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Synopsis: Evolution of and opportunities for the fresh produce value chain in PNG

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INTRODUCTION

Enhancing the fresh produce value chain in PNG will contribute to wider development goals including rural economic growth, food and nutrition security and rural employment diversification. An important component of strengthening agriculture value chains in PNG will be increasing crop productivity and quality. However, equally important is strengthening agricultural markets and rural – urban linkages. Recognizing the importance of supporting greater domestic fresh produce marketing, the PNG government (GoPNG) continues to promote investments that link farmers to markets, primarily through the Fresh Produce Development Agency (FPDA) (DAL 2023).

A principal mechanism for promoting rural economic growth and strengthening agriculture value chains involves enabling the more commercially oriented smallholder farming households to significantly increase their productivity through greater use of modern farming inputs over an increasing share of local arable land (Benny et al., 2022). As the income of more productive farm households grows, their demand for locally produced goods and services increases. These goods and services are generally labor-intensive, require limited capital in their production, and are typically not marketed outside of the local community. This includes construction and associated services; transport and infrastructure services; education, health, and other social services; food and beverage processing; and the like, which facilitate greater (and often higher value) labor diversification and specialization within the rural economy.

Fresh produce value chains remain understudied in many low- and middle-income countries, despite their demonstrated role in promoting rural economic growth, improved welfare, and dietary diversity. This lack of information and analysis is particularly acute in Papua New Guinea (PNG), whereby dated or limited evidence exists on agriculture production and expansion, fresh produce trade flows, price formation and price variation over time, throughout seasons, and across regions. Understanding these production and market dynamics is essential for supporting value chain actors in developing profitable and sustainable systems that provide farmers with the incentives they need to supply fresh produce to trustworthy and transparent markets.

This synopsis draws upon 2 detailed studies (Schmidt et al., 2025; and Minten et al., 2025) that aim to inform opportunities for investment in the fresh produce value chain by: 1) analyzing remote sensing data to estimate agricultural expansion in horticulture production areas of the PNG highlands; 2) evaluating unique market flow and fresh produce price data collected over a 15-year period by FPDA; and 3) estimating the price margins of each value chain actor in the fresh produce value chain through in-depth stakeholder interviews.

The structure of this synopsis report is as follows. Section 2 provides an analysis of agriculture expansion over time and fresh produce market flows from the Highlands fresh produce corridor. Section

3 examines price trends and marketing margins across 6 key markets in diverse locations of the country. Section 4 reports on in-depth stakeholder interviews to unpackage costs along the value chain from farmgate to retailer. Section 5 concludes with key findings and implications.

SECTION 1: AGRICULTURE AND PRODUCTION TRADE TRENDS OVER TIME

1.1 Land use landcover change in Highlands agriculture corridor

PNG's last agricultural census was conducted in 1961-62 (PNG Bureau of Statistics, 1963). Since then, there has been no widescale follow-up surveys to assess agriculture area or yield of key crops. In lieu of time series data on agriculture yields, we evaluate land use landcover (LULC) change using satellite imagery from 2018 and 2024.[1] Given image quality and data processing constraints, we focus the analysis on a 5km buffer along the Highlands Highway from Tambul to Goroka (total area: 2,207 km²).[2] Based on stakeholder interviews combined with a fresh produce vendor survey (collected by FPDA), a 5km buffer along the Highlands highway should provide important insights of land use change within one of the most important commercial surplus horticulture areas of the country.

Figure 1 illustrates the area evaluated for the land use land cover (LULC) analysis, improving upon earlier LULC analyses (e.g., Bryan et al., 2020) by leveraging index fusion for tropical climate constraints including cloud cover and spectral overlap. The light grey shaded area in Figure 1 shows the 5km analysis buffer area and the light and dark-red shaded areas display the consistent cloud cover (pixels that were obscured in every available image in 2018 or 2024, respectively), rendering these areas unanalyzable for landcover change analysis. Of the total area analyzed in the Tambul-Goroka corridor, 7.8 percent was not analyzable due to consistent cloud cover across images within a specific analysis year.

Analyzable pixel-level data was processed in Google Earth Engine, generating 12-band composites per year: six core bands (B2, B3, B4, B8, B11, B12) augmented by six spectral indices.[3] In doing so, a training dataset of 200,064 features was created across six land classes: cropland, forest, grassland, bushland, bareland, and urban areas, extracted from high-resolution Google Earth Pro imagery in 2018 and 2024 to define slash-and-burn cycles, fallows, and agroforestry typical of highland small landholdings. A Random Forest algorithm (smileRandomForest implementation, 500 trees) is applied to classify LULC types on the composites (6 image bands and 6 derived indices), with a 70/30 train/test split.

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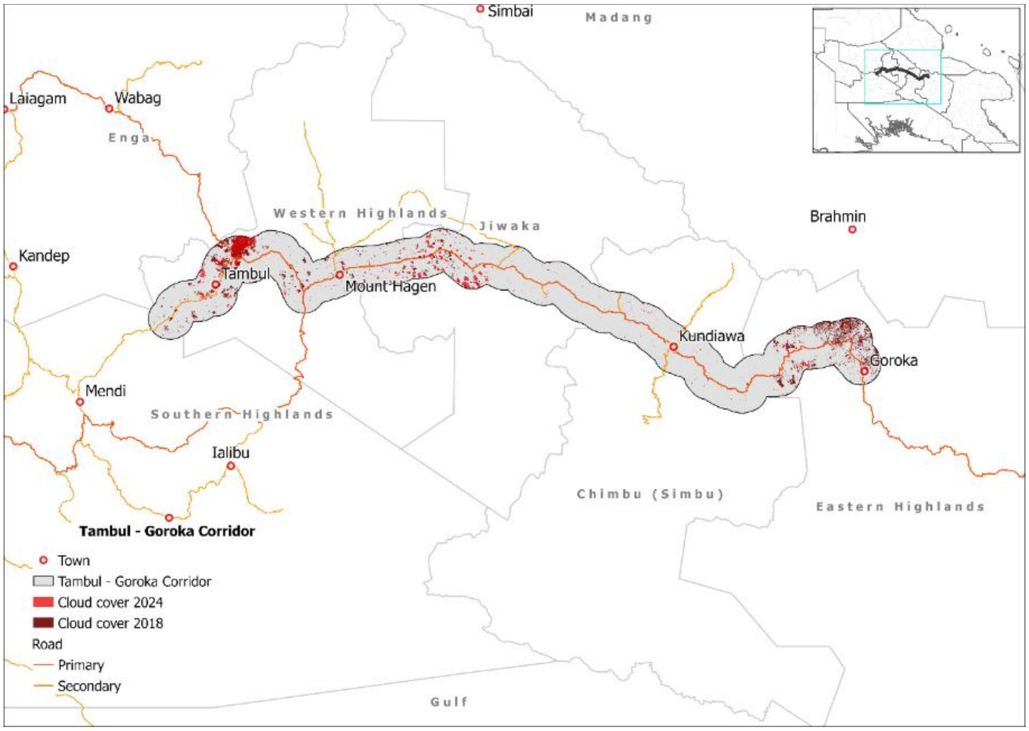
[1] 2018 was the first release of stable Sentinel-2 LULC processed data product that we use for the LULC analysis

[2] Schmidt et al. (2025) provide details on remote sensing data availability, constraints, methodology, and robustness checks. In doing so, they also attempted to analyze the corridor west and east of Port Moresby to account for agriculture expansion in Central region, however consistent cloud cover (along the Central corridor) in satellite imagery forfeit reliable remote sensing analysis of LULC.

[3] Spectral indices included Normalized Difference Vegetation Index (NDVI) for vigor, Normalized Difference Water Index (NDWI) for moisture, Normalized Difference Built-up Index (NDBI) for urban features, Soil Brightness Index (SBI) for bare soil, Normalized Burn Ratio (NBR) for disturbance, and Enhanced Vegetation Index (EVI) for canopy structure—to improve class separability amid mixed subsistence systems (Phiri et al., 2020; Weiss et al., 2020).

To address the near identical spectral characteristics among certain land classes (e.g., cropland and grassland), we validated the model using 1,000 independent points (500 cropland, 500 non-cropland) for each analysis year. Finally, model performance was assessed via confusion matrices, overall accuracy (OA) indicator, and the Kappa coefficient, suggesting sufficient accuracy for LULC analysis (model performance is reported in Appendix Table 1).

Figure 1: Tambul – Goroka 5-km buffer corridor



Source: Authors' analysis using Sentinel-2 imagery

Results suggest significant cropland expansion between 2018 to 2024, resulting in a 33% overall increase in cropped land (almost 5% cropland area increase per year) within the 5km buffer between Tambul and Goroka along the Highlands Highway (Table 1). Crop area expansion along this horticulture intensive corridor suggests that farmers may be responding to a growing demand for fresh produce in PNG. Figure 2 provides an example of the imagery used to assess LULC, comparing the same GPS location in 2018 and 2024. In addition, Figure 2 demonstrates how accompanying infrastructure (rural roads) is developing to support greater agriculture output and connectivity in higher producing areas.

Table 1: Land use land cover change (Tambul – Goroka corridor: 2018-2024)

Year	Crop area (ha)	Non-crop area (ha)
2018	19,479	201,273
2024	25,905	194,847
Net Change	*+6,426 ha*	*-6,426 ha*

Source: Author's analysis, classified based on Sentinel-2 imagery on Google Earth Engine (2018, 2024)

Figure 2: Remote sensing images in 2018 and 2024 at location **5°53'35"S 144°08'32"E along the Tambul-Goroka corridor**

A) 2018 B) 2024

Source: High resolution satellite image (Google Earth) used for visual comparison of land use land cover change between 2018 and 2024.

While the LULC analysis provides detailed information of cropland expansion along the Highlands corridor, we are unable to use remote sensing to look at specific crop production profiles (for example, broccoli production area change). This limitation continues to be a challenge in PNG despite successful crop classification achieved in other contexts (e.g., where monocropping is common and consistent cloud-free temporal data are available) using deep learning (Khan et al., 2023), object-based phonological analysis (Sitokonstantinou et al., 2018), and ensemble learning on vegetation indices (Sonobe et al., 2018). Other remotely sensed products (available for purchase) allow for finer resolution analysis, for example PlanetScope (3 meter) and WorldView-3 (0.3 meter) data, may provide more flexibility for more in-depth landcover analysis by crop type. However, the traditional agriculture system of rural PNG, consisting of small household garden plots that are commonly intercropped, remains a challenge for robust remote sensing analysis by crop type.

1.2 FPDA Urban vendors survey analysis

To evaluate the demand of specific fresh produce by crop type and production area, we use a unique dataset collected by the FPDA that asks market vendors across 6 urban wet markets (Goroka, Mt. Hagen, Banz (since 2021), Kokopo, Lae, and Port Moresby) to report the location source of their sales food crop (see Appendix description 1 for data collection methodology). Reported vendor data reveals substantial flows of fresh produce from diverse production zones to major urban centers, with Port Moresby emerging as the primary terminal market. The Highlands areas (around the Tambul – Goroka corridor) primarily supplies sweet potatoes, Irish potatoes, cabbage, bulb onion, carrots, broccoli, and similar crops to markets around the country. The Central region is reported to supply bananas, perishable vegetables (such as cucumber and cherry tomatoes), leafy greens, coconut, watermelon, sweet potatoes, yam, cassava, peanuts, ginger, and lemon, among others.

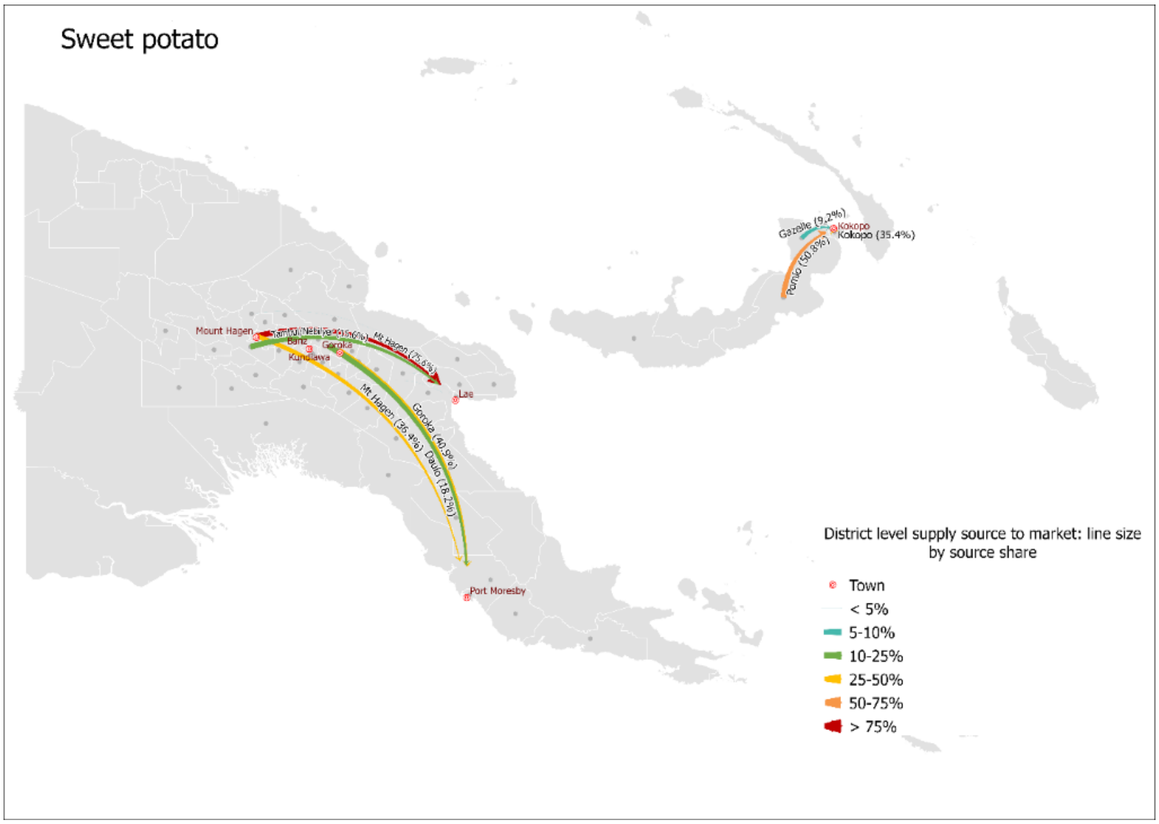
We use fortnightly data collected throughout 2024 to evaluate the flows of fresh produce from origin to destination across the 6 market areas. For each commodity, we calculate the annual share of the marketed commodity that comes from each reported production location. Appendix Table 2 provides a selection of the commodities and their respective sourced locations that is sold in the Lae main market and the Port Moresby Gordon's market (one of the biggest markets in the city). It is important to note that the FPDA market data is collected from select markets within each of the 6 major cities (further information on FPDA data collection methodology is provided in Appendix description 1). Note also that we do not control for seasonality in supply sources, as these may vary throughout the year.

Across all market locations, there are substantial flows moving from the highlands fresh produce production areas to Lae, Port Moresby and Kokopo. There is less produce moving from lowland areas (Morobe and Madang) into the Highlands. For most of the fresh produce moving from the highlands to Port Moresby and Kokopo, Lae wharf is the primary transit point where fresh produce is loaded onto sea containers and shipped via boat to its final destination.[4] We provide a limited selection of maps in this synopsis, however a full suite of trade flow maps is documented in Minten et al. (2025). We classify fresh produce into three categories: 1) staples which include sweet potato, taro, cooking banana (plantains); 2) soft fresh produce which has higher water content and is more perishable (broccoli, capsicum, pawpaw (papaya), pineapple, tomato); and 3) hard fresh produce which is dense, has lower water content and is more durable (cabbage, carrot, ginger, bulb onion, potato). This distinction is made because texture and structural firmness significantly influence critical nodes within the fresh produce value chain, including handling and packaging, transport, storage, wastage and marketing.

[4] The flow maps show arrows moving directly from highlands provinces to Port Moresby and Kokopo for visual clarity, however it is important to note that Lae is the first transit point for these final locations.

Focusing on two key staple crop flows (sweet potato and taro), vendor reports suggest that highland sweet potato is transported in greater volume to lowland markets compared to taro (Figures 3 and 4). However, large producers such as Pacific Adventist University (in Central region) also supply substantial volumes of sweet potato to Port Moresby markets.[5] Conversely, lowlands taro, grown in Morobe, comprises almost all the taro sold in the Lae market. Approximately 28 percent of taro sold in Gordon's market in Port Moresby comes from Central province, while a larger volume is sourced from the Highlands and Morobe provinces.[6]

Figure 3: Sweet potato flows to POM, Lae, and Kokopo

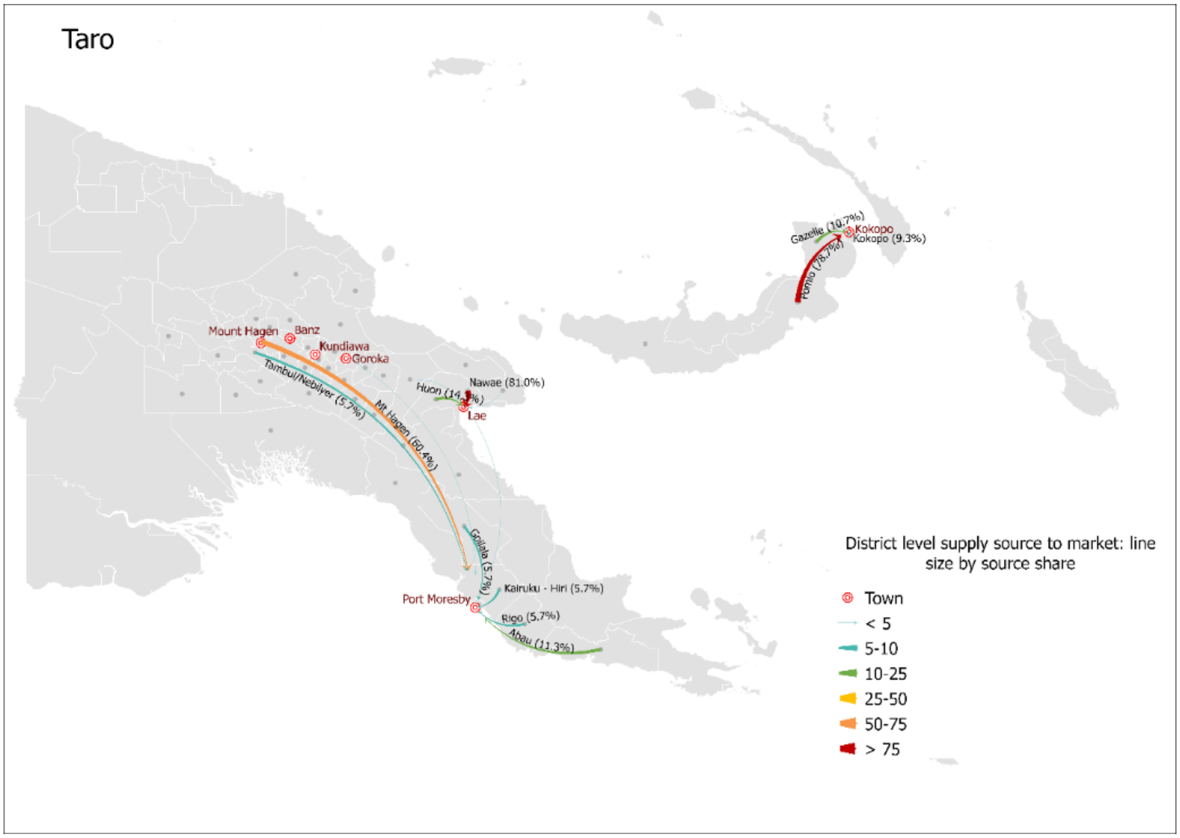


Source: FPDA Food Price Monitoring data

[5] The flow map for sweet potato to Port Moresby suggests a limited sample size of market vendors of Gordon's market, which receives a large volume of sweet potato from the Highlands. Central producers (located on the second floor of the market) also sell sweet potato at Gordon's market, however data suggest these vendors are not represented in the FPDA database.

[6] For further discussion and maps on trade flows of staple, hard, and soft produce, refer to Minten et al. (2025).

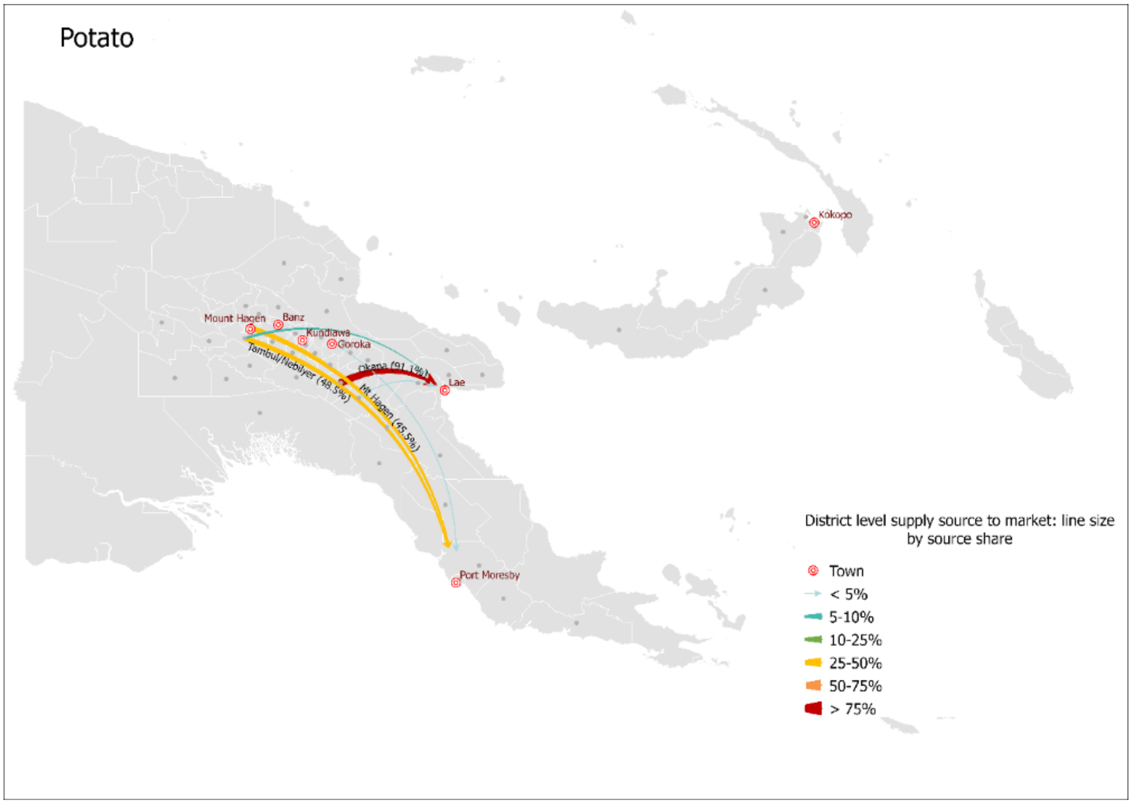
Figure 4: Taro flows to POM and Lae



Source: FPDA Food Price Monitoring data

A large share of hard fresh produce commodities (e.g., cabbage, potato, onion, carrot) that are sold in Lae and Port Moresby are produced in the Highlands. According to the FPDA vendor survey data, potato and onion cultivation represent the most geographically specialized commercial production of the hard fresh vegetables produced in PNG. Given colder climates and agro-ecological conditions in the highlands for potato cultivation, 48 and 45 percent of market vendor responses in Gordon's market of Port Moresby reported sourcing their potatoes from Tambul / Nebilyer (Western Highlands) and Mt. Hagen, respectively (Figure 5).

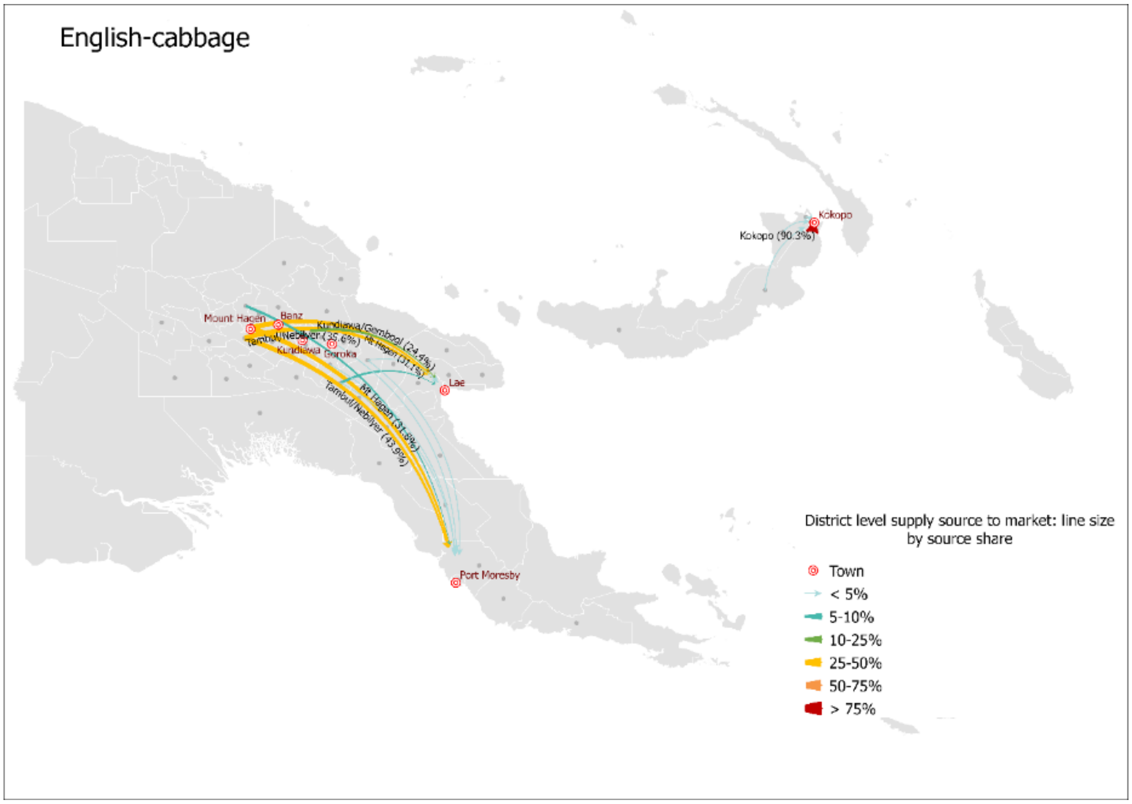
Figure 5: Potato flows to POM and Lae



Source: FPDA Food Price Monitoring data

Commercial cabbage cultivation has a wider geographic production area in the highlands compared to the other hard fresh produce, and most cabbage in Port Moresby and Lae markets is sourced from the highlands (Figure 6). Over 3/4 of vendors in Gordon's market of Port Moresby reported cabbage was sourced from Western Highlands districts of Tambul / Nebilyer (44 percent) and Mt Hagen (32 percent). Similarly, 36 and 31 percent of vendors in Lae reported sourcing their cabbage from Tambul / Nebilyer and Mt Hagen, respectively.

Figure 6: English-cabbage flows to POM and Lae



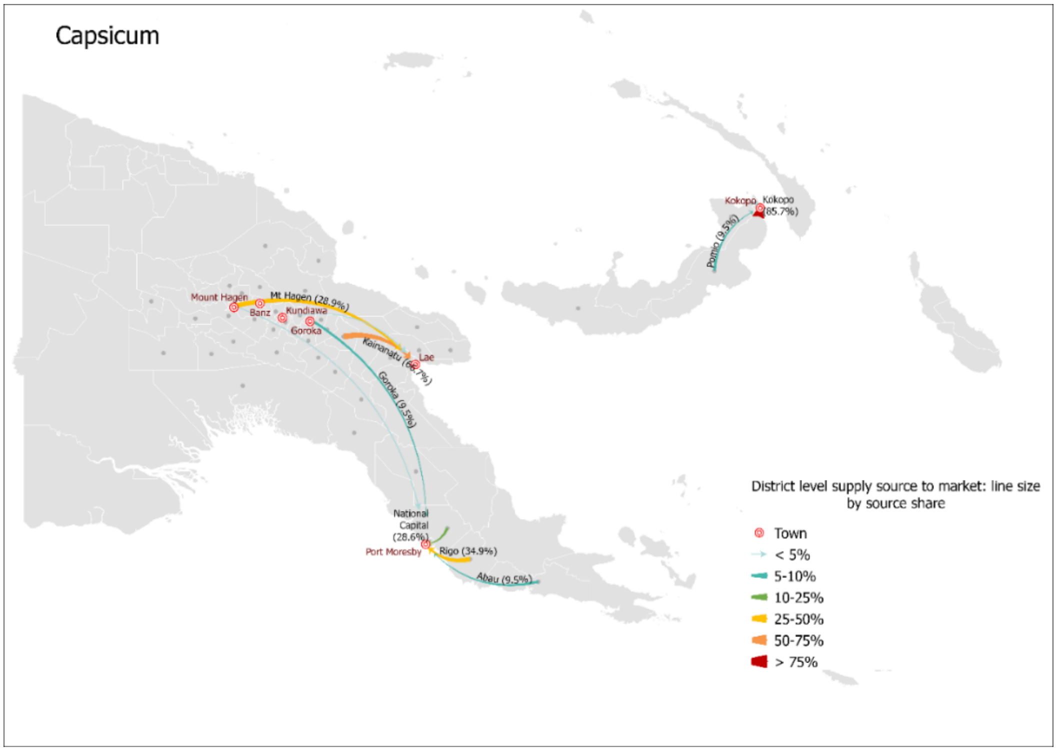
Source: FPDA Food Price Monitoring data

Finally, given the higher perishability of soft fresh produce, sales vendors reported sourcing a greater share of these products from localized sources.[7] For example, most vendors in POM source tomatoes and capsicum from peri-urban areas of POM or nearby Central province production areas such as Rigo, Abau, and Kairuku-Hiri (Figure 7). Lae vendors have better access to differing production areas given their linkage with the Highlands highway. Thus, for Lae, capsicum and tomato are primarily sourced from highlands provinces.

An exception to localized soft fresh produce specialization is broccoli, which demonstrates strong geographic specialization. It is important to note that vendor data for broccoli sources were limited in POM given the less frequent availability of broccoli in Gordon's market. Nevertheless, the available data indicates that in both POM and Lae markets, most broccoli is sourced from Tambul / Nebilyer district of Western Highland Province (Figure 8). This pattern reflects the concentration of cool-climate, high-value vegetable production in high-altitude areas where conditions favor crops such as broccoli, cauliflower, and cabbage (Bourke, 2005; Bonney et al., 2015).

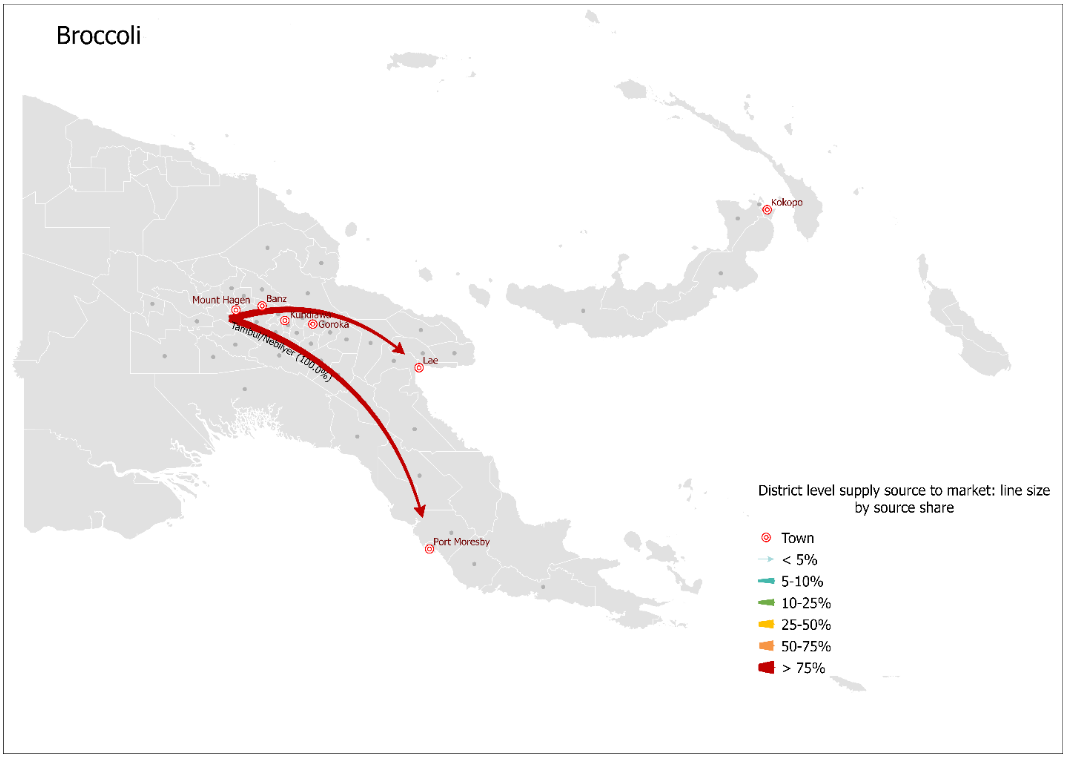
[7] This result echoes earlier work (Chang et al., 2015; NZ MFAT/Program evaluation, 2018) where peri-urban producers outside of POM and Central province are important perishable food production sources.

Figure 7: Capsicum flows to POM and Lae



Source: FPDA Food Price Monitoring data

Figure 8: Broccoli flows to POM and Lae



Source: FPDA Food Price Monitoring data

Based on the remote sensing LULC change analysis and the FPDA trade flows analysis, the Highlands corridor has potential to grow, specialize and diversify into a fresh produce cluster for the country. Currently, agriculture production in the Highlands is characterized by traditional farming systems, efficiently employing production techniques to maximize the benefits they obtain from their efforts, while reducing the costs they might incur given available production technologies and risks. Productivity levels are lower in traditional agriculture not because the farmers are 'bad' or 'lazy' at farming, but rather, because the only production technologies that farmers can profitably use, given the conditions under which they farm, generate low yields (Schultz 1964; Ellis, 1993; Benny, 2022). If the risks of producing a surplus can be minimized, while the incentives for motivating production can be lifted, both individual farmers and the agricultural sector of the overall economy can be considerably more productive. Pairing these incentives with targeted interventions could dramatically improve the domestic fresh produce value chain across the country.

SECTION 2: LONG-TERM PRICE TRENDS OF THE FRESH PRODUCE VALUE CHAIN

We now turn our attention to evaluating long-term price trends of fresh produce in PNG to inform more effective policies to improve the efficiency of the fresh produce value chains. Assuming efficiencies can be realized across the value chain, targeted goals of improving farmer incentives for increasing productivity; enhancing trader incentives for greater revenue sharing; and, ultimately, securing affordability of domestically produced fresh vegetables and fruits for a growing population should be achievable.

2.1 FPDA Urban Market Price Survey

We utilize fresh produce price data that FPDA has been collecting fortnightly in major retail markets across the country since 2009. As produce is sold in non-conventional units in the 6 wet markets that FPDA monitors, enumerators record the weight of each item and then convert conventional prices into PGK per kg.[8] Each of these markets offers a substantial number of price observations over the period considered (Table 2). While these data provide a unique resource for analysis, several caveats apply. First, the time series are not fully consistent, with some months completely missing in certain years—most notably 2015 (6 months available), 2016 (2 months), 2017 (3 months), and 2020 (9 months). Second, there is very little variability in the reported quality of each commodity, reflecting more the methodology employed to collect price and weight data of fresh produce. Third, coverage varies by market. For this analysis, we focus only on markets with consistent data over the study period: Mt. Hagen, Banz (data collection started in 2021), Goroka, Lae, Port Moresby, and Kokopo.

[8] The resulting data are available at https://www.fpda.com.pg/market-info/. Price series might not be complete as foods might not be available or data collection might sometimes not have happened.

Table 2: Markets surveyed and number of price observations, 2009-2025

Market	Number of Observations
Mt. Hagen	3,770
Banz	868
Goroka	3,879
Lae	2,377
Port Moresby	3,809
Kokopo	3,209
Total	17,912

Source: Authors' calculations based on FPDA price data

From 2009 to 2025, nominal prices increased substantially, with the official price index in 2025 standing 41 percent higher than in 2009. To enable meaningful comparisons over time, we deflate prices using the official Consumer Price Index (CPI), setting January 2025 as the base (index = 1) and expressing all real prices in January 2025 terms. We retain only those products for which sufficient price observations are available across the selected period and markets.

Table 3 presents descriptive price statistics for the retained products.[9] Several patterns emerge. First, some fresh produce items are significantly more expensive on average: bulb onion is the most expensive fresh produce per kilogram, while sweet potato (kaukau) – the major staple in PNG – is the least expensive. Second, based on median prices, hard and soft fresh produce are 142 and 122 percent more expensive, respectively, than staple fresh produce. Finally, price variability is substantial, with coefficients of variation averaging 65 percent for staples, 67 percent for soft fresh produce, and 79 percent for hard fresh produce over the study period.[10] Looking at the commodity level, variability is low for major staples such as sweet potato and cooking bananas, capsicum and pawpaw in soft fresh produce, and potato in hard fresh produce.

[9] We winsorized or trimmed prices at the 2 and 98 percentile and replace them with the winsorized values.

[10] As a comparison, the coefficient of variation of international wheat prices over the period January 2009 – June 2025 (using U.S. No.2 HRW, Gulf export price, published by IndexMundi) stood at 0.28.

Table 3: Descriptive prices, 2009-2025

	Mean	Median	Standard Deviation	Coefficient of Variation	Number of Observations
Staples					
Cooking Banana	2.84	2.57	1.38	0.49	1,456
Sweet Potato	1.74	1.44	0.88	0.51	1,667
Taro True	3.80	3.16	2.28	0.60	944
Total	2.61	2.19	1.69	0.65	4,067
Soft Fresh Produce					
Broccoli	7.18	6.24	4.00	0.56	1,015
Capsicum	8.67	7.80	4.27	0.49	1,585
Pawpaw	2.65	2.32	1.26	0.47	1,202
Pineapple	4.04	3.37	2.43	0.60	1,545
Tomato	6.37	5.53	3.33	0.52	1,637
Total	5.85	4.87	3.91	0.67	6,984
Hard Fresh Produce					
English Cabbage	4.04	2.98	2.89	0.72	1,620
Carrot	5.46	4.21	3.83	0.70	1,313
Ginger	8.80	7.42	4.96	0.56	1,234
Onion Bulb	10.53	8.15	6.72	0.64	1,409
Potato	3.99	3.41	1.76	0.44	1,285
Total	6.49	5.29	5.11	0.79	6,861

Source: Authors' calculations based on FPDA price data

2.2 Price analysis methods

To examine price trends and seasonal price variation in fresh produce markets, we follow the hedonic price modeling framework as outlined by Lancaster (1966). Using this framework, a hedonic price regression can be estimated, where product prices are modeled as a function of characteristics such as quality and location. A simplified model can be expressed as follows:

$$p = \sum_{\mathrm{k}=0}^{\mathrm{N}} \beta_{\mathrm{k}} X^{k} + v$$

where p is the price of the commodity, X^k is the level of the attribute k, β_k the implicit price of a change in attribute k, and v a stochastic error term. We apply this conceptual framework to fresh produce prices in PNG and analyze price formation using a regression approach. Specifically, we regress the price of the vegetable (p_{it}) on a set of binary variables for each level of the value chain (going from producing areas to the major city in the country) as follows:

$$p_{it} = \sum_{w=1}^{n} \beta_w W_{it} + \sum_{m=1}^{12} \gamma_m M_{it} + \sum_{r=1}^{p} \alpha_r T_{it} + \varepsilon_{it}.$$

Setting the price level in Mt. Hagen – the major producing area for a large number of hard fresh produce – as the base category, variables W_{it} equal 1 if the vegetable price i in time period t was observed at other markets. Variable M_{it} captures monthly dummies, equaling 1 if the price i was observed in a particular month while T captures yearly dummies. ε_{it} is the error term. The computed standard errors are adjusted for heteroskedasticity (White, 1980). This specification is our base regression.[11] We estimate this equation separately for different product groups (staple, fresh and soft fresh produce) as well as all products separately. We use the logarithm of prices as the dependent variable for analyzing price trends and seasonality, while real price levels are retained for assessing marketing margins.

2.3 Price trends

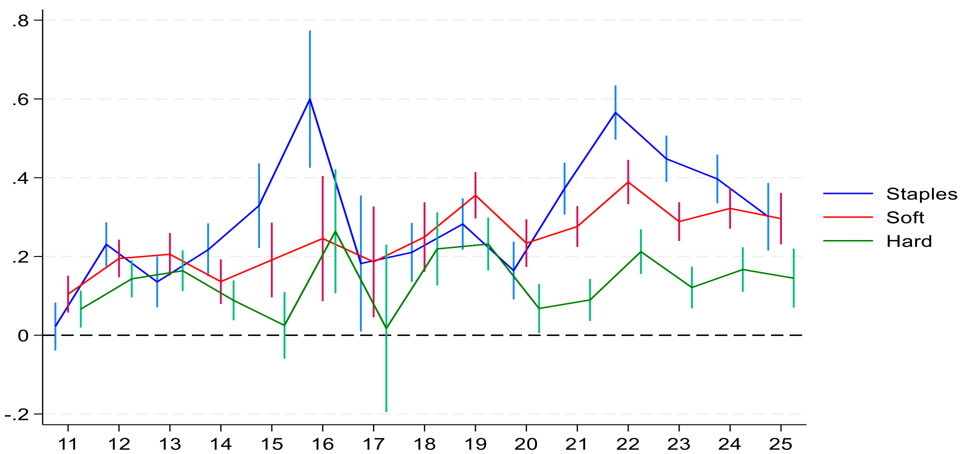
We assess (real) price changes over the last 15 years. Figure 15 presents the results of this exercise, illustrating the changes of prices compared to the Mt. Hagen market in 2010 (through a ratio). All crop groups exhibit significant real price increases compared to 2010, indicating that food price inflation has outpaced non-food inflation (Figure 9). Hard fresh produce shows the smallest overall increase, with prices in 2025 less than 20 percent higher than in 2010. In contrast, soft and staple fresh produce prices were approximately 30 percent higher in 2025 compared to 2010.

While real prices in all crop groups increased over time, notable price spikes for staples and hard fresh produce are recorded in 2016 and 2021-22. These spikes are likely linked to strong El Niño-induced

[11] The full results are shown in the appendix.

droughts and frosts in 2016, and signals of another predicted strong El Niño in 2021-2022. In addition, in 2016, the PGK also depreciated by nearly 10 percent against the Australian dollar in 2016, raising the cost of imported agricultural products (such as bulb onion, carrots, and potatoes), explaining the significant rise in prices for hard fresh produce that year. Finally, between 2017 and 2020, lower prices were reported, potentially associated with low international coffee prices during that period. Stakeholders reported significant labor shifts in the Highlands from fresh produce to coffee when coffee prices were more remunerative, suggesting strong interlinkages of prices between these commodity groups. A more in-depth analysis and discussion of seasonality and commodity level price analysis can be found in Minten et al. (2025).

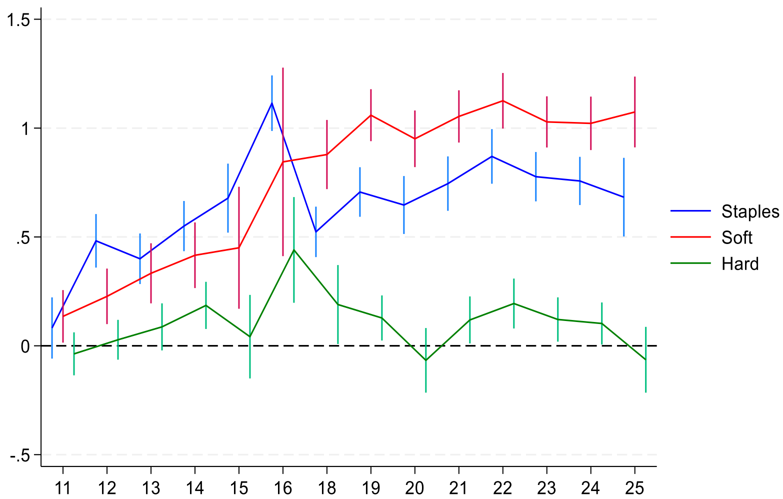
Figure 9: Price changes compared to 2010, all markets, 2011-2025 (ratio)



Note: Markers are coefficients, vertical lines confidence intervals; Source: FPDA Food Price Monitoring

We also examine the price evolution of different fresh produce categories in Port Moresby (Figure 10). Prices for soft and staple fresh produce have increased significantly over the period, with soft fresh produce prices roughly doubling, while prices for hard fresh produce have remained relatively stable. Given that hard fresh produce is almost exclusively supplied by the Highlands, this suggests that marketing channels for fresh produce not sourced from the Highlands—namely staples and soft fresh produce—have comparatively deteriorated. Further investigation into the underlying causes of this trend would be valuable.

Figure 10: Price changes compared to 2010, POM, 2011-2025 (ratio)



Note: Markers are coefficients, vertical lines confidence intervals; Source: FPDA Food Price Monitoring

2.4 Margins

Marketing costs of fresh produce from production areas to Port Moresby are substantial. For marketing to be profitable, price differences between these different markets should reflect the costs incurred by aggregators and traders. In this section, we examine these margins based on retail prices observed in the different markets. The available data only include retail prices—thus not capturing the full marketing costs from producers to end consumers—however, they provide a useful indication of the costs involved in moving fresh produce from the Highlands to Port Moresby.

Using the methodology described in Section 2.1, we compare price differences across food categories and markets with Mt. Hagen. Prices are significantly higher in POM than in Mt. Hagen for all three food groups. Over the entire period (2009-2025), the average prices of soft and hard fresh produce—the latter most often sourced from the Highlands—are nearly 4 PGK/kg higher in POM than in Mt. Hagen. In contrast, staple price differences between POM and other regions are much smaller, reflecting that most staples are not sourced from the Highlands but also indicating lower marketing costs for those products (e.g., sweet potatoes do not require chilled containers for transport). For fresh produce, price differences between Mt. Hagen and Lae are relatively small, whereas substantial increases occur between Lae and POM, highlighting the contribution of higher marketing costs from Lae to POM. We also observe very high prices (compared to Mt. Hagen) for hard fresh produce in Kokopo, located off the mainland in East New Britain.

To facilitate interpretation and address data gaps in some years, we divide the time series data into three periods—2009–14, 2015–20, and 2021–25—to assess how margins have evolved across the three crop groups between Lae and POM, and Mt. Hagen and POM. The difference between Lae and POM reflects transport costs by sea, while the difference between Mt. Hagen and Lae indicates road transport costs. The price gap between Mt. Hagen and POM therefore captures marketing costs incurred over both land and sea routes.[12] Margins between Mt. Hagen and POM increased across all groups, with the largest rise observed for soft fresh produce (Figure 11). In the most recent period (2021–25), price differences between Mt. Hagen and POM reached 2.0 PGK/kg for staples, 4.6 PGK/kg for hard fresh produce, and 8.2 PGK/kg for soft fresh produce. Margins from Lae to POM are generally lower than those from Mt. Hagen, except for staples. This exception in the price gradient likely reflects the limited marketing flow of staples from Mt. Hagen to POM. A separate analysis focusing on sweet potatoes (graph on the top right) – which are more commonly traded in POM compared to other staples (e.g., taro) – shows the expected larger price differences for Mt. Hagen compared to Lae.

Sea transport costs—measured by the price gap between Lae and POM—are substantially higher for soft fresh produce (5.7 PGK/kg) than for hard fresh produce (2.7 PGK/kg), likely due to the need for chillers and greater wastage during transit for soft fresh produce. In contrast, road transport costs between Mt. Hagen and Lae are much smaller, at 2.5 PGK/kg for soft fresh produce and 1.9 PGK/kg for hard fresh produce, reflecting the shorter journeys.

[12] It should be noted that these price differences with POM also include additional loading and unloading costs at ports, as well as likely higher distribution margins in POM, since produce must be transported from the port to markets within the city.

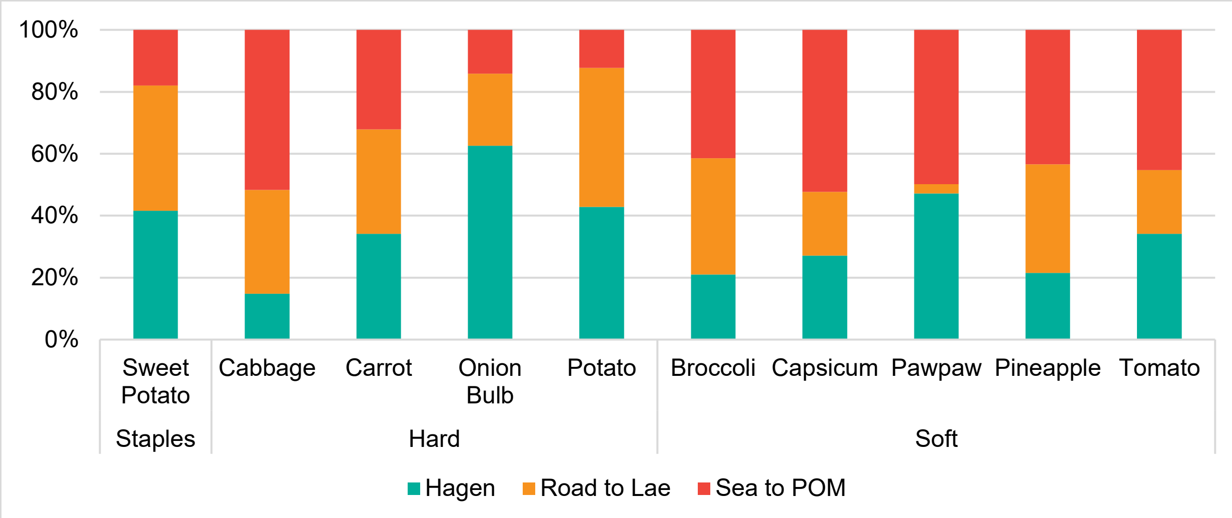
Figure 11: Price differences (real PGK/kg) with retail prices in POM, 2009-2025[13]

Source: FPDA Food Price Monitoring

A price composition exercise (Figure 12), where the final retail price in POM is set to 100 percent, allows us to assess the relative importance of different cost components of the value chain in the retail price. This is admittedly a rough approximation, as we only observe retail prices in Mt. Hagen rather than producer prices and cannot account for quality differences. We find substantial variation in the producer's share of final consumer prices in POM, ranging from a low of 15 percent for cabbage and 21 percent for sweet potato to a high of 61 percent for potatoes. Consequently, marketing costs – including packaging, handling, transport, as well as wastage - account for the largest share of retail prices in POM, ranging from 85 percent for cabbage to 39 percent for potatoes. This underscores the importance of reducing marketing costs to improve the affordability of fresh produce in POM and to increase the producer's share in the final retail price.

[13] Differences in staple fresh produce between Mt. Hagen and POM were not statistically significant for the period 2009-14; therefore, that bar is omitted from the figure in the top-left corner.

Figure 12: Price composition POM prices, real prices, 2023-2025



Source: FPDA Food Price Monitoring

SECTION 3: OPPORTUNITIES AND CONTRAINTS FOR REDUCING MARKETING MARGINS

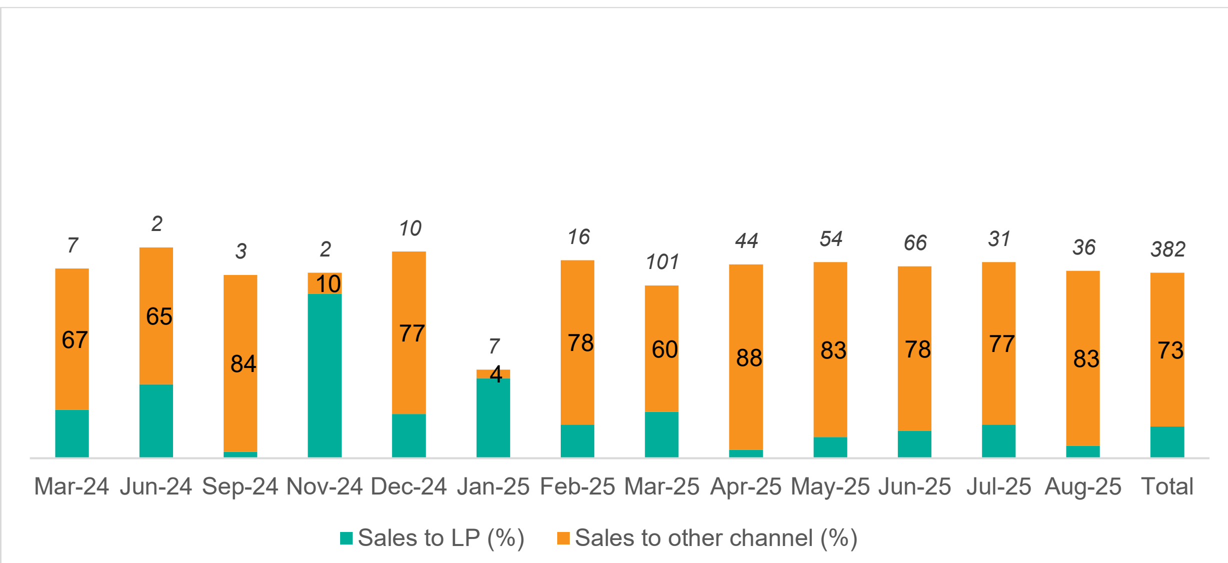
The available data (e.g., remote sensing LULC analysis; vendor surveys on production source, and time series commodity price data) suggest that the Highlands corridor is an important cluster for higher value fresh vegetable production in PNG. However, costly transactions along the value chain increase marketing margins and decrease competitiveness for farmers, traders and retailers. To better understand bottlenecks, we conducted in-depth interviews with key stakeholders from Mt. Hagen to Port Moresby. Schmidt et al. (2025) provide a detailed account of the fresh produce value chain scoping exercise, however for this synopsis, we briefly highlight key insights we gained while discussing the challenges and unique solutions that diverse actors are taking to increase efficiency and improve quality along the fresh produce value chain.

3.1 Stable demand and price incentives

During scoping interviews, actors along the value chain explained that they struggled to meet the quantity of fresh produce demanded from urban retailers while also meeting profit margins required to support a burgeoning fresh produce sector (e.g., remunerate farmers sufficiently to incentivize greater investment). Medium to long-term fixed prices from buyers for specific goods restrict price negotiation month to month following fluctuations in supply and demand. As one lead partner described: “The buyers (wholesalers / retailers) fix prices per kilo of produce for 6 months to up to 2 years.” At the same time, the fresh produce market in Papua New Guinea is highly volatile, both at the market level due to large price swings and at the production level due to changing weather conditions. This volatility complicates investment decisions for all actors in the supply chain. Several stakeholders we interviewed highlighted market volatility as a major concern.

In addition to suboptimal price incentives, there seems to be no consistent mechanism across lead farmers (or lead partners) to ensure contact farmers that they will purchase a pre-agreed volume of specific produce. Often these orders are made verbally, based on trust and good Wantok connections between the two parties. The Market for Village Farmers (MVF) project that aims to connect producers with traders collects information on sales streams for rural farmers to better understand how fresh produce farmers balance investment and sales decisions. MVF data suggests that even farmers that are a part of the MVF program (and linked to formal aggregators) sell a limited share (only 15 percent) of their production to pre-arranged traders (Figure 13), with the remainder sold at informal markets or to market vendors. This lack of future volume demand makes it difficult for farmers to efficiently scale up production or invest in greater quality and yield output.

Figure 13: Share of produce sold to lead partners and others, by report months



Note: Values on top of the bar represent the number of contact farmer data submissions. Several months are not reported due to lack of sales data submitted by contact and lead farmers; Source: Authors' calculation using MVF Contact Farmer Monthly Report data

3.2 High cost of inputs

The high cost of inputs was repeatedly reported by producers as a major constraint to increasing production capacity. According to a variety of lead farmers, broccoli, cabbage, capsicum, tomato and Irish potato require very expensive inputs. Contact farmers in the MVF project reported that they spend, on average, 199 PGK on a 40 kg vege mix fertilizer and 385 PGK on a 40 kg pot mix fertilizer for crops such as cabbage, potato and broccoli to produce approximately 300-700 Kgs of harvest. The cost of seed varies based on the crop.[14] To address some of these production costs, the MVF program has offered a portfolio of small grant opportunities to contact and lead farmers. According to a lead farmer interviewed during the scoping, “Before MVF, there was no way that farmers could afford high value crop production. I have seen farmers moving into more diversified crops that require high investment like soil management, nursery management, and inputs.” Assuming these types of grant or loan schemes are designed to meet farmer needs and constraints, continued access to financing will be critical for supporting greater expansion of the fresh produce value chain in PNG.

3.3 Access to foreign exchange and banking services

Inadequate access to finance (both foreign exchange and domestic credit) is slowing fresh produce growth opportunities in PNG. Several input suppliers explained that there is large competition among importers for foreign exchange and more lucrative imports are prioritized[15]. Lack of access to agricultural inputs quickly affects agricultural output and planting schedules, as one contact farmer explained that she accessed a Market for Village (MVF) 30:70 grant but was unable to plant the necessary lettuce she had promised to grow for a lead farmer because she was still waiting for the seeds (that should have been imported and available months earlier). A variety of farmers echoed her frustration on continuous seed shortages for fresh produce. Lack of foreign exchange and delays in importing agricultural imports (e.g., seeds, fertilizer, packaging and storage technology (e.g., crates and chillers), transport vehicles, machinery, etc.) will continue to significantly impede higher value agriculture expansion.

Lack of access to banking and bank services was a commonly reported constraint to expanding production activities for contact and lead farmers. Responding to this constraint, lead farmers are partnering with a small loan scheme, whereby they can serve as MiBank agents who can vouch for farmers to be able to open a bank account using their SIM card.[16] The SIM card then becomes the users’ bank account number and banking is completed via mobile phone. MiBank offers a 10 percent loan program whereby users commit 10 percent of the requested loan amount and receive the remaining loan amount with a 2 percent monthly interest (at the time of this study). According to interviews, this has opened up opportunities for more women to have independent bank accounts, as well as allowed farmers to invest in inputs (e.g., fertilizer, pesticide, improved seed, etc.) to increase output, which the wholesaler hopes

[14] For example, a group of three sampled farmers from Mt. Hagen, owning plots approximately 0.7 ha, reported spending 169 PGK on broccoli seeds which yield 8 broccoli bags of 25 kgs each, 200 PGK on a carrot tin which yields 14 carrot bags of 30 kgs each, and 300 PGK on onion seeds which yield 18 onion bags of 20 kgs each per production cycle.

[15] During the scoping trip, input suppliers explained that when foreign exchange become expensive, they do not prioritise agricultural inputs as it accounts for less than one percent of their total revenues. Given that the agricultural inputs contribute less to their overall profits, other lucrative imports are prioritized during the period of foreign currency shortage.

[16] Under this strategy, the wholesaler serves as a MiBank agent and vouches for farmers to help them open their bank account using their SIM card. By doing so, the wholesaler receives a small commission from MiBank, which is then used to build nurseries for lead farmers.

will improve their ability to fulfil fresh produce orders. Further investigation is needed to better understand how this strategy is working and whether repayment has been successful.

3.4 Packaging and Handling

Wholesalers and retailers lamented that fresh produce quality is severely impacted by poor packaging, handling and transport prior to arriving at wholesaler depots. Packaging materials such as reusable plastic crates have only been recently introduced in the last 10-15 years, and only by the largest wholesaler operators. These interlocking crates have improved quality in two points in the value chain. First, at farmgate level, several aggregators have implemented policies that farmers must bring their produce to the depots in the allocated crates, and produce will be paid for by kilogram rather than per bag. This has decreased the number of lead farmers that arrive at the depots with fresh produce in unconventional bags that result in greater spoilage. Second, at wholesale transport level, one wholesaler who uses the crates to pack produce into the sea freight containers estimated a 10 percent spoilage loss, upon reaching Port Moresby, compared to produce that is packaged and shipped in cardboard boxes that experiences a 30 percent loss. Perhaps one of the most impactful lower-cost investments that could improve quality and decrease wastage along the fresh produce value chain is low-cost access to reusable, interlocking plastic crates for packaging and shipping.

3.5 Cold Storage

The lack of cold chain facilities affects almost all actors in the fresh produce value chain, and creates a weekly scramble to harvest, pack, and transport fresh produce at last minute to minimize perishability of fresh produce and maximize profit of wholesalers (reducing losses from spoilage). Most actors who do not have a cold storage depot or a reefer (refrigerated container) store their produce without refrigeration for one to three days (maximum) before it arrives in Lae.

We asked wholesalers about their reasons to invest in cold chain facilities. The respondents noted that the post-harvest refrigeration of fresh produce is critical to preserve shelf life and minimize spoilage. However, despite owning reefer containers, these lead partners still use dry containers to transport fresh produce from the farm gate to the depot location where the reefer is connected to electrical supply for cooling, increasing the risk of spoilage before it gets loaded in the cold containers. By the time produce is loaded into a chiller in the Mt. Hagen depot or the depot in Lae, a share of fresh produce spoils because of the heat generated from the produce after harvest and the non-refrigerated transport in the truck.

Investment in cold chain infrastructure is costly. Although the grants offered by the MVF project help the lead partners to defray costs, most lead partners report taking loans between 300,000 – 400,000 PGK for a period of 4 years so that they can obtain the funds to contribute 60 percent of the investment (as required by MVF) to apply for the MVF grant. Based on the information received through interviews, there are no suppliers of cold chain containers in the highlands. Lead partners procure reefers from either Lae or Port Moresby, whereby suppliers take around 3-5 months to deliver the containers to the lead partners.[17]

A potential intermediate solution offered to improve cold storage access was to construct and power a central cold storage warehouse that could be shared among a variety of lead partners or smaller wholesalers. Based on observations of one of the largest fresh produce wholesalers, this is a viable solution, however it is unclear if there are cost advantages of this strategy. Many of the smaller lead partners are receptive to a cold chain depot where they can drop off their aggregated produce for sale at the depot, at which point the cold chain depot would be responsible for transportation, logistics, and delivery of produce to the final buyer. They anticipate that such an initiative will help in reducing cost of transportation, limiting risk of spoilage of fresh produce and improving the overall quality of the vegetables procured.

Regardless of the potential solutions to facilitate access to cold storage facilities, it is important to note that the cost and reliability of electricity present a major challenge to cold storage.[18] This constraint should not be underestimated. The two larger wholesalers that we interviewed have transferred all of their cold chain activities to run on generators due to unreliability of the public grid. One of these wholesalers estimated that their electricity generation per chiller container (which is used for fresh produce storage at Lae), when running 24 hours per day costs approximately 20,000 PGK / month. According to this wholesaler, "if the cold chain was maintained, farmers would be able to receive the real value of their produce."

Future research could evaluate the willingness to pay (of lead farmers or small holders) for membership to cold warehouse facilities (run on generators), rental of reefers, or other shared / rental solutions to supplying cold chain technology for produce storage and transport. If economically viable, facilities in key aggregation points (Mt. Hagen, Goroka, Lae, etc.) should also consider how to provide a safe warehousing facility for women farmers. Throughout our interviews, lead farmers and wholesalers suggested the need for a separate depot for women lead farmers and wholesalers that should be offsite of the Lae port and other public depots.

In summary, fresh vegetable production output and quality deteriorates at several points in the value chain increasing transaction costs throughout the process, however opportunities for improvement exist at each node. At the producer level, designing systems that provide transparent information to contact

[17] One of the lead partners owns secondhand reefer containers for which he paid between 45,000-54,000 PGK.

[18] 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) aims to connect 70 percent of the population to the power grid by 2030.

farmers on the quantity of produce demanded, with a price per kg that is attractive to incentivize farmer investment will be crucial to securing reliable quantity and quality. Relatedly, improved access to inputs (e.g, improved seeds, fertilizer, machinery, etc.) is tantamount to improving overall fresh produce output. Wholesalers have also identified other areas of improvement to increase quality throughout the value chain. These include: 1) improved and specialized packaging and handling, 2) expanded cold storage facilities, and 3) improved transportation infrastructure (rural roads) and tools (e.g., wheelbarrows to carry produce from farmgate to access roads and rural road construction and rehabilitation).

SECTION 4: CONCLUSIONS

Marketing of fresh produce has undergone significant changes in recent years, driven by several factors. First, urban populations—particularly in Port Moresby—have grown substantially, with an officially estimated annual growth rate of almost 3 percent, implying an approximate 50 percent increase over the past 15 years. Second, as observed in many low- and middle-income countries (Reardon et al., 2003), modern retail and institutional demand (e.g., restaurants and hotels) has become increasingly important in urban PNG markets. This development, coupled with greater willingness to pay for quality, has attracted large modern commercial suppliers - such as Hilans Fresh and NKW Fresh - into fresh produce value chains. Third, open wet markets in Port Moresby—such as Gordon's Market, Boroko Market, and Waigani Market—remain the primary outlets for fresh produce, accounting for an estimated 80 percent of all fresh produce sold in the city, according to one stakeholder. In total, fifteen open markets currently function in the city, and growing demand from peri-urban areas is driving calls for the establishment of additional markets.[19]

This increase in demand has driven significant changes in the supply of fresh produce to urban centers. Large-scale farms—particularly in Central Province—have expanded production to meet the needs of growing wet markets.[20] However, the biggest contributors remain smallholders, who have responded strongly to rising urban demand. This is reflected in the substantial expansion of horticultural production by smallholders in recent years, with cropland area increasing by nearly 5% annually along the Highlands Highway. These trends highlight the potential and opportunities in PNG's fresh produce markets. To fully realize these opportunities, several interventions could improve the functioning of fresh produce value chains and enable smallholders to benefit more.

First, research and agricultural extension services should be improved. Support for agricultural research, innovation, and yield-enhancing technologies remains limited (Benny, 2022). Funding for research and development (R&D) declined steadily between 2013 and 2017 due to reductions in donor and

[19] As stated by key informants of the POM Market Authority.

[20] Notable examples include IAI's 9 Mile Vegetable Farm, a state-of-the-art greenhouse complex, and the modern farm operated by the Pacific Adventist University near Port Moresby.

government contributions (ASTI, 2021). Agricultural extension services are also inadequate: fewer than one-third of households in the 2023 rural household survey reported receiving information on new crops (Schmidt et al., 2024), with non-poor households more likely to access these services. Expanded and better targeted extension—possibly leveraging digital platforms—should be prioritized for fresh produce value chains.

Second, production and marketing risks should best be reduced. Price volatility and weather variability make fresh produce farming and marketing risky. Exploring the introduction of insurance products—such as weather-related and freight insurance—could reduce risk exposure for farmers and value chain actors, encouraging more assured profitability and greater investment. Additionally, developing stress-resistant crop varieties and supporting climate-smart technologies will help mitigate the risks of climate change.

Third, there is a need for investments in infrastructure. High marketing margins from farm to consumer as documented in our studies significantly inflate urban retail prices and reduce farmers' incentives. Investments in rural roads, electrification, cold chains, and port infrastructure—preferably using domestic labor and inputs—are essential to reduce these margins and improve efficiency in both domestic and export-oriented value chains.

Fourth, input and credit markets require strengthening. Producers frequently face challenges accessing essential agricultural inputs due to limited foreign exchange and delays in importing seeds, fertilizers, and pesticides. Seed shortages, in particular, remain a major constraint for fresh produce growers. Similar issues affect midstream products, including packaging materials, storage technologies (e.g., crates and chillers), transport vehicles, and machinery. These bottlenecks significantly hinder the growth of the fresh produce sector. Facilitating access to foreign exchange, improving input supply chains, and expanding access to agricultural credit will be critical for boosting productivity and ensuring higher-quality outputs.

Fifth, there is a need for enhanced data and market information gathering and dissemination. There is a lack of updated, representative data on fresh produce supply and demand. Key gaps include information on farmer profiles, input use, yields, incomes, and challenges, as well as marketing costs, wastage levels, and consumption data. Better evidence is needed to inform policy and investment decisions.

The Market for Village Farmers (MVF) project continues to address structural constraints in PNG's fresh produce value chain. Its approach of linking farmers to village aggregators and wholesalers has improved producer–consumer connections. Future efforts could focus on reducing price and demand information asymmetries, building transparent marketing systems, financing quality improvements (e.g., interlocking packaging crates), and integrating incentives for productivity through pre-arranged volume orders and flexible pricing aligned with market trends.

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APPENDIX

Appendix Table 1: Land use landcover classification accuracy

	2018	2024
Total Reference Points	1000	1000
Overall Accuracy (OA)	55.70%	68%
Kappa Coefficient	0.114 (Slight)	0.360 (Fair)
Cropland metrics		
Reference Cropland Points	500	500
Correctly Predicted	459	411
Producer's Accuracy	91.80%	82.20%
User's Accuracy	53.30%	64%
Non-Cropland metrics		
Reference Non-Cropland Points	500	500
Correctly Predicted	97	269
Producer's Accuracy	19.40%	53.80%
User's Accuracy	70.50%	75.10%

Source: Author’s calculations

Appendix description 1: How FPDA's Urban Market Survey (UMS) is implemented

Since 2009, the Fresh Produce Development Agency (FPDA) of PNG collects market prices of 27 different fresh food items every two weeks (when funding and logistics are amenable) in urban markets of major towns and centers in PNG by trained FPDA enumerators, including Gordon's-Port Moresby, Kokopo, Mt. Hagen, Goroka and Lae main markets. The 27 food items include staples, vitamin dense, dark leafy greens, citrus, fruits, nuts and other vegetables.

Before recording the price and quantity (heaps, bundles or single item) of fresh produce item, the enumerators are instructed to walk throughout the market and observe the availability of produce sold at the market and assess the current quality status of produce. Then the enumerators are instructed to purchase three samples of each vegetable type from three different vendors in the market. As they do so, they record the prices and quantity of each vegetable from each vendor and ask the seller where (which district) they are sourcing the produce from. After recording the price, quantity and supply source district of each three samples of the 27 different fresh food items, they carry all the produce to the FPDA office where each product sample is individually weighed and recorded on a paper template, which is then transferred into a tablet program that saves uploaded data to the cloud.

It is important to note that these data are not nationally representative, however they provide useful information on prices of each produce in different regions of PNG in a given time.

Appendix Table 2: Share of fresh produce supplied to Lae and POM markets by commodity and production location

Commodity	Main supplier districts	Lae-main market (%)	POM – Gordon's market %)
Staples			
Sweet potato	Mt Hagen, Tambul / Nebilyer, Mul/Baiyer (WHP); Goroka, Daulo (EHP); Kairuku-Hiri (Central)	76% Mt Hagen; 16% Tambul/Nebilyer; 8% Other	41% Goroka; 36% Mt Hagen; 18% Daulo; 5% Kairuku-Hiri
Taro	Nawae, Huon, Finschafen, Markham (Morobe); Goilala, Kairuku-Hiri, Rigo, Abau (Central); Mt Hagen, Tambul/Nebilyer (WHP)	100% (Morobe)	60% Mt Hagen; 28% Central; 6% Tambul / Nebilyer; 6% Other
Cooking banana	Nawae, Huon (Morobe); Rigo, Kairuku-Hiri, Abau (Central)	91% Nawae; 9 % Huon	82% Rigo; 14% Kairuku-Hiri; 4% Abau
Hard fresh produce			
English cabbage	Tambul/Nebilyer, Mt Hagen, Mul/Baiyer (WHP); Kundiawa/ Gembogl (Chimbu); Okapa, Kainanatu, Goroka, Lufa (EHP)	36% Tambul/ Nebilyer; 31% Mt Hagen; 24% Kundiawa/ Gembogl; 9% (EHP)	44% Tambul / Nebilyer; 32% Mt Hagen; 6% Mul/Baiyer; 18% (EHP)
Carrot	Goroka, Daulo, Henganofi, Lufa (EHP); Mt Hagen, Tambul / Nebilyer (WHP)	56% Daulo; 24% Mt Hagen; 18% Tambul/Nebilyer; 2% Goroka	55% Goroka; 18% Henganofi; 18% Mt Hagen; 5% Daulo; 4% Lufa
Bulb onion	Kundiawa / Gembogl (Chimbu); Mt Hagen (WHP); Goroka (EHP)	100% (Chimbu)	43% Kundiawa / Gembogl; 43% Mt Hagen; 14% Goroka

Irish potato	Okapa (EHP); Mt Hagen, Tambul / Nebilyer (WHP)	91% Okapa; 7% Tambul / Nebilyer; 2% Other	48% Tambul / Nebilyer; 45 % Mt Hagen; 7% Other
Soft fresh produce			
Capsicum	Kainanatu, Goroka (EHP); Mt Hagen (WHP); Rigo, Kairuku-Hiri, Abau (Central); National Capital (NCD)	67% Kainanatu; 29% Mt Hagen; 4% Other	35% Rigo; 29% NCD; 13% Kairuku-Hiri; 10% Abau; 9 % Goroka; 5% Mt Hagen
Broccoli	Tambul / Nebilyer, (WHP)	100%	100%
Tomato	Unggai / Benna; Goroka; Henganofi, Daulo (EHP); Mt Hagen (WHP); National Capital (NCD); Abau (Central)	69% Unggai/Benna; 16% Goroka; 11% Henganofi; 4% Daulo	55% National Capital; 35% Mt Hagen; 5% Abau; 5% Goroka
Pawpaw	Markham, Huon (Morobe); Kairuku-Hiri, Goilala, Abau, Rigo (Central)	70% Markham; 30% Huon	73% Kairuku-Hiri; 18% Goilala; 6% Abau; 3% Rigo;
Pineapple	Mt Hagen (WHP); Markham (Morobe), Kairuku-Hiri, Abau, Rigo (Central)	98% Mt Hagen; 2% Markham	33% Kairuku-Hiri; 31% Abau; 28% Rigo; 8% Mt Hagen

Source: FPDA Food Price Monitoring data

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