main reasons behind declining yields. Thanks in part to investment in extension support services, yields have increased from 10 tonnes per hectare in 2008 to 15 tonnes per hectare 10 years later.

The government is acutely aware of the challenges associated with ineffective extension support. As part of its Vision 2050 strategy, the government is planning to hire at least two agricultural extension officers in each of Papua New Guinea's 89 districts to reduce distance between officers and the farmers. The Papua New Guinea government is also working with universities and schools to add courses on agriculture to expand the pool of candidates from which to hire extension officers. Finally, the government is working to improve the terms of employment for agricultural officers to increase the rate of retention of qualified officers.⁵⁷

52. CIC, 2008, "Papua New Guinea. Coffee Industry Strategic Plan 2008-2018." Available at: https://www.cic.org.pg/wp-content/uploads/2016/07/images_pdfdownload_downloads_previousyears_StrategicPlan.pdf

53. National Research Institution Papua New Guinea (NARI), Papua New Guinea APEC Study Centre, APEC Study Centres Consortium Conference (ASCCC), 2018, "Reducing Poverty through Technology and Inclusive Agribusiness Model." Available at: <https://www.apec.org/Groups/Other-Groups/APEC-Study-Centres-Consortium>

54. Interview with Niugini Coffee Tea and Spices (NCTS), Agmark.

55. E.C. Sitipai, "A Critical Analysis of Agriculture Extension Services in Papua New Guinea: Past, Present and Future, CIMC National Agriculture Conference, May 2012. Available at: http://www.inapng.com/pdf_files/A%20Critical%20Analysis%20of%20Agriculture%20Extension%20Services%20in%20Papua%20New%20Guinea%2018%20July%202012.pdf

56. New Agriculturalist, 2013, "Country Profile - Papua New Guinea." Available at: <http://new-ag.info/en/country/profile.php?a=2924>

57. Department of Treasury Papua New Guinea, 2011, "Papua New Guinea Vision 2050." Available at: http://www.treasury.gov.pg/html/publications/files/pub_files/2011/2011.png.vision.2050.pdf

4.5. Spotlight on needs assessment in Morobe Province

Morobe Province is one of Papua New Guinea's important agricultural production areas, with increased private-sector activity across a wide variety of value chains. Key drivers for agribusiness investment in the province include proximity to the Port of Lae, which offers access to Port Moresby and international markets, ongoing modernisation of the region's infrastructure and fertile land suitable for the cultivation of crops. Recently, the province has attracted significant investment from government, donor organisations and the private sector. Still, field research has confirmed that agricultural challenges observed in other parts of the country are also relevant to farmers and agribusinesses in Morobe Province.

4.5.1 Needs assessment of agribusinesses in Morobe Province

In March 2019, the GSMA met with executives from seven agribusinesses operating in Morobe Province in a variety of value chains, including coffee, cocoa, rice, palm oil, fresh produce and spices. Agribusinesses in Morobe Province are not immune to the challenges facing the agriculture sector in other parts of Papua New Guinea. Challenges may affect multiple parts of the value chain where agribusinesses operate. Besides the challenges of operating in cash, commercial buyers procuring crops from smallholder farmers are also affected by a lack of visibility in the supply chain, which can impede successful roll out of traceability and certification programmes and the provision of extension services to farmers. This section explores the main agribusiness needs resulting from pain points they face in the last mile.

Agribusiness need #1: Reduce the cost and risk of dealing in cash

Since most farmers in rural areas lack access to formal financial services, including a bank account at a financial institution, agribusinesses still use cash for a substantial share of their procurement payments. Even when a farmer has access to a bank account, they often opt to receive payments in cash to avoid travel to the closest bank branch, which may be located far from a farmer's home.

In Morobe, there are very few financial access points outside Lae and the mining areas and farmers must travel long distances to reach the nearest bank or ATM location. Once there, they must often spend hours waiting in line, wasting up to a day's work just to cash a paycheck. Farmers may also have to spend the night in town, incurring lodging and additional meal expenses if they are unable to cash out before the last bus leaves for the day. As a result, farmers may end up selling to buyers who are ready to pay in cash.

Paying in cash creates several operational inefficiencies for agribusinesses, which must deal with manual acceptance, recordkeeping, counting, storage and transportation. Also, the probability of fraud increases significantly, with consequences for both producers and buyers. Given the poor state of many roads in Papua New Guinea, there is a substantial amount of time associated with paying farmers, particularly during the rainy season when many roads become impassable. The risk of handling cash requires most agribusinesses to invest in security staff and armored vehicles. To avoid transporting large amounts of cash via dilapidated roadways, some agribusinesses use helicopters to deliver cash payments to farmers living in remote locations, driving up the cost of payments.



To reduce the risk to their staff and intermediaries, and the costs associated with using security services, armored vehicles or helicopters, agribusinesses have teamed with Papua New Guinea's banks to digitise farmer payments. Cocoa agribusiness Agmark, for instance, partnered with the Bank of the South Pacific (BSP) to offer financial literacy training to cocoa farmers and help them open bank accounts in the areas where it operates. So far, Agmark estimates it has provided literacy training to 3,000 to 5,000 farming households and that nearly 50 per cent of its farmers now have a bank account.⁵⁸ A few years ago, several agribusinesses teamed with financial services providers, BSP and MiBank, to migrate farmers to mobile banking products in an effort to replicate initiatives that had seen some success with mining and construction workers.

However, the digitisation of farmer payments has failed to gain much traction among agribusinesses for several interrelated reasons. First, while bank agent networks tend to have greater reach in Morobe, agent availability and liquidity are problems, reducing their effectiveness and creating frustration for farmers. Even when banks and agents are nearby, farmers face high account maintenance and withdrawal fees that deplete their incomes and create mistrust in financial institutions. The lack of a broader digital payments ecosystem is another challenge. As most large expenses are handled in cash (school fees, medical bills, transportation) farmers prefer to have cash on hand. The government's plan to digitise 100 per cent of government payments is a positive first step in creating a digital payments ecosystem. However, there is still a need for more payments to transition from cash to digital.

Agribusiness need #2: Ensure end-to-end traceability and certification

Leading agribusinesses in Papua New Guinea's palm oil, coffee and cocoa value chains are seeing growing demand for sustainable agriculture practices and traceable production. Demand for sustainable sourcing of certified crops is coming from downstream supply chain actors driven by consumer interest in health and food safety, and the need to assess the impact of agricultural expansion on global biodiversity and the environment. Traceability is not only relevant for agribusinesses operating in cash crops, but also for agribusinesses engaged in livestock trade. The price that a pig or cow can bring is directly related to the animal's pedigree, diet and medical history. Failure to maintain up-to-date records limits the amount of money that an agribusiness, and by extension a farmer, can earn from their livestock.

Much of Papua New Guinea's palm oil is exported to European markets where buyers are committed to purchasing sustainably produced palm oil. According to local palm oil buyers, 100 per cent⁵⁹ of the palm oil exported from Papua New Guinea is sustainably produced, meeting the criteria established by the Roundtable on Sustainable Palm Oil (RSPO).⁶⁰ Certification is also critical in the coffee and cocoa value chains. Most coffee exporters operating in Papua New Guinea manage one or more of the following certifications: Rainforest Alliance, UTZ, Organic Certified or Fair Trade.


58. Agmark, 2019.


59. Confirmed by Papua New Guinea's two palm oil agribusinesses: New Britain Palm Oil (NBPOL) and Hargy Oil Palms.


60. RSPO is a not-for-profit association that unites stakeholders from seven sectors of the palm oil industry (including palm oil producers, processors or traders, consumer goods manufacturers, retailers, banks and investors, environmental NGOs and social NGOs). Its objective is to develop and implement a global standard for sustainable palm oil.


Principles for the production of sustainable palm oil


8 PRINCIPLES FOR GROWERS TO BE RSPO CERTIFIED


 **1** Commitmet to transparency


 **2** Compliance with applicable laws and regulations


 **3** Commitment to long-term economic and financial viability

 **4** Use of appropriate best practices by growers and millers

 **5** Environmental responsibility and conservation of natural resources and biodiversity

 **6** Responsible consideration of employees, and of individuals and communities affected by growers and mills

 **7** Responsible development of new plantings

 **8** Commitment to continuous improvement in key areas of activity

To date, much of the data needed to maintain certification standards has been collected manually with pen and paper. This process is extremely time intensive, costly and prone to error and fraud. As agribusinesses seek to meet rising demand for certified products, the need to streamline the monitoring of their field operations becomes vital. In response, several agribusinesses and government agencies have been involved in pilot projects aimed at using digital technologies to optimise the certification and traceability processes.

One of these projects is a last-mile digital solution currently being piloted by PNGAC in East New Britain Province with the support of Farmforce (see Section 6.3). A second initiative is a pig traceability pilot in Jiwaka Province with the backing of national government agencies, the International Telecommunications Union (ITU), the Jiwaka provincial government and the Food and Agriculture Organization of the United Nations (FAO).⁶² The pilot relies on blockchain technology to collect data on the

history of individual pigs, including their pedigrees, what they were fed, when they were ill and what medicine was administered. The implementation of the new tracking system helps to build consumer trust and ensure farmers can expand their markets and earn a fair return on their investments. Both pilots are relatively recent so their impact has not yet been widely felt.

Agribusiness need #3: Improve visibility in the supply chain

The lack of visibility in Papua New Guinea’s agricultural supply chain prevents agribusinesses from developing reliable procurement forecasts, improving last-mile processes, preventing fraud and identifying areas for additional support, such as agricultural extension services. In some less established or less formal value chains, such as fresh produce, agribusinesses often meet farmers at buying points with no prior knowledge of what crops the farmers are ready to sell. Even in more formal value chains

61. Available at: <https://rspo.org/resources/certification/rspo-principles-criteria-certification>

62. FAO, 2019, "Pig farmers in Papua New Guinea capitalize on blockchain technology." Available at: <http://www.fao.org/in-action/pig-farmers-in-papua-new-guinea/en/>



with long-established relationships between value chain participants, visibility levels for different farmers or intermediaries can be inconsistent. Paradise Foods' Queen Emma Chocolates, for instance, has relatively good visibility into the cocoa sourced from its farmers in Bougainville, but in Morobe visibility is far more limited, adding unnecessary complexity to its production process.

Lack of real-time visibility in the last mile makes it difficult for agribusinesses to ensure steady supplies of crops that would allow them to sign advance contracts with their own buyers. Lack of visibility can also make it difficult to sustain farmer loyalty. If too many farmers arrive at a buying point with the same crop, such as fresh produce, agribusinesses may be unable to purchase it all, frustrating those expecting to sell all their produce after a long trip.

To address the lack of visibility in the supply chain, several agribusinesses in Papua New Guinea have been testing last-mile digital solutions using the Farmforce app (see Sections 6.3 and 6.4). For example, through the use of Farmforce, SP Brewery is aiming to build a visible and reliable supply of local cassava which will eventually replace barley as the source of starch in the brewing process.

Agribusiness need #4: Enhance extension support for farmers

For farmers in Papua New Guinea, poor access to much-needed agricultural information is a country-wide challenge (see Section 4.4), and felt acutely in Morobe Province. Understanding the direct links between extension support and higher yields, many large commercial agribusinesses have introduced customised agricultural extension support to help their suppliers improve productivity.⁶³ Some agribusinesses use extension services as a tool to generate farmer loyalty, understanding that farmers prefer to supply to a buyer that offers the support they need to improve the quality and yield of their crops.

This agribusiness-led approach has several limitations, however. First, hiring and training extension officers can be costly and time consuming. As extension officers must travel long distances to remote locations, the number of farmers they are able to reach and the amount of time they can spend with those farmers is limited. Agribusiness-led extension services also lack the economies of scale that government-led services enjoy, making it more difficult to stay up to date on best practices or to benefit from the lessons of other agribusinesses in the country.

With government funding for face-to-face agricultural extension steadily decreasing, there is a need to find other cost-effective ways to provide consistent and up-to-date agricultural extension support to more farmers. In an environment where farmers must adjust quickly to changes in certification processes, pest infestations or adverse climate events, extension services that are timely and have a broad reach are especially important.

4.5.2 Needs assessment of farmers in Morobe Province

In March 2019, the GSMA organised focus groups with two groups of farmers supplying cocoa beans to the agribusiness Olam in Morobe Province. One of the groups was located in Gabensis, a small town off the highway linking Lae to the Wau-Bulolo mines. The second group was located in an area known as "40 mile." The project team met with approximately 50 farmers between the two locations. Local agribusinesses that work directly with farmers, and a series of videos by the Market Development Facility (MDF) that included interviews with farmers supplying fresh produce to NKW Fresh, offered additional insights into farmer challenges.⁶⁴

63. Monpi Coffee Exports, Agmark, Hargy Oil Palms and NKW Fresh are examples of agribusinesses that invest in extension services for smallholder farmers. Monpi Coffee Exports operates a division called Sustainability Management Services (SMS) to provide extension services to coffee farmers in the Highland regions. The company has a dedicated staff of 19 extension officers that spend the bulk of their time in the field working with farmers on best practices for coffee farming.

64. MDF, 2019, "NKW Fresh: A fresh approach to farmers in Papua New Guinea." Available at: <https://www.youtube.com/watch?v=xRbuJN7Q6U8>. MDF, 2018, "NKW Fresh: The humanity of horticulture." Available at: https://www.youtube.com/watch?v=1mFs_gHo-8U. MDF, 2017, "NKW Fresh: Teaser 1 - innovation." Available at: https://www.youtube.com/watch?v=1mFs_gHo-8U

Farmer need #1: Access to information and markets

Lack of information, particularly about best practices in productivity and weather advisory, remains a significant pain point for farmers (see Section 4.4). Olam's cocoa farmers require agronomic advice on topics such as crop mix selection, cultivation practices, pest and disease management, and milling and fermentery techniques to increase yields and crop quality and secure higher commodity prices. Inadequate information may also have an impact on farmers' access to markets. For example, producers will travel up to a day, at significant cost, to reach markets in Lae without prior knowledge of current market prices or demand for their produce.

Farmers also lack access to accurate, timely and localised weather forecasts (see Section 4.1). Access to information, such as daily rainfall, temperature data and drought advisories,⁶⁵ is important because it helps cocoa farmers make informed decisions about land preparation, irrigation, pest and disease management and harvest timing. For example, the lifecycle of several insects affecting the cocoa plant is tied closely to climatic factors, such as temperature and humidity. As weather patterns become more unpredictable with significant year-to-year variation, farmers could benefit from climate-smart agronomic advice for climate adaptation, mitigation and food security. The Australian Centre for International Agricultural Research (ACIAR) has identified several strategies that would help strengthen farmers' resilience in the face of unpredictable weather patterns. These include, among other strategies, the planting of drought-tolerant crops and cultivars; reduced reliance on sweet potato, which is highly sensitive to both drought and soil moisture; better soil and water management techniques; the application of flowering hormones for out-of-season production of some fruit varieties; and the planting of food-producing tree crops at lower elevations to increase yields.⁶⁶

Currently, farmers rely on personal observation and insight from family members, neighbours and community and church leaders as their primary source of information. However, these groups do not always have access to up-to-date or even accurate information. There is an opportunity for direct-to-customer (B2C) and enterprise solutions (B2B2C) with embedded digital information services to close the information gap for smallholders.

Farmer need #2: Accessing formal financial services

Financial inclusion rates in Morobe Province are lower than the national average (see Section 4.2). A World Bank report estimated that in Madang and Morobe Provinces, 21 per cent of men and nine per cent of women had an account with a formal financial institution, compared to a national average of 37 per cent.⁶⁷ Although most commercial banks have a presence in Morobe Province, most bank branches and ATMs are located either in Lae or the Wau-Bulolo mining area.

A select number of agribusinesses, like Olam, recognise the benefits of offering farmers access to credit to acquire inputs and farm equipment. Loan repayments are then deducted periodically from procurement payments made to farmers. This practice is more common in palm oil and coffee value chains where agribusinesses have developed loyal relationships with their suppliers and can assess a farmer's risk and ability to repay a loan. Despite this solution's potential to increase farmer loyalty, agribusinesses often voice concerns about its scalability across a larger farmer base in the Province. Additionally, with women often excluded from the sale of crops, and crop procurement still a largely informal process for young farmers, there are concerns that not all types of farmers will be represented equitably among beneficiaries.

65. Australian National University (ANU), 2019, "Engaging agricultural communities in climate responsive food production: a PNG case study," Steven Crimp.

66. Australian Centre for International Agricultural Research, 2016, "Engaging agricultural communities in climate resilient food production adaptation: a Papua New Guinea highlands case study," Steven Crimp. Available at: <https://www.aciar.gov.au/project/ASEM/2016/041>

67. The World Bank, 2015, "Financial Inclusion and Financial Capability in Morobe and Madang Provinces, Papua New Guinea." Available at: <http://documents.worldbank.org/curated/en/704801471496337675/pdf/105185-REVISED-WP-P145131-PUBLIC.pdf>

Farmer need #3: Improving opportunities for women

Although women actively participate in the production of cash crops, they generally do not generate much income from their efforts due to firmly established gender roles,⁶⁸ security concerns associated with travelling to the buying point, low literacy levels and lack of access to financial services to receive payment. Women have also been historically excluded from other employment options in the agricultural sector, including the opportunity to become extension officers. Due to concerns over their security, female extension officers may require a driver, increasing the cost for agribusinesses or industry boards.

Bridging the gender divide is a key objective of the national government, donor agencies and agribusinesses alike. Donor agencies often impose minimum requirements for the involvement of women in the projects they fund. Agribusinesses have also looked for ways to compensate women more fairly for their efforts. In the palm oil industry, for example, the Mama Lus Frut programme was introduced in 1997 to pay women directly for collecting the loose fruit that falls on the ground during the harvesting process. Women are paid for the fruit they collect via a “mama card,” distinct from the “papa card” used to pay men for the initial harvest. Through this programme, agribusinesses have benefitted from less waste and

higher yields, while women have increased their incomes. Men have also benefitted as the combined income of palm oil households involved in Mama Lus Frut has increased by as much as 18 per cent for a single household.⁶⁹ Hargy Oil Palms estimates that 21 to 22 per cent of total production in 2018 originated from the Mama Lus Frut initiative.⁷⁰

To address the challenge of safe transportation for women, the Australian High Commission’s Pacific Women programme joined forces with the Ginigoda Foundation and UN Women Papua New Guinea to introduce Meri Seif Buses. Meri Seif Buses provide a safe transportation option for women and their children so that they can access services and engage more freely in economic activities.⁷¹ First introduced in Port Moresby, the buses are now operating in Morobe Province’s capital city, Lae. Although the buses provide women with safe transportation within the city, they do not address the challenge of travelling safely from farms to buying points.

It is evident that agricultural sector stakeholders must overcome some major challenges in different parts of the value chain to enable equitable and sustainable development of the agricultural sector. In this context, mobile technology’s wide reach across geographies, income levels and cultures has the potential to address various pain points in Papua New Guinea’s agriculture sector and deliver transformative socio-economic benefits to key stakeholders.

68. The United Nations Development Programme (UNDP) ranks Papua New Guinea 159 out of 160 countries on its 2017 Gender Inequality Index (GII). The GII measures gender inequalities in three important aspects of human development: reproductive health, measured by maternal mortality ratio and adolescent birth rates; empowerment, measured by proportion of parliamentary seats occupied by females and proportion of adult females and males aged 25 years and older with at least some secondary education; and economic status, expressed as labour market participation and measured by the labour force participation rate of female and male populations aged 15 years and older. The GII is built on the same framework as the HDI to better expose differences in the distribution of achievements between women and men. It measures the human development costs of gender inequality. United Nations Development Programme (UNDP), 2018, “Human Development Indices and Indicators: 2018 Statistical Update Papua New Guinea.” Available at: <http://hdr.undp.org/sites/default/files/Country-Profiles/PNG.pdf>

69. Australian Centre for International Agriculture Research (ACIAR), 2002, “Mama Lus Frut Scheme: an assessment of poverty reduction.” Available at: <http://ageconsearch.umn.edu/bitstream/47698/2/IAS20.PDF>

70. Hargy Oil Palms, 2017, “Privatising Extension Services in Biella Oil Palm Project.” Available at: <http://www.agsummitpng.com/uploads/presentations/Hargy-Agricultural-Advisory-Service-Hargy-Oil-Palms-Limited.pdf>

71. UN Women, “The Meri Seif Bus.” Available at: <https://unwomen.org.au/wp-content/uploads/2017/01/Safe-Bus-FactSheet.pdf>

5. The mobile ecosystem landscape

The mobile landscape in Papua New Guinea has seen a burst of activity recently with the emergence of new players and partnerships, a rapid increase in mobile phone access and use and the expansion of

cellular coverage to more remote parts of the country. The following section explores the country's mobile ecosystem landscape and identifies the foundational elements for digital interventions in Morobe Province.

5.1. Papua New Guinea's mobile ecosystem

The mobile market in Papua New Guinea is currently in transition, as two smaller state-owned operators — bmobile-vodafone and Telikom PNG — come together under the bmobile-vodafone brand.⁷² Digicel, an international mobile service provider with operations in 32 countries in Asia Pacific, the Caribbean and Central America, is the market leader with a 91.6 per cent share of total connections as of year-end 2018, while bmobile-vodafone controls the remaining 8.4 per cent of total connections.⁷³ The company has focused most of its commercial activity on urban areas, leaving Digicel with a virtual monopoly in rural farming areas.

At the end of 2018, there were 2.7 million mobile connections in Papua New Guinea, a slight decline over the previous year as a result of new SIM-registration guidelines put in place by the National

Information and Communications Technology Authority (NICTA). There were 2.5 million unique subscribers, giving Papua New Guinea a subscriber penetration rate of 29.7 per cent. Just over three quarters (76.2 per cent) of connections are prepaid.⁷⁴

There were just under 600,000 smartphone connections in Papua New Guinea at the end of 2018, translating into a smartphone penetration rate of just seven per cent. The GSMA expects the number of smartphones to quadruple by the end of 2025, pushing penetration levels up to 25 per cent.⁷⁵ The vast majority of smartphone users live in urban areas, where 3G and 4G networks are prevalent. NICTA estimates that 67.5 per cent of the population of Papua New Guinea lives within access of a 2G/3G/4G network and 40.9 per cent of the population lives within access of a 3G+ network.⁷⁶

72. GSMA, 2019, "Digital Transformation, the Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/03/Digital-Transformation-The-Role-of-Mobile-Technology-in-Papua-New-Guinea.pdf>

73. GSMA Intelligence, Q1 2019

74. GSMA Intelligence, Q1 2019

75. GSMA Intelligence, Q1 2019

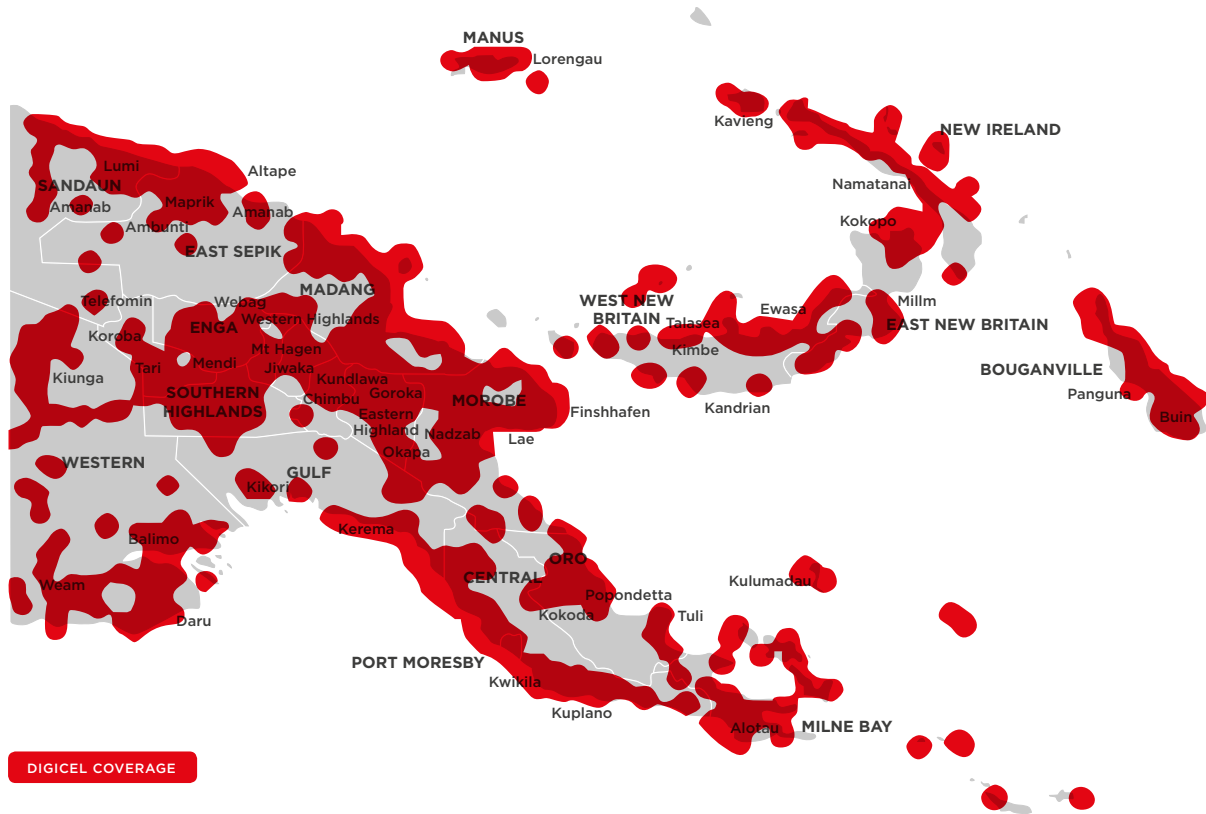
76. GSMA, 2019, "Digital Transformation, the Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/03/Digital-Transformation-The-Role-of-Mobile-Technology-in-Papua-New-Guinea.pdf>



Figure 16

Source: Digicel

Digicel network coverage in Papua New Guinea



MNOs face a variety of challenges providing coverage in rural areas. Operators must build roads themselves to reach new tower locations or rely on helicopters to provide fuel and maintenance. Land disputes between individuals or tribes is common, making it difficult for MNOs to secure the rights to new tower locations. Vandalism of mobile infrastructure is also common. The cost associated with building and maintaining towers in rural locations is not cost efficient given low average revenue per user (ARPU) levels in rural areas (averaging less than \$1.00).⁷⁷

Digicel introduced mobile money services in 2011 under the brand Cellmoni. However, the complexity of setting up a mobile agent network, particularly in rural areas, and liquidity challenges prevented Cellmoni from scaling.⁷⁸ The service is currently suspended while Digicel develops a new strategy to relaunch mobile money. bmobile-vodafone opted not to launch its own mobile money service although it is currently considering a deployment in the Solomon Islands.

77. Ibid.

78. Ibid.

Figure 17

Source: bmobile-vodafone

bmobile-vodafone’s mobile money partnerships with banks



The dominant model adopted in Papua New Guinea has been a bank-led model in which the main commercial banks, including BSP, Westpac, Kina Bank and ANZ, as well as microbanks such as MiBank, leverage the Digicel and bmobile-vodafone networks to reach customers. With the exception of MiBank’s mobile money service, most mobile money services provided by brick and mortar banks in Papua New Guinea require users to have an anchor bank account. This requirement, combined with being unable to access money immediately due to either a limited agent network in rural areas or lack of agent liquidity, have limited the uptake of mobile money.

CEFI estimates that as of year-end 2018, there were just over 601,000 mobile money accounts in the country, 167,000 of which were held by women. Most of these accounts are concentrated in urban areas. As part of the NFIS, the government seeks to increase the number of mobile money accounts to one million by the end

of 2020, in part by expanding mobile money services into rural areas. As MNOs are well placed to play a key role in achieving this objective, Digicel is in the process of revamping its mobile money strategy and plans to relaunch the service before the end of 2019.⁷⁹

Beyond mobile money, MNOs can leverage their scale, technical know-how, network of partners and experiences in other markets to offer a more comprehensive suite of services to stakeholders in agricultural value chains. Through mobile-enabled tools, for example, MNOs can work with AgriTechs to help agribusinesses streamline operations related to farmer profiling, agricultural extension, traceability and certification, and farm management systems, among others. In addition to the direct revenue opportunity these services can offer, MNOs benefit from the ability to increase their rural customer base and network use, and explore new lines of business from services such as IoT applications in agriculture.

79. Ibid.



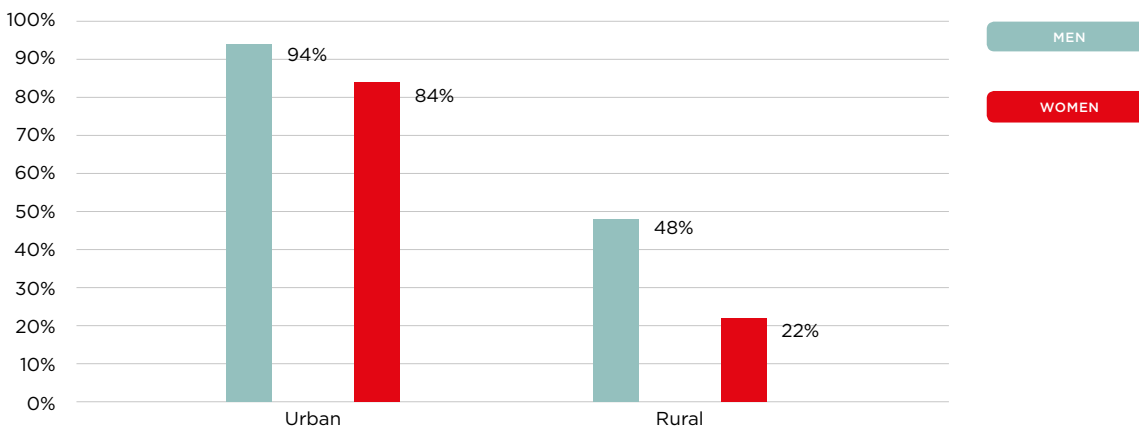
5.2. Foundational elements for digital interventions in Morobe Province

The share of the population covered by a 2G/3G/4G network in Morobe Province is likely to mirror national trends. Market leader Digicel and bmobile-vodafone both have a presence in Morobe Province. As bmobile-vodafone’s coverage is limited to more populated areas, Digicel is the only choice available to farmers in rural areas of the province. Digicel has been investing in tower expansion in Lae and surrounding areas to support some of the new mineral extraction projects in the region. 3G/4G coverage is strongest in Lae, in the Wau-Bulolo mining area and along the three major transportation routes leading to Wau-Bulolo, the Highlands and Madang Province. Coastal areas continue to be served primarily by 2G networks.

It is estimated that roughly 260,000 mobile subscribers, or 9.4 per cent of all subscribers in Papua New Guinea, are in Morobe Province,⁸⁰ putting its penetration rate roughly in line with the national average. There are stark differences, however, between urban and rural penetration rates, as well as between men and women. According to a World Bank report looking at the status of financial inclusion and financial capability in Morobe and Madang Provinces, men living in urban areas are four times more likely to have access to a mobile phone than women living in rural areas.

Figure 18 Source: The World Bank, 2015, “Financial Inclusion and Financial Capability in Morobe and Madang Provinces Papua New Guinea”

Mobile phone use in Morobe and Madang Provinces



Access to electricity is limited outside Lae. In the Momase Region (including Morobe, Madang and Sepik Provinces), only 5.9 per cent of the population has access to the electricity grid, compared with 16.7 per cent nationwide.⁸¹ This has a negative impact on an individual’s ability to keep their mobile phone charged. A new project in the Markham Valley, however, is using wood chips from trees sustainably grown in the valley

to fuel a biomass power plant and generate electricity to power Lae and surrounding areas.⁸²

Recognizing the role mobile technologies can play in Papua New Guinea’s digital transformation, a diverse mix of players in the wider agriculture ecosystem are driving digital interventions to meet the needs of stakeholders across the value chain.

80. GSMA, Digicel, bmobile-vodafone

81. The World Bank, 2015, “Financial Inclusion and Financial Capability in Morobe and Madang Provinces, Papua New Guinea,” p. 29. Available at: <http://documents.worldbank.org/curated/en/704801471496337675/pdf/105185-REVISED-WP-P145131-PUBLIC.pdf>

82. The National, 2018, “Using wood to fuel power plant.” Available at: <https://www.thenational.com.pg/using-wood-fuel-power-plant/>

6. Mapping recent and current digitisation initiatives in Papua New Guinea

The impact of mobile-enabled digital tools on Papua New Guinea's agriculture sector is already notable. In their most basic form, mobile services are the primary information dissemination and communication tools for farmers to learn about crop prices, crop pick-up schedules and more. Within smallholder cooperatives, mobile voice and messaging services are used extensively to coordinate farmer activity.

Digital interventions in Papua New Guinea's agriculture sector have been gradually moving beyond basic use cases to address a range of opportunities, including digital solutions to improve agribusiness' operational processes and support for extension services. These interventions rely on a combination of delivery models, from last-mile digital solutions for business-to-business (B2B) configuration to business-to-consumer (B2C) models.

About half of the digital interventions in the country's agriculture sector are last-mile B2B digital solutions designed to alleviate the pain points of agribusinesses and, in many cases, transform the management and visibility of the crop procurement chain. For example, tools such as Farmforce are improving market access for smallholder farmers by providing buyers with better visibility into crop availability or transforming the crop pick-up and delivery process. Although Farmforce does not have a physical presence in the country, it offers remote support from its Thailand office and in-country presence when projects demand it. Farmforce's ability to tailor its digital tool to a variety of agribusiness client needs, and a clear

ownership structure driving digital tool design and evolution, have the potential to create a scalable and commercially viable solution.

Papua New Guinea is also seeing more pilots of B2B apps related to the traceability of crops and livestock through farmer management systems and new traceability systems using blockchain. Traceability systems are central to efforts to accelerate Papua New Guinea's participation in global sustainability programmes, as well as initiatives to strengthen the security of the country's food supply chain.

Another set of digital interventions is supporting agricultural extension, one of the biggest challenges facing farmers in Papua New Guinea. Extension support tools are predominantly B2C mobile applications (apps) that disseminate information and content to farmers on market prices, weather or training on best practices in crop production.

Agri e-commerce models are another area of exploration, with a growing number of platforms being tested to link crop sellers with buyers. Finally, there is an uptick in initiatives aimed at analysing and forecasting weather and rainfall data, but these are still primarily small scale, highly localised and use proprietary technology.

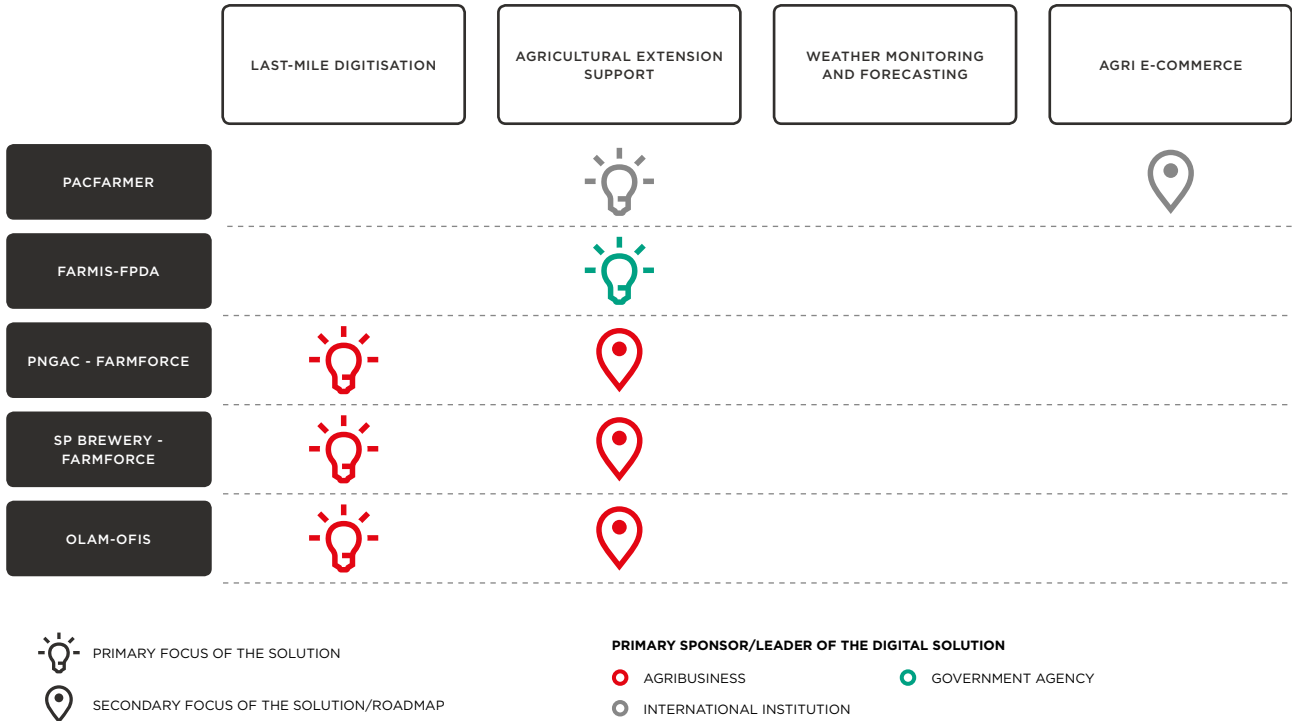
A more in-depth assessment of digital tools in Papua New Guinea's agricultural sector reveals a variety of core and interrelated use cases, highlighting the complex nature of the challenges these tools aim to address.



Figure 19

Source: GSMA

Digital tools in Papua New Guinea's agriculture sector



Most digital interventions in Papua New Guinea are either in the pilot stage or have been operational for less than two years. This is due to the relatively low penetration of mobile and broadband services in the country. With basic mobile penetration at 30 per cent and smartphone penetration at only about seven per cent,⁸³ Papua New Guinea has not seen the groundswell of mobile service use that typically drives or justifies an aggressive deployment of digital technologies. The predominantly rural context of the agricultural sector, where mobile adoption levels are lower than average, has compounded the slower roll out of digital agriculture use cases.

In addition, most digital interventions are proprietary. The country's low levels of mobile adoption and related concerns about scale make it challenging for third-party providers to develop apps for the

domestic market that are suitable for a diverse group of agribusiness clients. Agribusinesses often decide to develop their own digital tools customised to address their unique pain points. Low smartphone penetration also means that some consumer apps that would have been successful in other markets are likely to face more hurdles in Papua New Guinea.

Low adoption levels of digital technologies are also a deterrent to further investment in digital solutions. Rolling out a digital solution requires not only financial resources, but also human capital to roll out and manage the services, and extension efforts to drive adoption among smallholder farmers. As a result, many businesses remain skeptical of the adoption potential and ultimate viability of investments in digital technologies, which they may not see as their core business.

83. GSMA Intelligence, Q1 2019

Interestingly, a large share of digital interventions over the last five years have been led by, or received strong support from international institutions such as the Australian government (DFAT), The World Bank, United Nations Capital Development Fund (UNCDF) and the FAO. While this is partly due to Papua New Guinea's historical reliance on international support for economic development, it also shows that international institutions have had to step in to make up for the low private-sector appetite for investment in digital tools for the agricultural sector. However, there is still an expectation that support from international institutions, combined with successful ownership and implementation models from the private sector, will provide an initial foundation for broader adoption of digital tools.

Also notable is the somewhat tepid MNO participation across the range of interventions observed in Papua New Guinea. The mobile network is central to most digital interventions, as it provides the communications infrastructure for digital tools. However, most deployments take place without the direct, active

participation of MNOs. Operators in Papua New Guinea have focused primarily on expanding their networks and developing models that would increase basic service adoption levels. Combined with traditionally low ARPU levels, this has limited the development of a broader portfolio of value-added and enterprise services.

Low MNO participation is a considerable hurdle to scaling digital interventions in Papua New Guinea. Most interventions to date lack the scaling capacity, distribution reach, marketing power and the sheer volumes that mobile operators are typically able to contribute. This is especially evident in the mobile money segment, where the absence of MNOs has stunted the growth of initiatives to digitise agricultural payments.

The development of new mobile-enabled digital tools in Papua New Guinea's agriculture sector is inextricably tied to the broader context of digital services in the country, from basic mobile adoption and network coverage to the availability of services such as mobile money.

6.1. PacFarmer mobile app for improving farmers' access to markets

In March 2019, UNCDF in Papua New Guinea began exploratory work on a pilot project that would develop a mobile-enabled digital tool for coffee farmers in the Eastern Highlands Province. The project is expected to run in collaboration with CIC, the industry body tasked with overseeing the country's coffee sector. The tool, known as Pacific Farmer (PacFarmer), is a noteworthy example of using digital technologies to provide agricultural extension support.

PacFarmer is an app developed as part of PFIP, a long-standing effort to deepen financial inclusion across the Pacific islands. PacFarmer's long-term objective is to become a one-stop shop for farmer information on market prices, weather, government support programs, market linkages, digital payments, credit opportunities and other relevant information on market conditions.

The PacFarmer app, developed by software developer ITGalax, was first introduced in Fiji⁸⁴ in 2018 in partnership with Vodafone Fiji, the University of the South Pacific, local farmer cooperatives and the Government of Australia, which, like PFIP, provided funding.⁸⁵ The tool aims to address one of the most persistent obstacles to market access in the agricultural sector: the lack of reliable and timely information on market conditions to help farmers sell their crops. UNCDF also sees PacFarmer as a tool to help farmers grow and better manage their hard-earned incomes and start building the foundation for broader financial inclusion using digital technologies.

The initial focus of the app in Papua New Guinea is improving farmers' access to market by supplying market price data that CIC provides on a periodic basis.

84. PFIP, 2019. Available at: <http://www.pfip.org/our-work/work-streams/financial-innovation/pacfarmer-app/>

85. PacFarmer, 2018, "PacFarmer App - Linking farmer produce digitally." Available at: <https://www.youtube.com/watch?v=Tn3WtQIMtKQ&t=7s>



Depending on the success of the pilot, PacFarmer will expand to cover a wider array of crops, including cash crops like cocoa, as well as subsistence and food crops like potatoes, cassava and tomatoes. Addressing a variety of crops is critical for broad-based adoption, as many smallholder farmers in Papua New Guinea practice intercropping, a practice that involves growing a variety of cash crops and fresh produce in adjacent plots. The partnership with CIC will serve as a test case, and ultimately a template, for partnerships with other stakeholders whose participation would be vital to the success of the digital tool.

PacFarmer is a purpose-built Android OS app. The app requires a compatible smartphone and is available as a free download from the Google Play store. To register for the tool, the user creates a user profile authenticated through device and PIN access. The user also has the option to register as a member of a specific cooperative, which enables access to pricing available to members of that cooperative. Access to content is free, however, the user is charged for data consumed when accessing the app.

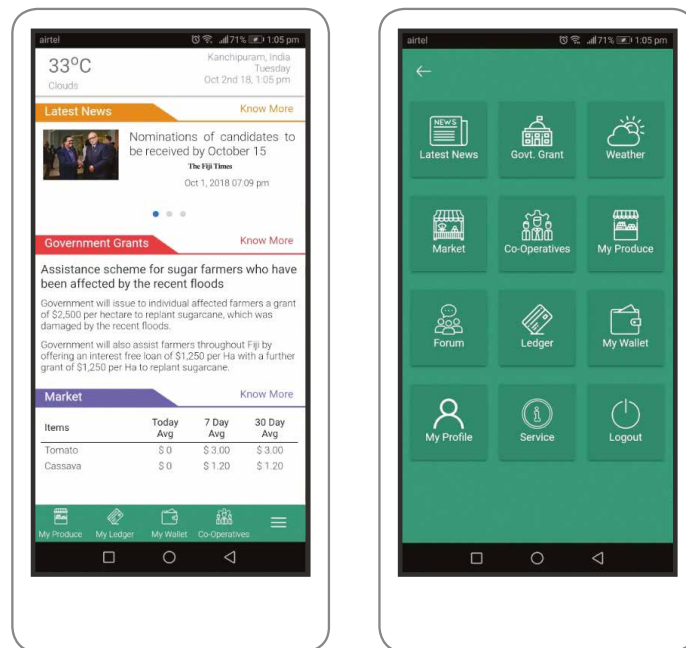
At full deployment, the Papua New Guinea PacFarmer tool will include five main channels, which together will help alleviate the market access gap. A market information channel disseminates general information to farmers, including sector-focused news and alerts. A digital marketplace links crop buyers and producers. Myproduce channel enables farmers to track the market prices of various crops. Myledger channel allows the user to track their sales and expenses, creating a foundation to build a credit profile and deeper financial inclusion. Where possible, the other four channels will be integrated to a fifth channel – mobile money – which allows the farmer to receive digital payments for their crops. In Fiji, PacFarmer is linked to partner Vodafone’s M-PAiSA mobile money service, but a mobile money service has not yet been identified in Papua New Guinea.

During the initial pilot phase, the PacFarmer app will only include the market information channel, the digital marketplace and the Myledger channel.

Figure 20

Source: PacFarmer

PacFarmer app user interface



The PacFarmer app is likely to face several barriers in Papua New Guinea, the biggest of which is arguably the low penetration of smartphones, estimated at seven per cent of the total population and likely lower in remote farming areas. 3G/4G network coverage and the cost of data are also likely barriers, although government agencies and MNOs could presumably find creative solutions to subsidise usage, at least at the outset. Papua New Guinea's low digital literacy and mosaic of over 800 languages will likely present an additional hurdle, and a version using the local Tok Pisin language may be required early on.

Beyond this initial pilot phase, the tool's long-term viability also depends on UNCDF's ability to hand over

management of the tool to a third party, whether an AgriTech that can find a way to monetise the service or a government agency like CIC that is invested in the tool's long-term success.

These hurdles notwithstanding, the roll out of PacFarmer is a bet that mobile broadband network coverage and penetration in Papua New Guinea will continue to grow. In a market where literacy and education levels are generally low, the ability to offer simple, picture-based tools will be vital to long-term adoption and success. By providing clear, useful, easy-to-use and life-enhancing solutions for farmers, mobile apps like PacFarmer can serve as one of the drivers of mobile broadband adoption in farming communities.

6.2. FARMIS mobile app for information dissemination to farmers

In 2018, the FPDA developed the FARMIS⁸⁶ app, a one-stop information portal with end-to-end solutions for farmers growing fresh produce in Papua New Guinea. The FARMIS app, launched in July 2019, is an example of a mobile-enabled digital tool for disseminating information.

The app provides information on market prices and weather and crop advisory services that can be tailored to farmer needs, such as pest and disease management information, or crop and agromet advisory.⁸⁷ Additionally, FARMIS informs farmers on the availability of inputs for major crops in real time and offers a tool for farmers to enter all their crop expenses and keep track of daily expenses. All content is provided by FPDA.

Besides relevant content, the app is designed to include a number of useful features and functionalities, such as a messaging platform for direct interaction with technical experts on crop agronomy and management; farm calculators to help farmers understand how to maximise the financial efficiency of their operation; news and event reports; and interactive voice and text recognition through natural language processing for disabled and visually impaired farmers and users (ChatBot).

The FARMIS app is hosted and managed by FPDA. The app is built for Android OS and is available as a free download from the Google Play store. Users are responsible for the cost of data. The content is available in English and Tok Pisin, and the plan is to eventually include audio assistance to support farmers with low literacy levels.⁸⁸

86. FARMIS: Fresh-Produce Advisory Resources Market Information Services

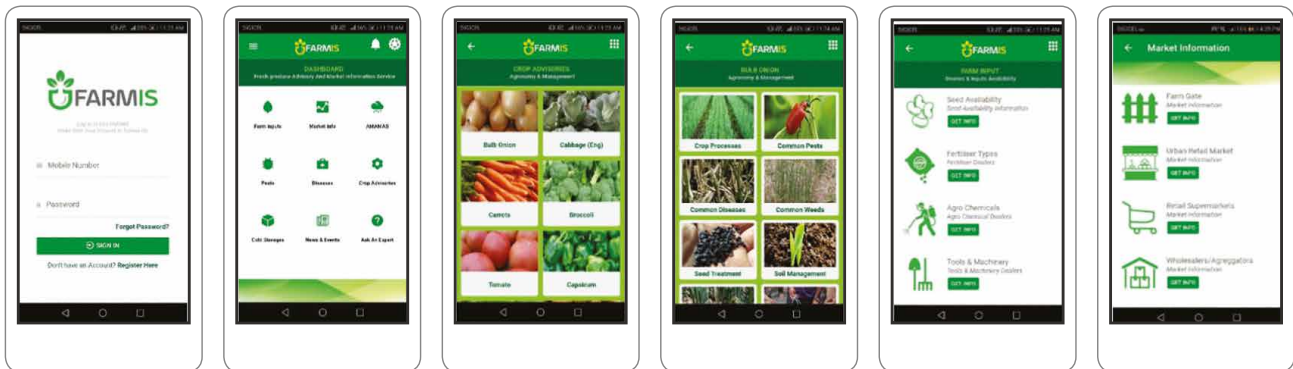
87. Weather information-based crop/livestock management strategies and operations dedicated to enhancing crop production by providing real-time crop and location-specific agromet services with outreach to rural communities.

88. GSMA, 2019, "Digital Transformation, The Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/resources/digital-transformation-the-role-of-mobile-technology-in-papua-new-guinea/>

Figure 21

Source: FPDA, NICTA, DAL and ITU

FARMIS app user interface⁸⁹



The FARMIS app replaces Mobile Market Information Services (MOMIS), an SMS-based information dissemination tool launched by the FPDA in 2009 with the same objective. Funded by the Australian Agency for International Development (AusAID) via the Agricultural Innovative Grant Scheme (AIGS), and operated in partnership with mobile operator Digicel, MOMIS allowed smallholder farmers to send text messages to a shortcode to request and receive information on the price, supply and quality of 12 different fruits and vegetables in eight different urban markets in Papua New Guinea.⁹⁰ The service failed to gain much traction due to a combination of factors, including the cost to the farmer, which at approximately \$0.10 per SMS was perceived to be too high, and occasional information gaps that made the content unreliable or outdated. MOMIS was shuttered in 2018.

For implementing partners, the design of the FARMIS app raises some important considerations. Use of the service requires the user to own a smartphone. With a national smartphone penetration rate of just seven per cent and the majority of smartphone users located in urban areas, service adoption is expected to be limited initially and highly dependent on farmers' access to low-cost, reliable smartphones. While tech literacy is likely to remain a critical obstacle, the cost of data access may also deter users from using data-heavy pieces of content like photographs unless there is a clearly defined value proposition for them. Finally, limited 3G+ network coverage in rural areas where most farmers are located might limit use of the FARMIS app to semi-rural areas close to urban centres and major network-covered transportation arteries.

89. ITU, 2018, "The Need for Developing National E-agriculture Strategy", Mollina Mercy Kapal and Glen Hayoge. Available at: <https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/SiteAssets/Pages/E-agriculture-Solutions-Forum-2018/Molina.pdf>

90. The 12 fruits and vegetables tracked by MOMIS included: avocado, beans, broccoli, cabbage, carrots, garlic, onion, orange, pineapple, Irish potato, sweet potato and tomato. The eight metro areas covered included: Port Moresby, Goroka, Lae, Mt. Hagen, Kokopo, Medang, Wewak and Popondetta. Available at FPDA.

6.3. PNGAC deploys Farmforce's enterprise tool to facilitate access to formal credit

In 2016, the Cocoa Board of Papua New Guinea and i2i Development, an Australian firm focused on indigenous development projects, used funding from the Australian government to design a new agribusiness model and in 2018 launched the Papua New Guinea Agriculture Company (PNGAC), an independent, farmer-owned aggregator and exporter of cocoa.

The PNGAC's mission is to increase smallholder farmers' incomes and improve their livelihoods through helping them capture a higher share of the cocoa supply chain, produce higher volumes of high-quality cocoa beans, implement efficient cocoa bean drying methods and control a higher share of direct exports of both raw and processed cocoa beans.⁹¹ The PNGAC purchases cocoa beans directly from farmers who are the company's main shareholders. At the moment, the PNGAC is running a pilot in East New Britain Province, with four cooperatives and 250 cocoa farmers among its founding shareholders. Nearly 10,000 farmers are currently waiting to become shareholders.

As part of its plan to empower cocoa farmers by instilling more structured, disciplined and consistent processes in the growing and sale of crops, the PNGAC has selected Farmforce, a mobile and web-based farm management software, to drive productivity improvements and introduce traceability and certification compliance processes.

The mobile interface of Farmforce's digital tool used by PNGAC field officers is a purpose-built Android OS app. Field officers equipped with smartphones use Farmforce for digital collection of farm and farmer data, such as farm size and geolocation, soil quality and crop growing activities at different phases of the production process, from planting to harvesting. Data

is collected at various intervals every time a field officer interacts with the farmer.

The app allows for online and offline data collection, permitting field officers to gather data in areas with poor mobile network coverage. The data is then synced to the office server once the user is within coverage.⁹² The PNGAC's operating model also includes Bluetooth-enabled digital scales that field officers use at cocoa procurement points. The scales feed procurement weights to the Farmforce app while a Bluetooth printer is used to issue paper receipts to farmers. Barcode scanning is also available in the mobile app for post-harvest traceability.⁹³

While Papua New Guinea cocoa is generally well regarded, inconsistent quality means that most of the country's cocoa exports end up in the Asian bulk market and yield lower prices for farmers.⁹⁴ Analysis of data gathered by field officers allows the PNGAC to monitor and optimise the growing of cocoa while improving the quality of the beans. For example, the PNGAC can design and deliver in-person training to farmers focusing on activities most likely to increase cocoa bean quality. Farmforce therefore is instrumental in the PNGAC's efforts to help farmers produce quality cocoa beans that can be sold on the premium cocoa market.

In addition, the Farmforce app allows the PNGAC to strengthen monitoring and certification compliance processes, introducing consistency to cocoa-growing activities. By tracking production to the farm plot, the PNGAC will also be better able to trace the source of its beans, a critical requirement for the certification standards that are essential to the premium cocoa market.

91. The National, 2018, "Cocoa Board forms company to help growers." Available at: <https://www.thenational.com.pg/cocoa-board-forms-company-to-help-growers/>

92. i2i Development Projects Pty, 2018, "Reducing poverty through technology and an inclusive agribusiness model," Brad Jackson. Presented at the APEC Study Centres Consortium Conference, Port Moresby, May 14-15 2018.

93. Ibid.

94. PHAMA, 2017, "Papua New Guinean Specialty Cocoa, Technical Report 107." Available at: <http://phama.com.au/resources/technical-reports/papua-new-guinean-specialty-cocoa/>

Figure 22

Source: i2i, Farmforce

Bluetooth-enabled digital scales and receipt printer



Another area where use of the Farmforce app can be beneficial is improving farmers' access to finance, a considerable challenge for many smallholders in the country. Nearly 97 per cent of smallholder land in Papua New Guinea is held under customary tenure, which cannot be used as collateral when applying for credit at a financial services provider.⁹⁵ To address the challenge of smallholder farmer financing, the PNGAC has partnered with the Asian Development Bank's Pacific Private Sector Development Initiative (PSDI) and microfinance institution MiBank to offer farmers a clearer path to digital financial inclusion.

Here, the Farmforce tool is used at two levels. First, as a source of foundational data on the productive capabilities of the farmer based on the characteristics of their plots and other factors. This data forms the basis

for a forward sales contract between a farmer and the PNGAC. The Farmforce app's digital footprint is also populated with farm and farmer data that can help farmers forge an economic identity. When shared with the bank, the combination of a farmer's digital footprint and their forward sales contract can be used to assess the farmer's creditworthiness and allow access to credit. Once the cocoa harvest is sold, the farmer receives their proceeds net of the loan repayment to the bank.

The project is still in the pilot stage. In April 2019, the PNGAC's bank partner awarded its first loan under the programme. The PNGAC aims to have 130,000 farmer shareholders within 10 years and a direct, positive financial impact on at least a million people. If successful, the PNGAC model would be extended to other agricultural crops.

95. Australian High Commission in PNG, 2018, "Smallholder farmers in PNG struggle to access finance." Available at: <https://www.facebook.com/AusHCPNG/posts/smallholder-farmers-in-png-struggle-to-access-finance-with-97-per-cent-of-land-i/1802407849836929/>

6.4. SP Brewery employs enterprise tool to develop reliable sourcing to beer supply chain

A subsidiary of Heineken International, South Pacific Brewery Limited (SP Brewery) has been operating in Papua New Guinea since 1951. The company is the largest brewery in the country,⁹⁶ producing upwards of 60 million litres of beer annually,⁹⁷ with around 400 staff in its premises in Lae and Port Moresby. The importation of barley has long been a central part of the brewing process for SP Brewery. As production expands, so does the need to import larger volumes of barley, an increasingly costly activity due to the declining value of the national currency, the kina, on foreign exchange markets, and other challenges tied to cumbersome administrative red tape and import controls. To address this challenge, SP Brewery has been exploring alternatives to imported barley.

In 2018, SP Brewery committed to replacing the equivalent of up to 10 per cent of its 2018 imported barley volumes with locally grown starch flour from cassava. To achieve that, the company invested around \$2.5 million (PGK 8 million) in building a cassava starch factory in Erap, around 50 kilometres from Lae in Morobe Province, and committed to source its cassava from 450 local smallholder farmers. Under the project, SP Brewery, working in partnership with the IFC will engage smallholder farmers to grow and supply cassava to the Erap starch factory; the cassava will then be transformed into flour and mixed with the starch syrup to brew local SP beer.

Critical to the initiative is the need to build a steady, visible and reliable supply of local cassava, meeting the stringent requirements of the brewing process to ensure no deterioration in the taste of the beer. For example, of the more than 600 varieties of cassava in Papua New Guinea,⁹⁸ not all are appropriate for brewing, making a rigorous growing process vital.

To address these challenges, SP Brewery has partnered with Farmforce to build digital profiles of its 450 cassava farmer suppliers that include information on farm location, intercropping,⁹⁹ distance to the starch processing factory and soil data, among others. SP Brewery field extension officers use Farmforce's purpose-built Android OS app on company-provided tablets to streamline data collection. Like previous digital initiatives that used the Farmforce enterprise tool, data can be collected in either online or offline mode and synced once data connectivity is restored.

The enterprise digital tool allows an extensive repository of information on farmers and their farms. Last-mile data captured by the brewer is then analysed and used to improve real-time visibility in the supply chain, assess crop production capability and introduce predictability in sourcing. For example, plot location may be adjusted and optimised to maximise yield and preserve the cassava from external flavour contamination. SP Brewery's agricultural extension team will also leverage information from the farmer profiles to monitor training progress, prioritise interventions and provide advice to address specific farmer needs.

For SP Brewery, the Farmforce digital tool has potential to streamline the cassava cultivation and sourcing process and create operational efficiencies that can help to reduce the cost of production. The current roll-out across 450 cassava farmer suppliers is at pilot stage. If the initial pilot is successful, SP Brewery will look to expand its farmer base to around 1,000, providing a foundation for the cassava industry to begin downstream processing in Morobe and other provinces of Papua New Guinea.

96. Business Advantage PNG, 2019, "SP Brewery MD Sees Better Future for Manufacturers in Papua New Guinea." Available at: <https://www.businessadvantagepng.com/sp-brewery-md-sees-better-future-for-manufacturers-in-papua-new-guinea/>

97. Loop PNG, 2016, "SP Export Lager Recognised at International Level." Available at: <http://www.looppng.com/content/sp-export-lager-recognised-international-level>

98. Business Advantage PNG, May 2015, "SP Brewery aims to bolster Papua New Guinea agriculture sector with cassava project." Available at: <https://www.businessadvantagepng.com/sp-brewery-aims-to-bolster-papua-new-guinea-agriculture-sector-with-cassava-project/>

99. Understanding an intercropping plan is important as the proximity of cassava to certain crops (e.g. spices) can affect flavour.



6.5. Olam's digital tool supports business sustainability targets

Global commodity buyer, Olam, is one of the largest buyers and exporters of cocoa in Papua New Guinea. The company began operating out of East New Britain Province in 2000. Today, Olam is active across Papua New Guinea's cocoa-producing regions, with seven buying locations around the country. Olam also exports coffee beans from the Highlands and Morobe Provinces.¹⁰⁰

As a large player in global agricultural value chains, Olam has developed a suite of proprietary apps it uses to monitor and manage its last-mile operations. The apps are part of a broader portfolio of digital solutions used at different steps in the supply chain, from farmer registration and monitoring to crop aggregation and purchasing. The apps are deployed globally, affording Olam a global view of its operations, with country variations tied to local context.

In Papua New Guinea, the primary digital app implemented by Olam is Olam Farmer Information System (OFIS). Olam uses the OFIS app across a number of countries and crops, such as cocoa, coffee, cashew and cotton, to address the company's procurement needs.¹⁰¹ The OFIS app is used to support

Olam's sustainability programme through improved farmer management and extension services. For the cocoa value chain, understanding the location, type and quality of the cocoa fermentary is central to assessing and managing the quality of the fermented beans. The information is collected by field extension officers at onboarding phase and updated during regular visits through OFIS-equipped Android smartphones. Due to network coverage limitations and data service costs, the information is typically collected offline and synced once data connectivity is restored. Using OFIS, Olam is able to collect and analyse detailed farm and farmer data, including farmer demographics, farm location and size, number of trees and more.¹⁰²

Data analysis empowers Olam to achieve in-depth visibility into its supply chain, allowing it to forecast and monitor production and plan accordingly. The additional transparency helps Olam address the sustainability concerns of its customers while supporting its own sustainability initiatives. The app also allows the company to better calibrate its agricultural extension support, developing personalised plans to improve the quality of crops and sending extension officers where they are most needed.

100. Olam, 2018. Available at: <https://www.olamgroup.com/locations/asia/papua-new-guinea.html>

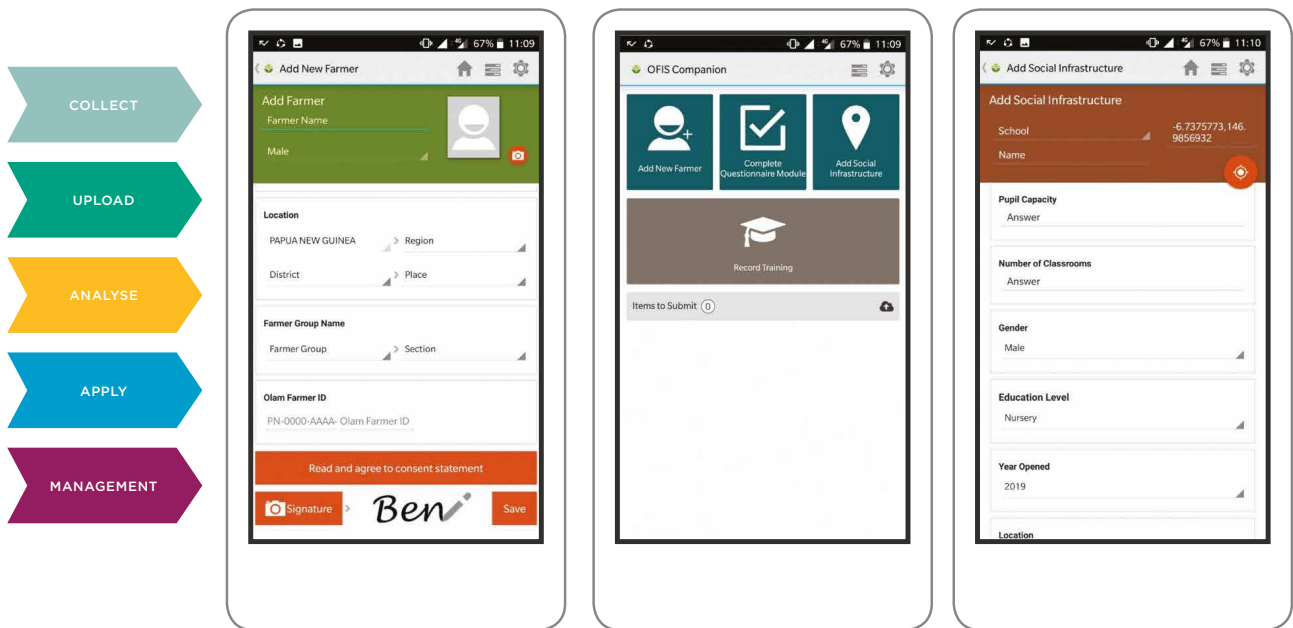
101. By the end of 2018, around 248,850 farmers were registered and more than 187,230 farms mapped on OFIS globally. Olam, 2019, "Re-imagining Olam." Available at: https://www.olamgroup.com/content/dam/olamgroup/investor-relations/ir-library/annual-reports/annual-reports-pdfs/olam-annual-report-fy18_strategy_report.pdf

102. Olam, 2019. Available at: <https://www.olamgroup.com/sustainability/reimagine/olam-farmer-information-system.html>

Figure 23

Source: Olam

OFIS snapshots



Across Papua New Guinea, over 4,200 cocoa farmers are now profiled on the OFIS app. Over time, this initial enrollment base is expected to form the foundation for the deployment of Olam’s broader suite of digital apps, potentially allowing deeper integration with services as adoption increases, such as mobile payments.

Section 6 offered evidence that private-sector organisations tend to lead the development of

digital interventions in Papua New Guinea. To maximise the socio-economic impact of the digital channel and achieve development goals, donors and impact investors need to consider the current digital agriculture landscape before investing in new solutions. The following section assesses the opportunity for digital transformation in Papua New Guinea’s agriculture sector with an emphasis on Morobe Province.

7. Opportunity assessment for digital interventions with a focus on Morobe Province

7.1. Weather monitoring and forecasting tools

Climate change represents an ongoing threat to the people of Papua New Guinea and other islands in the Pacific region. Much of the early attention and investment have been focused on making the country's infrastructure more resilient to extreme weather events. However, better early warning systems and weather forecasting tools still need to be built to enable farmers and agribusinesses to develop more appropriate adaptation strategies. Mobile-enabled digital tools can play a pivotal role, not only in the dissemination of weather forecasts and early warning information, but also in the provision of agro-economic advice that can help agricultural stakeholders act on the data they receive.

MNOs can play a variety of roles in the delivery of weather forecasting and advisory services. They can

play a passive role whereby third parties leverage the MNO's network, and potentially its geolocation capabilities, to offer weather forecasting services to end users. MNOs can also play an active role by investing in weather monitoring infrastructure, placed alongside radio base stations, and leverage the data that is collected to build a suite of services for individual and commercial end users.¹⁰³ Microwave rainfall monitoring is a relatively new area that involves analysis of radio spectrum propagation and degradation to conduct weather monitoring, which takes advantage of the fact that electromagnetic signals are weakened by certain weather conditions, especially rain. Rainfall monitoring using microwave links has been proven to provide accurate mapping and measurements in places like the Netherlands,¹⁰⁴ Nigeria and Sri Lanka.

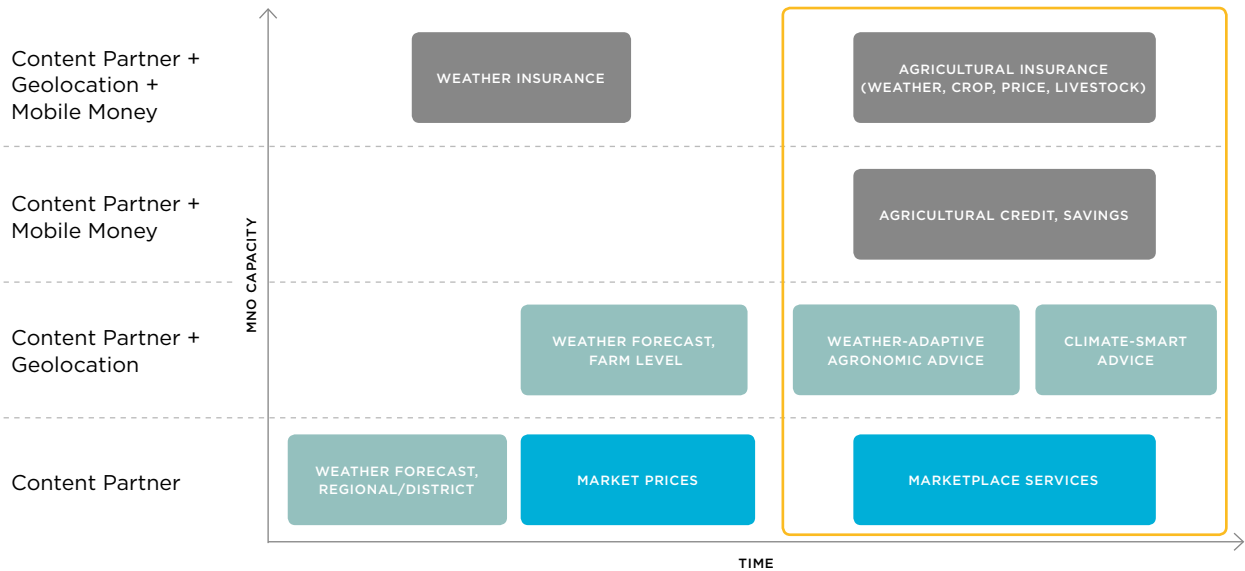
103. GSMA, 2016, "Weather Forecasting and Monitoring: Mobile Solutions for Climate Resilience." Available at: <https://www.gsma.com/mobilefordevelopment/resources/weather-forecasting-and-monitoring-mobile-solutions-for-climate-resilience/>

104. Ibid.

Figure 24

Source: GSMA

Evolution of mobile-enabled weather forecasting solutions



To convert weather data into actual services that provide value to farmers and agribusinesses, MNOs need to form viable partnerships, either directly or through content providers, with ecosystem players (weather and agriculture experts) that can interpret the data and develop relevant services. The ability to interpret and explain weather data in a meaningful way is central to any weather forecasting service, but it is especially important for services targeting low-income users.¹⁰⁵ In the context of Papua New Guinea, service providers should consider teaming up with organisations that already collect weather-related information, such as Papua New Guinea’s National Weather Service (PNGNWS), as well as with other groups tackling the challenge of climate change, such as the Climate Change Development Authority (CCDA), the Australian Centre for International Research and UNDP.¹⁰⁶

The success of any model depends on consistently available, highly accurate and localised information.¹⁰⁷

In other developing economies, the GSMA has observed that when service providers offer frequently updated and accurate localised information, mobile users will access weather information more often than other types of agricultural value-added services (VAS).¹⁰⁸ To offer highly accurate and localised weather information, investment must be made in a large network of weather stations. Although the cost of buying and maintaining weather stations has decreased in recent years, it is still out of reach of Papua New Guinea’s cash-strapped government agencies, which is why the country often relies on donors to acquire weather station technology. Getting weather stations into the country has also proven a challenge due to import restrictions. Once in place, weather stations are also subject to vandalism and the solar units that power the stations are subject to theft. These are challenges that need to be taken into account to ensure the continuous provision of timely and accurate data.

105. Ibid.

106. Australian Centre for International Agricultural Research (ACIAR), 2017, “Engaging agricultural communities in climate resilient food production adaptation: a Papua New Guinea highlands case study.” Available at: <https://www.aciar.gov.au/project/ASEM/2016/041>

107. PNGNWS, for example, uses its own network of weather and climate observation stations to collect weather information and provide advisories for the four main regions in Papua New Guinea and for approximately 20 different cities in the country. Although farmers occasionally access this information via their mobile phones and other media, the information is not useful enough to be their primary source of information when making decisions as it is not localised enough to address farmer needs.

108. GSMA, 2016, “Weather Forecasting and Monitoring: Mobile Solutions for Climate Resilience.” Available at: <https://www.gsma.com/mobilefordevelopment/resources/weather-forecasting-and-monitoring-mobile-solutions-for-climate-resilience/>



Weather forecast and advisory information must be provided in a consistent way across various media. Since farmers trust their observations and the opinion of church and community leaders more than they trust media and third-party material, the information they receive via a mobile-powered tool must be consistent with what they receive from extension officers, other digital tools and, most crucially, church and community leaders. Getting church and community leaders to embrace the digital tool will be critical to its success. One way to facilitate this engagement is to enable two-way communication on the tool, so that users can provide feedback on the information received in real time. The ability to link weather information with specific agronomic advice that is dynamically linked to localised weather insights would also make the service more valuable.

In addition to content, service design is also important. Papua New Guinea's low digital literacy rates, as well as its multiplicity of languages, creates a unique set of considerations. Since the majority of farmers do

not own a smartphone, voice or SMS-services may be preferable to app-based solutions. Understanding how users consume information is also critical. Telenor Pakistan and Vodafone Ghana, for example, provide contextual weather information (e.g. descriptions of the conditions) rather than specific data points (e.g. degrees Celsius, millimetres of rainfall) that the farmer may not be able to interpret and apply.¹⁰⁹

As with any agricultural value-added services (Agri VAS), working toward commercial sustainability with a weather forecasting and advisory service is an important goal for service providers. An initial challenge for many MNOs considering launching a service is the capital expenditure (CapEx) that may be involved. CapEx may be minimised by partnering with existing vendors who are already invested in the service and willing to share or bear the development costs. In the past, MNOs have found ways to reduce CapEx to as little as 10 per cent of the total budget by engaging their existing ecosystem of vendors and service providers.

7.2. Agricultural payment digitisation

With most farmers in Morobe Province's rural areas lacking access to formal financial services, agribusinesses still rely on cash for a substantial proportion of their procurement payments.

Digitising payments using mobile money offers significant opportunities for key agricultural stakeholders in the broader payments ecosystem.

¹⁰⁹. Ibid.

Opportunities for key agricultural sector stakeholders arising from the digitisation of farmer payments

FARMERS	MOBILE MONEY PROVIDERS	GOVERNMENTS AND AGRIBUSINESSES
<ul style="list-style-type: none"> ◦ Time and cost saving – saving time and associated cost of travelling to either collection centres where farmers are paid for produce or where they cash in subsidies. ◦ Efficient cash management – with mobile money, farmers no longer receive lump sums of cash, which they tend to spend as the cash comes in. ◦ Financial identity – for unbanked farmers, mobile money enabled agricultural payments offer the potential to create a financial identity (transactional records) that can open the door to a broader range of agricultural financial services, such as savings and credit. ◦ Convenience – digitised payment is quick and convenient for users, and can give access to a larger digital commerce ecosystem. For example, some farmers are already using mobile money to pay utility bills and school fees. 	<ul style="list-style-type: none"> ◦ Direct revenue from digitising B2P and G2P payments <ul style="list-style-type: none"> • B2P payments – Formal agribusinesses and cooperatives that procure agricultural produce from farmers are willing to pay for digitising payments to farmers. • G2P payments – Governments that make payments to farmers use mobile money to distribute funds more efficiently. ◦ Indirect benefits for mobile operators around improving operational key performance indicators (KPIs) in rural areas. 	<ul style="list-style-type: none"> ◦ Cost – Digitised transactions lower the costs of withdrawing, transporting and securing cash and distributing payments. ◦ Efficiency – Mobile money can facilitate real-time and scalable payments to smallholder farmers across multiple locations. ◦ Accountability and transparency – Mobile money can help mitigate cash handling risks, such as theft and fraud, and enables transparent and traceable transactions with smallholder farmers.

The GSMA AgriTech programme estimates that the value of formal agricultural B2P value chain payments in Papua New Guinea could be as high as \$608.3 million in 2019 and grow to \$764.8 million by 2025. For mobile money providers, this represents a direct revenue opportunity of up to \$1.5 million in 2019, increasing to \$2.2 million by 2025, which would come from charging bulk payment fees to facilitate the transactions. Cash withdrawals are another source of direct revenue, although withdrawals hinder

ecosystem development and additional revenue opportunities from transactions (P2P, bill payments, merchant payments) as the e-money is converted into cash. However, mobile money providers stand to benefit not only from the direct revenue opportunity, but also indirectly through the acquisition of new users, greater loyalty, higher frequency and volume of transactions and increasing overall activity on mobile money accounts to support a sustainable agent network.¹¹¹

110. GSMA, 2016, "Market size and opportunity in digitising payments in agricultural value chains." Available at: <https://www.gsmaintelligence.com/research/?file=29e480e55371305d7b37fe48efb10cd6&download>

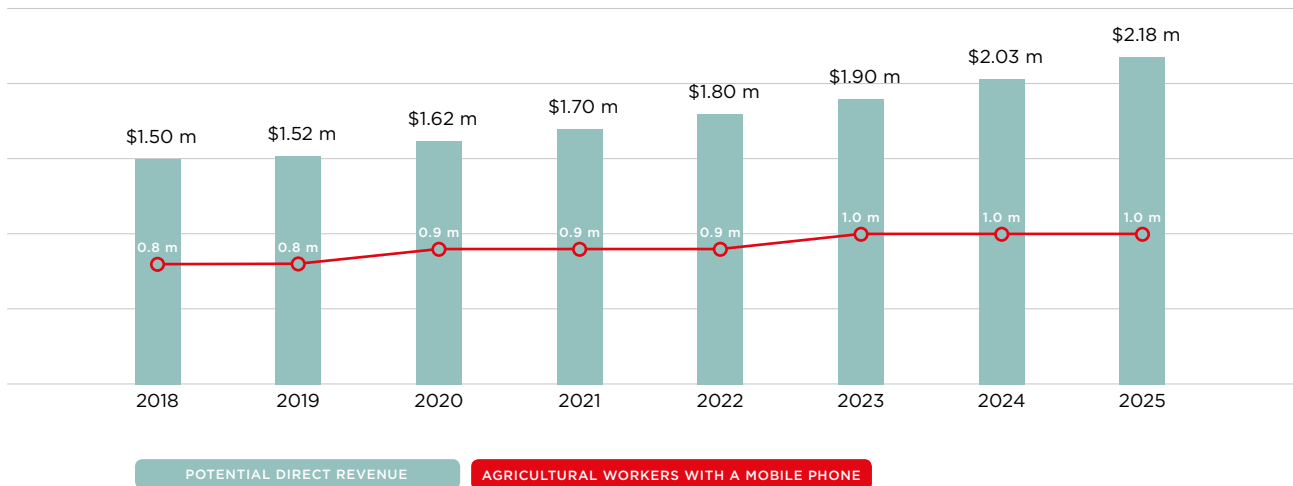
111. Ibid.



Figure 26

Source: GSMA

Potential direct revenue opportunity in agricultural B2P payment digitisation for mobile money providers in Papua New Guinea



In recent years, there have been several initiatives in Papua New Guinea to move away from cash transactions. Most of these initiatives have involved partnerships between agribusinesses and financial services institutions, often with the support of donor agencies. The success of these initiatives has been uneven, with some value chains, such as palm oil, seeing higher rates of payment digitisation than others (e.g. coffee and fresh produce). To date, MNOs have played a relatively passive role in these digitisation initiatives, in some cases providing the underlying network for the transactions to be processed. As of August 2018, for example, Digicel was processing more than a million financial transactions per month, primarily through its bank partners.¹¹²

For digital payments to achieve scale, MNOs must drive their own mobile money services. Mobile operators are in a unique position to leverage their extensive distribution network to reach the agricultural last mile and expand rural financial inclusion. To be successful, this ownership model will depend on the ability of

MNOs to invest in developing a mobile money services ecosystem that addresses the needs of users, including those in rural areas. Besides agriculture-specific mobile money use cases like agricultural savings and credit (see Section 6.3), related use cases like utility bill and school fee payments are just as critical to facilitate mobile money adoption in rural areas.

Digicel is aiming to relaunch its mobile money service later in 2019, leveraging its airtime agent network selling flex¹¹³ and electronic top-ups as mobile money agents. For its part, bmobile-vodafone will evaluate the success and assess the feasibility of extending a mobile money deployment it is planning to launch in neighbouring Solomon Islands to Papua New Guinea.¹¹⁴

Given the current uncertainty around the roll out of Digicel's mobile money services, the ability to build a scalable and sustainable mobile money-based service in the short term may be limited. Once the mobile money services are live, their value for rural areas and

112. GSMA, 2019, "Digital Transformation, the Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/03/Digital-Transformation-The-Role-of-Mobile-Technology-in-Papua-New-Guinea.pdf>
 113. Flex cards are sealed plastic cards that contain a 13-digit voucher number that Digicel customers can purchase to top-up their account.
 114. GSMA, 2019, "Digital Transformation, the Role of Mobile Technology in Papua New Guinea." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2019/03/Digital-Transformation-The-Role-of-Mobile-Technology-in-Papua-New-Guinea.pdf>

customers can be increased dramatically if integrated with other digital tools for agricultural stakeholders.

When rolling out a mobile money network around last-mile digitisation projects, agent reliability and liquidity would need to be addressed. The GSMA has found that liquidity management specialists that work with lead mobile money agents can ensure there is no disruption in service.¹¹⁵ To mitigate the risk of insufficient float for mobile money agents, mobile money providers, such as MTN in Ghana, work with agribusiness partners to forecast demand and address any liquidity gaps with the help of lead agents. These MNOs deploy mobile agents in areas immediately after the disbursement of payments and for up to three days after the bulk of withdrawal activity occurs.¹¹⁶

Special consideration should be given to business models that make it easier for women to gain access to financial services, given all the obstacles that currently stand in their way (see Section 4.5.2). Women's Micro Bank is one entity that is committed to improving the livelihoods of women by providing financial services to rural women.

Ultimately, the attractiveness of mobile money to facilitate digital payments to farmers will depend on the cost of rolling out a service and the fees associated with bulk payments, cash withdrawals and transactions. Cost mitigation initiatives aimed at farmers may be necessary to stimulate the uptake of digital payments.

For example, agribusinesses may be willing to absorb the withdrawal fees associated with the payment. In cases where the agribusiness does not step in to absorb the fee, mobile money providers may opt to implement preferential withdrawal and transaction fees to farmers. While it is technically possible for mobile money providers with the latest generation of mobile money platforms to introduce preferential rates to farmers, the decision to do so must be considered against the sustainability of the business model. Service providers must balance the need to provide sufficient incentives to farmers to boost adoption, with the equally important need to ensure sufficient economic incentives for mobile money agents. Considering that commissions for mobile money agents are partially based on the volume of cash withdrawals, mobile money providers must ensure that when they introduce preferential pricing, their commission scheme is attractive enough to rural agents.¹¹⁷

An alternative to reducing or fully absorbing mobile money fees is to offer a holistic suite of enterprise solutions beyond just mobile payments. The GSMA AgriTech programme has found that when digital payments are combined with other last-mile solutions that enhance farmers' income potential, agribusinesses can offer a more compelling value proposition for farmers who are hesitant to abandon cash payments. In Ghana, for example, one agribusiness combines digital payments with digital scales, which has helped entice farmers to make the transition to digital.¹¹⁸

7.3. Digital enterprise solutions

For agribusinesses in Morobe Province, two major pain points are ensuring end-to-end traceability and certification and improving visibility into the supply chain. For local MNOs, supporting the commercialisation of digital enterprise tools for the last mile provides a compelling new opportunity to diversify their offering for rural customers beyond a B2C value proposition (see Section 6.2). To date, most of the tools that have been launched or are

in pilot stage have been proprietary, designed to address the specific needs of the agribusiness deploying the solution. Examples of these digital interventions include Olam's OFIS, which supports Olam's sustainability programme (see Section 6.5) and Farmforce, a mobile and web-based farm management tool that has been deployed in at least three digital interventions in Papua New Guinea in the last two years.

115. GSMA, 2017, "Opportunities in agricultural value chain digitisation: Learnings from Uganda." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/01/Opportunities-in-agricultural-value-chain-digitisation-Learnings-from-Uganda.pdf>

116. Ibid.

117. Ibid.

118. Ibid.



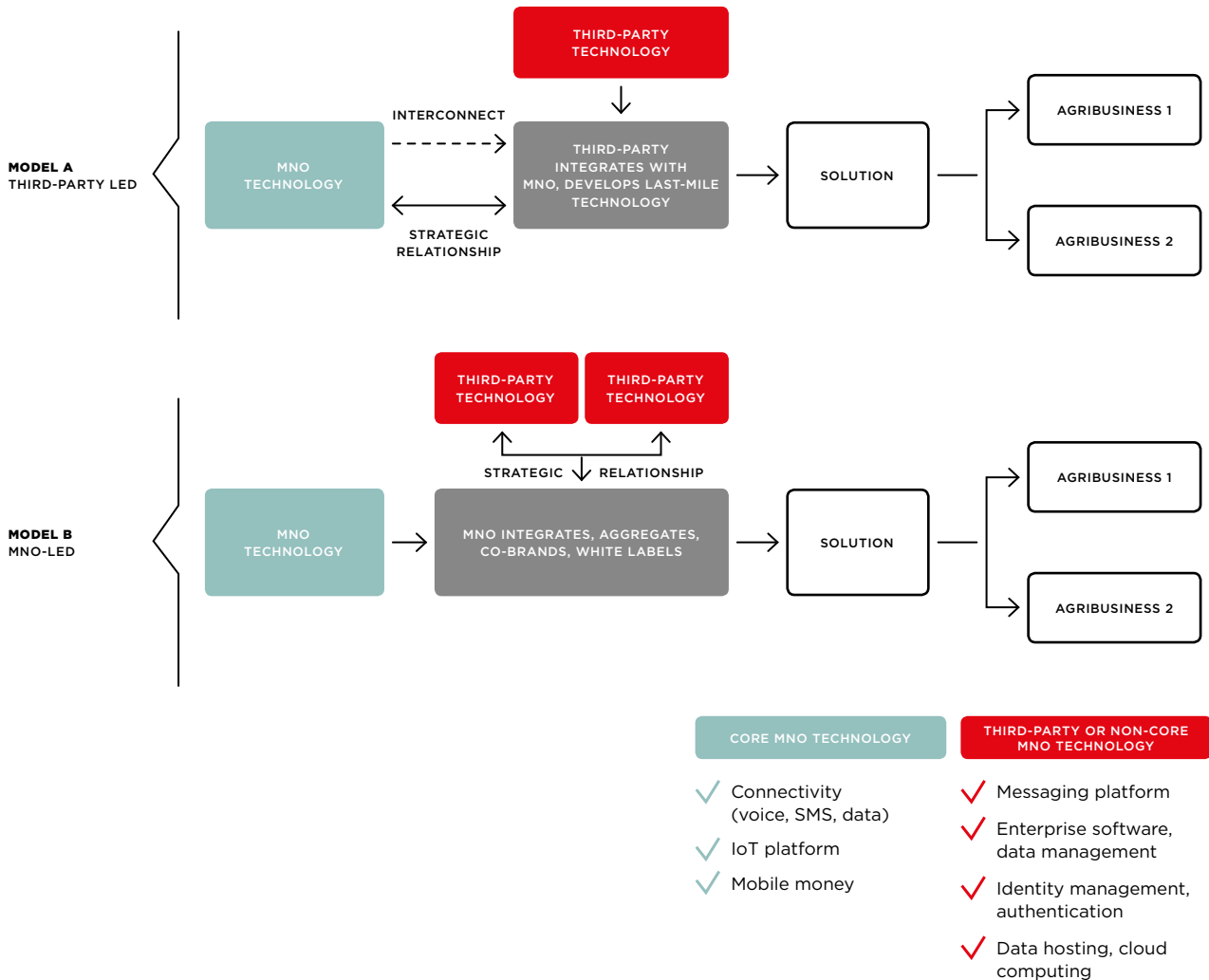
The GSMA has identified two broad models for offering digital tools to agribusinesses. Under the first model (model A in Figure 27), a range of third-party tech providers with different skill sets and capabilities use an MNO's core assets, such as connectivity and mobile money, to develop their own digital solutions and market them directly to agribusinesses. Under the second model (model B), the MNO partners with one or more tech providers in a market to package a

white-labelled or co-branded solution for agribusiness customers. Comparing the two models, it becomes clear there are incentives for MNOs and third parties in both, with opportunities to generate revenue from agribusinesses. In Papua New Guinea, given the limited number of institutional buyers participating in each value chain, and therefore the barriers to scaling and monetising a solution, a third party-led model has been the most popular.

Figure 27

Source: GSMA

Models for agricultural last-mile digitisation



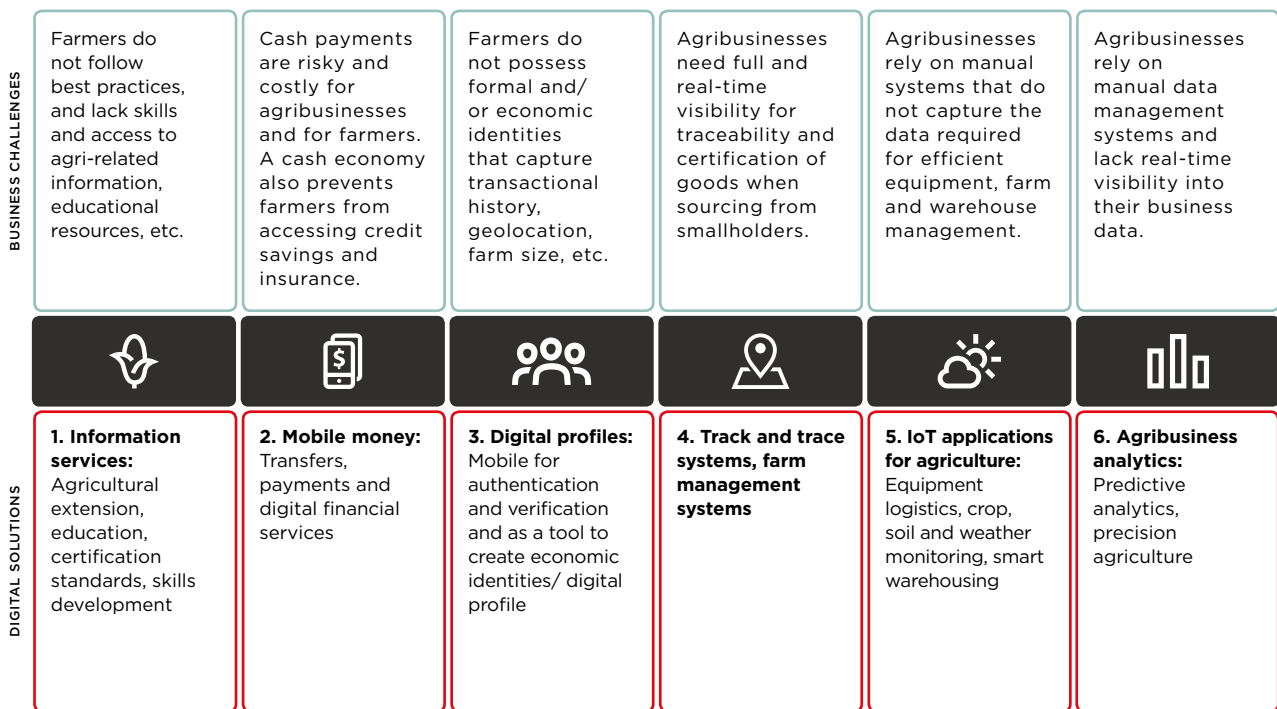
Under this third party-led model, there is an opportunity for local MNOs to form strategic partnerships with technology owners like AgriTechs to support the roll-out of digital last-mile tools that meet agribusiness demands for a comprehensive solution in business process management. This solution would extend all the way from an agribusiness's office through the entire supply chain down to the field staff and farmers. Partnerships like this will allow MNOs in Papua New Guinea to integrate their own mobile

money offerings when these become available for the rural segment, and support partnerships with financial services providers like MiBank that are beneficial for both parties and address smallholder farmers' need for credit. Such partnerships will also enable MNOs to enhance the value proposition for digital tools by integrating their own value-added advisory services (see Section 7.4) to increase the use of core services (SMS and voice), drive data usage and raise brand awareness.

Figure 28

Source: GSMA

Digital solutions to optimise last-mile procurement





In the realm of end-to-end traceability and certification, the palm oil value chain seems especially suitable for digitisation given the presence of Hargy Oil Palms and New Britain Palm Oil — two strong players with international backing in the industry (although only the latter is present in Morobe Province). Both companies have expressed interest in, or are in the process of building, a digital last-mile tool, and remain committed to exporting 100 per cent RSPO-certified palm oil. Their highly structured operations make digital interventions more likely to succeed.

Fresh produce represents a particularly attractive value chain for tools that improve visibility into the supply chain. Demand for traceable fresh produce is coming from international markets, including neighboring Pacific islands and China. China's interest in sourcing organic fresh produce from Papua New Guinea is such that it recently announced plans to invest \$600 million in an agricultural park in the Highland region. In Morobe Province, the presence of domestic agribusinesses keen to invest, such as NKW Fresh, also make the fresh produce value chain suitable for investment.

7.4. Agricultural extension support through information dissemination and access to markets

One of the major pain points for farmers in Papua New Guinea is a lack of relevant information, from crop prices to demand for crops in local markets, to agronomic advice on best practices to weather information. MNOs can play a variety of roles in the provision of information services to farmers. At one end of the spectrum, third parties can leverage an MNO's network connectivity to market information services to end users. At the other end of the spectrum, MNOs become owners of the service and take responsibility for the design, implementation and maintenance of Agri VAS. In the case of the MOMIS

text-based service, Digicel received weekly content from the FDPA and disseminated that via SMS to end users. Digicel was able to monetise the service by charging \$0.10 per SMS.

Customer retention is one of the key challenges for digital solutions that disseminate information to farmers.¹¹⁹ In addition to introducing service tools, such as reminders/notifications to increase engagement with idle users, delivering timely, personalised and localised content is one of the key ways to promote engagement and minimise attrition.

119. GSMA, 2016, "Case Study: IFFCO Kisan Agriculture App Evolution to Data Driven Services in Agriculture." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/10/IFFCO-Kisan-Agricultural-App.pdf>

Figure 29

Source: GSMA

The agriculture cycle and farmers' information needs at different stages

	PLANT	SEED	GROW	HARVEST	MARKET
PAIN RELIEVERS AND GAIN CREATORS: AGRI VAS SOLUTION (EXAMPLES)					
	<ul style="list-style-type: none"> Farmer success story (IVR) Farmer management course (IVR) Nutritional tips (SMS) Seasonal weather forecasts (SMS) 	<ul style="list-style-type: none"> Calls to agriculture specialists (helpline) Farming 'how to' tips (IVR) Farmer success story (IVR) Seed price information (SMS) 	<ul style="list-style-type: none"> Calls to agriculture specialists (helpline) Farming alerts on milestones, pests and diseases (SMS) Half-day weather forecasts 	<ul style="list-style-type: none"> Calls to agriculture specialists (helpline) Farming 'how to' tips (IVR) 1/2 day weather forecasts 	<ul style="list-style-type: none"> Market prices (SMS) Marketplace service
	↑	↑	↑	↑	↑
PAIN POINTS AND POTENTIAL GAINS FOR FARMERS					
MARKET ACCESS	<ul style="list-style-type: none"> Price trends and fluctuations Cost and availability of transport 		<ul style="list-style-type: none"> Accurate market pricing Potential price fluctuations 		<ul style="list-style-type: none"> Accurate market pricing Potential price fluctuations
INPUTS	<ul style="list-style-type: none"> Seeds/fertiliser availability, prices and locations 			<ul style="list-style-type: none"> Availability, cost and location of storage services Instructions for self-storage 	
AGRONOMIC ADVISORY	<ul style="list-style-type: none"> Crop and seed selection Land preparation 	<ul style="list-style-type: none"> Techniques to protect against and prevent disease and pest infestation Weather-adaptive planting advice 	<ul style="list-style-type: none"> Diagnose and treat disease and pest infestation Weather-adaptive growing advice 	<ul style="list-style-type: none"> Timing and methods of harvesting 	
WEATHER FORECASTS	<ul style="list-style-type: none"> Long-term (seasonal) weather forecasts Implications of local agro-environment 	<ul style="list-style-type: none"> Short-term, localised weather forecast (e.g. to know when to plant) 	<ul style="list-style-type: none"> Weather forecasts and implications for storage 		<ul style="list-style-type: none"> Long-term (seasonal) weather forecasts Implication of local agro-environment
FINANCIAL SERVICES	<ul style="list-style-type: none"> Credit and insurance (crop, weather, price insurance) availability, rates and contacts 	<ul style="list-style-type: none"> Credit availability and rates for non-farming activities 	<ul style="list-style-type: none"> Savings account rates and availability 	<ul style="list-style-type: none"> Credit and insurance (crop, weather, price insurance) availability, rates and contacts 	<ul style="list-style-type: none"> Credit availability and rates for non-farming activities



For agronomic advice, the GSMA AgriTech programme has found that timing content to the farming calendar has helped generate engagement. Beyond content, user-centric service design is critical, and low literacy levels may make pictures or audio functionality preferable. Information must be presented in a way that is familiar to farmers, and preferably in a language that the farmer can understand. Service registration also needs to be simple and straightforward. GSMA research suggests that 'one-click' registration has been key to driving uptake of value-added services. Onboarding processes that take longer than this lead to drop off during self-registration.¹²⁰

Information services are only useful if farmers can act on the information received. One of the findings from the failed MOMIS service was that having enhanced information did not always change farmer behaviour. For instance, farmers still opted to sell their produce at their local market despite knowing they could get a higher price at markets further away, as the cost and risk associated with transporting the crop cancelled out the benefits. One way to ensure that farmers can act on the information they receive is to enhance the value proposition by making information dissemination part of a more holistic suite of services that may include digital payment and digital marketplace functionalities. Unsurprisingly, both the PacFarmer and FARMIS apps currently include or will include these capabilities.

Given the challenges posed by transportation in Papua New Guinea, providing information on bus routes and schedules, crop pick-up times, infrastructure conditions (e.g. road closures, bridge collapses, flooding) and travel times, is an area that merits exploration. Information on the spare capacity of trucks travelling

to and from mines was a concept recently explored by start-up, Blackspace. The service would enable farmers to find out when trucks will be at specific pick-up locations near their farms; determine how much spare capacity is available; and reserve a share of the space to transport their crops to a buying point.

Once again, commercial sustainability is an important goal for any service provider considering introducing information dissemination services. Since low-income farmers are likely unwilling or unable to pay for the information, B2B monetisation models can also be pursued. To facilitate new revenue streams from B2B services, Agri VAS service providers could leverage the wealth of data they collect to build data analytics on farmers and farming practices, create detailed farmer profiles and explore opportunities for monetisation. For example, Agri VAS platforms can be used to promote the products and services of agriculture sector stakeholders like input suppliers through targeted marketing campaigns. In addition to general data analytics, Agri VAS tools are also well-suited to conduct customised research surveys for external clients by leveraging a service provider's relationship with farmers on their database.

It becomes evident that smallholder farmers and other agriculture-sector stakeholders must overcome some major challenges that impact their day-to-day activities. This report provides insights and recommendations on the potential of mobile technologies to play an active role in the digital transformation of agriculture in Papua New Guinea. Prioritising efforts to target these barriers in a collaborative and inclusive way will be key to ensuring maximum socio-economic impact towards a new digital future.

120. GSMA, 2017, "Creating scalable, engaging mobile solutions for agriculture: A study of six content services in the mNutrition Initiative portfolio." Available at: <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2017/07/create-scalable-engaging-mobile-solutions-agriculture.pdf>

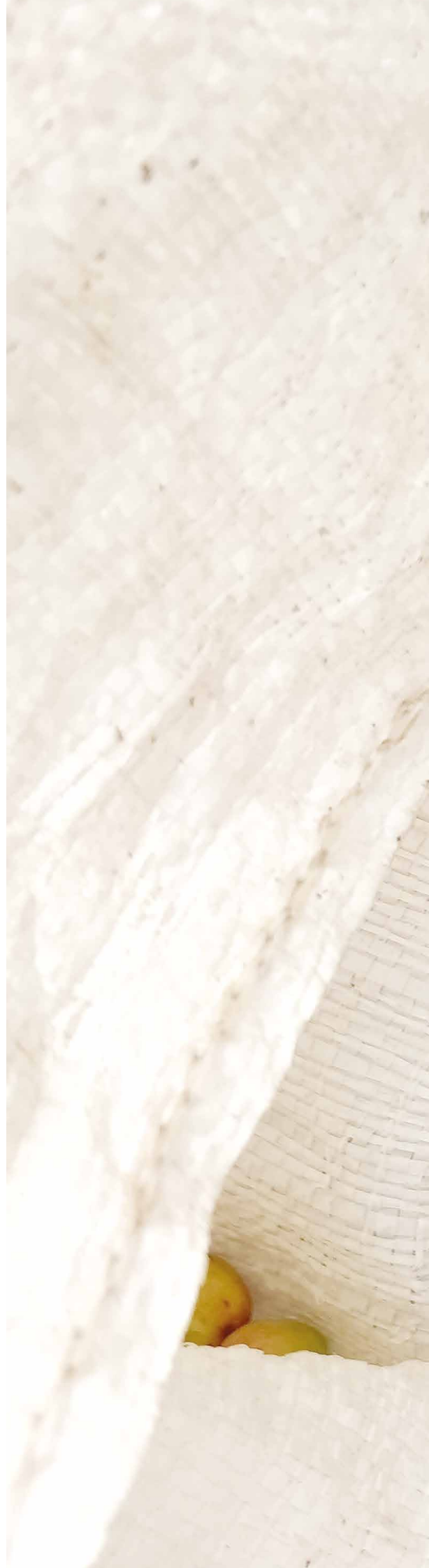
Future outlook

The objectives of this feasibility assessment are three-fold. First, to identify key challenges in the agricultural sector that have a negative impact on crop production and affect farmers, agribusinesses and other agricultural sector stakeholders. Second, to map recent and current digital interventions in agriculture, identify the key stakeholders and value proposition, and evaluate success and adoption. Third, identify context-specific opportunities for digitisation initiatives that can help address agricultural sector challenges and offer practical suggestions to project implementers.

In August 2019, the GSMA presented the findings of this study in a workshop in Lae, Papua New Guinea. The workshop was attended by a broad range of agricultural sector stakeholders, including agribusinesses, farmers, mobile operators, development and government agencies, donor organisations and financial institutions. Hosted in partnership with Grow PNG and the Lae Chamber of

Commerce, it reconvened those who had contributed to the original research for this report and welcomed others interested in participating in the digital transformation of the agricultural sector in Papua New Guinea. Together, participants prioritised digital interventions and efforts that would be needed to address barriers in a collaborative and inclusive way, which will be key to maximising socio-economic impact in Papua New Guinea's new digital future.

Coordinating efforts with other digital agriculture implementers appears to be a step in the right direction. Building strong partnerships around a common goal will lead to operational efficiencies and create value for all parties involved. A supportive ecosystem for digital interventions is vital to the success of any digital tool that aims to overcome barriers to value chain stakeholders realising their full potential and to support equitable and sustainable food chains that empower farmers and strengthen local economies.



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