



Markham/Ramu Agricultural Growth Corridor

A possible path of transformational agricultural development.

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I. Executive Summary

In recent years, there has been a growing interest in investments from the government, development partners and the private sector in integrated development/growth corridors and other spatial development initiatives, where coordinated investments in transport infrastructure, power, communications and markets are expected to create conditions to unleash Papua New Guinea's undoubted agricultural potential.

Growth corridor strategies are increasingly invoked to coordinate public and private investment around strategic backbone infrastructure in developing countries. Investments in soft and hard infrastructure to promote investment in processing zones or out-grower schemes and facilitate multi-stakeholder dialogue aim to overcome coordination failures and bottlenecks related to market linkages or producer-relations to secure supply chains.

This paper, the Markham/Ramu Agricultural Growth Corridor study, discusses the model of growth corridors as a tool for inclusive agricultural development in Papua New Guinea. It provides corridor and other spatial development approaches in terms of i) their geographical scope, ii) their objectives and iii) their governance mechanisms - the driving force behind the corridor initiative. Finally, it analyzes the potential and the needs of how the Markham and Ramu valleys can be a role model for an agricultural transformation in Papua New Guinea.

To better understand the potential of an agricultural transformation initiative, the historical, current and future potential of the two valleys were analyzed. A number of interesting opportunities to increase agricultural exports while decreasing the reliability of food imports were studied. These opportunities would not only be beneficial for the larger companies, but also enable the rural communities to participate in the growth of the agricultural value chains if projects are more holistically implemented. The micro, small, and medium-sized enterprises (MSME) sector could be a strong beneficiary in such an initiative.

The identified barriers and risk for investments are concerning. However, it needs to be pointed out that many countries were able to overcome these challenges in a number of corridor development projects which will be described as reference, therefore they should not stop the stakeholders in developing a vision for such an agricultural transformation plan.

In the second half of the study, a development path including an investment blueprint has been described but should not be seen as an all-encompassing final solution. It should be seen as a guideline and stimulus to start to develop visionary, sometimes outside of the box ideas and solutions for strengthening the agricultural growth in Papua New Guinea. It is highly recommended to work in joint effort and utilize synergies between individual projects in order to achieve the overarching goal.

The technical team consulted with a broad array of stakeholders from Papua New Guinea and internationally, too numerous to list here, receiving valuable input. The information presented herein is not exhaustive, however, and should not be relied upon for making investment decisions. Any inaccuracies are the responsibility of the technical team.

When the farmer is poor, then so is the whole country.

Polish Proverb

II. List of abbreviations, figures and tables

Abbreviations:

ADB	Asian Development Bank
AIFFP	Australian Infrastructure Financing Facility for the Pacific
AMDTP	Agriculture Medium Term Development Plan
BAGC	Beira Agricultural Growth Corridor
CCAFS	Climate Change, Agriculture and Food Security
CCDA	Climate Change and Development Authority
CF	Catalytic Fund
CGIAR	Consultative Group on International Agricultural Research
COVID-19	Coronavirus Disease 2019
CPI	Consumer Price Index
CSIRO	Commonwealth Scientific and Industrial Research Organization
DAL	Department of Agriculture and Livestock
DFAT	Department of Foreign Affairs and Trade
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMSC	Farm Management Service Companies
FPDA	Fresh Produce Development Agency
GBV	Gender-Based Violence
GSMA	Global System for Mobile Communications
ICTSI	International Container Terminal Services Inc.
IFAD	International Fund for Agricultural Development
ILG	Incorporated Land Groups
ISC	Infrastructure Services Company
JICA	Japan International Cooperation Agency
LDC	Livestock Development Corporation
LLB	Lease and Leaseback
MDF	Market Development Facility
MDP&F	Morobe District Planters and Farmers
MFAT	Ministry of Foreign Affairs and Trade
MM	Millimeter
MR	Markham/Ramu
MRACGP	Markham/Ramu Agricultural Growth Corridor Partnership
MSME	Micro, Small, and Medium-sized Enterprises
MT	Metric Ton
MTDP III	Medium-Term Development Plan III
NARI	National Agricultural Research Institute
NBPOL	New Britain Palm Oil Limited
NEROP	National Electrification Rollout Project
NFA	National Forest Authority
NFSP	National Food Security Plan
NGO	Non-Governmental Organization

PACD	PNG Agricultural Commercialization and Diversification Project
PGK	Papua New Guinean Kina
PHAMA	Pacific Horticulture and Agricultural Market Access
PNG	Papua New Guinea
MRAGCT	PNG Agricultural Growth Trust
PNGCCDA	PNG Climate Change and Development Authority
PNGDSP	PNG Development Strategy Plan
PPAP	Productive Partnership in Agriculture PNG
RMFZ	Ramu-Markham Fault Zone
SABL	Special Agricultural and Business Lease
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
UN	United Nations
UNDP	United Nations Development Programme
US\$	US-Dollar
WB	World Bank

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1. Introduction

Probably the most effective way to improve the lives of millions in poverty is by supporting the agriculture in emerging countries. Most of the world's poor are farmers. Consequently, transforming a country's agriculture sector can create jobs, raise incomes, reduce malnutrition, and kick-start the economy on a path to middle-income growth. In fact, almost every industrialized nation began its economic ascent with an agricultural transformation. Recent examples include Brazil, China and Vietnam, each of which at least doubled the value of its agriculture sector within 20 to 30 years of starting its transformation. Many other countries in Africa, Asia, and Latin America are earlier on the path of transformation.

The Markham/Ramu Agricultural Growth Corridor Development Scoping study comes at a critical time – a period of economic uncertainty marked by the Coronavirus Disease (COVID-19) outbreak, a challenging global policy environment for investment and trade, rising protectionism, shifting trade and investment preferences.

These forces are changing the patterns of international production and corporate decision-making, creating both opportunities and risks for investments in Papua New Guinea (PNG).

For the agriculture sector in PNG, COVID-19 amplifies the existing challenges, limiting required growth for job and income generation, food security and, consequently, political stability.

The private sector, the government and development partners tried to develop new business opportunities, models and sectors with limited impact upon agricultural development. One of the key reasons is that many successful projects are far away from each other, thus limiting the opportunity to create business clusters with a suitable environment for green and brownfield investments.

The main purpose of this study is to analyze whether an agriculture growth corridor strategy, which is increasingly cited as a developmental approach to promote economic transformation, could be used in PNG, specifically in the Markham and Ramu valleys. This more visible strategy would be employed to enable efficient investments in the agriculture sector, thereby leading into long-term investments and replication synergies.

1.1 Agricultural growth corridors

There has been a growing interest, in both the public and the private sector, in investments tied to integrated development corridors, where a coordinated plan encompassing transport infrastructure, power, communications and markets are seen to boost a developing country's agricultural potential.

Agricultural growth corridors are increasingly cited as a developmental approach to promote economic transformation towards higher productivity, improved employment and market opportunities across low-income countries, with agriculture as a focal sector. They have the potential to help reduce rural poverty, increase food and nutrition security, and enhance environmental sustainability – each important aspects of the UN Sustainable Development Goals.

Corridors can help improve agricultural production and processing, transport and logistics, trade and access to finance. Prominent examples are the Cerrado region of Brazil, as it was back in the early 1970s (before it became a major global agriculture producer), the more recent Southern Agricultural Growth Corridor of Tanzania (SAGCOT) and the Beira Agricultural Growth Corridor (BAGC) in Mozambique. Though both SAGCOT and BACG are still in their early stages, they are also seen to have the advantage over Cerrado when it comes to direct port access and existing transport networks.

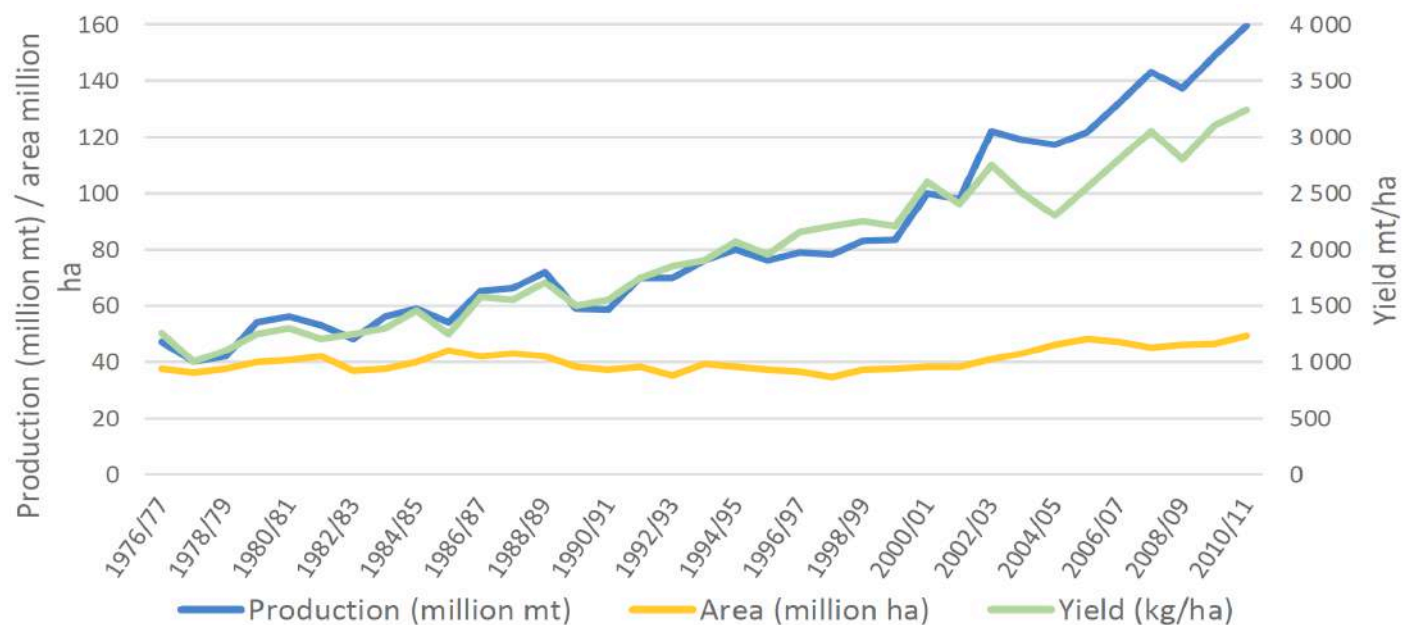
These Corridors share a lot of similarities (see table 1), ranging from the location against the Equator and crop suitability of the areas and, therefore, are selected in this study as reference.

Table 1: Comparison of corridors

	Cerrado Region, Brazil	SAGCOT, Tanzania	BAGC, Mozambique
Latitude	15° (Brasilia)	7.7° (Iringa)	16° (Tete)
Elevation	100m – 1,700m	3,000m	50m – 1,000m
Climate annual average	20°–26°	10.6" – 22"	19°–33°
Total area	2,031,990km ²	75,000km ²	230,403km ²
Population	13,844,222 (2007)	8,800,000 (2010)	4,588,003 (2006)
Population density	6.8/km ² (2007)	27/km ² (2010)	4,588,003 (2006)
Crop suitability	soya, rice, maize	rice, maize, wheat, sugar, coffee, tea, potato, horticulture, soya, citrus, livestock	maize, sugar, horticulture, soya

The Cerrado corridor is often seen as a role model for such transformational initiatives due to the strong agricultural growth. For example, from 1976 to 2011, Brazilian grain and oilseed area increased by 32%, while production and yields grew 240% and 257%, respectively (see figure 1).

Figure 1: Evolution of grain and oilseed production, area and yield in Brazil from 1976 to 2011



1 Conab database, elaborated by Martha, Contini, Alves; Embrapa: its origins and change. In: The regional impact of national policies: the case of Brazil, edited by Baer;2012

The successful evolution of Brazil is commonly attributed to a combination of:

- Public sector support for research, infrastructure and subsidized financial credit for farmers;
- Significant private investments which promoted economies of scale and scope for all players within the agriculture value chain.

The Brazilian experience shows that, given the right natural conditions, public and private investments to promote commercial agriculture, can bring about sustainable growth of profitable production and farm incomes. There is a risk, however, that rapid modernization of the farming sector could disrupt traditional livelihoods and exclude smallholder farmers from benefitting substantially.

That is why both SAGCOT and BAGC promote agricultural models where smallholder farmers and the rural communities can benefit from the development.

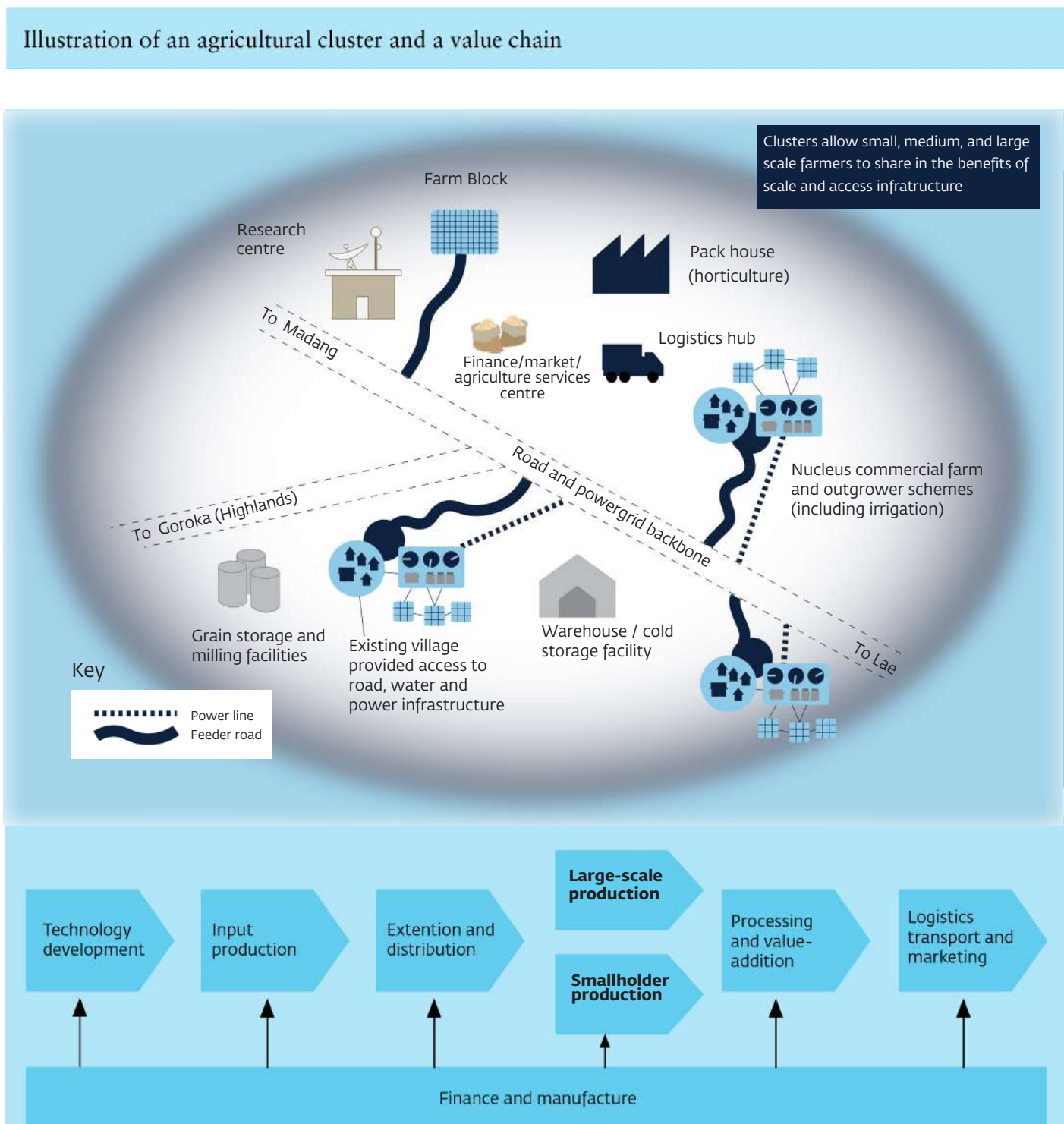
1.2 Agricultural growth corridor approach

Agricultural growth corridors can be a major breadbasket area, supplying agricultural produce to the region and the rest of the world.

The characteristics for a successful agricultural growth corridor include all the natural conditions to be present for a sustainable agriculture, such as:

- Good soils and climate, access to land and water resources;
- Improved access to agriculture-supporting infrastructure:
 - ▶ Energy, water and transport infrastructure in the area;
 - ▶ Input supply chains (i.e. fertilizer, seeds and crop protection);
 - ▶ Markets (i.e. storage, market roads);
 - ▶ Finance, particularly for farmers and small processors;
- Presence of clusters of farming, processing and service firms located in specific geographical areas fostering economies of scale, increased efficiencies and reducing production and marketing costs in the value chain;
- The public and private sectors coordinated to promote agricultural growth along the entire value chain:
 - ▶ Public regulatory framework supporting increased investments, research and development and infrastructure projects;
 - ▶ Private investments in the area and expansions where required.

Figure 2: Illustration of an agricultural cluster and value chain



The development of the corridor must also consider the potential impact on smallholders, which can have both positive and negative outcomes. The increased productivity and opening of opportunities are seen to improve farmer incomes. However, smallholders may lose their land to investors or suffer from land competition (migration of people from other areas to the corridors), thus limiting their benefits from the development. Competition with large commercial farms may render smallholder farming for commodity crops uncompetitive, but smallholders may move into more specialized markets and thus benefit from the new development.

These corridors can help emerging markets catch up with international competitors through:

- Taking a long-term approach to agricultural development, recognizing that transformation occurs over a 10 or 20-year period;
- Analyzing and addressing the existing constraints on the development of the agriculture sector;
- Ensuring coordinated agricultural development program and investments; and
- Using government and development partner resources to catalyze socially and environmentally responsible private investments.

As the corridor develops, the country will experience a virtuous agricultural growth cycle (see figure 3), with investments leading to increased production, thereby generating development throughout the supply chain and economies of scale that further increase competitiveness. In turn, this will encourage more investment and will result in accelerated growth. The challenge is how to get the growth cycle moving.

Figure 3: The virtuous agricultural growth cycle



1.3 Papua New Guinea within the East Asia/Pacific region

Papua New Guinea (PNG) has a remarkable diversity of geographic and natural resources. The country occupies the eastern half of the West Pacific island of New Guinea, together with the smaller islands of New Britain, New Ireland, the Autonomous Region of Bougainville and another 600 smaller islands and atolls.

PNG's overall economic growth performance has been consistent with the real GDP per capita averaging 4% since the mid-2000s. PNG's revenue continues to face challenges arising from fluctuating global commodity prices and the Coronavirus pandemic, COVID-19.

2020, the World Bank (WB) forecast that – compared to previous forecasts in January – real GDP growth will drop by 4.2 percentage points (to -1.3 percent) due to weaker demand and less favorable terms of trade as a result of the COVID-19 crisis. This will lead to a larger fiscal deficit, financing gaps and higher unemployment and poverty than previously anticipated prior to the onset of the COVID-19 pandemic².

Papua New Guinea's population of approximately eight to nine million is young and growing. PNG's growth trajectory and abundant resource potential provide a strong platform for greater economic engagement with Asia, Oceania and further abroad.

However, sound macroeconomic management and more efficient service delivery are critical to ensuring the development benefits reach a greater number of Papua New Guineans, particularly given that 87% live in rural areas.

Figure 4: PNG's geographic location



² World Bank, 2020

The country's economy remains dominated by two broad sectors:

- The agriculture (coffee, oil palm and cocoa), forestry and fishing sector, which engages most of PNG's labor force (majority informally);
- The minerals and energy extraction sector which accounts for the majority of export earnings and GDP.

In order to diversify PNG's asset base and increase employment, investment is required to strengthen capacity in institutions, human capital and physical infrastructure. Electricity, telecommunications, roads and other transport infrastructure remain critical to supporting private sector-led growth.

PNG has complex cultural dynamics deeply rooted in tribal and ethnic identity, traditional social institutions and relationship to land. These lead to daunting risk factors and also provide a key platform for PNG's resilience.

There are limited formal job opportunities for the growing working age population. Other risks include environmental management, population growth, political fragmentation, inequalities in PNG's resource dominated economy and social exclusion of some groups.

Despite the challenges, the main question remains: how will PNG develop over the next 20 year and how will it best utilize opportunities to become a viable link between Asia and the rest of Oceania? This report focuses on the opportunities in and around the agriculture sector brought about by the development of an agricultural growth corridor.

Firstly, PNG's population is fast growing. The UN statistics³ estimate PNG will have approximately 12.5 million people in 2040, which is 3.5 million more than today. However, urbanization will double during this period, meaning that food supply will need to grow. Considering that PNG has very high stunting rates, partially due to malnutrition, demand for nutritional food will further grow⁴.

Secondly, South East Asia is at the heart of the global food security challenge given the confluence of demand and supply-side challenges. On the demand-side, the Association of South East Asian Nations is experiencing rapid urbanization and growth of the consuming class. By 2030, more than 90 million people are forecasted to move to their cities, with the consuming class expected to double to 163 million households. This growth will fuel demand - spending on food in the region is expected to more than double to US\$1.5 trillion by 2030, driven by both a growing population and the demand for safer, healthier and more sustainable food⁵.

However, addressing this growing demand is a major challenge for South East Asian food system. Low availability of arable land, stagnating yields, aging workforce and food waste will render it difficult to fill in the supply and demand gaps in specific crops (e.g. animal feed, dairy products and even cereals for some countries), despite the majority of the South East Asian countries being net exporters. Could PNG play a role to fill in these gaps?

Thirdly, Australia and New Zealand might not be key off-takers of agricultural produce, but both countries rely upon skilled and unskilled seasonal workers⁶. This can be a strategic opportunity for both PNG and Australia/ New Zealand, not only when it comes to supplying labor, but also reverse knowledge transfer when workers return to their home countries.

3 UN, Department of Economic and Social Affairs website, World Population Prospects 2019

4 Save the Children, 2017; Short Change: The Human and Economic Cost of Child Undernutrition in PNG / World Bank, 2020; Human Capital Project

5 PWC, 2020; Maintaining food resilience in a time of uncertainty

6 Anu, 2018; State of the Pacific 2018: Labour Mobility: Learn from the Past, Look to the Future

1.4 Agriculture policy framework in Papua New Guinea

PNG's agricultural potential has been evident to national policymakers for decades and, therefore, it is of no surprise that the political visions and development frameworks have included a strong focus on boosting the agriculture sector. However, the implementation and possible impacts are behind expectations.

Approximately 80% of the population works in the agriculture sector, which is on the higher side to similar other emerging markets. In the right political setting, policies can stimulate agricultural growth and attract outside investments to achieve sectorial growth and generate job and income opportunities, especially for the rural population. In Papua New Guinea, political strategies and frameworks have focused on the agriculture sector to make it happen. This becomes evident with a number of development plans, like PNG's Vision 2050, PNG Development Strategic Plan, PNG's Medium-Term Development Plan III and National Food Security Policy.

PNG's Vision 2050 (2010-2050)

The Vision 2050 was developed in 2009 and recognizes the opportunities that exist in the country for food production for the domestic market, high value export crops and the development of import-competing industries, plantations and forestry. Adopting an economic corridor planning is laid down to drive economic growth and promotes the non-mineral sectors (of which agriculture is the largest). Land reform is regarded as an important factor for successfully adopting this strategy.

PNG Development Strategic Plan (2010-2030)

The PNG Development Strategy Plan (PNGDSP) further builds on the foundation of the Vision 2050 and maps out a path for the development of PNG to a middle-income country using economic corridors as a vehicle to alleviate poverty. An agriculture sector of the highest level is envisioned, which is capable of catering both the domestic and the international markets, by leveraging the underutilized fertile land. An integrated approach for developing essential infrastructures, in combination with industries and agribusinesses, is proposed. This can function as a foundation for the further development of such an economic corridor into an agricultural growth corridor.

Medium-Term Development Plan III (2018-2022)

The Medium-Term Development Plan III (MTDP III) recognizes the needs of the non-mineral economy, in line with the Vision 2050. It places agriculture at the center of the government's growth strategy and outlines four key priorities to further stimulate economic growth in the medium term, of which the first two are defined as (1) inclusive economic growth with renewed focus on agriculture, and (2) continuing with the infrastructure development.

National Food Security Plan (2017-2027)

The National Food Security Plan (NFSP) hinges on four pillars of food security in future agricultural development: (i) availability of affordable and sufficient quality food for consumers, (ii) access to the means to acquire proper food, (iii) to achieve nutritional wellbeing, and (iv) stability in maintaining these pillars from disruptive shocks and cyclical events. What the strategy requires now are policies in order to mobilize private investment in agriculture and maximize its positive contribution to economic growth and sustainable development. Private investment is essential if agriculture is to fulfill its role in economic development, poverty reduction and food security.

Agriculture Medium Term Development Plan (2020-2022)

The new Agriculture Medium Term Development Plan (AMTDP) is closely aligned with the MTDP III. It is a three-year development plan with an estimated budget of PGK 2.3 billion to transform the PNG agriculture sector through smart innovations, inclusive and, productive partnerships that are responsive to the 85% rural population.

Main focus will be on increase of export commodity crops and import replacement commodity crops.

AMTDP projected a total export volume for all export commodities to about 1.4 billion metric tons by 2022 with estimated export earnings of about PGK 3.2 billion. This projection is based on a 10% increase from 2018 baseline of about 970 million metric tons and PGK 2.2 billion respectively.

Also, AMTDP embarks on reducing food import volume by 10% from a baseline of 9.1 million metric tons in 2018 to about 6 million metric tons in 2022. A savings of 3.1 million metric tons of local food products will replace imports volume. The total value of products for import replacement decreased by 10% from a baseline of PGK 683.4 million in 2018 to PGK 448.4 million in 2022. A savings of PGK 235 million reduces food import bills for the government of PNG by 2022.

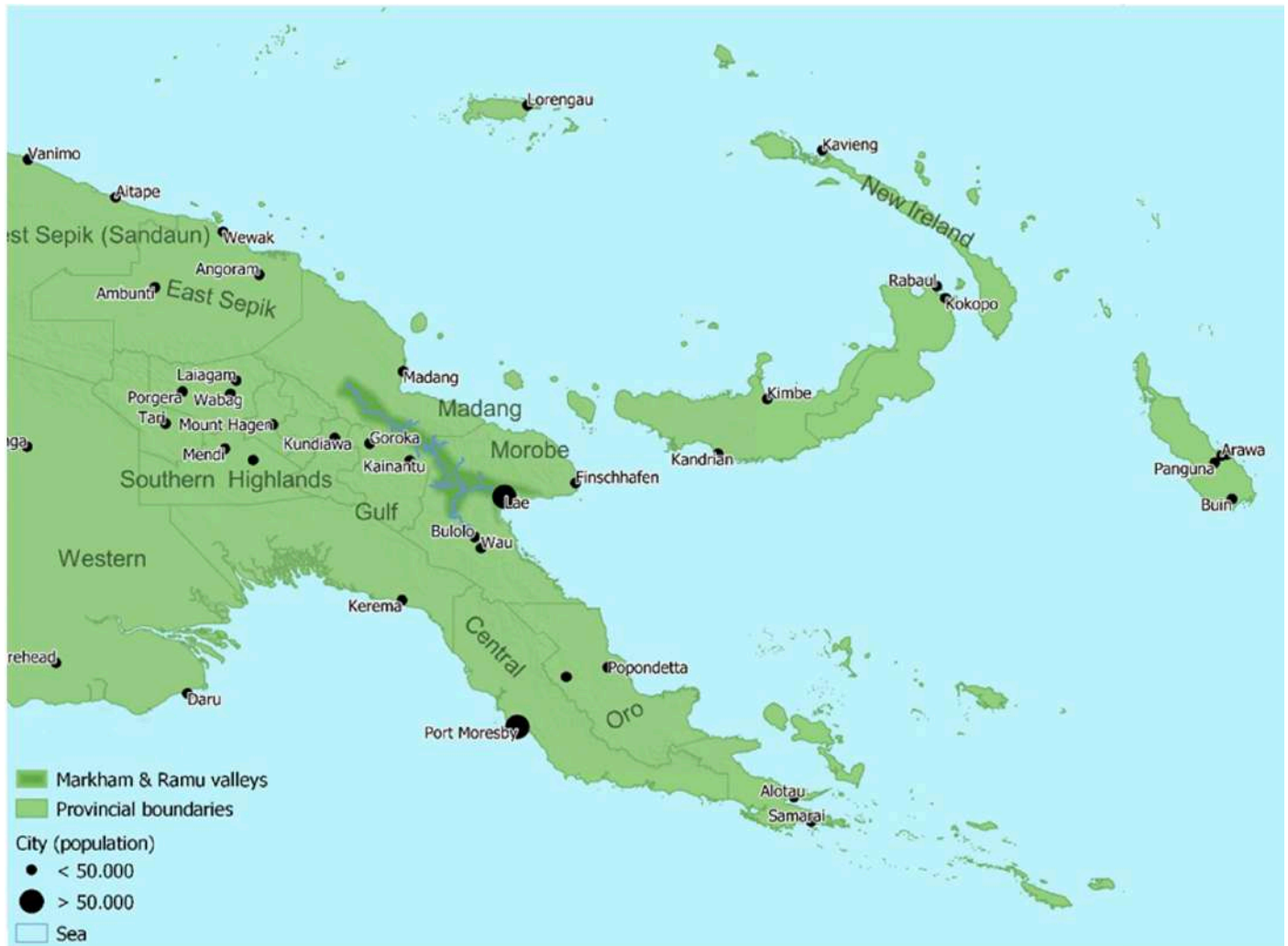
High-level coordination in the agriculture sector is to be expected from the Department of Agriculture and Livestock (DAL) by guidance of the relevant legislations, plans and policies of which the implementation will be steered through committees at national-, provincial-, district- and local government level. This should ensure the execution of various programs under the National Food Security Plan. Under this framework, the Government is expected to provide funding resources for policy implementation.

The challenges that may be faced in trying to realize the policy required to develop the full potential of agriculture in PNG include: mobilizing investment resources, bridging communication gaps between public sector and private sector, coordinating investment strategies by linking investors to suitable investments, provision of timely investment information and identifying suitable partners for investment in the agriculture sector of PNG.

2. Markham and Ramu Valleys

The Markham Valley is situated in the Morobe Province of Papua New Guinea (PNG) and joins with the Ramu Valley, which extends into the land border of Madang Province.

Figure 5: Location of Markham and Ramu valleys in PNG (dark green)



Despite this favorable political climate, the potential for agricultural activities in the Markham & Ramu valleys is underutilized, however, the two valleys hold the status as the breadbasket of the nation. Some industries have successfully settled in the valleys like oil palm, sugar plantations and livestock industries including poultry, cattle and pigs. Together with smallholder projects on maize, cassava, cocoa and coffee that have developed over the last couple of years, commercial agriculture only utilizes roughly 15% of the arable land in the valleys. Smallholder production of staple crops and a variety of fruits and vegetables only makes use of a very marginal part of the arable land in the valleys.

This leaves a large amount of highly fertile land in an agriculturally favorable political climate ready to be utilized.

2.1 Markham and Ramu valleys' history

The Markham and lower Ramu valleys are believed to have resulted from faulting. The depression is caused by the Ramu-Markham Fault Zone (RMFZ) running approximately 300 km along the lower Ramu and Markham valleys. This has determined to some extent the soil type in the Markham Valley, with similarities to the Hapludoll (fertile surface soil formed under grassland cover in semi-arid to semi-humid areas) and Tropofluent (floodplain soils) great soil groups. From Lae through to the hills of Watarais and to the southern flanks of the Ramu mountains sits on a very young geological unit called Leron Formation (LF) which has not gone through the process of lithification to form a consolidated conglomerate unit. As such, some areas in the two valleys are prone to erosion and flooding.

Much of the Markham Valley is covered in grassland. The origin of anthropogenic grasslands in PNG is not known, but the Markham grasslands are thought to be at least a few hundred years old based on succession of grass species and regional distribution patterns of species. Grasslands typically are undesirable for gardening because they are difficult to clear for gardens, susceptible to hot dry weather lacking some tree cover and low productivity due to loss of moisture and nutrients⁸. This might explain the vast emptiness and expanse of the Markham-Ramu Valley without much human habitation as seen in the early days. Other contributing factors can be linked to difficulties in accessing water sources, more droughts occurring with intensity, intertribal disputes and location of hamlets along the foothills or in tributary valleys⁹. It is mentioned that the Atzera and Wampar were the two main groups of people who controlled the Markham area before the first Europeans arrived in the valley¹⁰.

Figure 6: Markham and Ramu valleys (dark green)



7 Warren Hamilton, 1979; Tectonics of the Indonesian Region

8 Bulmer, 1975; Settlement and economy in prehistoric Papua New Guinea: a review of the archeological evidence

9 Garrett-Jones, 1979; Pollen flora: lowland Papua New Guinea. Evidence for changes in Holocene vegetation and lake sedimentation in the Markham Valley, Papua New Guinea. Dissertation, Australian National University Canberra

10 Holzknicht, 1974; Report on anthropological research and associated findings in the Markham Valley of Papua New Guinea

Major development began when the Markham Valley Road (the origin of the Highlands Highway) was constructed from Lae to Gabsongkeg in 1925/6, which was then extended to the Highlands provinces in the 1950s and eventually completed in 1965. The upgrade of the Highlands Highway from gravel to an asphalt road increased traffic movement of both people and goods between Lae and the Highlands in the 1970s¹¹. This has created economic, sociocultural and political opportunities for residents and travelers alike. These have also contributed to the development of Lae town and the development of the Nadzab airport sets an example.

The missionaries built an airstrip near Gapmadzung, now known as Nadzab, to cater for light planes. Lae had its own airstrip built in 1927 to cater mostly for the goldfields, but later abandoned it due to issues with the geology and geomorphological features of Lae's location, most likely liquefaction. However, Nadzab has operated as Lae's main airport since 1977 also because it was hugely developed by the Allied Forces during the World War II conflict. This created many economic opportunities for locals living next to the airport. It was in the early 1950's that the expat population looked at expanding the small nucleus of agricultural activity in the environs of Lae¹². In the 1970's plantation agriculture was established mainly in the lower Markham Valley within 30 km of Lae and a large cattle station operated at Leron Plains. Major crops cultivated were coconut, cocoa and sorghum¹³.

The most important crops for smallholder farmers grown then and still nowadays are banana, kaukau (sweet potato), yam, taro, cassava and Chinese taro. Also, nuts (such as coconut and breadfruit), vegetables (such as aibika, lowland pitpit and pumpkin tips), fruits (such as mango, pawpaw, pineapple, watermelon and sugarcane), narcotics (such as betel nut, tobacco and betel pepper) and cash earning activities (such as betel nut, fresh food (major), cattle and chilies (minor)) have persisted. Main fallow type has been short grass with expected two plantings before a long fallow period of 5-15 years. Accounts of soil fertility maintenance, water management and mounding techniques have been achieved through legume rotation, minor drainage and small mounds. Reports indicated some burn fallow vegetation, tillage and mechanization through use of tractors as part of soil management¹⁴.

Table 2: 1973 Commercial production volumes

Commercial production in 1973 Amount	Amount
Peanuts	1,200 mt
Cattle	50,000 heads
Coffee	2,295 mt
Copra	1,442 mt
Cocoa	285 mt

Commercial agricultural interest started to increase with foreign occupation in the area, but fierce battles raged through these plantations during World War II¹⁵. After the war, a large number of Australian returned servicemen were able to apply for land, enabled by the Australian government's ex-servicemen credit scheme, to establish farms in the Territory and this was the beginning of the commercial agricultural development for Papua New Guinea. In Lae, this started in the early 1950s and it progressed to the formation of The Morobe District Planters and Farmers (MDP&F) Association in the late 1950s and

12 Morobe Show website, updated 2017; A History of The Morobe Province Agricultural Society

13 Garrett-Jones, 1979, Pollen flora: lowland Papua New Guinea. Evidence for changes in Holocene vegetation and lake sedimentation in the Markham Valley, Papua New Guinea

14 Bourke, et al., 2002; Morobe Province: Text Summaries, Maps, Code Lists and Village Identification. Agricultural Systems of Papua New Guinea

15 Hearsay during interviews

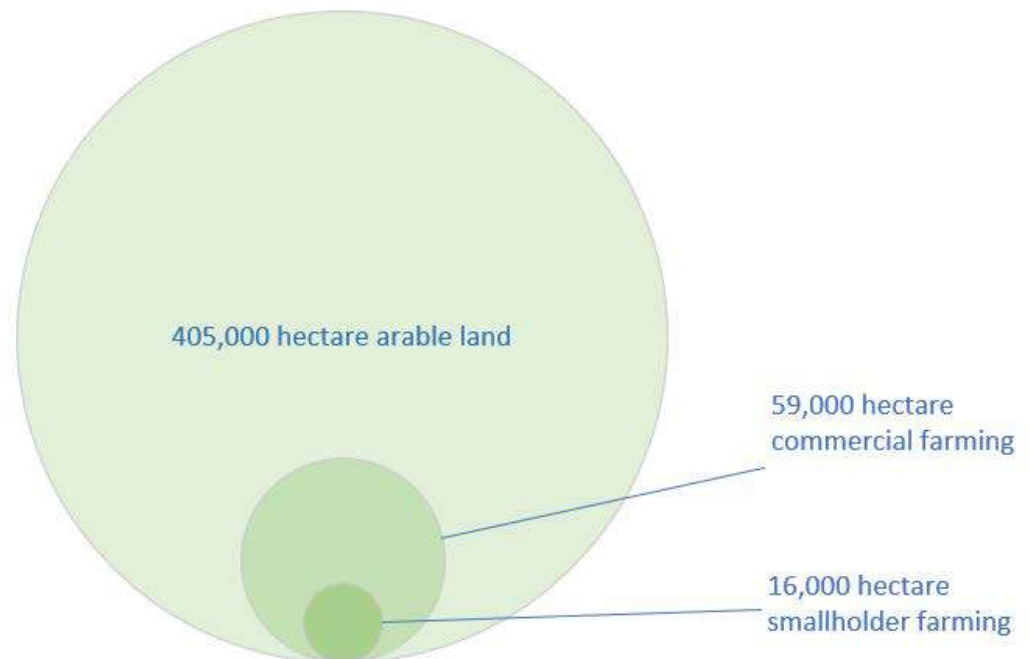
hosting of the first Lae Show on 24th and 25th October 1959 by the Lae Agricultural Society (later renamed Morobe District Agricultural Society).

1973, the Bubia Experimental Station (now part of National Agricultural Research Institute) was concentrating on commercial crops suitable to the valley's districts, including peanuts, sorghum and rice. It was indicated that the dry land rice in the upper Markham valley reached 2.5 metric tons per acre (6.25 mt/ha). In the same year, the amount of cattle raised in the valley were some 50,000 heads, of which 10,000 heads were on 350 smallholder blocks of which 50 more were being developed. Much of the early plantations did not succeed and the Australian ex-servicemen left in the 1970s. The challenges experienced then and still active now relate to a lack of synchronization with crops cultivated and local environmental conditions, usage of complex machinery which increased costs, lack of improved pasture for cattle and low return on local labor with competing prices, as well as an increase of crime against plantation owners¹⁶. An interesting example is the peanut butter factory, which was a major buyer of locally produced peanuts and was compelled to close operations due to a permeating toxin found in the butter because machinery was not further enhanced to address this issue.

2.2 Current agricultural land usage

Despite the governmental efforts to envision investments in agriculture, e.g. the intention to add the valleys to a Special Economic Zone¹⁷, extensive activities in the mid of the 20th century and the vast amount of arable land available in the Markham and Ramu valleys, there are currently very limited commercial farming activities in the area. Of the approximately 405,000 hectares of arable land, only 15% are being currently used for commercial agriculture and an even smaller percentage of that is being used by smallholder farmers. In the context of having 80% the population being active in agriculture, the utilization of land is very low.

Figure 7: Estimates of available arable land and its current usage



¹⁶ Hearsay during interviews

¹⁷ M. Bourke & D. Maul, personal communication, February 17, 2020

2.3 Established agribusinesses

There are a few large-scale commercial farming activities ongoing in the Markham & Ramu valleys. All together, these cover about 59,000 hectares of land, or approximately 15% of the arable land in the valley. The vast majority of this land is being occupied by palm oil plantations owned by New Britain Palm Oil Limited (NBPOL), a subsidiary of Sime Darby.



Oil palm plantation

New Britain Palm Oil Limited (NBPOL)

NBPOL is a subsidiary of Sime Darby and a leading producer of sustainable certified palm oil. It has two subsidiaries in the potential corridor, Markham Farm in Markham valley, with two oil palm plantations of 6,110 hectare still in a planting/growing stage, and Ramu Agri Industries in Ramu valley with sugar, palm oil and beef production. The annual sugar production is on approximately 5,700 hectares with a total production volume of 320,000 metric tons of cane. A plant for ethanol production was installed along-side the sugar mill. 11,490 hectares of oil palm and 8,800 hectares of pasture are part of the operation. NPOL is the largest producer of beef with 20,000 head of cattle in the country.

Livestock, though less prevalent than in the 1970s, is still present in the Markham and Ramu valleys. Currently, the poultry industry is the largest in the livestock sector, followed by the cattle and piggery businesses. Major livestock operators are Ramu Agri Industries, Trukai Industries, Rumion (cattle), Mainland Holdings (Niugini Table Birds), Highlands Products (Zenag, which is a little bit South of Markham valley) both poultry operators and Rumion and Pelgens in the piggery business. The sector has also a state-Owned Enterprise. The Livestock Development Corporation (LDC) owns its own abattoir in the valley, together with 700 hectares of rangeland for cattle, which is currently not being utilized, however, LDC was recently put back under the DAL structures. A unique operation is the largest crocodile farm in the southern hemisphere for skin, managed by Mainland Holdings.



Chicken egg hatchery

Mainland Holdings Limited and Highland Products Limited (Zenag)

Mainland Holdings with Niugini Tablebirds and Highland Products with Zenag Chicken are the leading poultry companies in PNG covering approximately 90% of the market. Both produce eggs, day one chicks and broilers. Mailand Holdings is based around Lae and has also other operations e.g. crocodile farming (largest in the southern hemisphere), flour and feedstock processing. Zenag's main operations are based in Bulolo, South of Markham valley. Both companies implemented a system of poultry contract farmers. Interestingly, a number of stakeholders mentioned that supply cannot cover demand efficiently.

Rumion Limited and Pelgens Limited

Rumion is the largest piggery in the country, with an average population of 12,500 heads and is the major supplier to an associated company Prima Smallgoods. In addition to pig production, Rumion grows corn (maize) and cassava exclusively for stockfeed and has a 3,500 head cattle herd. It is also currently building its own abattoir. Pelgens is a wholesaler of freezer goods and has also a piggery in the Lae area. Pelgens tried a piggery outgrower scheme where local farmers obtained weaned piglets from the company and raised them to supply to Pelgen's abattoir, but unfortunately it did not work out.

Since 2016, the PNG Biomass project by Oil Search has started to plant trial woodlots with different eucalyptus varieties. The company plans to develop 16,000 hectares of eucalyptus for the generation of energy. A 30 MW powerplant in the valley is planned to generate electricity from the locally planted eucalyptus, directly feeding into the Ramu power grid.

From 2017 onwards, Trukai Industries (the leading rice importer) has been planting 275 hectares of rice, to supply 100% homegrown rice to the PNG domestic market. However, lower than required yields to be profitable make an expansion difficult.

Trukai Industries Limited and Goodman Fielder

Trukai, a subsidiary of Sunrice, is the largest importer of rice in the country. The company has been trialing to grow rice in Markham valley. It also has a 1,500 head cattle farm in Erap, near Nadzab airport where it produces rice seed and stock-feed components for the cattle. The management believes that rice can be grown with proper irrigation systems, although this remains to be tested on a commercial scale.

Goodman Fielder, a subsidiary of Wilmar International, operates two flour mills, a stockfeed mill and is a large importer of FMCG products. It is the second leading rice importer and currently developing a major processing facility in Lae. This business has doubled its volume in three years.

Total rice imported into PNG is approximately 300,000 metric tons while collectively both companies import approximately 240,000 metric tons annually. Goodman Fielder also imports 50,000 metric tons of grains.

The latest additions to the commercial farming landscape in the valley originate from two outgrower projects. IFC supports an SP Brewery project that grows and mills locally grown cassava for the production of a cassava beverage for the local market. By 2023, 250 hectares will be realized. The second project, starting with a similar nucleus estate, is implemented by a Farmset partner to supply maize to Farmset's new feed mill. Currently covering 50 hectares, the project aims to increase volumes by six times. More details are provided under chapter 2.4.



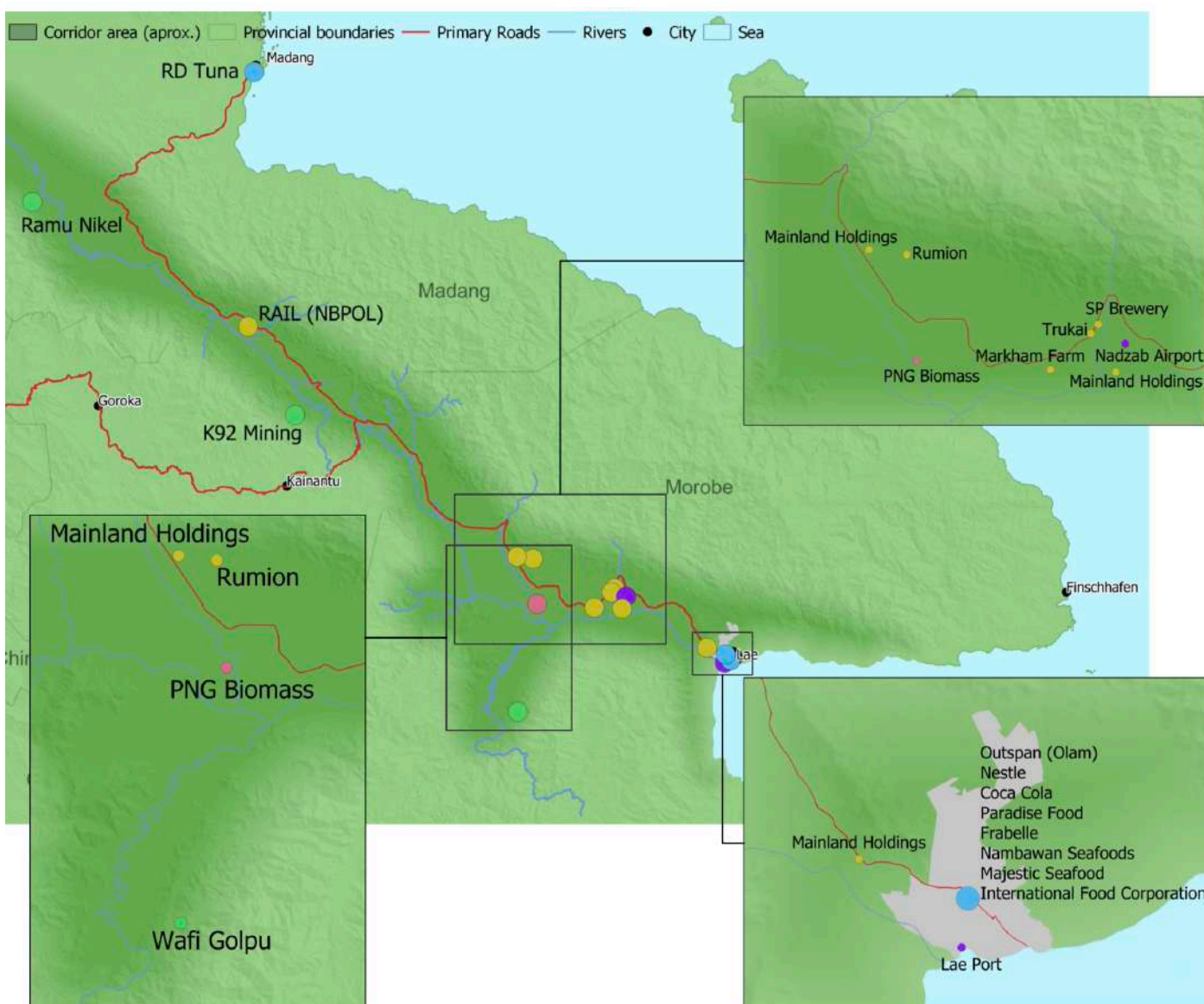
Maize harvest

On the farm input supply side, key companies are Brian Bell, Farmset and Chemica. All three companies have sales office in Lae and provide fertilizers, agro-chemicals, farm tools and machineries.

There are also a number of food processors who currently rely heavily on imports, but with a more efficient and affordable local production and would be interested to switch to local sourcing. Mainland Holdings and Goodman Fielder are major producers of flour and feedstock. Goodman Fielder is also competing on the rice imports with Trukai. Paradise Food, Lae Biscuit but also Nestle, Coca Cola and Pacific Industries (all with operations in Lae) could partially replace imports with locally sourced raw material.

Furthermore, food processors from other regions in PNG could be attracted to invest and source from the Markham and Ramu valleys, e.g. Hugo Canning producing Ox & Palm corned beef, Innovative Agri which produces fruits and vegetables, but also has the only dairy operation in the country, as well as BNG Trading which processes sausages and imports beef.

Figure 8: Overview of larger businesses in Markham and Ramu valleys



2.4 Smallholder farmers

With a combined rural population of approximately 200,000 people¹, the Markham and Ramu valleys have about 2% of the entire population of Papua New Guinea. Although exact numbers are hard to find, a general estimation of 0.08² hectares of farmland per rural head of the population would put the smallholder agricultural land at approximately 16,000 hectares.

The most extensively crop grown by smallholders is banana. This has been found as the dominant staple grown in 2/3rd of the agricultural systems identified in the valleys. Smallholder farmer interviews in the Markham valley have also identified that more than 95% of all the farmers grow banana on their land. After banana, sweet potato (locally known as kaukau) is the second most dominant crop together with coconut. Following those, other starch products that are being grown in the valleys include: taro, yam, corn and cassava.



Smallholder farmer

A range of fruits and vegetables are being farmed by smallholder farmers, although their exact numbers are hard to determine. A sample of the most common vegetables and fruits in the valleys are: aibika, amaranthus, cucumber, lowland pitpit, pawpaw, pineapple and ted fruit. Betel nut was very big in the past, but production volumes were almost destroyed by disease. Also, Markham farmers were known as herders, but the number of cattle owned by smallholder farmers diminished considerably.

1 Extrapolated from the 2011 census and the annual growth rate from the National Statistics Office
2 Bourke, R.M. and Vlassak, V., 2004; Estimates of food crop production in Papua New Guinea

Table 3: Estimates of smallholder production in some key crops

Smallholder production	Hectares (ha)	Harvest (mt/year)
Banana	4,200	50,400
Sweet potato	2,900	37,700
Coconut	2,900	2,030
Taro	1,600	12,800
Total	11,600	102,930

There are a number of companies sourcing from smallholder farmers. The most established operations procure coffee and cocoa. Cocoa is the larger of the two crops in the two valleys. Outspan (Olam) and Agmark are the two main companies in the cocoa sector. It needs to be noted that not all smallholder outgrower projects worked out due to a number of challenges, which are described in chapter 3.

Outspan PNG Limited (Olam International Ltd) and NGIP Agmark

Outspan PNG Ltd is a fully owned subsidiary of Olam International Limited, leading exporters of Cocoa and Coffee in PNG. They have established an extensive network of farmers and have been conducting various sustainability projects across the country. In Markham valley, they have partnered with Lindt & Sprüngli, a premium chocolate company working with farmers to improve livelihood through sustainable agricultural practices.

Agmark is the second key cocoa exporter in the country. It sources their cocoa from their own plantation and from smallholder farmers.



Cocoa nursery

Two new projects can be found around Erap. South Pacific Brewery (a subsidiary of Heineken) started to develop a reliable supply of quality cassava for its newly established factory in Erap, near Lae, in order to secure enough starch flour to meet the company's requirements for a new beverage product through the development of an effective smallholder supply chain. IFC is supporting the project, which will realize a more strategic objective by providing significant proof of concept and demonstrate the feasibility of engaging with local smallholder producers. This is a key step in formalizing the agriculture sector and replacing imports. A successful project will lead to employment and income opportunities, contributing to livelihood improvements within local communities. Through this investment, commercialization processes will be catalyzed by engaging key partners and structuring effective product development, commercialization and adoption partnerships between private sector partners, sources of financing and smallholder farmers, processors and other supply chain actors.

In a similar fashion, Farmset, a local provider of farming and manufacturing inputs, machinery, training and services since 1969, collaborates with a local producer to establish production of maize around the Nadzab area for their own stockfeed mill. They started with a nucleus farm, but want to expand further, including smallholder farmers. Selling the produce in their own stores, they have control over the entire value chain: training local farmers, providing the inputs, machinery and services, collecting and processing the maize to stockfeed.

PNG Biomass, mentioned above under chapter 2.3, works closely together with the landowners in Markham valley. The project provides employment and income for managing the growth cycle of the trees. Throughout the 25-year Power Purchase Agreement with PNG Power Limited, the plantations will not only benefit the landowners through the lease of their land, but also by giving the opportunity of further agricultural developments through intercropping. As the plantations will target the degraded grasslands and areas invaded by exotic species, the project ensures no deforestation or negative food supply impacts. The project sets an example on how to engage and cooperate with local landowners and provides opportunities for local farmers to show how they can be successfully involved in large-scale investments.



Eucalyptus plantation

2.5 Current agricultural agri-related development projects (government, international organizations, NGOs)

Government activities

The government of Papua New Guinea is active in the Markham/Ramu corridor through the Department of Agriculture and Livestock (DAL) and several of its commodity boards, and is focusing on a number of key crops (e.g. cocoa, coffee, coconut and livestock, etc.). DAL is also implementing the World Bank and International Fund for Agricultural Development (IFAD) funded Productive Partnership in Agriculture PNG (PPAP) project through the Cocoa board and Coffee Industry Corporation. The PPAP will be succeeded by the PNG Agricultural Commercialization and Diversification Project (PACD) and, additionally to coffee and cocoa, also coconut, spices and small livestock will be included in the development program too. All of these crops have suitable production areas in the possible Markham/Ramu corridor.

World Bank

Since 2010, the government has been implementing the World Bank funded US\$50 Million PNG Productive Partnerships in Agriculture (PPAP) project to improve the livelihoods of smallholder cocoa and coffee farmers, some of which are located in the Markham valley. The objectives are to be realized through these three components: productive partnerships, institutional strengthening and market access infrastructure, of which not only the targeted smallholder farmers will benefit, but the entire sector and corridor. From 2020, the US\$40 Million PNG Agriculture Commercialization and Diversification Project will continue working on the successes of the PPAP project with a focus on cocoa, coffee, spices, and small livestock (poultry and pigs).

The Fresh Produce Development Agency (FPDA) received funding from IFAD to increase their work in facilitating the development of the horticulture and fresh produce industry. Again, the Markham/Ramu corridor is part of their project area.

IFAD Through the Fresh Produce Development Authority

Since December 2017, IFAD has been financing the Maket bilong Villis Fama Project worth US\$25 million. Co-financing of up to US\$25 million will be contributed from the PNG Government, mainly through in-kind contributions, and from other development partners. The project aims to improve the livelihoods of farmers households by facilitating their transition to market-oriented production and farming as a business. It will support the development of sustainable business partnerships, in which farmers will have secure and remunerative market options, and buyers will obtain a reliable and consistent supply of vegetables and other fresh produce. The Fresh Food Development Authority (FPDA) is implementing the project. The FPDA is the government's agency responsible for managing the fresh food and horticultural industry in PNG.

To strengthen the development and growth of agriculture in PNG, the National Agricultural Research Institute (NARI) was established in 1996. Functioning as the head office of NARI, the station at Bubia, just outside of Lae, leads all the research for the Momase region (West Sepik, East Sepik, Madang and Morobe provinces). Besides crop improvement and protection research, there is a special focus on rice and grains. Additionally, the facility hosts the livestock research program, although it is unclear which projects are currently still running due to limited funding. The SP Brewery cassava project is currently providing cassava to NARI for stockfeed trials. More of such public-private partnerships are envisioned.

International organizations

International organizations focus either directly on agriculture or indirectly on challenges around agriculture, e.g. policies and infrastructure. The World Bank is most probably the strongest development partner when it comes to agricultural development in the Markham/Ramu corridor.

The IFAD fresh produce project is at an early stage, but could potentially have a tremendous impact, especially on the female smallholder farmers, where fruits and vegetables represent a strong income source. The Food and Agriculture Organization of the United Nations (FAO) had a number of projects in the corridor area, however, it is currently mainly focusing on the Sepik region through an European Union (EU) funded project. International Finance Corporation is supporting SP Brewery on a cassava outgrower project and has the appetite to support and invest in larger agricultural developments.

FAO – STREIT

In late 2019, the FAO started the EU funded €82 Million Support to Rural Entrepreneurship, Investment, and Trade in Papua New Guinea project with a focus on (a) cocoa, vanilla and fisheries value chains, and (b) strengthening climate resilience with planned results in a more conducive business, trade, policy and regulatory environment for sustainable rural agri-entrepreneurs and micro, small and medium sized enterprises (MSME). During its commencement, the project focused mainly on the Sepik province, however, the government of PNG already asked if the project could be expanded to other provinces, e.g. Morobe. A possible expansion would bring another development partner into the Markham and Ramu corridor.

Asian Development Bank (ADB) is probably the strongest organization in infrastructure development projects at the moment, with its \$1 billion Sustainable Highlands Highway Investment Program, the Highway which goes through the Markham valley, connecting the highly populated Highlands provinces with the international port in Lae, the key import and export sea port in PNG. The World Bank on the other side wants to focus on the rehabilitation of the Ramu Highway, which passes through the Ramu valley and is connecting Madang. The Japan International Cooperation Agency (JICA) supported the improvement of the international port in Lae and is currently focusing on the upgrade of the Nadzab airport in Lae. Additionally, JICA is interested to look at improving the overland power grid through the Markham and Ramu valleys.

Australia, through the Department of Foreign Affairs and Trade (DFAT), and New Zealand, through the Ministry of Foreign Affairs and Trade (MFAT), support/fund the larger international organizations, but also a number of smaller initiatives, like the Market Development Facility (MDF) that is focusing on smaller projects which include agriculture e.g. a fresh produce project with NKW, the Pacific Horticulture and Agricultural Market Access (PHAMA) with a focus on opening greater market opportunities and increasing exports of high value primary products, or the PNG Incentive Fund, which provides grants to high performing organizations to assist them in improving service delivery and/or economic opportunities to the people of PNG. Groupe Speciale Mobile Association (GSMA) was invited by DFAT to analyze new technology opportunities, especially telecommunication technologies in the agricultural value chains. Their first report³ focused on the Markham/Ramu corridor. It will be interesting to see how the Papua New Guinea Electrification Partnership (a joint project between the Australian Infrastructure Financing Facility for the Pacific (AIFFP), New Zealand and the United States) will achieve its target to support PNG in connecting 70% of the population to the power grid by 2030.

3 GSMA, 2019; Landscaping New Opportunities for Digital Agriculture in Papua New Guinea

PHAMA

The Pacific Horticulture & Agricultural Market Access (PHAMA) program was launched in PNG in 2015, transitioned into PHAMA Plus in 2018 and will continue until 2022. The focus of the project lays with cocoa, coffee, high-value coconut products and fisheries. In the Morobe & Madang provinces, the project works in both the cocoa and coffee sector. PHAMA Plus will also support work on identified thematic and cross-cutting issues.

MDF

In PNG, the Market Development Facility (MDF), implemented by Palladium and funded by the Australian government, focuses on market systems within the agribusiness sector. These include value chain development for various commodities, including honey, animal feed, vanilla, coffee/cocoa and fresh produce. They recently opened a satellite office in Lae and are cooperating with NKW Fresh in the region.

Grow PNG is a country partnership under the Grow Asia Secretariat, a unique multi-stakeholder partnership platform that brings together farmers, governments, the private sector, NGOs and other stakeholders in PNG aiming to lift the productivity, profitability and environmental sustainability of the smallholder agriculture in the region. First focus area is the Markham valley. More about their potential role in the development of an agricultural corridor will be described in chapter 5.

Non-governmental organizations (NGOs)

NGOs and churches engagements are essential for grass-root level work to improve livelihoods at village levels in PNG. Many of them are very strong in specific regions and/or engagement topics. There is a long list of national and international organizations in this sector (e.g. Care International, World Vision, but also company foundations like Digicel Foundation, Brian Bell Foundation etc.), that can provide specific social grass root information to potential investors in the corridor.

A special role has the extractive industries. Part of their business engagement is a commitment to support communities around their operational areas. Key focus is often job/income creation, mostly through agriculture, education and health services. The Wafi Golpu mine is located in the Watut valley, at the southern part of the Markham valley, approximately 65 kilometers from the port of Lae. Their planned infrastructure corridor from the mine to Lae will create road access to the southern plains of the Markham and to the Watut valley, which have no commercial agricultural activities at the moment. The mine is planning to develop a foundation to strengthen their support in agricultural development around the mine.

Since the study cannot go into in-depth details about current activities in the two valleys, it is recommended to contact the Lae Chamber of Commerce, the Australian Consulate-General Lae and/or Grow PNG for further details.

3. Barriers for Further Agricultural Development

Despite the long history of agriculture in the two valleys, their strategic location between the largest sea port and the highly populated Highlands province as a key market, and the support by many organizations to develop the Markham and Ramu valleys, it is still very challenging to start or expand an agribusiness. An online survey with 87 companies and organizations pointed out these challenges, barriers and risks for businesses to operate in the area.

Barriers and country risks for further development refer to the uncertainty associated with investing in PNG, and more specifically in the Markham and Ramu valleys. Both can come from any number of factors, including political, economic, foreign currency or technological influences. In a broader sense, country risk is the degree to which political and economic unrest affects the securities of issuers doing business in a country.

The barriers presented in this section were mentioned by the interviewed key stakeholders in and around the Markham/Ramu valleys during an online survey and individual telephone calls completed in March-May 2020.



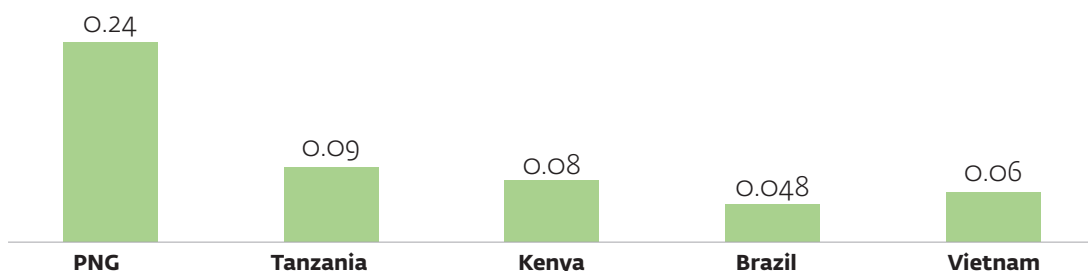
Road conditions

3.1 Infrastructure

The basic backbone infrastructure in the Markham and Ramu valleys provides a good basis for the further development of commercial agriculture in the corridor. Most of the infrastructure is, to the best of its ability, already in use for the production and transportation of agricultural produce, although the cost of transportation in PNG is very high.

Figure 9: Transport cost⁴

ROAD TRANSPORTATION COST (US \$ MT⁻¹ KM⁻¹)



The main infrastructure in the two valleys comprises of:

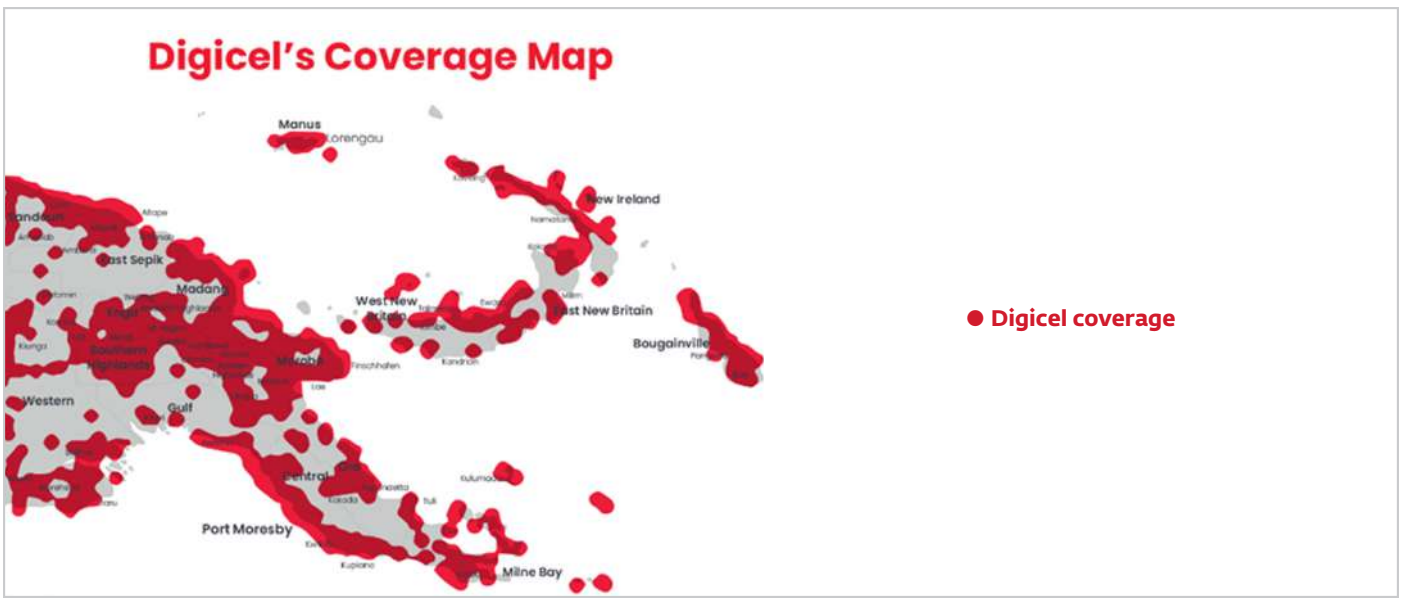
- The Highlands Highway National Road 0007, which is the most important road in PNG, connecting the seaport of Lae with the five Highlands provinces. It runs all the way from Lae, through the Markham valley and, at Waterais Junction, turns west to the Highlands provinces.
- The Ramu Highway, which branches off the Highlands Highway at the Waterais Junction and runs all the way through the Ramu valley until the town of Madang.
- Existing feeder roads that connect the main Highway road to the more inland areas of the valleys. These are mostly unpaved roads and often not maintained.
- The Ramu electricity grid is connecting the two major cities in the valleys, Lae and Madang, with the Highlands region. This grid includes 4 power stations, including the Madang, Lae and Yonki hydropower stations in the Markham & Ramu valleys. The fourth power station, Paunda, is located in the Highlands. There are two sub-stations in the valleys, at Nadzab and Ramu Sugar⁵.
- The Port of Lae, with its 11.44-hectares South Pacific International Container Terminal, is the largest port in PNG, and has recently undergone a 350 million Kina expansion.
- The airport at Nadzab is being used for domestic flights carrying both passengers and cargo, and the government has plans to change its status to an international airport with possible connections to Australia.
- A small seaport and airport in Madang.

4 IFC, 2018; New Gulf Province Transport Route

5 Lawrence, 2017; Infrastructure Challenges for Papua New Guinea's Future

- Also, telecommunication is available throughout the entire corridor, as Digicel has coverage that includes the entire Markham / Ramu valleys. Other services providers with a stronger focus on urban areas are B-mobile and Telikom PNG.
- PNG Water supplies water to both Lae and Madang urban areas.

Figure 10: Digicel coverage map⁶

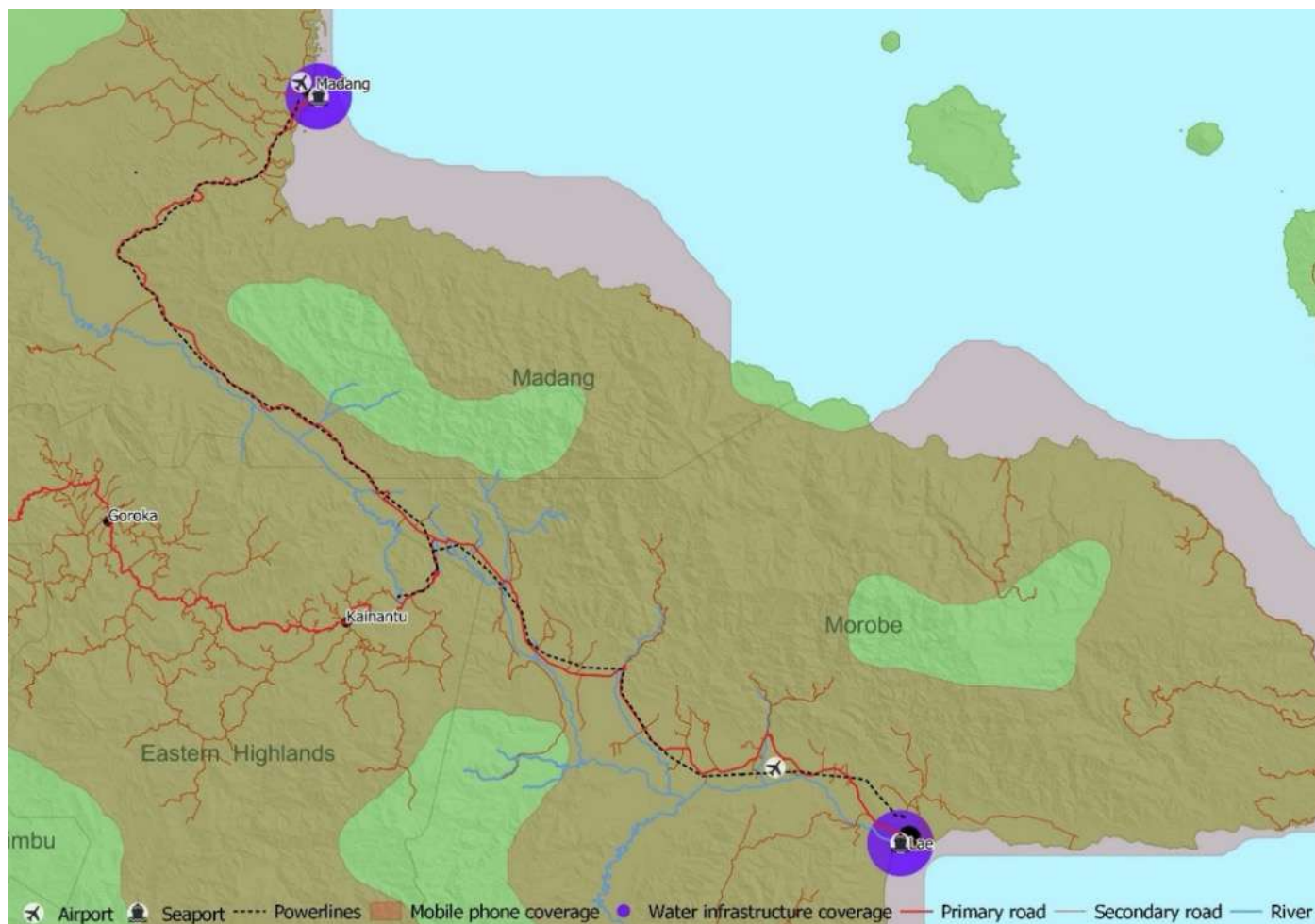


Even though this backbone infrastructure provides a fair basis for future developments, a number of important improvements are required to make it suitable to provide the services required to drive agricultural development in the corridor. Firstly, the Highlands Highway needs to be improved, as the quality of the road varies greatly along its entirety, from good to very poor. As the main transportation route, it is vital that the road is, and remains, in good condition. Secondly, the transport hubs in the corridor need an upgrade. The airport in Nadzab needs to be upgraded to handle more flights and a higher volume of import and export of cargo. Upgrading the airport to an international hub would be an immense improvement, as it would circumvent all international transport that goes through Port Moresby. Several stakeholders who travel regularly mentioned this point. Direct flights would make Lae much more attractive for investors. Thirdly, the electricity infrastructure needs to be extended and improved. There is currently a heavy reliance on generators in the corridor, as the electricity network does not include last-mile infrastructure, and the supply is unreliable. It will be interesting to see how the PNG Biomass and the Ramu 2 Hydropower projects will change the supply in the region. Finally, the water network needs to be extended beyond urban areas.

Many of these challenges will be overcome in the near future, as donors, international financing institutions, development organizations and the government of PNG have projects ready to commence that will address these infrastructure bottlenecks.

⁶ Website Digicel Group

Figure 11: Key transport infrastructure



3.2 Land ownership

97% of the nation's land is customary land while 3% is held in alienated title (freehold and leasehold). Under customary principles of landownership, the customary land is held by its traditional owners. The specific elements and rules of the system of customary land tenure vary from place to place. However, customary landownership generally recognises the traditional users of land and their personal and clan arrangements for land use.

A foreign investor cannot purchase or lease customary land directly from its traditional owners. If a foreign investor requires access to customary land, it is the government that has to acquire the land from its traditional owners and then lease it to the foreign investor.

The alienated 3 % is the locus of economic activity and of most urban development. The government's power to acquire land is contained in the Land Act 1996. The state can acquire land by agreement with landowners (Land Act 1996, s.10), or under some circumstances the Minister for Lands can decide to make a compulsory purchase (Land Act 1996, s. 12).

The Land Act prevents customary landowners from directly leasing land to foreigners. But they can lease it to the State and then lease it back. Thus, landowners wishing to engage in land dealings are able to enter into a

lease – lease back arrangement with the government. In this way, landowners acquire a leasehold interest in their land, which may then be mortgaged or subleased to investors (Land Act 1996, s.11).

In order to be able to enter into a lease with the State, the customary landowners have to organise themselves into Incorporated Land Groups (ILG). Once the group is legally incorporated as an ILG, they gain legal status as a corporation with perpetual succession. Perpetual succession means that the corporate body continues to exist after the death of any of its members and the sale of its assets. Once legally incorporated, the group can sue and be sued, enter into contracts and do other things a corporation can do. The main benefit though is that the owners can use their land in the formal economy while protecting their customary interests.

Unlike a State Lease, Lease and Lease Back has no security of tenure. The 'lease and lease back' (LLB) agreement is when the ILG gives the land to the state, the State creates and grants a title – Special Agricultural and Business Lease (SABL) - with a defined term to the ILG. The lease title becomes a tradeable asset that can be used by the group or sold to any other entity and is thus valuable collateral, but only for the term of the SABL; at the expiration of which the land reverts to customary tenure. Hence, the collateral value of SABL titles are limited.

Having title to the land, the ILG can also issue leases to other groups or individuals to use the land. However, it seems that the LLB process has been abused and large parcels of forest land in PNG had been subject to claim under SABLs, resulting in a Commission of Inquiry, established in 2011, which has led to a moratorium on dealings with SABLs across the country imposed in 2013. Hence, State Acquisition by Agreement (s.10) and Compulsion (s.12) remain the two secure ways of creating secure land titles.

3.3 Labor

PNG's labor market is characterized by a small formal sector comprising of about 10 to 15 percent of the working-age population. The remaining 85 to 90 percent work in the informal sector, primarily in subsistence agriculture, mostly due to lack of skills and limited economic opportunities. In addition to skills shortages, human factors are also a barrier to hiring more staff. These include staff productivity, attendance and punctuality.

Only 59 percent of the population has completed primary school, and many of those who do finish lack basic literacy and numeracy skills (82 percent and 64 percent, respectively, in 2012). Many are unable to communicate effectively at a reasonably advanced level in written and spoken English, with ability levels skewed towards the bottom end of the normal curve of distribution. Education is tuition-free, but attendance is not compulsory. With a literacy rate of 64.2%, Papua New Guinea has the lowest literacy rate in Oceania.

It is estimated that 67 percent of the country's population is below 35 years of age and about 40 percent under 15 years of age, yet less than 10,000 young people enter the formal labor market every year. Among young people aged 15 to 24 in Port Moresby, 29 percent were estimated to be living on less than US\$3.10 per day in 2009/2010, and 31 percent were unemployed. This number is set to increase by more than 50 percent over the next 25 years⁷. With the economic development focused primarily on urban areas and limited gainful employment opportunities in rural areas, young people are gravitating towards urban centers in pursuit of better jobs and standards of living. However, this is starting to lead to an over-aged workforce at farm level, which can already be seen in many other countries, making it even more difficult for investors to find the required skilled labour in rural areas.

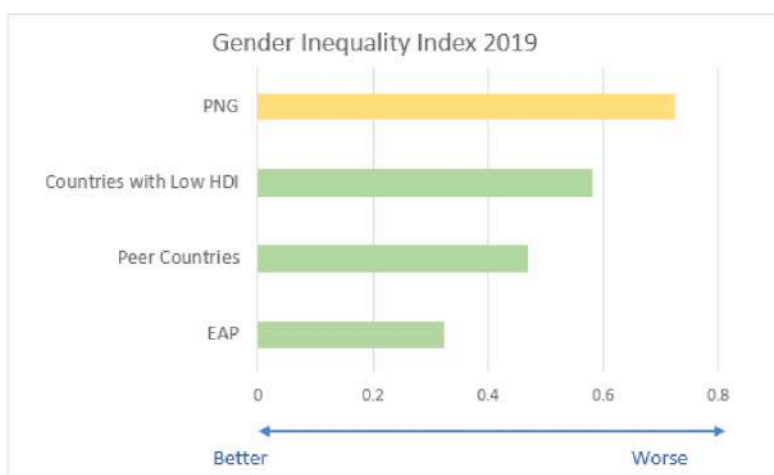
7 Worldbank, IFC 2019; WBG Country Partnership Framework for Papua New Guinea for the period FY19-FY23

A number of studies⁸ show the importance of women in the workforce who are contributing to the rural development and the country's GDP. However, pervasive gender inequities and gender-based violence in PNG have an impact on women's education and health outcomes, employment opportunities, and political voice and representation, thus holding back half the population from contributing fully to the country's economic and social development. One of the immediate outcomes seen by companies is the high absenteeism rates of women due to violence. Companies like tuna canneries, where the female workforce can be up to 75%, experience often underutilization of processing facilities because workers do not attend to their shifts. A case study by the IFC⁹ identified that companies can lose 3 to 9 percent of the payroll due to lost staff time. Staff lose 11 workdays per year due to gender-based violence (GBV), including two days of presenteeism, five due to absenteeism and four due to assisting other GBV. There are also indirect costs like increased staff turnover, additional healthcare or simple fraud under duress from a family member or partner.

GBV can have an impact on the reputational risk of an organization, therefore companies started to work with the Business Coalition for Women or the IFC to find gender smart solutions. Gender smart programs not only improve the reputation of an organization, but also attract skilled female workers which is highly important in the agricultural sector, where they play a key role in the production of agricultural produce¹⁰.

As of June 2014, women held 23 percent of senior management roles and 31 percent of middle management roles, although over recent years there has been an increase in the number of promotions and appointments of women.

Figure 12: Gender inequality index, 2017³



Gender inequality is worsened by high levels of gender-based violence (GBV) and family and sexual violence (FSV).

Estimates from Médecins Sans Frontières suggest that 70 percent of women in PNG have experienced some degree of physical or sexual assault in their lifetime. These risks generate substantive productivity losses due to related absenteeism and time taken to provide support for coworkers affected by GBV, and have a direct impact on women's ability to accumulate human capital and participate in the economy and society. The formal justice system is often difficult to access, especially for women in rural areas. Other obstacles include inadequate policing services, inefficient, sporadic, and underfunded support services (i.e. at hospitals and emergency shelters), a shortage of counseling services and limited collection of data on GBV, which impedes policy reform.

8 IFC, 2015; The fruit of her labor: promoting gender-equitable agribusiness in Papua New Guinea IFC, 2014;
 9 Gender-Smart Business Solutions, Case Study: Addressing GBV with Companies in PNG
 10 WB, 2018; Household Allocation and Efficiency of time in PNG

3.4 Political

The significant political focus over the last years on the development of the agriculture sector in PNG has unfortunately, not yet led to a highly favorable investment climate. This becomes evident from the World Bank's Ease of Doing Business, where in 2020 PNG ranked 120 out of the 190 countries' evaluated business regulations.

Table 4: World Bank's Ease of Doing Business⁴

Rank	Country	DB Score
117	West Bank and Gaza	60
118	Ghana	60
119	The Bahamas	59.9
120	Papua New Guinea	59.8
121	Eswatini	59.5
122	Lesotho	59.4
123	Senegal	59.3

It stipulates that reforms are necessary to simplify and streamline business regulations, on which good first steps were made by the investment promotion authority kicking off a Regulator's Summit in 2019. The main political constraints mentioned by the stakeholders include:

- **Law and order problem** - this was the most critical challenge for most of the businesses. Many businesses were either victims or witnesses of crime, impacting negatively business operations. Prevention of crime contributes significantly to the cost of operations.
- **Political uncertainty** - businesses are still highly impacted by political uncertainty. The delays in negotiations with the extractive industries not only impact the large resource companies, but also the service industries around the camps and mines, which experience delay and shortage of contracts. As these service companies source material and laborers mostly locally, these uncertainties influence also heavily the local markets.
- **Instability of laws, rules, and regulations** - investments are often discouraged due to cumbersome and complex regulations. Many businesses experienced major challenges under sudden changes in regulations and policies.
- **Corruption.**

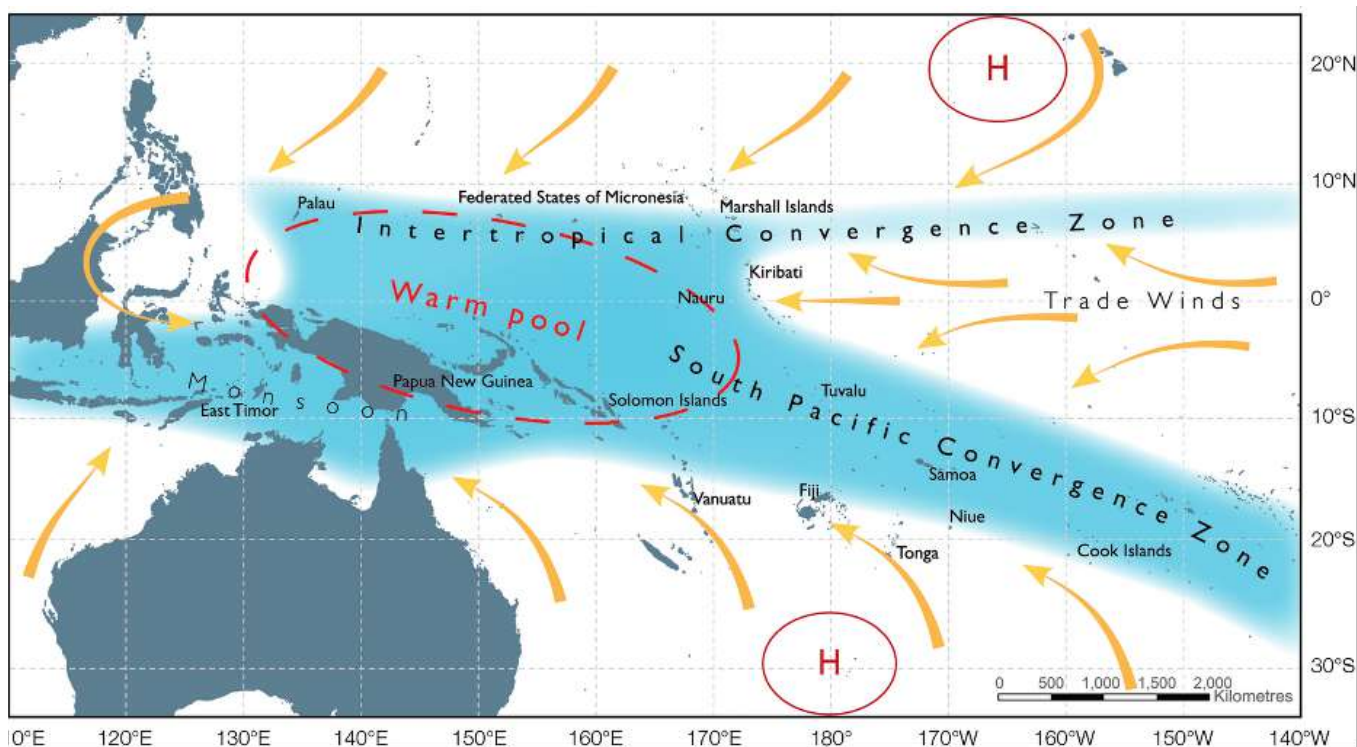
These findings are similar with the results from the ADB study "The Challenges of Doing Business in Papua New Guinea" from 2014, indicating that not much has changed. Stakeholders only confirmed that telecommunication has improved.

11 UNDP, 2019

3.5 Climate

The country is located in the West Pacific Warm Pool with a wet season from November to April and a dry season from May to October.

Figure 13: Climate zone map¹³



It is affected by the Intertropical Convergence Zone and, to a lesser extent, by the South Pacific Convergence Zone. Most of the rainfall comes from the West Pacific Monsoon. PNG's climate varies considerably from year to year due to the El Niño-Southern Oscillation. This is a natural climate pattern that occurs across the tropical Pacific Ocean and affects weather around the world. There are two extreme phases of the El Niño-Southern Oscillation: El Niño and La Niña. There is also a neutral phase. Generally, in Papua New Guinea, El Niño years are usually drier than normal, while La Niña events are usually wetter. La Niña - associated prolonged rainfall has led to flooding and landslides, whilst El Niño associated droughts have also taken their toll on Papua New Guinea. During El Niño events, the monsoon season also starts later. For example, the dry season in Port Moresby is cooler than normal in El Niño years and warmer than normal in La Niña years, while the wet season tends to be warmer and drier than normal during an El Niño event.

Stakeholders confirmed experiencing climate change impact. For Markham Ramu valleys, they recognized an increase in temperatures with more severe hot days. Negative El Niño impacts were especially remembered for the years 1997 and 2014. The Markham and Ramu valleys have different rainfall zones. Starting from the Lae or Madang sides, rainfall is high to the close proximity of the ocean. Going more inland, annual rainfall is decreasing. However, stakeholders confirmed that rainfall has increased in general. It is concerning that rainfall is less consistent and more extreme rainfall days are experienced. This is in particular challenging since irrigation systems are not common. Most farmers are used to rainfed farming. It also results in flooded areas alongside the rivers, landslides and an increase in road maintenance since most roads are unpaved.

Fortunately, Markham and Ramu valleys are not affected by cyclones as often seen in many other South Pacific islands.

¹³ Pacific Climate Change Science Program, from International Climate Change Adaptation Initiative

3.6 Access to markets

Access to markets was mentioned as a challenge by a number of stakeholders. It is mainly related to lack of transport/storage infrastructure within the country as mentioned under subchapter 3.1. However, there are also other challenges, making it difficult for expansion of current businesses, but also new investments.



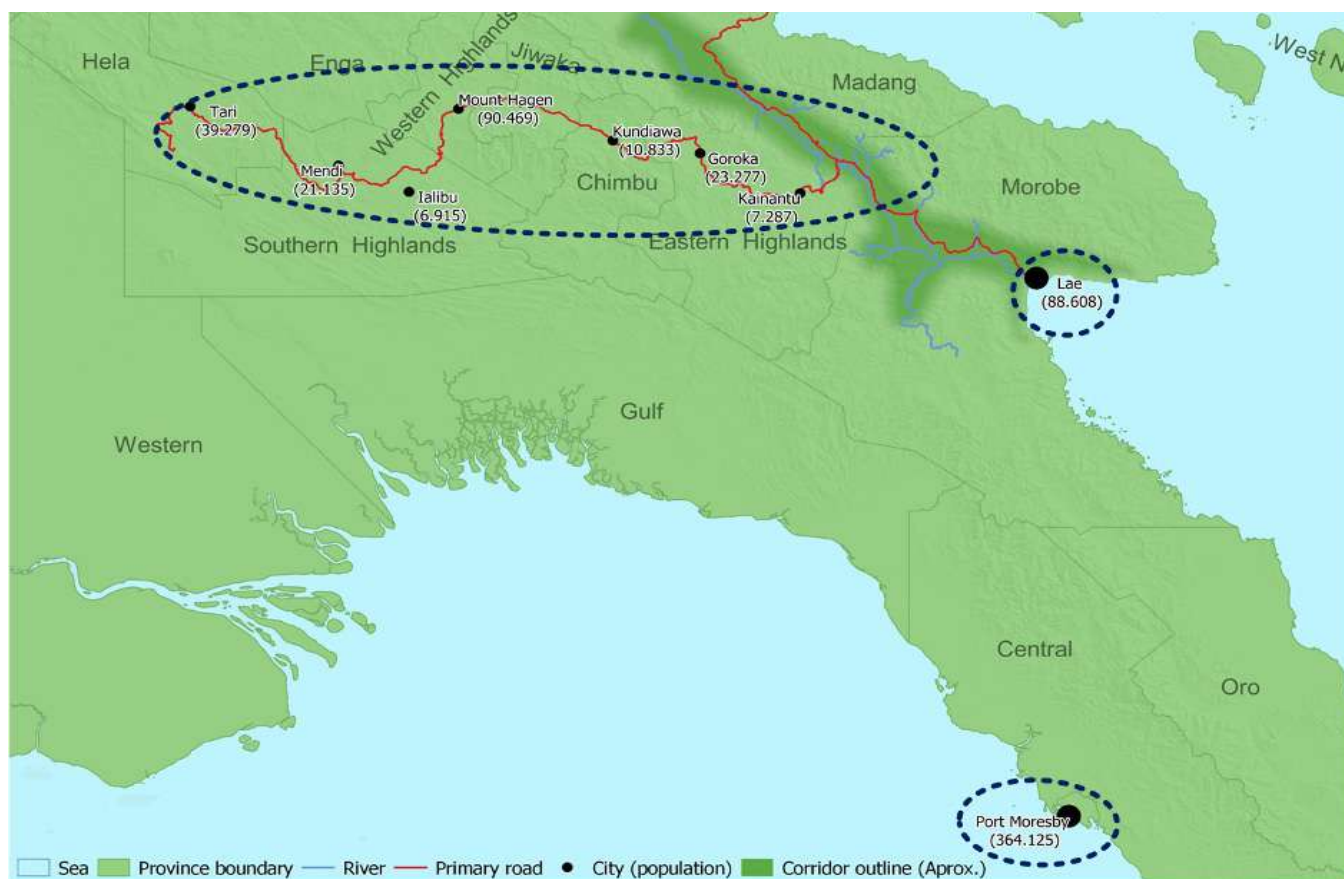
Open market

With eight to nine million people, the PNG population is, from a global perspective, relatively small, therefore investors will need to analyze the growth potential of this market, as well as how easy it is to access the majority of the population. Since the country is topographically challenging and many people live in remote locations, not all of the eight to nine million people can be seen as potential consumers in a short or medium term.

Key market areas in PNG are the Highlands, especially the population living alongside the Highlands Highway and the two most strategic cities, Port Moresby and Lae.

For businesses in the Markham and Ramu valleys, both Lae and the Highlands province are connected by the Highlands Highway, while Port Moresby can be only reached via shipping services. This is an incredible advantage, but due to lack of maintenance, still very challenging.

Figure 14: Key market areas (Port Moresby, Lae and Highlands) with population numbers¹⁴



It needs to be pointed out that the population numbers are from the 2011 census and do not present the additional growth within the last 9 years as well as does not include the villages surrounding the cities where a large number of consumers live. It is estimated that around 4 to 5 million people live in the Highlands.

For exporters, the key challenge is to transport their products from their inland location to either a sea or airport (Lae). Often, the inland transport alone makes it difficult to be competitive with the global market in a similar commodity, e.g. coffee or cocoa. Furthermore, the limited availability of shipping and flight routes require a detailed analysis on how much the product would finally cost at the port of destination (e.g. China) which would allow the exporter to compare the product's price competitiveness. Due to COVID-19, this challenge has dramatically widened, especially airfreight services have been impacted badly.

The Markham and Ramu valleys have the advantage to be in close proximity of sea and airports in Lae and Madang, where both Lae port and Nadzab airport have the better connectivity, being the main gate to the Highlands.

Other critical points for a limited access to markets, especially to international markets, are:

1. Lack of required quality standards, certifications, biosecurity etc.
2. Lack of required volumes - in most cases available volumes do not reach required minimum volumes for efficient transport, e.g. exporters cannot reach the volume of a standard 20-foot container. However, there are also cases the other way around, for example some companies would like to export small volumes of specialty coffee or cocoa and administrative export requirements are too burdensome.

¹⁴ PNG 2011 Census

3.7 Finance

Inadequate access to finance is challenging for the agriculture sector in PNG. The situation is mainly two-dimensional, with difficulties to secure forex (e.g. US Dollar or Australian Dollar) for imports of agricultural inputs, machineries and construction materials for new investments, and affordable long-term finance in local currency for working capital and local currency costs in new investments.

The current policies in relation to the extractive industries give a lot of tax concessions to the project partners for the development of major projects in PNG. These tax concessions have resulted in lower foreign exchange and tax revenue for the government. Most of the export earnings in foreign currency are held in offshore accounts and do not enter the foreign exchange market, resulting in a forex backlog. While there has been an improvement in the foreign exchange market, especially over the last two years, the imbalance of supply and demand for foreign exchange, although reduced, continues to persist in the first quarter of 2020 with approximately Kina 1.2 billion¹⁵.

For local currency requirements, only a few banks are lending to the agriculture sector. There are no countrywide accumulated numbers on how much local banks lend to the agriculture sector, however the largest local bank, Bank of South Pacific, had a loan portfolio with the sector of PGK 327 million at the end of 2019¹⁶. Kina Bank, with its ambitious plans to grow on the market, had only a portfolio of PGK 7 million¹⁷.

When banks do lend, it is usually on a short-term basis, to fund working capital, and at rates of interest that are often too high to be commercially affordable for agricultural companies in PNG. The micro, small and medium sized enterprises report regularly major challenges to secure finance despite the government's effort to connect banks with smaller companies.

15 Bank of Papua New Guinea, 2020
16 BSP Annual Report 2019
17 Kina Bank 2019 Annual Report

4. Analysis of the Agricultural Potential

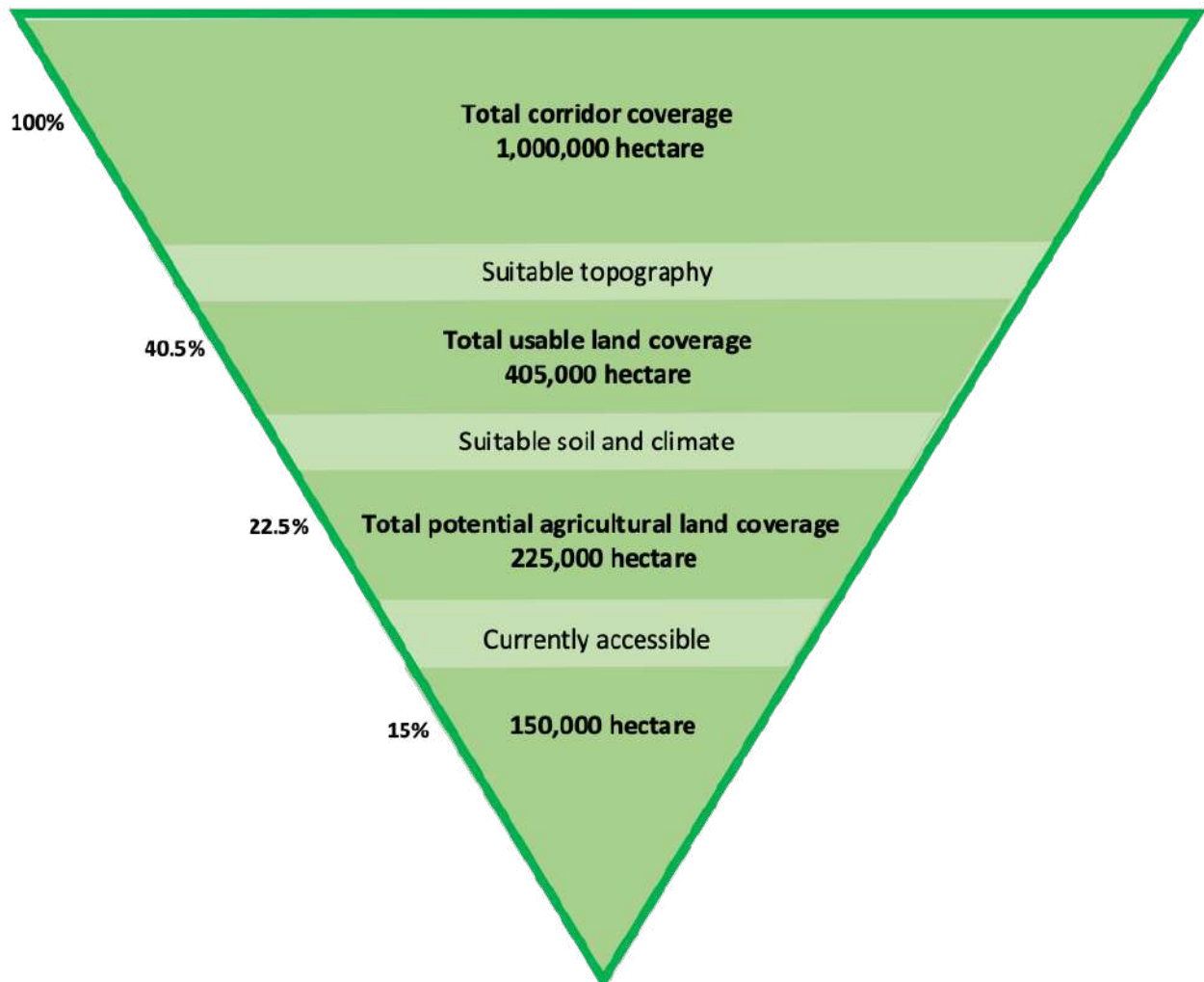
A historic higher level of farming activities, in combination with the current scene of private investments and agricultural development projects, indicate a very substantial agricultural potential in the Markham and Ramu valleys. Despite the barriers that refrain new investors from settling in the valley, or expand their agribusinesses, the political climate sets a framework that promotes further development of the PNG's agriculture sector. Analysis of the natural environment indicates that the Markham and Ramu valleys contain highly suitable land to grow a range of crops and livestock.

Analysis of the agricultural potential focuses on the topographic, climatic, and soil characteristics of the two valleys. A wide abundance of crops will flourish in the valley, as the current agricultural practices of smallholder farms prove. But for the suitability analysis, there was a focus on the most predominant food and cash crops already grown in the valley. The results indicate that there is enough room for the expansion of these crops in the valley.

4.1 Current land suitability

The assessment of the current suitability looks at the feasibility for the land to grow and distribute certain crops, giving steady development of infrastructure and supply chain activities. A methodological approach for the suitability assessment is given in the figure below.

Figure 15: Suitability of land in hectare and percentage



Methodology

STEP 1: TOPOGRAPHIC SUITABILITY

Identify the area in the wider valleys that is suitable for agricultural purposes. This excludes all the topographic features that are not suitable for crops or livestock due to their topographic nature.

STEP 2: SOIL AND CLIMATIC SUITABILITY

After topographic suitability, land is evaluated by its soil properties and climatic variables for the purpose of growing a specific crop. Soil properties considered are: depth, drainage, texture and fertility as a product of chemical attributes. Detailed soil maps are used where available. Crop properties are taken from FAO's EcoCrop.

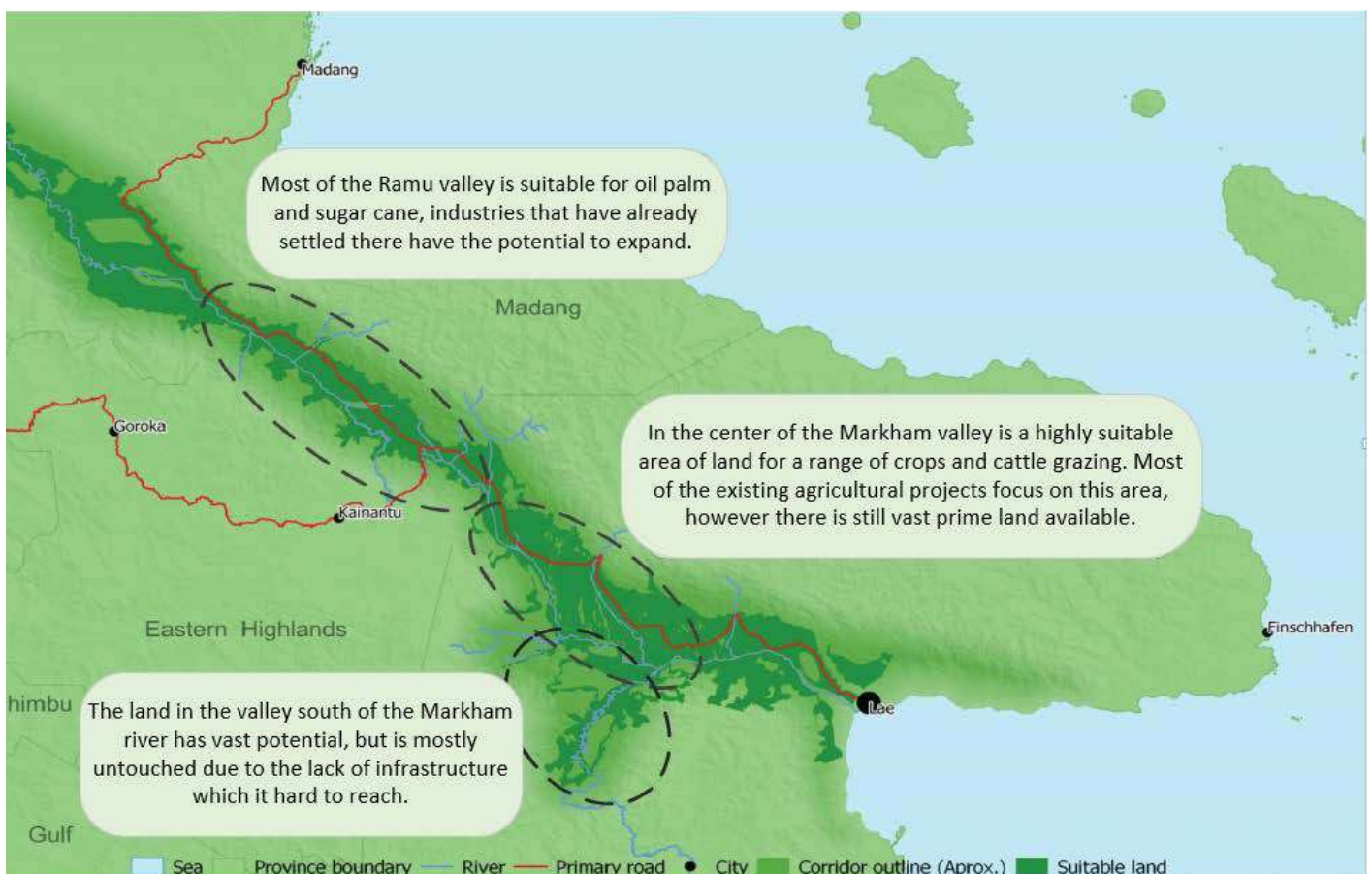
STEP 3: INFRASTRUCTURE ACCESSIBILITY

The distance to vital infrastructure, like roads, electricity and a water source is considered to determine the suitability for agricultural expansion over the next years, without rigorous investments.

Step 1: Topographic suitability

Figure 16 below shows the outline of the corridor, which includes the entire valleys of the Markham and Ramu rivers and is extending north-west until the dense forest is reached, slightly further than the Ramu highway. This area covers roughly 1,000,000 hectares, most of which are unsuitable due to their topography. However, more than 400,000 hectares of land are fit for agricultural purposes, while the rest is unsuitable due to the steepness of the terrain or being permanently flooded, like rivers and lakes.

Figure 16: Suitable land overview



Step 2: Soil and climatic suitability

Figure 16 also shows the suitability of the corridor's land for agricultural crop types which will be presented in more detail in the following maps. A key resource of information were maps conducted in the 1970s¹⁸. The data from these old sources (one example is figure 17) have been digitalized for the current work.

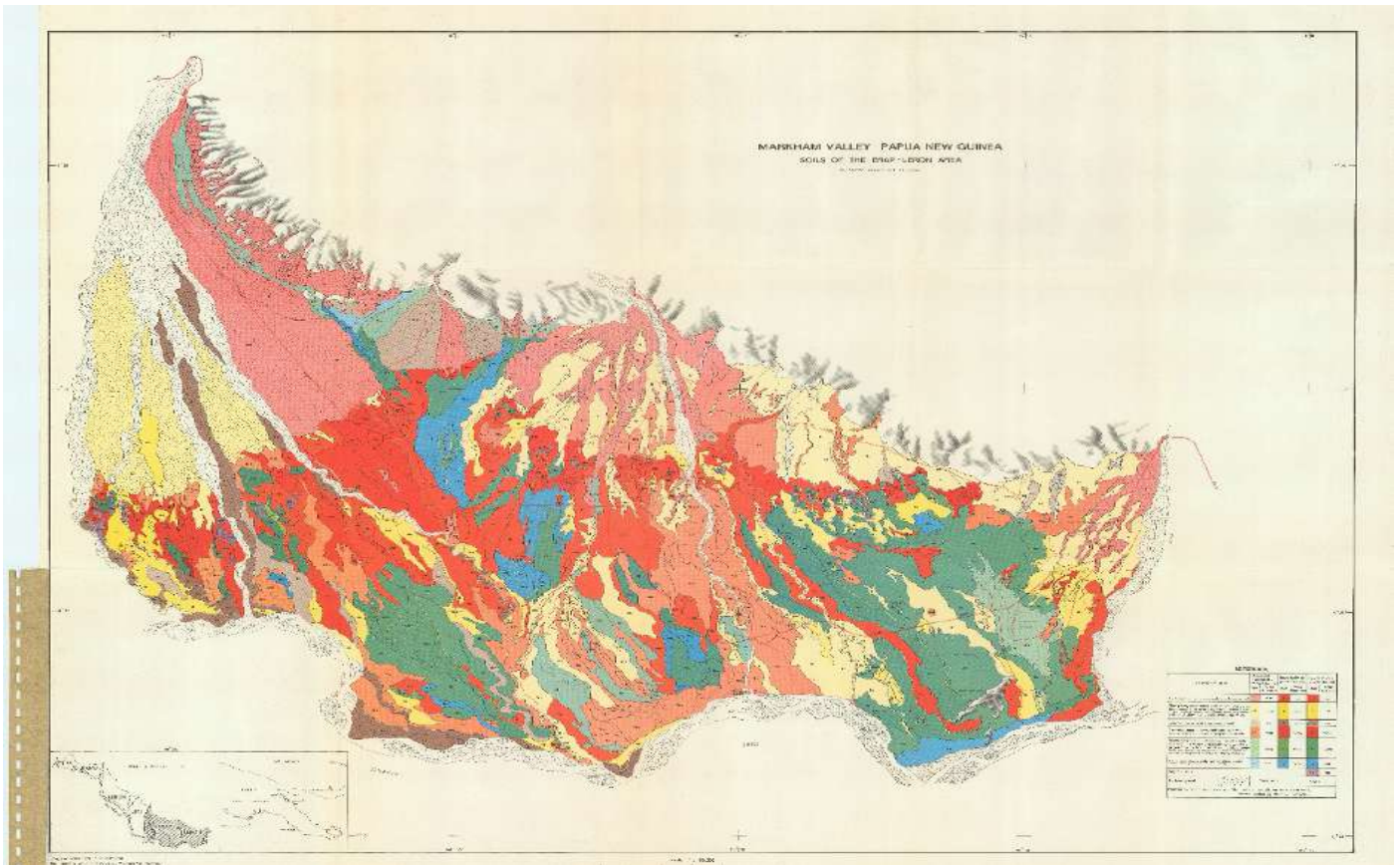


Soil in Markham valley

Unfortunately, not all areas were covered by past surveys. It becomes apparent that there is a large potential for pasture in the flatter and lower laying areas just outside of Lae for cattle or other livestock. A large part of this land used to be cattle production areas in the early 1900s, making good use of their potential. The shallow topography and easy access to water for the livestock make it a very suitable area for the re-development of cattle herds.

18 Holloway et al., 1973; Land resources and agricultural potential of the Markham Valley

Figure 17: Land usability maps from 1973



A number of crops were analyzed for presentation purposes. Depending on the interest of stakeholders, more crops could be added to the analysis.

Figure 18: Sugarcane (*Saccharum officinarum*) suitability



The areas of the corridor that are suitable for sugar cane production are located in the upper part of the Ramu valley, the upper part of the Markham valley, and below the Markham River. The largest sugar-growing plantation in PNG, Ramu Sugar, is located in the Ramu valley, and there is an opportunity for further expansion or the development of new plantations. However, a sugar specialist confirmed also that the Ramu valley has a number of sugar cane disease affecting production volumes.

Figure 19: Cassava (*Manihot esculenta*) suitability



There is a massive potential for cassava farming in the corridor. As cassava can be grown in relatively marginal soils, where other crops might fail, it is a good alternative for otherwise unusable soils.

The commercial growth of cassava is unlikely to be demand constrained, as there is a local demand for consumption, stockfeed and the substitution of imported starch. Additionally, there is a very large demand from the Asian market, where exporting cassava from large commercial farming could be profitable if production costs in PNG can be reduced by achieving scale in production volumes.

The overall combined suitability indicates that more than half of the arable land in the corridor is suitable for the evaluated crops. Taking into account market demands, there is a prosperous opportunity for the agriculture sector to be developed in the corridor. On the domestic market, there is a demand for both food crops and animal protein products, and a well-managed export facility could open up bigger markets in Asia and Australia for both food and cash crops.

Figure 20: Pasture suitability



From historical information, the potential of livestock farming in the corridor has been evident. With the extreme decline of the livestock industry over the last decades and limited local supply, there is a very high potential for the industry to grow again. Considering the threat on the local pig production because of the African Swine Fever, especially the smallholder production, new and current businesses could try to fill the animal protein gap.

Three other crops were analyzed (maize, eucalyptus and oil palm).

Figure 21: Maize (*Zea mays* ssp. *Mays*) suitability



Figure 22: Eucalyptus (*Eucalyptus pellita*) suitability



Figure 23: Oil palm (*Elaeis guineensis*) suitability



Step 3: Infrastructure accessibility

Large parts of the corridor are suitable for growing agricultural crops. However, provision of vital infrastructure as access roads, electricity and water, can be challenging in these remote areas. For a long-term development plan, it is feasible to extend the existing infrastructure throughout the entire valley and unlock all the suitable agricultural land. Nevertheless, in order to kick start these developments, first agricultural expansion should take place on the suitable lands closest to these infrastructures. It has been calculated that around 150,000 hectares of this suitable land are situated within 5km of a primary road, power lines and a water stream. This will make it feasible to connect these utilities to the land in the short-term and provides easy entry into the corridor.

Suitability platform

Access to relevant information has been identified by the stakeholder analysis as one of the main barriers to invest in PNG and the Markham & Ramu valleys. To make information on the suitability of investment in the valley more accessible, the project has always aimed to share this information with the general public. For that reason, the relevant topographic, soil and climatic data has been published on the PNG REDD+ and Forest monitoring platform managed by the Climate Change and Development Authority (CCDA) and National Forest Authority (NFA) supported by the FAO, UN-REDD Program, EU and JICA. This platform and the data from this project can be explored on www.png-nfms.org.

Maintenance of the platform and updates of the information can be kept relatively affordable, as other organizations will also share a responsibility in this. Furthermore, it is expected that the platform will be extended with other relevant information from the associated government departments (DAL, NFA, and CCDA) and, through them, the relevant private sector stakeholders.

Critical cost drivers would be if information would need to be updated in very short-term periods, e.g. daily or weekly. Also, the higher the resolution of satellite images, the more imagery providers will charge. Due to high cloud coverage, firms eventually will also need to use the service of aerial imagery (fix-wing or drones). This is why joint efforts to collect data would be more cost efficient.

For companies that do not want to wait for a joint solution, a very helpful point of contact for remote sensing is the PNG Remote Sensing Centre Ltd from Port Moresby. They have detailed data for many areas in PNG. However, each company would pay for the service individually.

4.2. Future land suitability (climate change adaptation)

For this scoping study, the Commonwealth Scientific and Industrial Research Organization (CSIRO) has evaluated 29 delta scaled climate models that are suitable for the Pacific. They project WorldClim 2.1 to 30-year averages for the 2030s, 2050s, 2070s, 2080s. Results of these models were used to evaluate the future suitability of a number of crops in the corridor. For this simplification, only two climatic variables were considered - rainfall and temperature, to not overcomplicate the study.

Over the valleys, temperatures are predicted to rise an average of 2 degrees Celsius, from 25 to 27 degrees, with extreme outputs between 26 and 28 degrees Celsius between 2020 and 2080. Precipitation changes are more unpredictable, with an average modelled increase of 250 mm/year, from 2,150 mm/year to 2,400 mm/year. However, extreme model outcomes almost vary as much as 1,000 mm, with a minimum at 2,200 mm/year and a maximum at 3,150 mm/year. This indicates the extreme variability in model outputs, especially for precipitation.

Following outcomes, three key crops were identified. More crops can be evaluated if requested. For the downscaled projection data, information provided by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) was used.

Cassava suitability

The outputs of the models indicate that at least until the 2050s, there is no prohibiting influence of the temperature on the suitability of cassava cultivation in the valleys. Precipitation extremes could have some influence; however, the largest part of the models still indicates suitable precipitation levels in the central part of the valley. When looking all the way to the 2080s, the potential risk of too much precipitation becomes more prevalent, but this is mainly affected by the large variability on the output of the models so far into the future. For those decades, temperature extremes are also predicted to limit the suitability for cassava cultivation.

Cocoa suitability

Similarly, the temperature is predicted to stay suitable for cocoa production until at least the 2050s. After that, specifically the lower parts of the valley, around the rivers, are forecast to have unsuitable temperatures. However, the high ridges of the valley, where cocoa production is currently located, is foreseen to remain suitable. The modelled increase in rainfall will also affect the suitability for cocoa in the 2080s. As with cassava, the uncertainty of the models makes only half of them to predict very suitable precipitation.

Oil palm suitability

Climatic suitability for oil palm in the valley is already high for the 2030s. However, the increase in temperature and rainfall predicted by the models indicate that this might even slightly increase towards the 2080s where the entire valley is climatically suitable to grow oil palm.

Figure 24: Climate suitability analysis

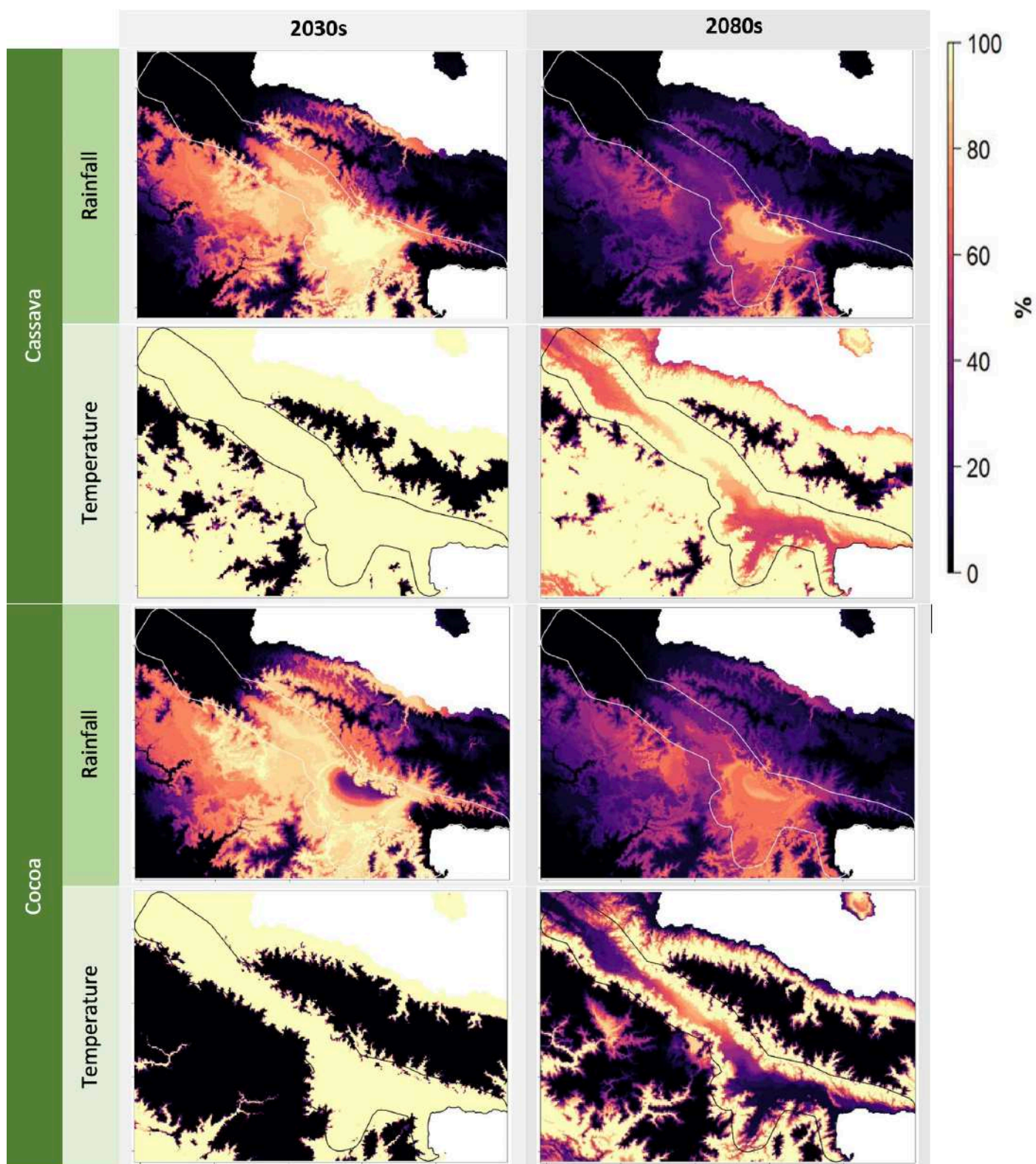
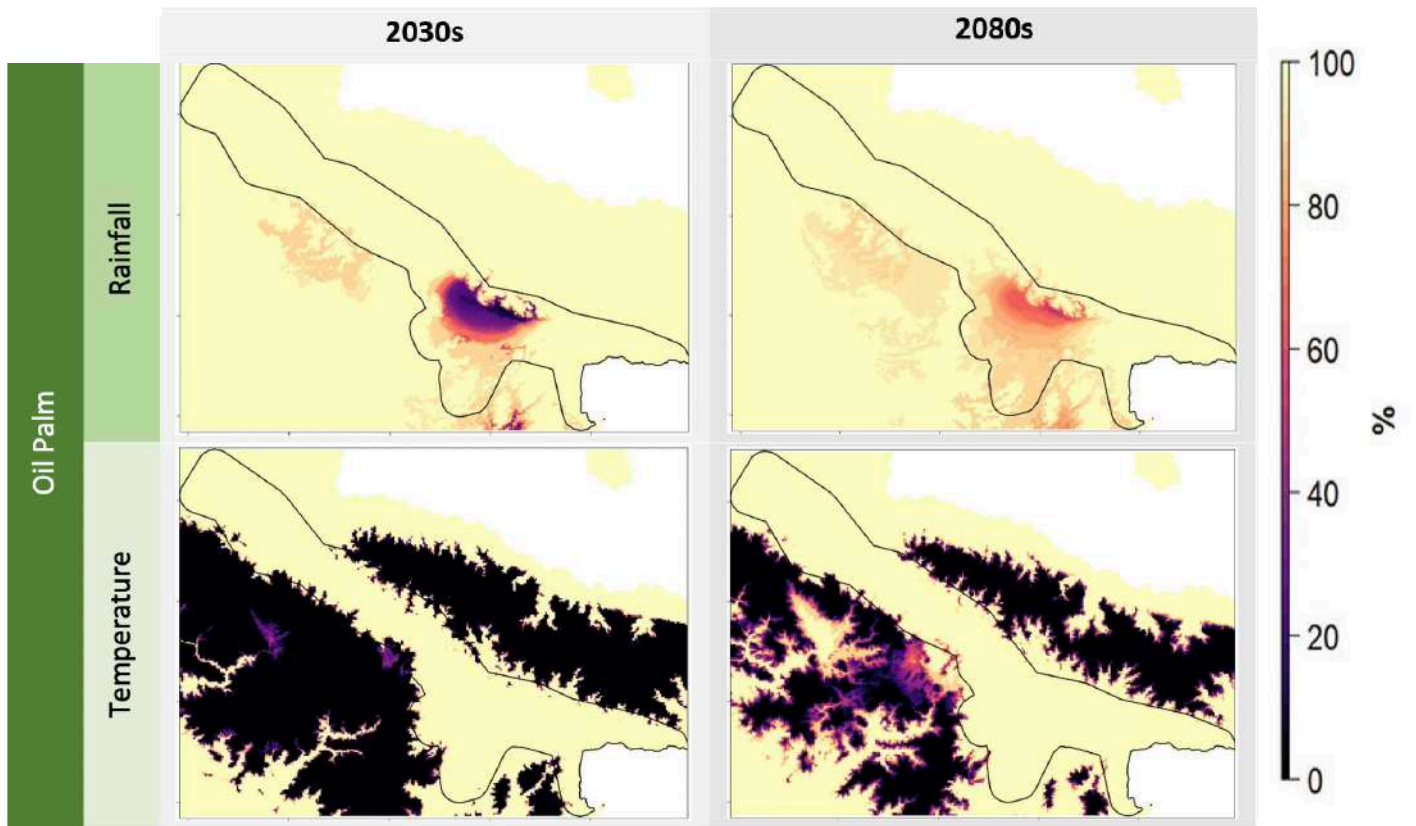


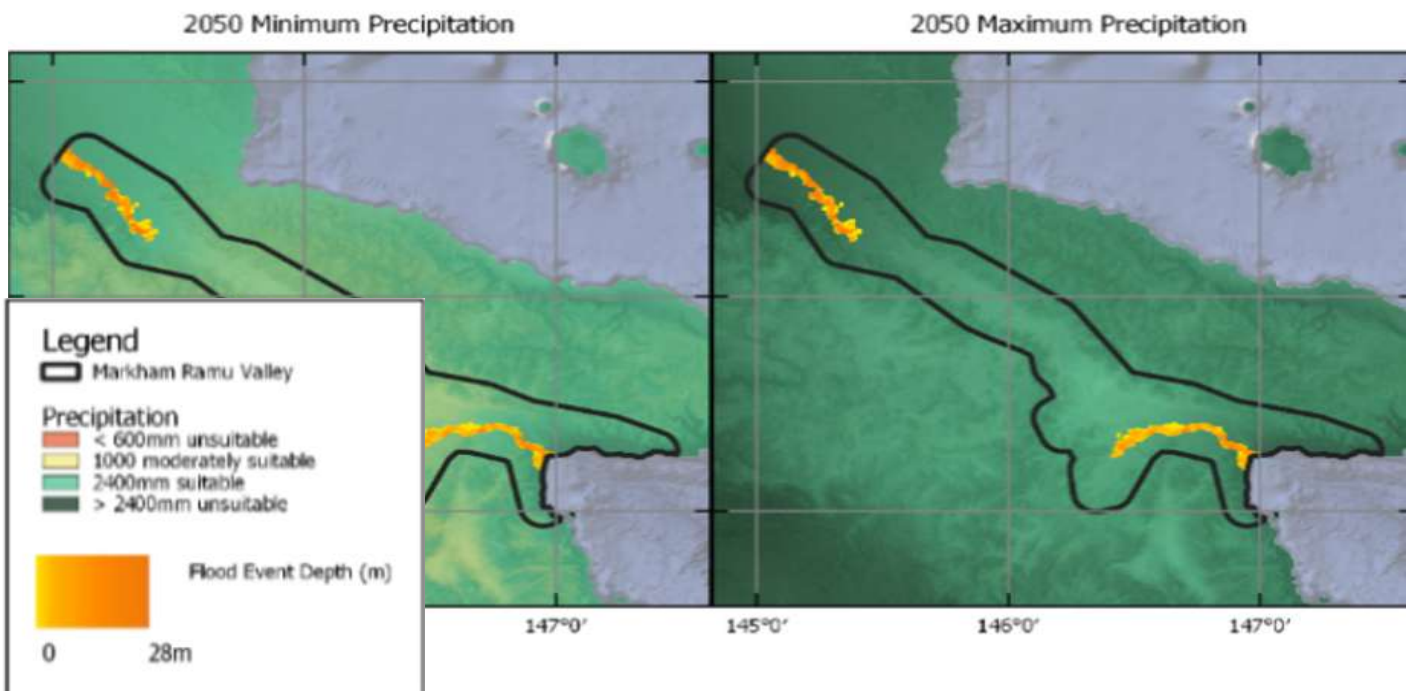
Figure 24: Climate suitability analysis



***% of models to have a "very suitable" output for two decades (2030, 2080), per crop, per variable*

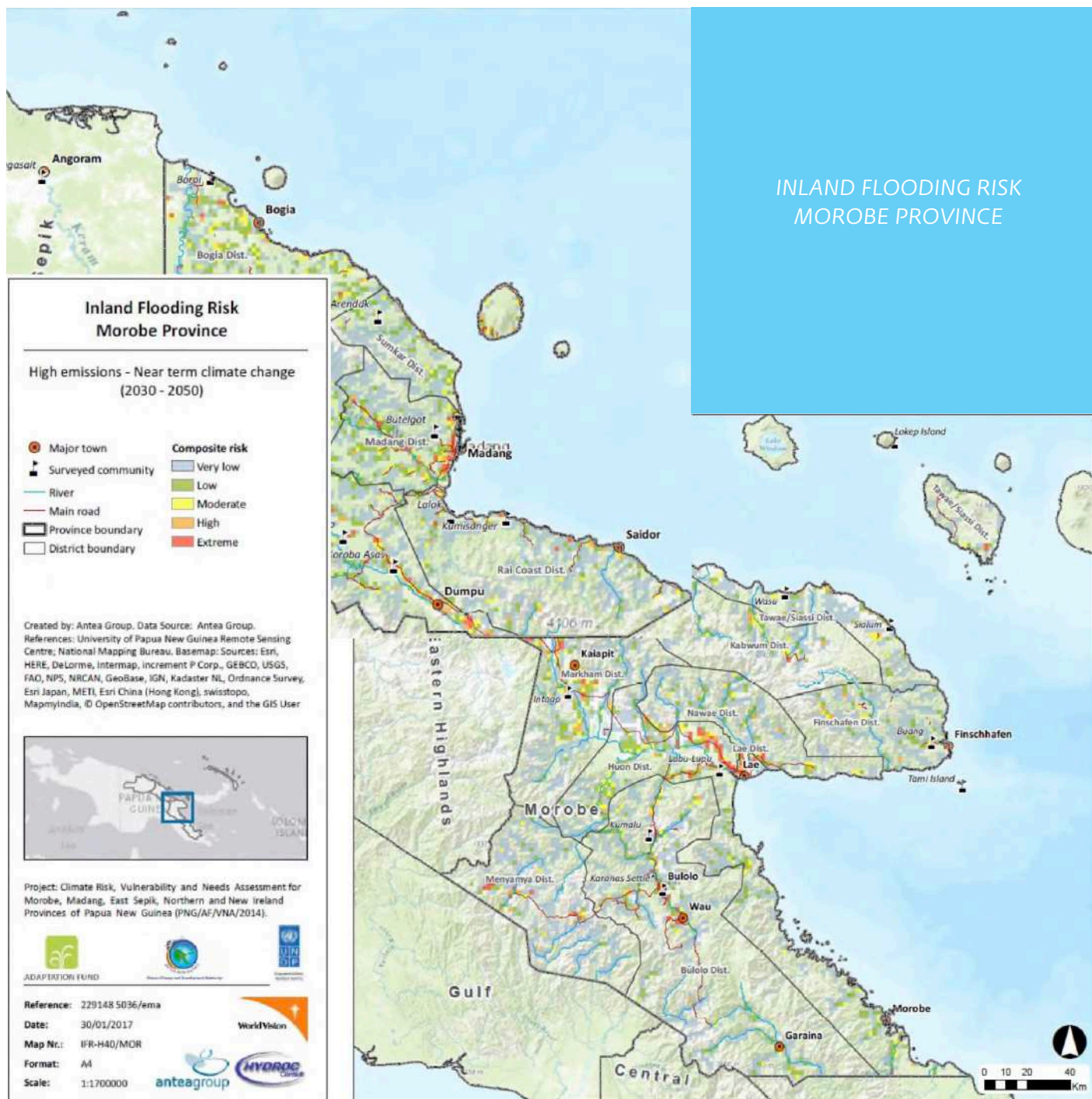
Flood risk was also evaluated by CSIRO, specifically the area to be flooded once every 100 years.

Figure 25: Flooding analysis by CSIRO



In 2017 the 'Climate Risk, Vulnerability and Risk Assessment' taken by United Nations Development Programme (UNDP), PNG Climate Change and Development Authority (PNGCCDA) and Adaption Fund investigated similar inland flooding risks, for a return period of 5, 10 and 50 years. Both studies give a comparable result, that there are areas prone to flooding, specifically the lower, down-stream river basins of both the Markham and Ramu rivers. These assessments coincide with events on the ground, as flooding already occurs locally in these areas. It is good to keep these extreme events in mind and adjust the future agricultural activities to these risks. Nevertheless, the largest part of the valley will not be affected by extreme inland flooding, as the area lays relatively higher, and upstream of the Markham and Ramu rivers.

Figure 26: Flood risk maps from UNDP



19 UNDP, PNGCCCA, Adaption Fund, 2017; Climate Risk, Vulnerability and Risk Assessment in the Morobe/Madang Provinces in PNG (for each province one study)

The work by UNDP, PNGCCDA and Adaption Fund is excellent and very in-depth, identifying not only an assessment of climate hazards, but also risks and vulnerability in the Morobe and Madang provinces. It shows that there is a lot of data available, but, in many cases, the private sector is not aware of this data, or cannot use it for the business development plans since it is not easily processable. For example, IFC was not able to access the raw data which could have been also uploaded to the PNG REDD+ and Forest monitoring platform to be aligned with the other collected data. An improved and consolidated data collection would enable organization to make evidence-based decision.

5. Development Path

Reviewing the historical and current agricultural activities (chapter 2, the barriers for further expansion (chapter 3 and the analysis of current and future agricultural potential (chapter 4, we found sufficient evidence and support from the majority of the stakeholders for the development of a successful agricultural corridor by the government of PNG jointly with the private sector, and development partners.

A possible vision concept:

The overall vision of the development of the Markham and Ramu Agricultural Growth Corridor is to transform and accelerate the agricultural green growth, coupled with infrastructural developments (e.g. reinforcing the transport backbone over the next 20 years. It will stimulate investments through a multi-stakeholder partnership, within the commercial agriculture and agribusiness inside the Markham and Ramu valleys corridor. It will develop highly productive sectors while improving domestic food supply (food security, export earnings and the productivity and incomes of smallholders. The initiative works towards attracting strategic private sector partners with environmentally responsible business models to enhance linkages with smallholders and fix critical links in the value chains, which will be key to engine economic growth.

Having a clear vision is not enough. This vision needs to be shared by all the corridor stakeholders. This is why one of the first steps in a corridor program is to forge a consensus vision and to align stakeholders around shared goals and strategies.

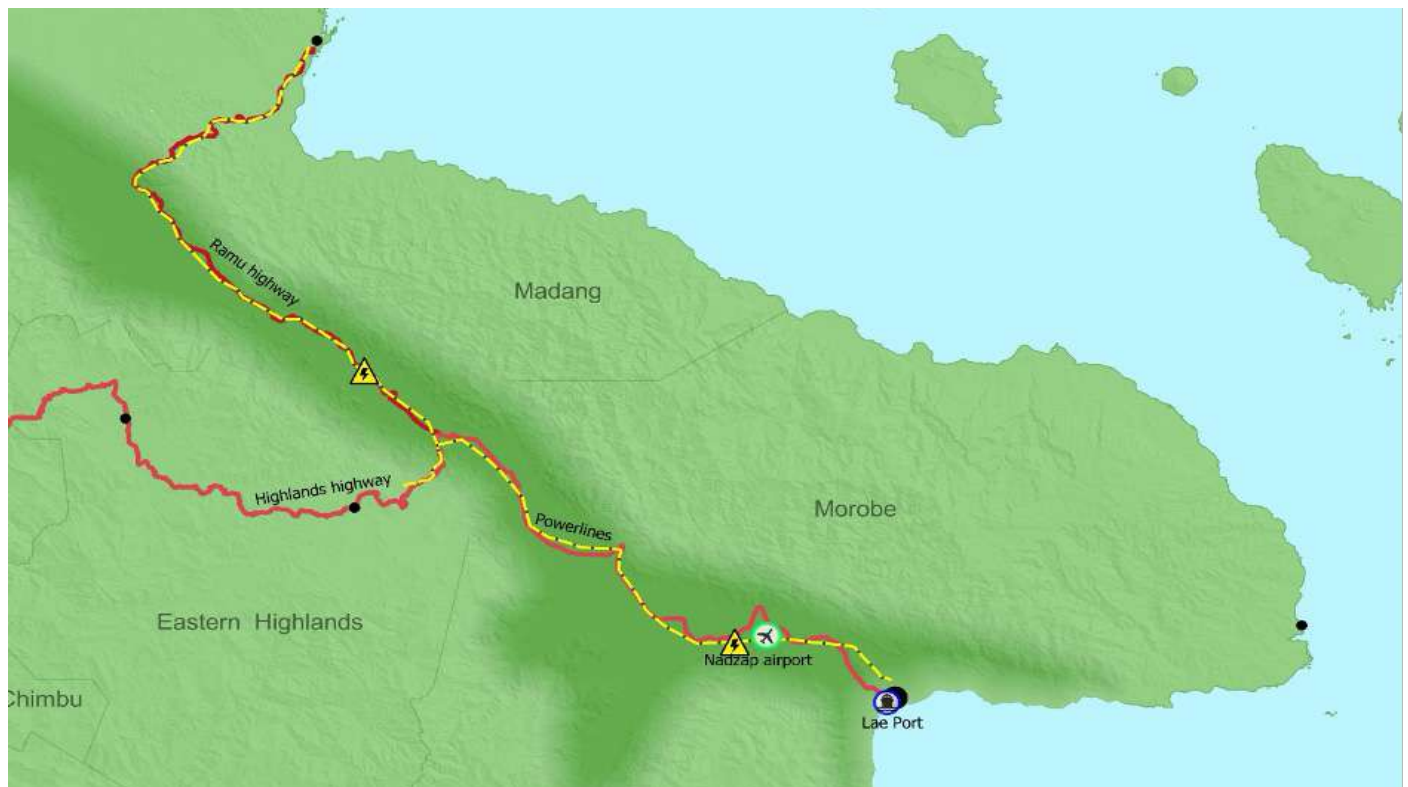
5.1 Stakeholder commitment

As outlined in the PNG Development Strategy Plan (PNGDSP by the government, the focus of the economic growth in the country is planned to be based around various economic corridors in the country. As a result, infrastructure developments have been high on the agenda of the government of PNG, but also their development partners, over the last year. For the Markham and Ramu valleys, a number of infrastructure sectors projects have been scheduled and budgeted for.

This is essential, as other corridors around the world confirm, that a strong backbone infrastructure is necessary for a successful agricultural growth corridor.

A number of infrastructure projects are encouraging to lay out the initial structure for any development in the Markham and Ramu valleys:

Figure 27: Major infrastructure projects



Highlands and Ramu Highway

Department of Works is the PNG's government's implementing agency for infrastructure in the country. It coordinates the National Road Network Strategy 2018 – 2037 to rehabilitate and upgrade national roads. This includes the primary roads like the Highlands and Ramu highways, but also secondary roads. They are supported by the World Bank and ADB.

ADB is supporting the upgrading of the Highlands highway through the US\$1 billion Sustainable Highlands Highway project. The project started in 2017 and is aimed to be completed in 2027.

Simultaneously, the World Bank supports the rehabilitation of the Ramu highway.

Watut valley road connectivity

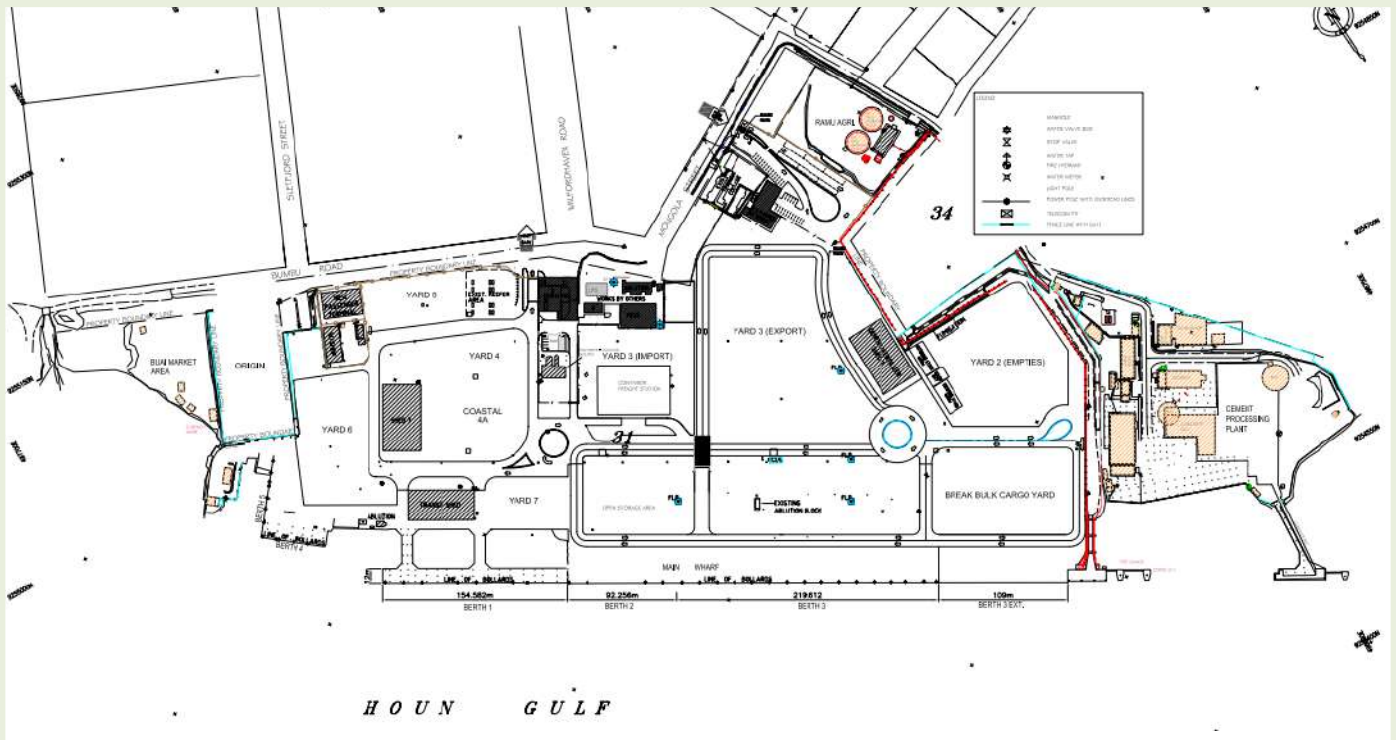
With the development of the Wafi-Golpu joint venture, infrastructure will be improved in the southern part of the corridor. This will likely include road infrastructure, as well as electricity. Construction is planned to commence in 2021.

Nadzab

US\$200 million JICA funded project is set to upgrade the Nadzab airport. The upgrade includes the extension of the runway to accommodate the scheduled landing of Boeing 737 aircrafts. Terminal facilities will be upgraded, and the airport will be able to function as an international airport and handle diverted Boeing 767, 777 and 787 aircrafts.

Lae Seaport

Business activities are improving in the Morobe province with the expansion of the Lae seaport. With an investment of K350 million, the project includes the greater Lae Tidal Basin Project and the Huon Industrial Park development in Lae. Also, part of this project, the West Lae Tidal River Basin project is reputed as of the same size as Port Moresby's recently refurbished Motukea seaport and is where all the non-containerized cargo will go. This will complement the eastern side of Lae container terminal, so the result will be increased volumes and shorter ship turnaround times. Due to the fact that about 80-90% of commodities shipped through seaports are included in the CPI (consumer price index), the efficiencies gained can be transferred through lower prices down to grocery shop items (McQuillan, 2018). Also, the computerized installation and operation of operating system has contributed to a 6% increase in International Container Terminal Services Inc. (ICTSI) handled shipping volume in 2018²⁰.



Electricity

The PNG Electrification partnership is a joined initiative between the government of PNG with multiple donors aiming to implement the National Electrification Rollout Project (NEROP). A total of US\$1.7 billion has been committed to give access to electricity to 70% of the country by 2030.

PNG Biomass is planning to commence the construction of a new power plant (a combination of biomass and solar) centrally located in the Markham valley, while Kumul Consolidated Holdings is planning to develop Ramu 2 hydropower plant, which would benefit Eastern Highlands and Morobe.

The above projects will/would be major game-changers for the development of the possible agricultural corridor. However, it is not clear how all the different types of planned or current infrastructure investments are coordinated efficiently in a joint effort to utilize synergies during construction, but also how the different infrastructure developments will jointly work in providing the highly required services. In particular, the last mile to the villages (e.g. feeder roads, water and electricity connections) is clearly underinvested and requires a stronger focus for the near term.

This is important since the private sector would like to expand their operations and the strongest agricultural opportunities would be to invest in local sourcing from farmers in the two valleys. Improvements in rural infrastructure alongside the Highlands Highway would enable agricultural stakeholders to invest primary and secondary production systems with a strong involvement of smallholder farmers in the new value chains. This would not only allow import substitution and reductions of forex dependency, but would also enable prosperity development in the Markham and Ramu valleys.

5.2 Corridor partnership

As already indicated in the previous chapters, there is a need for effective mechanisms to overcome the coordination problems. Implementing an Investment Blueprint involves a series of interconnected investments along the value chain. The coordination challenge is that the success of an investment at one point in the value chain is often dependent on successful timely implementation of investments by other parties elsewhere along the chain.

For example, on-farm investment (private sector) will often only be profitable if off-farm investments in infrastructure (public sector) are made as and when planned; investment in processing facilities will only be profitable if farm production grows as and when planned; and investments in improving input supply chains will only pay off if on-farm demand for those inputs grows as and when planned.

How can private sector companies minimize the risks of failure by other private sector and/or government parties to complete planned investments on time? The situation is particularly complicated here because there are a large number of parties involved from the private sector, national and provincial government and the international development partners.

Markham/Ramu Agricultural Growth Corridor Partnership

To address some of these coordination problems, it has been proposed that there should be a Markham/Ramu Agricultural Growth Corridor Partnership (MRACGP) with a board and small Secretariat. Partnership membership would include participants from the private sector, government and the international community. In principle, it would be open to anyone with a substantive interest in the development of the MRACGP. The two main objectives of the partnership would be: (i) to facilitate communication between private sector companies about their respective investment plans in Markham/Ramu when they choose to do so (while recognizing the importance of commercial confidentiality and independent decision making, and (ii) to facilitate communication between private sector companies and the responsible arms of government when there is a collective private sector view (while recognizing that individual companies will wish to deal directly with the responsible arm of government in relation to its own business transactions and that the partnership does not in any way cut across governments' powers and responsibilities. The Secretariat could play an important role in assisting farmers and entrepreneurs in the agricultural supply chain to access finance and other types of support from government, donors and private investors. Subject to the wishes of MRACGP members, the Secretariat could also conduct relevant studies (e.g. on ways to improve the business

environment) and take on marketing and promotion responsibilities. An advantage for the development of the MRACGP is having GrowPNG already being active in the partnership area. GrowPNG could either be the temporary Secretary until a formal Secretary will be established or, if partnership members agree, GrowPNG could be restructured and strengthened to take over the role officially.

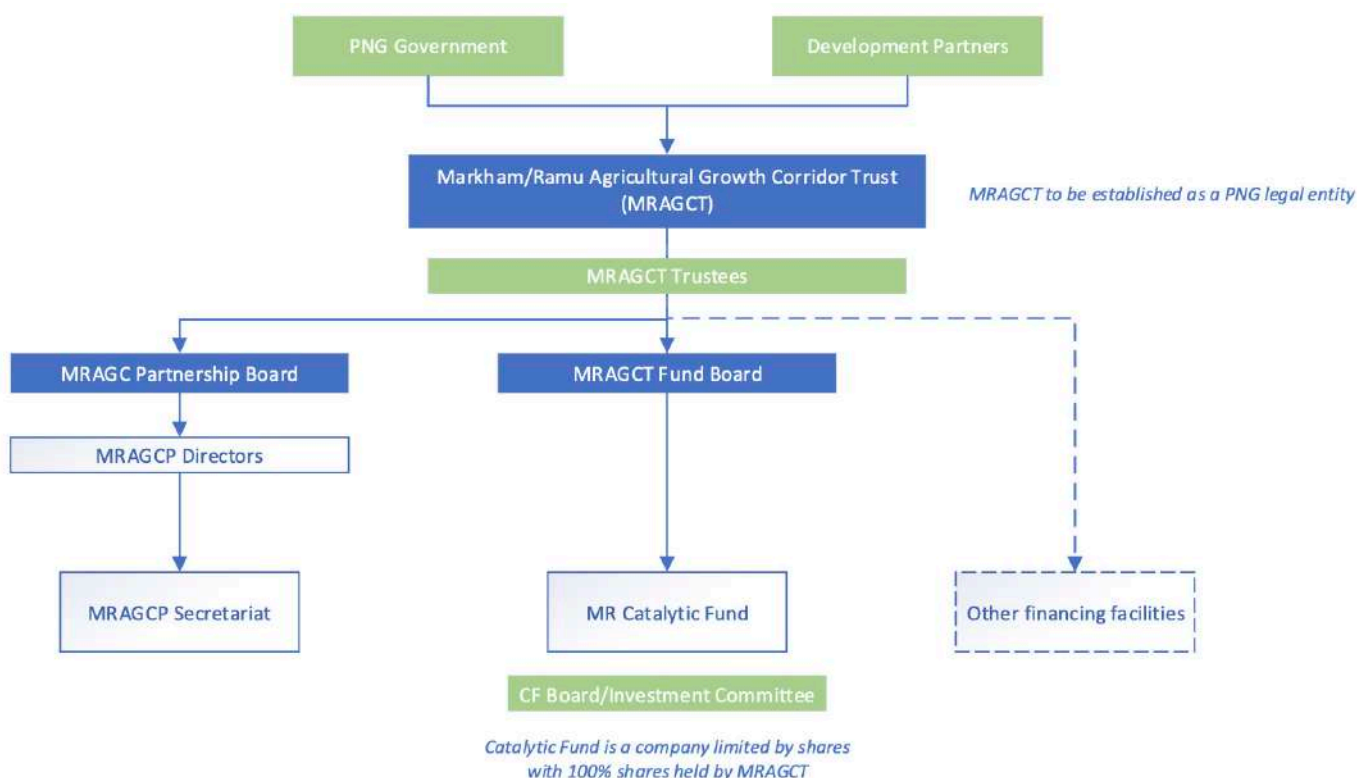
Institutional framework

An institutional framework for the MRAGCP and Secretariat is required. Furthermore, other programs are seeking to align to the Partnership and, therefore, a broader coordinating body would seem to be the most favorable structure.

Under this institutional framework, a possible structure could be that the Secretary will become part of a Markham/Ramu Agricultural Growth Corridor Trust (MRAGCT). The MRAGCT will be responsible for the oversight and coordination of the partnership activities. Its role will be to ensure that agreements entered into between the funders and the different coordination units are compliant.

The MRAGCT would have autonomous legal status in order for it to conduct its own affairs independently. In particular, it must be able to source and receive funds from the public and private sector to support its work in developing MRAGCP operations and, potentially, other corridor initiatives in the future.

Figure 28: Possible governance and administration structure as seen in other corridor programs

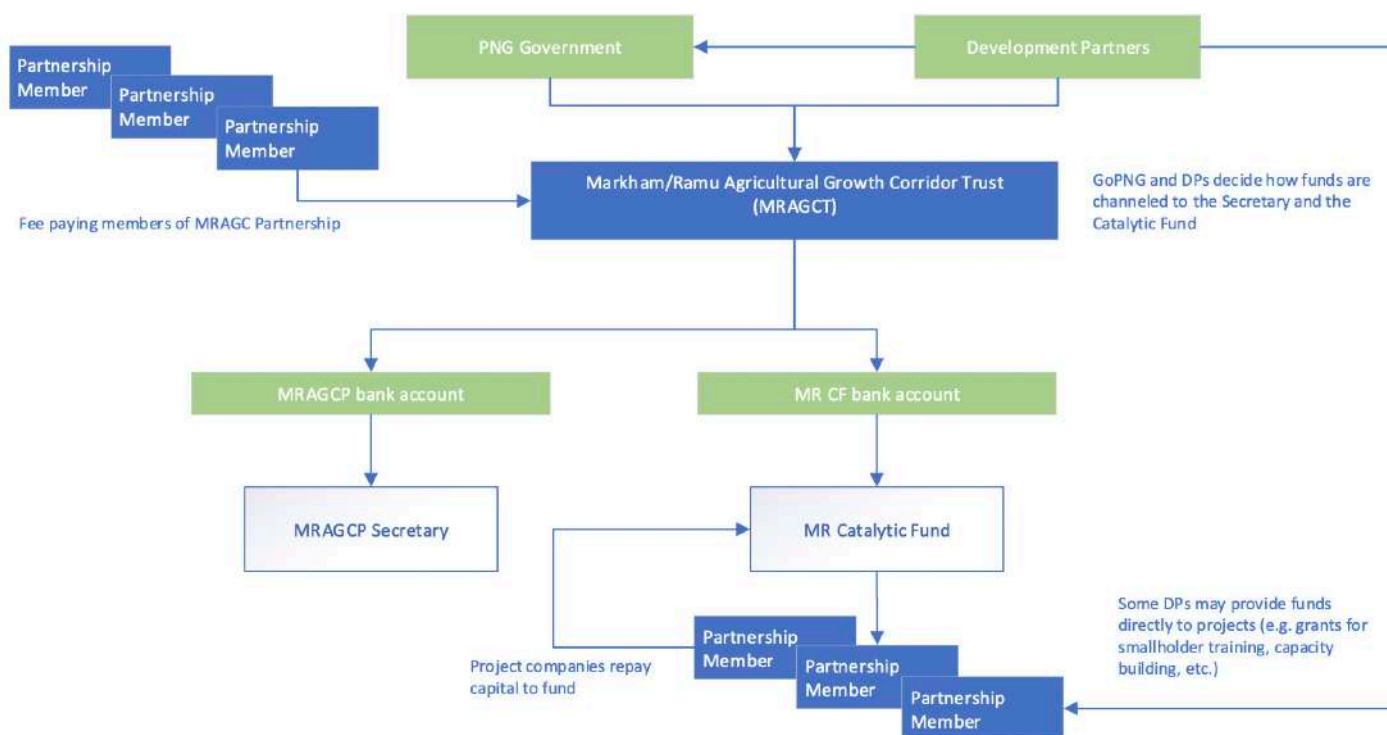


The MRAGC Trustees with the MRAGC Directors will agree on an annual operating plan and budget, and will be responsible for overseeing the performance of the MRAGCP Secretary, while ensuring satisfactory implementation of the agreed plan and budget. All decisions taken by the MRAGCT Trustees shall be consistent with the purpose and objectives set out in the funding agreements. For the MR Catalytic Fund (CF), all investment decisions will be made by the MR Catalytic Fund board on the advice of the Investment Committee in accordance with the Operating Policies and Procedures (OPPs) approved by the funders. In terms of information flow, the Managing Director of the Partnership and the MR Catalytic Fund investment committee will report to the funders through the MRAGCT Board of Trustees.

Flow of funds

Funds will be provided to the MRAGCT by supporters (government, donors, private sector) for onward disbursement granted to the MRAGCP Secretariat and, separately, to the MR Catalytic Fund for use by them in accordance with the terms of the agreed funders' agreements. Development Partners may fund MRAGCT directly, or through the Government of PNG.

Figure 29: Possible flow of MRAGT funds as seen in other corridor programs



6. Investment Blueprint

An investment blueprint for the corridor will be required for the suggested development path. The investment blueprint defines the areas where investments are needed, aligns stakeholder needs, define possible funding needs and required timelines. Since there are many infrastructure projects planned, key focus of the investment blueprint would be to align these infrastructure investments to utilize synergies, ensure that the last mile to producers, but also off-takers is built, increase agricultural production, provide support for food manufacturers and provide the final link to local and international consumers.

It is obvious from other agricultural corridor projects, that stakeholders will need to mobilize large sums of investment capital over a long period of time to achieve planned outcomes and impact. However, other corridors have proved that these investments can have substantial positive economic and social impact if managed well.

This chapter will mainly focus on missing infrastructure and how agriculture and agri-business can be linked into the proposed corridor. It needs to be pointed out that the government will also need to focus strongly on security and education (two critical points mentioned by stakeholders to ensure long-term sustainable development).

6.1 Infrastructure

As described under the barriers and infrastructure projects chapters, there is already a solid backbone infrastructure available, and, where this is in dire need of an upgrade, projects will address these in the near future (chapter 5.1. However, even after all the proposed projects have been realized, there will need to be some additional investments into the infrastructure to unlock the entire agricultural potential of the corridor. The current projects have not taken into account the development of the corridor and, therefore, some key infrastructure has been overlooked. This blueprint considers what investment in infrastructure would be needed to utilize an additional 150,000 ha of land under agricultural production by 2040.

Backbone infrastructure

The backbone road infrastructure, existing of the Highlands highway and the Ramu highway, will be very adequate to support the agricultural developments after the planned improvements have been implemented. The south side of the corridor would be accessible through the proposed Northern Access Road by the Wafi-Golpu mining project. Power transmission lines run through the entire valley and, once upgraded, will be able to support agricultural businesses in the corridor. However, additional sub-stations will need to be constructed in order to connect the last-mile infrastructure, which could be included in the NEROP project. In order to supply the entire valley with (drinking water, a massive investment in the extension of the water infrastructure is required. This could be connected to either the network in Lae, Madang, or a newly developed facility. This could also eventually be combined with large-scale irrigation systems.

Table 5: Assumptions of possible additional infrastructure requirements

Infrastructure type	Amount
Backbone infrastructure	
South-corridor main road	50 km
Electrification	3 Sub-stations
Last mile infrastructure	
Feeder roads	200 Km
Electrification	TBD
On-farm infrastructure	
	TBD
	TBD
Agriculture supporting infrastructure	
	TBD
	TBD
Community infrastructure	
Electricity supply	75 wards
Water supply	75 wards

Last mile

A larger network of feeder roads will need to be established to connect the hard to reach and high potential areas. It is estimated that at least 200 km of feeder road will need to be constructed to link these areas with the main infrastructure and facilitate the usage of input materials and transport of produce. Similarly, power lines will need to connect large farms, or farming communities, to the power-grid through a connection to sub-stations. For the cocoa and coffee farmers that fall under the new PACD project of the World Bank, the government is interested to look into the supply of this last-mile electricity infrastructure. Options of decentralized power supply should be also considered to fasten the development.

On-farm infrastructure

On-farm infrastructure will be required to prepare greenfield land for agricultural production. This includes the clearing of the land, leveling and ploughing. As proposed by the government, the rehabilitation of old farms can also be a viable option to quickly restart agricultural practices in a cost-efficient way.

Agriculture supporting infrastructure / services

Providing improved opportunities for value addition and access to markets will require investment in processing / milling and storage facilities. Besides these physical facilities, there needs to be an investment in agricultural services that can be offered in the corridor. This will include the establishment of service providers that can offer input materials like seeds, feedstock and chemicals, the rental of on-farm heavy machinery and the provision of information and technical advice. Such a service provider needs warehousing and operation facilities. More details on such a service provider will be given in the fast-track opportunities.

6.2 Production/investment models for farmers

With a large body of identified evidence showing that agricultural growth has a high poverty reduction payoff and that it leads to disproportionate income increases for the poorest in impoverished countries it is important to look at production/investment models for small to large-scale farms. These types of investments have been shown to yield higher income gains for the poor than non-agricultural investment.

Agricultural investment that generates positive outcomes can be understood to be multi-faceted and requires a deep understanding of the governance structures and land rights facing the agriculture sector in developing countries. This is in particular true where agricultural investment attempts to achieve sustainable natural resource management for those dependent on farming for their nutrition and livelihoods needs.

When choosing an investment model, it needs to meet the following conditions:

- Supports family farming;
- Provides demonstrable benefits to the local community;
- Results in equitable forms of agricultural investment;
- Generates economic, social and environmental outcomes that are beneficial to smallholders and their wider communities on a sustainable basis; but
- Is also able to mitigate the business risk and challenges identified in this study.

Below is a list of agricultural investment types identified in other projects which would/could strengthen agricultural growth in the Markham and Ramu valleys. It is important to note that it is required to have the right balance to attract larger investors, but also to ensure that smallholder farmers and landowners benefit from any intervention. A strong focus on the MSME sector would not only de-risk from the reliance of a few aggregators as we currently have, but also increase in-depth agricultural entrepreneurship at village level, generate new ideas and build a strong rural foundation for sustainable long-term growth.

Stakeholders in these models will require long-term advisory and financial support to build up a sustainable foundation for further growth. However, models from other regions clearly show an efficient cost benefit ratio, especially since individual models can utilize cross synergies.

Table 6: Types of agricultural investments

Types of agricultural investments		
Investment Type	Details	Objectives
Capital	Physical	On and off farm infrastructure
		Land improvements
	Human	Skills acquisition
Research and Development	Improved farming techniques	Seed development
		Input optimization
		Pest and disease control
Institutional	Enabling governance environments	Improvement attractiveness of investments
	Supply chain enhancement	Improvement of cost efficiency
	Accessible input and output markets	Improvement of productivity and production costs

A specific model of such investment types is the service delivery model or also often called outgrower schemes. A number of service delivery models are used globally, but some of them can also be seen in PNG.

Service delivery models/contract farming

The service delivery model describes supply arrangements agreed before the start of the growing season between farmers and agricultural-output buyers. Farmers agree to provide a certain quality and quantity of output, perhaps by an agreed date. In exchange, the buyers provide inputs including credit, seeds, fertilizer and technical assistance (to be charged against the final purchase price) and commit to buying the farmers' output, often at an agreed price.

Contract farming is most often seen in production of labor-intensive, perishable crops, where the farmers have few options for the sale of their output other than the agribusiness, rather than crops that benefit from scale economies.

Management contracts

These refer to farmers or management companies producing agricultural output on land they do not own. Profit sharing between the owner and manager incentivizes the manager who farms on behalf of the ultimate owner.

For smallholders, the management contracts can take various forms, where the management company runs the farms on behalf of the smallholders, but does not acquire the land directly.

Tenant farming and sharecropping

This is a variation of the management contracts described above. With regard to smallholder farming, these arrangements are the mirror image of the management contracts described above, i.e. smallholders farm land, which is owned by larger agri-businesses. Tenant farming usually entails a fixed fee or rent paid by the farmer to the landowner. Sharecropping sees the farmer and landowner pre-agree to split the output produced or its proceeds.

In developing countries these arrangements may be preferred where agricultural production requires costly investments, e.g. where the inputting of irrigation infrastructure is undertaken by the landowner, local communities carry out the farming of the land and the output is shared with the landowners.

Joint ventures

These models describe arrangements where both risks and profits are shared between farmers and agri-businesses, e.g. a processing plant, with decision-making power shared according to the relative equity share of each party. Partners retain individual legal status. The arrangements may be formal (creation of a separate legal entity to represent the venture that ensures limited liability of the partners) or informal, a more flexible arrangement.

Farmer owned business

Here farmers enter into formal business structures to pool their assets in order to enter an upstream business, e.g. crop processing, gain access to finance, or limit the liability of individual members. These businesses are often owned by co-operatives in many countries.

Such type of arrangement aims to provide farmers with enhanced outcomes or reduced costs that would not be available to smallholders individually.

Upstream and downstream business links

These business links encompass arrangements that facilitate smallholder farmers engaging with other local enterprises that may reach beyond direct agricultural production. Upstream links include supply of inputs and business services. The latter include micro-credit, farmer extension services and insurance.

Downstream links include specialized wholesale and retail services.

Large-scale agriculture

Large-scale agriculture may provide spillover effects that smallholders can benefit from, e.g. large-scale enterprises may attract suppliers, buyers and processors, and, therefore, act as a catalyst for agricultural development.

Table 7: Agricultural investment models and case studies in Markham/Ramu

Agricultural Investment Models And Case Studies In Markham/Ramu Valleys	
Investment models	Examples
Contract farming Management contracts Tenant farming and sharecropping	SPB Cassava Project Rumion PNG Biomass Mainland Holdings, Zenag Farmset's maize project
Joint ventures	
Farmer owned businesses	
Upstream and downstream business linkages	
Large-scale agriculture	NBPOL, Trukai, (Mainland Holdings tried large scale sorghum farming)

6.3 Fast-track opportunities

A number of specific fast-track opportunities have been identified, each which could be initiated either immediately, or within the next few years. These range from livestock farms to medium sized mixed crop farms to smallholder farmer extensions and marketing programs. What is common to all the projects is that they can be delivered on a commercially sustainable basis, contain significant benefits for smallholder farmers, however, all must overcome specific constraints before they can proceed.

Some of these prospects only require access to early stage venture capital and affordable working capital. They show fully commercial returns but have sponsors with limited track record and balance sheet. Other opportunities require access to agriculture-supporting infrastructure, as well as finance.

Animal protein production

Discussions with stakeholders clearly pointed out that animal protein production has major opportunities in PNG. Considering that there is a shortage of available animal protein, as mentioned by the poultry and cattle specialists, while imports are limited due to the forex backlog, investments would show fast results. The pig production is currently affected by the African Swine Fever. Nucleus estates with a well serviced outgrower system could be suitable to expand production. Considering that the four leading producers - Mainland Holdings and Zenag for poultry, Ramu Agri for cattle, and Rumion for pigs - are already in the region, a partnership with the Livestock Development Corporation and Development Partners could lead to the rehabilitation of the old cattle farms and smallholder production systems, while in the poultry sector outgrower systems could be expanded.

First step would be to build a gross margin and make assumptions around fixed costs and the balance sheet (the largest item being the cost of land to get a ROI – to compare with similar enterprises in Australia as reference. This would show if the production in PNG has a comparative advantage and at what stage in the production and supply process. This could be done for various herd sizes – smallholders to larger farms and even different production systems e.g. grass feed to semi feed lotting.

Animal feed production

One of the major challenges identified for commercial animal protein production is the supply of feedstock. Multiple companies tried and are trying to replace imports due to the forex challenges. Considering the high bio-security risk e.g. African Swine Fever, it is important to review the needs of locally produced animal feed. Farmset is currently developing some maize production trials, while the SPB cassava outgrower system could also supply raw material to the feedstock processors. Considering that feedstock is a major cost component in the animal protein production, a key success factor in Markham/Ramu would be the availability of affordable quality feedstock. Partnerships with the large feedstock suppliers like Mainland Holdings and Goodman Fielders could/would bring new technologies into the country to increase efficiency and competitiveness to imported products. It is important for the skills to be transferred to small actors who will be able to fill also niche markets.

Fruit and vegetable production

The fresh produce industry is looking into expansion opportunities to satisfy the local market, but also to supply other Pacific Island countries. Successful first export trials could open up further opportunities to export to Asia, where bigger markets are available.

This would allow expansion of local production based on contract farming models, where farmers are provided with detailed supply requirements. Markham/Ramu would open up the opportunities to invest in medium sized farms to achieve better economical costing, while airfreight to international markets can be provided by Nadzab airport near Lae. The second largest fresh produce operator, NKW, is already operating in the region. The land is very suitable for larger orchards under irrigation systems with outgrower models around the nucleus farms. There would be easy synergies with the agricultural support activities of the Wafi Golpu mine at the southern side of the Markham valley.

The initial phase would focus mainly on the local markets with initial trials of exports to establish a name on the market. In a second phase, cool storage facilities could be developed around Nadzab airport for fast airfreighting to overseas clients, but also processing facilities e.g. fruit pulp production and canning, freezing could be established for second grade production.

Cocoa to chocolate production

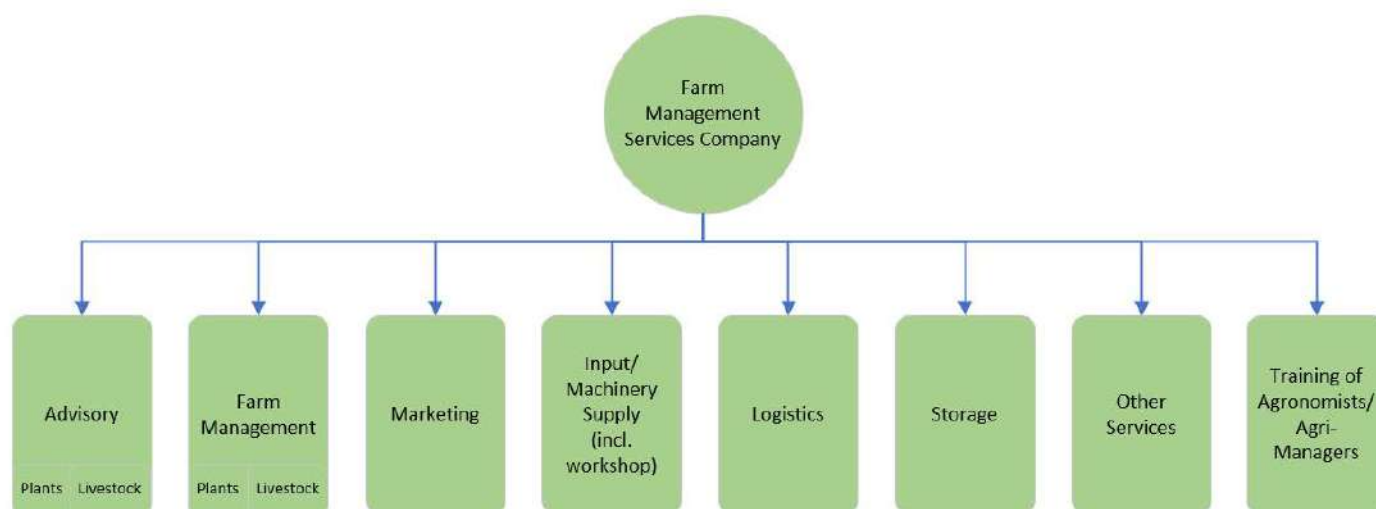
Paradise Food, the leading FMCG company in PNG, has started a small chocolate production using cocoa produced in PNG. The company is interested to expand production and is looking into opportunities to source more from local farmers (part of the current cocoa is produced in Markham valley). A new factory with increased chocolate production would require more supply of sustainable high-quality cocoa of which farmers in the region would benefit. There are already synergies utilized with the Wafi Golpu agri-support activities and could be further strengthened. Also Outspan (Olam, the largest cocoa exporter in PNG, is very active in Markham valley).

Farm Management Service Companies (FMSCs)

Supply of affordable farm inputs, agri-services e.g. tractor services and transport but also agronomists, is limited and one of the major challenges for growth and new investments. Some of the larger companies tried to establish individual services, but were limited in their efforts due to high costs.

Consolidated services provided to multiple companies, landowner groups and farmers by specialized services companies could use synergies on the procurement, but also sale sides while reducing costs. Possible partnerships with input suppliers e.g. Brian Bell, Farmset or Chemica could build a strong foundation for such FMSCs.

Figure 30: Farm Management Services Company

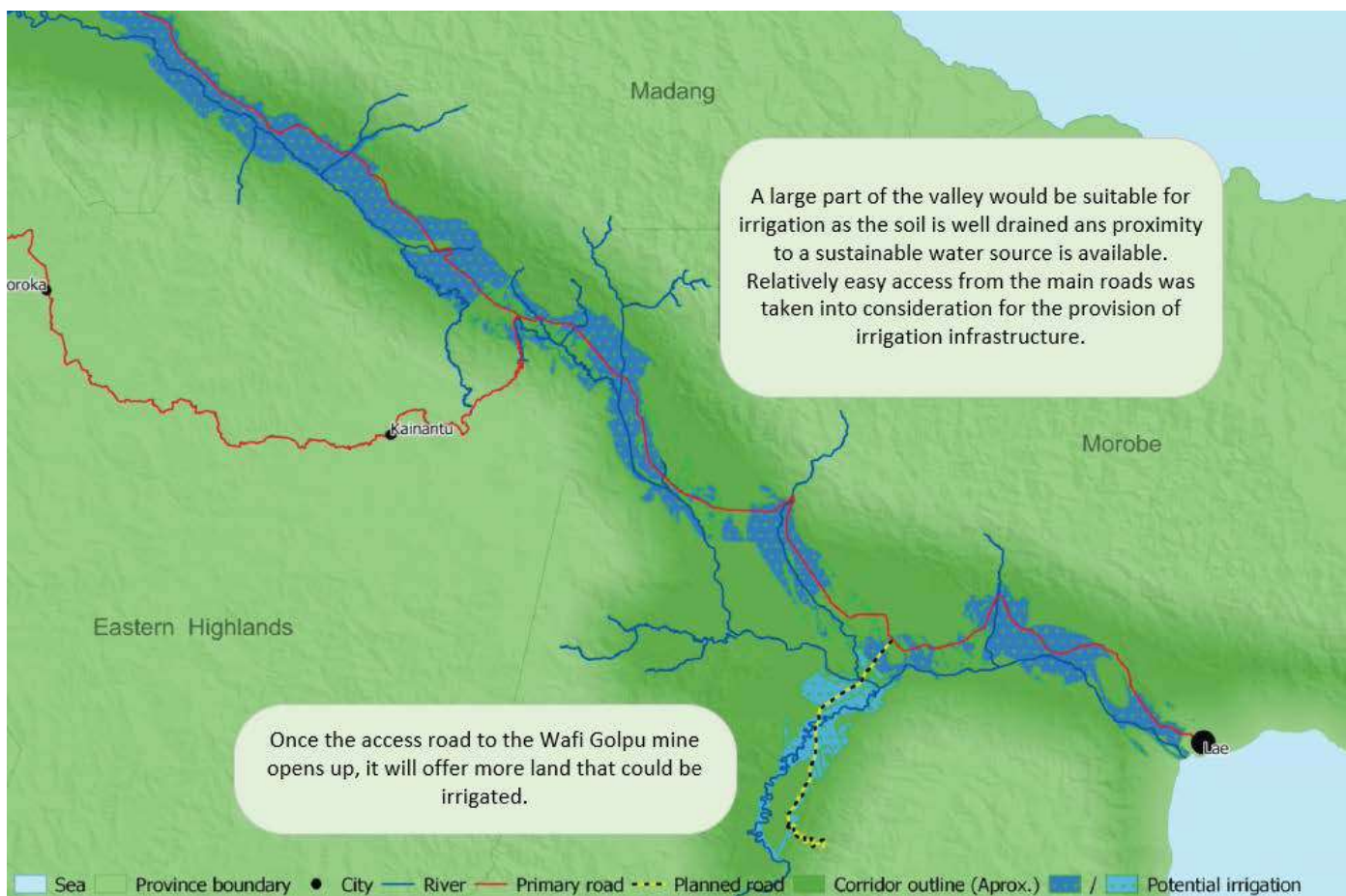


The advantage is that this opportunity could start at a very low-cost level with simple advisory services at an initial partnership between an input supplier, an aggregator and a group of farmers. In a very advanced stage, this could even go so far that the services company provides crop insurances and finance in partnership with insurance companies and banks.

Infrastructure Services Companies (ISCs)

Several stakeholders mentioned possible opportunities for irrigation systems. Delivering several thousand hectares of irrigation within a medium-term timeframe would be a major task. If this could be achieved, then a competent entity will need to be given responsibility for developing the business plan, arranging finance, building the assets and managing commercial relationships with small and medium-sized commercial farms and smallholder farmers.

Figure 31: Potential irrigation areas



The proposal is that one or more ISCs should be established to undertake these tasks with an initial trial to identify the appetite for the first partners. The Australian Infrastructure Financing Facility for the Pacific (AIFFP) could perform this role to initiate the first trial, potentially in partnership with the Government of PNG and other investors (see text box below).

About Australian Infrastructure Financing Facility for the Pacific (AIFFP)

This AU\$2 billion infrastructure initiative looks at significantly boost Australia’s support for infrastructure development in the Pacific countries and Timor-Leste. It uses grant funding, combined with loans to support the development of high priority infrastructure.

The Office of the Pacific, within DFAT, manages the AIFFP.

The Australian Government continues to work with their Pacific partners to identify projects that will support transformative and sustainable economic growth.

The AIFFP invests in high priority infrastructure across the Pacific, including in areas such as telecommunications, energy, transport, water and other essential infrastructure. This list is not exhaustive.

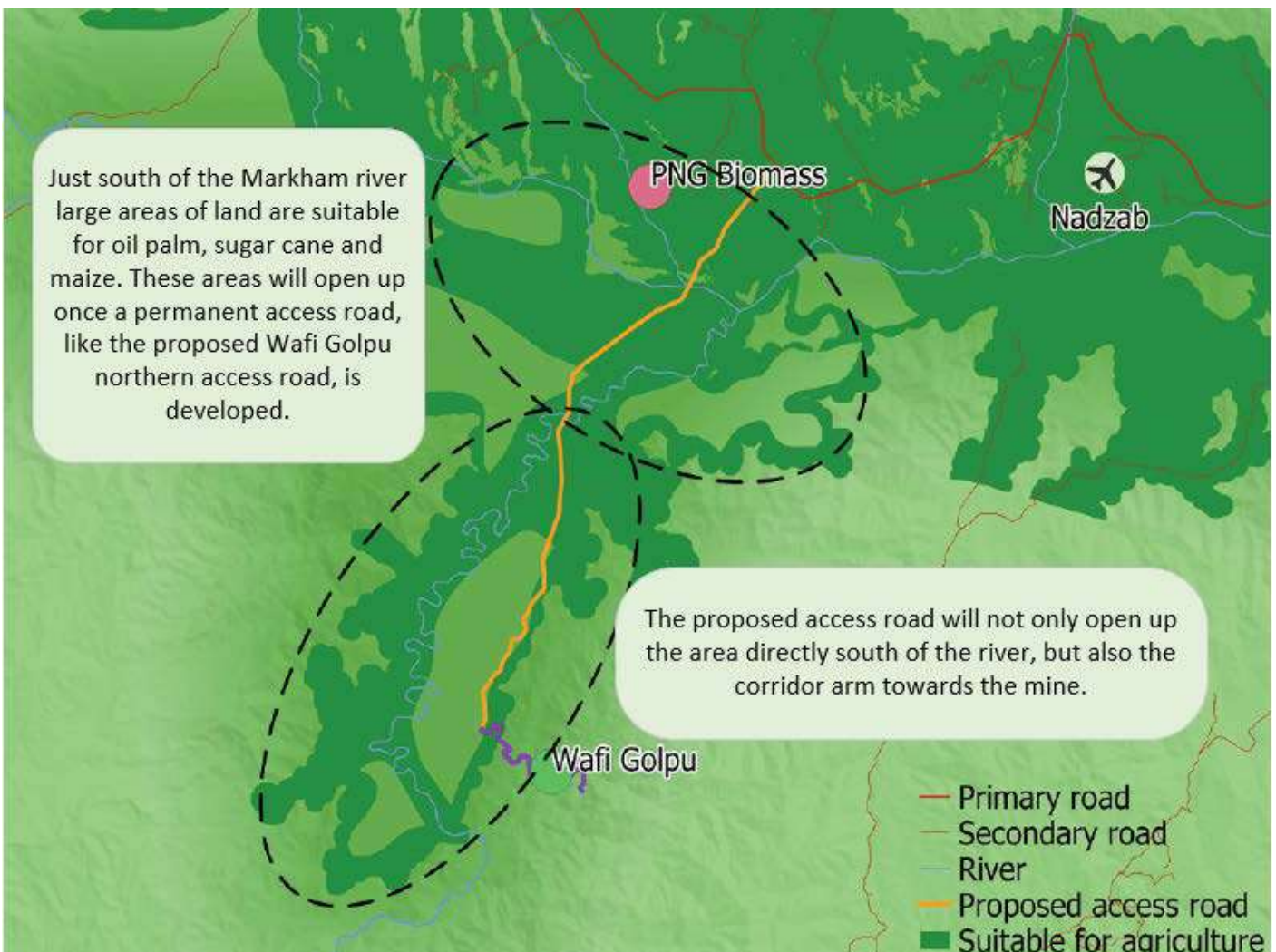
The AIFFP looks for opportunities to work with bilateral and multilateral partners and the private sector.

Exploiting the opportunity of major mining projects

Commitments to develop a major mine project in a side valley of Markham offers an important, near-term opportunity to accelerate the development of agriculture in the Markham/Ramu corridor. There are four areas where benefits can be realized:

- The growth of demand for food for the mine workforce and the communities that develop around the mine;
- The development of new mine infrastructure (roads, electricity, water) which may be used by agribusinesses and local communities at low marginal cost. This will not interfere with the mine operations; see figure 32 with the southern side of the Markham valley opening up after the bridge to the mine will be completed;
- There may be scope to extend access by local farmers to electricity and water supply provided for the mine to facilitate irrigated agriculture at low marginal cost; and
- The mine company has committed to support development of local communities, including agriculture, and they have resources which may expedite on-the ground implementation of smallholder farmer projects in some cases.

Figure 32: Possible access to southern Markham and Watut valley



7. Social & Economic Benefits

Agriculture is known as the backbone in many developing countries. It is the major source of employment in most of them. In PNG, agriculture forms a critical component of private sector activity, providing income, employment, and livelihoods for nearly 80% of PNG's population and accounting for a quarter of GDP.

Farm and community level

There is major potential to generate significant farm and off-farm employment and income within the proposed corridor as agricultural production grows over time – input providers, processing, transport, storage, marketing as well as indirectly additional beneficiaries from employment in a household.

As the corridor continues to develop, improvements will occur in various areas and are not limited to:

- Reduced prices from increased demands, better supply, economies of scale;
- Increased profitability from higher yields, increased production, less spoilage from better transportation, more affordable inputs, better storage, savings from mechanization;
- Lower transport costs from increased activity, use of larger vehicles/vessels, better roads;
- Increased leasing businesses for farm equipment;
- Introduction of more added value processing, resulting in more income for the country;
- Products are more competitive and open up new markets;
- Financial services to finance the various activities in the whole value chain and businesses/farmers become more bankable.

Research by the World Bank shows that economic growth originating in the agriculture sector can increase the income for the poorest 40 percent of the population by a multiple of three times growth originating in the rest of the economy²²

Considering the high percentage of 80% of the population working in agriculture, it is essential that the smallholder farmers benefit from the agricultural growth. Some of these benefits will accrue as new employment opportunities in commercial agriculture and off-farm agribusiness. Smallholder farmers will have the opportunity to become profitable producers linked to markets, with affordable access to more affordable inputs, irrigation and other agricultural support services. However, they may not be as competitive as large-scale agribusinesses.

Therefore, this study proposed a number of service delivery/outgrower models (sub-chapter 6.2) which should/need to be implemented in the proposed corridor to ensure that the rural population will participate in the economic development.

Aligned with the development of these models, the government will need to increase the efficiency of the current educational system. Agriculture, basic agri-finance, and agri-entrepreneurship should/need to be embedded in primary and secondary school, to provide a strong foundation for the next generation of farmers and increase the potential development of smallholder farmers to medium scale farmers and even agri-entrepreneurs.

22 Ligon, Sadoulet, 2007; Estimating the effects of aggregate agricultural growth on the distribution of expenditures., Background paper for the 2008 World Development Review

The success of smallholder farmers in the agricultural growth corridors will impact positively the development of their rural communities. These often include:

- increased employment opportunities and wage income for on- and off-farm agricultural workers who do not have their own land;
- the higher local purchasing power will stimulate non-agricultural enterprises;
- access to electricity and clean water, at lower cost in the long-term;
- improved food security and health status as incomes increase;
- improved access to infrastructure (e.g. feeder roads, electricity and potable water);

In cases where nucleus farm and outgrower schemes incorporate community owned land on a leasehold basis, local residents can be given an equity share in the farming business.

Provincial/national level

There are different indicators of the economic performance of corridors. The most important are GDP gains, additional exports and domestic sales, higher investments and employment generation. A summary of some of these indicators is given in table 8 as estimated for the BAGC and SAGCOT Corridors²³, and could be replicated in a small scale for the Markham/Ramu Agricultural Growth Corridor.

Table 8: Corridor development indicators

Corridor Name	GDP gains (%)	Incremental jobs	Private investment (USD million)
BAGC	12.9	350,000	1,356
SAGCOT	5.2	420,000	2,100

Note: these data are estimates

The contribution to the GDP of the corridor area can vary between different corridors. BAGC and SAGCOT plan to generate total incremental revenues per annum worth US\$1,875 and US\$1,300 million, respectively. These increases represent GDP gains estimated at 12.9 percent in the case of Mozambique, and 5.2 percent in the Tanzanian corridor. These estimated revenues include projected annual farming revenue and additional supply chain revenue, as well as major indirect benefits for a broad section of the corridor population by inducing growth in other sectors (e.g. construction, services and retail, which generate a multiplier effect).

SAGCOT expects to create at least 420,000 new employment opportunities in agriculture with improved employment for a total of 2.3 million people through the creation of employment opportunities across the agriculture value chain. BAGC sees employment creation as one of its main outcomes: 350,000 wage paying jobs initially for smallholder farmers and then, target job creation in upstream and downstream linkages, and MSME development.

Another important impact of corridors is the inducement of private investments. Investment numbers can vary greatly compared to multinational agribusiness firms. The second level of mobilized investments is the infrastructure investment (e.g. feeder roads and on-farm infrastructure and productive investments relating to agribusiness and agro-industry processes (e.g. processing facilities and equipment

23 FAO, 2014; Making economic corridors work for the agricultural sector

8. Conclusions and Recommendations

As pointed out in the previous chapters, the drivers of agricultural transformation are multidimensional, interrelated, and change over time, but they can be organized into categories to provide a better opportunity for pragmatic diagnostics and decision making on national priorities.

Mc Kinsey & Company identified six core elements of planning and delivery of a successful agricultural transformation which provide a guideline the following conclusions and recommendations.

Firstly, changes to a country's institutional framework, governing mechanisms, and political environment can significantly influence the likelihood of accelerating an agricultural transformation. Secondly, the quality of the national agricultural plan, in this case the Agricultural Medium Term Development Plan 2020-2022, is critical. Lastly, there are drivers related to delivery mechanisms. This includes the ways in which countries manage decision making and progress against targets, a major role of the commodity boards, as well as how they use change agents to support the large-scale behavior change that underpins a successful agricultural transformation among smallholder farmers.

Prioritization, and capitalization of the low hanging fruits

Developing the Markham/Ramu Agricultural Growth Corridor demands prioritization—a plan will not succeed if it tries to cover everything. Instead, it should focus on the changes that are most likely to kick-start rural economic growth. Successful plans identify goals in a limited number of crops and livestock value chains, cross-cutting agriculture sector enablers (such as lower transportation costs or access to irrigation, and specific geographies (starting near Lae, or opening up a new area like the southern Markham. For example, since a number of infrastructure projects have started or will start soon, a coordination of these projects to ensure synergies and cross-utilization/connectivity will strengthen the required backbone infrastructure, improve connectivity, and reduce transport cost.

The second related success factor is differentiation. Successful agricultural transformation plans differentially target agri-food systems with tailored strategies. For example, more productive land that is already well connected to markets (e.g. all the land bordering directly the Highlands Highway, can support large- or small-scale farms, as well as agribusiness services providers can scale-up easier due to easier reach by customers. In more remote areas, though, with bad roads (e.g. closer to the mountains alongside the valleys, poor-quality land, and less well-connected areas, different strategies are required. These might involve greater focus on staple crop productivity with longer storage lifetime, without cool or cold storage, less input requirements or, in the case of tree crops, longer harvest cycles.

A third related success factor lies in weighing the trade-offs among multiple objectives. Governments work toward a number of different goals, including growth in agro-processing, reduced unemployment, lower poverty incidence, food self-sufficiency, economic growth, increased exports, or lower rates of malnutrition. If these trade-offs are explicitly considered and communicated when developing the agricultural transformation plan, it is possible to tailor the choice of value chains, cross-cutting enablers, and geographies to differentially achieve the government's chosen goals. Important is also the time factor. Strategies of government and development partners change regularly, creating inconsistency as well as are counterproductive since agricultural transformation takes a long time. When the trade-offs among multiple objectives are not explicitly integrated into the agricultural transformation plan of the Markham/Ramu Agricultural Growth Corridor, progress is characterized by under delivery across too many, sometimes competing, objectives as sometimes seen in PNG.

Opportunities for farmers need to be market-driven

Agricultural transformations often focus too much on volume rather than value and on productivity of row crops (e.g. grains, root crops rather than opportunities for high-value crops, downstream processing, and livestock). In the case of PNG, there is a strong focus on seeing an increase of locally produced rice, without a neutral consideration of the competitiveness with Southeast Asian countries. Farmers everywhere are business people. Farming households in developing countries balance a portfolio of crops, livestock, and nonfarm work. Because they feed their families with some of the farm output, as well as sell into markets, they make decisions based on their potential profit, risk, and cash flow across family food consumption, as well as sales. Too often, agricultural plans recommend particular commodities without paying attention to this basic calculus of farmer household economics. The planned expansion by the Livestock Corporation seems to be very interesting, but involving smallholder farmers would mean also that the government would have to re-establish an entire livestock value chain, starting with a time-consuming breeding program. The currently positive development of the horticulture production is supported by a growing local demand, but also the advantages of less land and capital needed, as well as much better manageable short production cycles. Female farmers see fruits and vegetables as ideal crops. Successful agricultural transformation plans give farmers the opportunity to raise their household incomes.

However, high-value crops like avocado, citrus fruits etc. will not be a viable long-term opportunity for farmers if the current major lack of cool storage and costly access to international markets are not sorted out. Promoting the intensification of row crops makes probably more sense in an initial starting phase. Even then, the focus should be on the profitability for the farmer, including attention to sustainability, quality, storage, and processing.

A new version of Didiman and Didimeri, change agents identified and mobilized

The success of the agricultural transformation relies also on how well thousands of smallholders and small- and medium-size enterprises can be helped to change farming practices as quickly and effectively as possible. A lot of lessons learnt, positive and negatives, can be drawn from the work of Didimen after World War II and the current work by FPDA. The critical enabler, without which an agricultural transformation is likely to fail, is a frontline change agent that helps farmers modify their practices. Initial efforts should be spent on companies who are already engaged strongly with farmers to utilize their networks and achieve fast-tracked improvements and role models for other possible change agents. The high-level objectives of a transformation are realized in practice only when they are effectively translated to smaller, on-farm shifts. Change agents provide the critical interface with farmers. To catalyze this, a change agent might be the person providing extension knowledge, offering financing for farm inputs such as fertilizer, aggregating crops, or facilitating marketing services.

Effective change agents can also exist in the public sector. Many scholars cite countries' investments in national agricultural extension services as critical to agricultural transformation. The advantage of public sector change agents would be independency from the private sector partner, providing most probably a broader advice to the farmer. Other mechanisms for organizing farmer-facing change agents, though, have also played critical historical roles in transformation. Agricultural cooperatives, for example, can provide technical assistance to farmers but can also fundamentally change the farmers' risk and potential revenue by providing access to storage, equipment, finance, and marketing services. The typical model of cooperatives has not worked in PNG, however, landowner companies developed through the mining sector investments could play a role model on how farmers can consolidate their initiatives. Small-scale stockists, or input dealers, also have an important influence on the changes required among smallholder farmers if agricultural transformation is to succeed.

Finding the right starting points for scaling production systems

Change in agricultural systems requires multiple parallel advancements. For example, improvements in agricultural extension and seed systems might enable farmers to switch to a more productive hybrid seed, but lack of access to fertilizer (upon which the hybrid depends) could prevent productivity increases and leave the farmer unwilling to buy hybrid seed next time. A recent example was seen on social media where farmers complained about a new rice variety but did not consider also the needs of improved inputs. As in any complex economic system, when so many elements are interrelated, any one of them can become a constraint and stall progress. A good example are the efforts made by Brian Bell, Tininga and other input suppliers to supply improved seed for the horticulture sector, however, this sector needs also advanced fertilizers and chemicals, which are either too expensive or not available.

A common reaction to this interdependency problem is to try to move all elements ahead in a highly prescribed way, specifying interventions up and down the value chains, and creating complex plans with a high potential for failure. Instead, the best agricultural transformation plans have two critical characteristics: (1) they anticipate the need for agility, and (2) they selectively focus on the points of the system where small changes are likely to cause larger shifts. A possible good starting point could be to focus on particularly influential value chains, which in PNG seems to be coffee and cocoa but for the Markham and Ramu valley it might be more livestock and fresh produce.

Overly prescriptive and inflexible strategies in agricultural transformation fail because of the complexity of agriculture-based economies. For example, a strong growth in agricultural production might outstrip storage and local consumption capacities. Market prices would be depressed, and farmers will not invest in the next season if off-takers will be not able to identify other overseas markets to utilize the overproduction. As changes begin to occur, the most critical success factor is that the plan allows for learning and that it is flexible enough to be adjusted as understanding progresses, a clear role for the MRAGCP Secretary.

Pragmatic approach with an investor mind-set

Approaching the transformation of the two valleys with an investor mindset is critical to the success of the process. The initiation of the agricultural transformation, coordination among government, donors, and private sector is critical, but it is equally important from the start to plan for private-sector engagement. Without this, the transformation may proceed more slowly, stall, or not reach scale. Therefore, the suggestion in this paper to develop a joint public/private partnership, the Markham/Ramu Agricultural Growth Corridor Partnership. To involve the largest agribusiness/food processors, e.g. NBPOL, Mainland Holdings, Paradise Food, Olam etc. as flagship partners would be a strong commitment of the private sector and would also increase the interest of smaller companies that might not see immediate benefits when participating in the partnership.

As pointed out in the previous chapters, the Markham/Ramu Agricultural Growth Corridor Partnership with an investor mindset include three strategic planning components. Firstly, the plan identifies public investments that complement likely private-sector investment. Secondly, a good agricultural transformation plan identifies public investments designed to catalyze additional private-sector engagement. Lastly, the MRAGCP plans with an investor mindset anticipates changes in the enabling environment that will be necessary as the transformation of the two valleys progresses to support increasing private-sector engagement. These policies, laws and regulations are usually across multiple sectors in addition to agriculture, including banking, trade and land policies.

Progress on enabling policies

The MRAGCP is more than just changes in farming practices. It is about catalyzing transformation of the two valleys rural economy, and even most probably having a country-wide impact. As such, more than agricultural trade and subsidy policies are in play. For example, laws and regulations that influence banking, labor, infrastructure, land ownership and access, access to water, telecommunications, taxes, and insurance are also critical considerations. That most banks do not finance smallholder farmers is a global phenomenon, however, in many countries other service providers or off-takers have started to pre-finance crops. Changes in landownership/tenure is most probably the most challenging area under policy development in PNG. However, the population size in Markham and Ramu valleys is much lower compared to the highly populated areas in the Highlands provinces and, therefore, solutions to consolidate larger tracks of land for nucleus estates are most probably easier to identify. The larger land size per farmers makes it also easier for them to invest in their production, enabling them to build profitable agri-businesses. Also, a land lease market is already established in the two valleys and might become more important in the future since farmers move out of agriculture into other jobs and need income from their land.

Finally, effective policy making for agricultural transformation needs to become more evidence-based over time, a clear role of the MRAGCP Secretary to develop a knowledge management system. During the study, excellent research documents were found, however either they were not easily accessible or not easily usable by non-researchers. Also, policy makers should invest more in making use of existing data and analytics to comparatively assess the costs and likely outcomes of different potential transformation programs. Policy makers also need to use data and analytics to set reasonable targets and redirect programs where outcomes are not meeting targets. Evidence-based policy making builds better plans and integrates accountability into the systems responsible for implementing the policies. A good start would be to further upload all available GIS data (e.g. the UNDP risk maps) on the PNG REDD+ and Forest monitoring platform, and develop analytic tools for simple a presentation of findings.

What next?

Chapters 5 and 6 describe a possible development path with an example investment plan to provide guidance on how the public and private sectors could initiate the Markham/Ramu Agricultural Growth Corridor.

- 1.** The most important factor is the willingness of the government, donors, farmers, companies, and other organizations to take risks and change behaviors to pursue a better outcome. Based on this study, a stakeholder forum should be initiated to secure commitment from the highest levels of government and other stakeholder groups. Both political and financial capital are at stake for public-sector investors and securing high-level commitment will ensure the development process produces more clearly defined practical plans that have a higher likelihood of being implemented. The stakeholders need to be aware that sometimes a country is just not ready for change, either because it is undergoing conflicts (e.g. the political leadership challenges within the PNG government) or because the wider political system itself is not ready to work on agricultural transformation because there is too much focus on the extractive industry development with larger short-term investment incentives. If the change readiness is not present or is very limited, and there is no good prospect for an agricultural movement in the Markham and Ramu valleys, then it is best to stop wasting time and resources. In the meantime, many steps described in this study can be taken to improve the regional or even national welfare, but this does not have to be approached with a transformation mentality to develop an agricultural growth corridor.
- 2.** For the MRAGCP to succeed, there must be a common understanding of the plan, stakeholder roles, and approach to management of the process. At the highest level, key government ministries, the local and international private sectors, and donors, but also representatives of the civil society must be aligned. This alignment would start with the development of the Markham/Ramu Agricultural Growth Corridor Partnership as described under sub-chapter 5.2, and would be followed by the development of strategies and investment plans.
- 3.** The agricultural transformation of the Markham and Ramu valleys is not just a planning exercise. It takes management over time. Lessons learnt from other projects, suggests that creating the project management office, in this case the MRAGCP Secretary, can greatly increase the chances of carrying out a successful large-scale change program. They can concentrate talent, monitor implementation, act as a source of truth, be mediator/arbitrator, and, in general, help get things successfully implemented. The office can apply accepted project management technologies to break the transformation into discrete initiatives, each with specific goals, timing, and responsibility, something GrowPNG has already done to target certain agricultural challenges in PNG. The MRAGCP Secretary will be in charge of engaging relevant stakeholders when problems arise.
- 4.** Many transformational initiatives can be traced to specific single individuals who had an extra-ordinary impact on the project. There is great upside to a more systematic approach to supporting key leaders by the MRAGCP Secretariat, from high-level government officials to frontline employees. In private-sector transformations, leadership training and peer networks are made available. In large-scale public-sector transformations, where the goal is to improve the lives of millions of people, the return on investment for leadership skill building can be tremendous.




It needs to be strongly pointed out that the suggested agricultural transformation of the Markham and Ramu valleys is a long-term development project spanning over a 10 to 20-year cycle with major political but also financial commitments. Agricultural transformation is essential to the future well-being of emerging economies. The Markham/Ramu Agricultural Growth Corridor could play a strategic role for not only for PNG but also for other economies in the South Pacific as key supplier of agricultural commodities.

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About the PNG Partnership

IFC's work in Papua New Guinea is guided by the PNG Partnership. Australia, New Zealand and IFC are working together through the Partnership to stimulate private sector investment and reduce poverty in Papua New Guinea.

