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# Scoping Report: Understanding the fresh produce value chain in Papua New Guinea

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# INTRODUCTION

The Government of Papua New Guinea (GoPNG) aims to promote agricultural transformation through strategic investments to support greater commercialization via increases in production output and quality. To accomplish this goal, the GoPNG recently released the National Agriculture Sector Plan (NASP) 2024-2033 which acknowledges the fresh produce sector's potential to contribute to poverty alleviation and economic growth via increased income for rural farmers (Department of Agriculture and Livestock 2023). With growing urbanization and expanding mining operations, the demand for fresh produce is increasing within the country (Chang et al. 2015). While the challenges that PNG faces to promote a more competitive fresh produce agriculture sector are not simple hurdles to overcome, they are not impossible barriers to surpass either.

This report sets out to achieve three goals: 1) provide an assessment of PNG's fresh produce farming and sales trends using remote sensing data and recent data collected by the International Food Policy Research Institute (IFPRI) and the Fresh Produce Development Agency (FPDA); 2) report on current programming (namely Market for Village Farmers) aimed at supporting fresh produce value chain development; and 3) inform future programming of fresh produce value chain support through a detailed account of a scoping study of the fresh produce sector conducted in June, 2025 and November, 2025.

# SECTION 1: PNG AGRICULTURE

## 1.1 Land use land cover change in fresh produce agriculture corridors

Papua New Guinea has limited data on agriculture production trends over time. The country's last agricultural census was conducted in 1961-62 (PNG Bureau of Statistics, 1963), and there have been no agriculture sample surveys conducted in the interim. A variety of localized assessments of agricultural productivity and production practices have been conducted to evaluate specific value chains or programs (ACIAR, 2015; Bonney et al., 2015; Chang et al., 2015; Martin and McKay, 2009; NARI,2014); however, these disparate assessments do not provide a time series database and are not nationally representative to evaluate agricultural expansion over time and space.

In lieu of time series data (collected via in-person surveys or crop cutting, etc.), we evaluate cropland change over time between 2018 (corresponding to the first release of stable Sentinel-2 LULC processed data product) and 2024 in key horticulture producing corridors. In doing so, we utilize Sentinel-2 imagery, which enables high-resolution (10-20 m) cropland mapping via multi-temporal composites and machine learning (e.g., Random Forest [RF], U-Net [UNet]), with red-edge bands enhancing vegetation discrimination (accuracies 80-95 percent) (Phiri et al., 2020; Weiss et al., 2020). Initially, the analysis

aimed at evaluating two corridors highlighted as high producing areas for fresh produce in Papua New Guinea: 1) the highland corridor from Tambul to Goroka (total area: 2,207 km²); and 2) the Central Province corridor extending bidirectionally from Port Moresby (POM) to Kerema and to the southwest to Kupiano (total area: 4,628 km2). While we were able to successfully analyze the Highlands production corridor, we were unable to draw any conclusions from the Central corridor analysis due to persistent cloud cover (>80%) in agricultural zones which precluded remote sensing analysis and remained unresolvable with quarterly and 2019-extended composite analysis as well.[1]

For both corridors of interest, we restricted the analysis within a 5 km buffer of the primary road corridors to facilitate data processing for high resolution imagery. In addition, insights drawn from the scoping study (described in detail in Section 3) suggest that most fresh produce that is farmed for commercial sales is produced close to a major road to facilitate transport and logistics challenges. Figure 1 and Figure 2 demonstrate the area evaluated for the land use land cover (LULC) analysis performed on the two corridors. For both figures, the light grey shaded area shows the 5 km analysis area and the light and dark-red shaded areas display the consistent cloud cover that was present in the satellite imagery for 2018 and 2024, respectively (of which, for the Central corridor, resulted in unreliable data analysis).

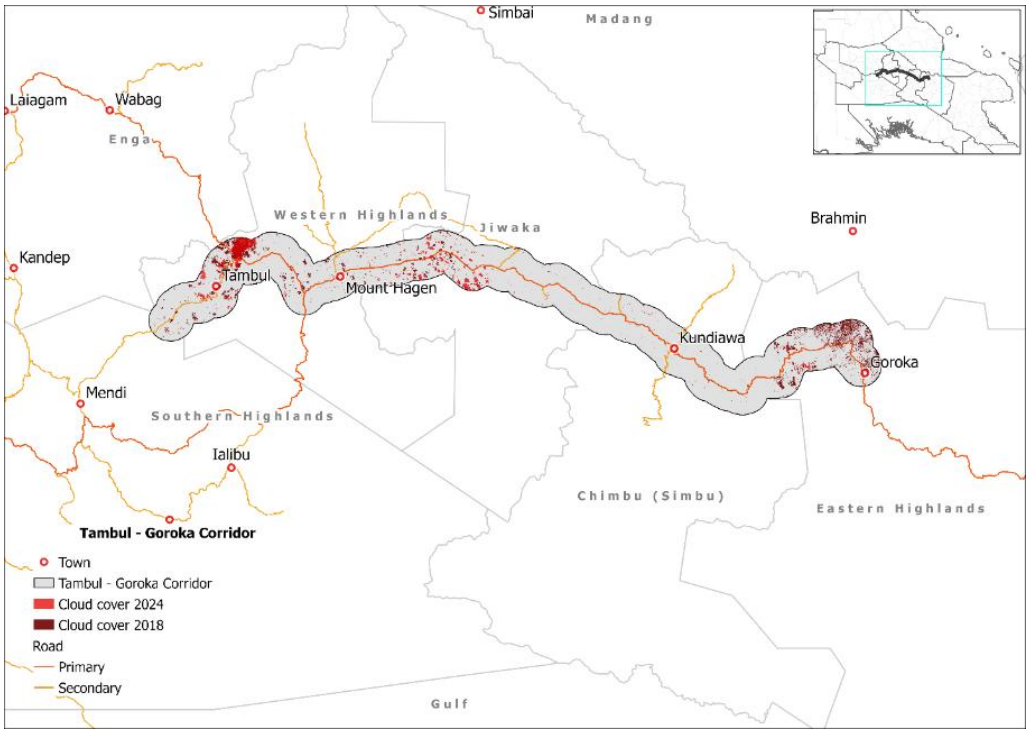
For the Highlands corridor, data were processed in Google Earth Engine, generating 12-band composites per year: six core bands (B2, B3, B4, B8, B11, B12) augmented by six spectral indices—Normalized Difference Vegetation Index (NDVI) for vigor, Normalized Difference Water Index (NDWI) for moisture, Normalized 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). See Appendix A for cloud-masking visuals, and index-derived snapshots.

To evaluate the Tambul - Goroka corridor LULC imagery over time, a training dataset of 200,064 features was assembled across six land classes: cropland, forest, grassland, bushland, bareland, and urban areas, manually extracted from high-resolution Google Earth Pro imagery (2018/2024) to represent slash-and-burn cycles, fallows, and agroforestry typical of highland smallholdings. Classification applied a Random Forest algorithm (smileRandomForest implementation, 500 trees) on the composites, with a 70/30 train/test split. Model validation used 1,000 independent points (500 cropland, 500 non-cropland) for each year (2018 and 2024), assessed via confusion matrices, overall accuracy (OA), and the Kappa coefficient. The methodology described above and employed for this analysis refines prior PNG LULC

[1] This methodological constraint has been documented in previous analyses in humid lowlands (Weiss et al., 2020), where cloud cover necessitates the use of Synthetic Aperture Radar (SAR) data fusion for continuous time-series generation. SAR: satellite-based radar technology that penetrates clouds and collects data in all weather conditions.

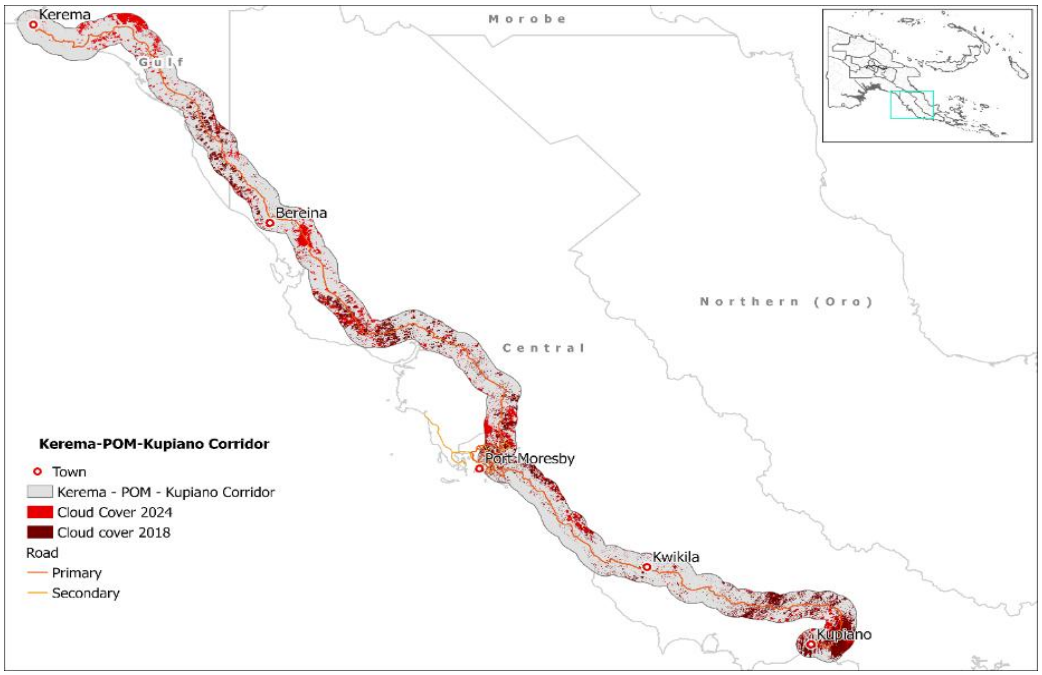
efforts (e.g., Bryan et al., 2020) by leveraging index fusion for tropical climate challenges such as cloud cover and spectral overlap, enabling reliable detection of intensification signals.

**Figure 1:** Tambul – Goroka 5-km buffer corridor




**Source:** Authors' analysis using Sentinel-2 imagery

**Figure 2:** Kerema-POM-Kupiano 5-km buffer corridor




**Source:** Authors' analysis using Sentinel-2 imagery

Results suggest a net cropland gain from 19,479 ha in 2018 to 25,905 ha in 2024—a 33% overall increase (4.9% cropland area increase per year), with a corresponding decline in non-cropland area from 201,273 ha to 194,847 ha, within the 5km buffer of the Tambul – Goroka corridor (Table 1). This increase in cropland area within the corridor shown in Figure 1 suggests a growing demand for agricultural produce in PNG, and a potential opportunity for higher value agriculture development within this corridor. Figure 3 compares high resolution imagery of the same agriculture area along the highlands corridor in 2018 and 2024, providing an example of cropland expansion detected in the remote sensing analysis.

**Figure 3:** Remote sensing images in 2018 and 2024 at location 5°53'35"S 144°08'32"E

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.

**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)

## 1.2 Fresh produce production and sales in PNG and the highlands

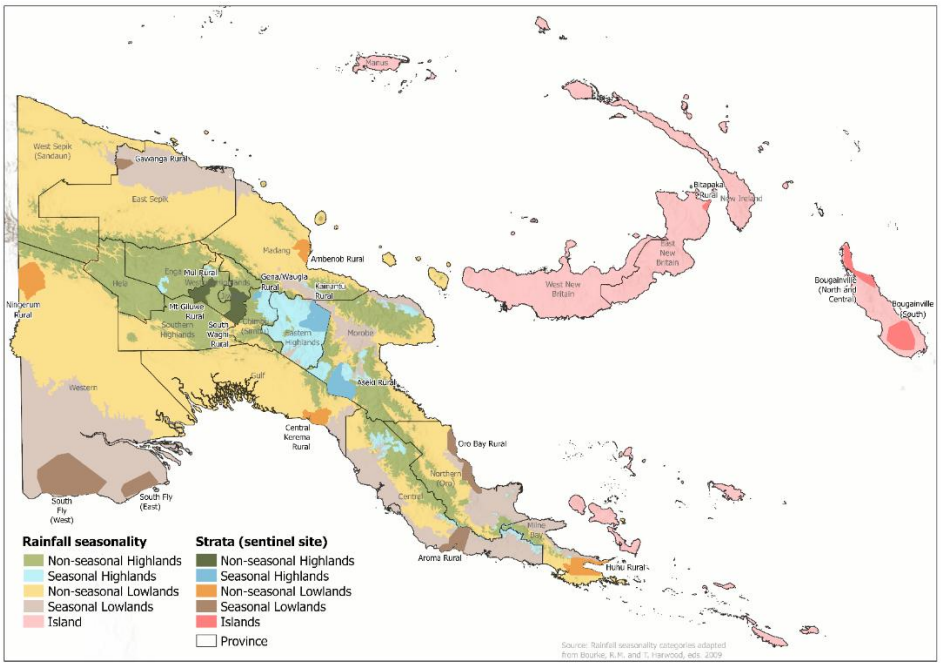
We use the 2023 PNG Rural Household Survey (RHS) data (International Food Policy Research Institute, 2025) to further investigate agricultural production and sales of rural households, with a particular focus on highlands households, cultivating vegetables[2] on their own or on rented-in agricultural plots.

[2] Following Bourke & Harwood (2009), we consider sweet potato, taro, and yam as staple crops and do not include them in the vegetable analysis described in this section. However, to gain a clearer understanding of crop cultivation practices in rural PNG, we present the prevalence of staple production and sales across different sampled regions in Appendix B.

In doing so, we disaggregate the analysis by distance-based measures to assess whether vegetable sales and input use vary by travel time to the nearest food market and town. We also investigate the use of agricultural inputs including improved seed, fertilizers, pesticides, and/or herbicides, and hired labor applied to produce horticultural crops. Lastly, to understand women's agency and decision-making in fresh produce cultivation, we analyze the production data to evaluate gendered plot ownership as well as access of extension services, particularly among female-headed agricultural households.

The 2023 PNG RHS collected detailed quantitative data on rural production and consumption profiles of 2,699 households from 270 communities across 14 provinces. While the survey is not representative at any administrative level, it provides valuable insights into production profiles of rural households across diverse agro-ecological zones defined using rainfall and elevation patterns.[3] These include Seasonal Highlands, Non-Seasonal Highlands, Seasonal Lowlands, Non-Seasonal Lowlands, and Islands. Figure 4 illustrates the survey sample areas disaggregated by the agro-ecological zones.

**Figure 4:** 2023 PNG Rural Household Survey




Source: Author's compilation

### 1.2.1 Vegetable production and sales across the survey sample

According to the 2023 PNG RHS data, approximately 98 percent of sampled households cultivate agricultural plots, of which 97 percent are household owned and 3 percent are rented-in. Approximately 93 percent of households use their gardens to produce at least one vegetable crop (Table 2). Households

[3] The 2023 PNG RHS distinguishes lowland (areas below 1,000 meters above sea level) and highland (areas 1,000 meters or more above sea level ) LLG areas based on median elevation in the LLG. Further, areas with large seasonal variation in rainfall (heavy to light depending on the seasons) are classified as seasonal, while those that experience moderately to heavy rainfall are classified as non-seasonal.

from the Highlands survey areas produce a greater variety of vegetable crops. Recent investments by the British American Tobacco Agency and the Fresh Produce Development Agency (FPDA) to install solar bulb dryers is reflected in the survey data, with 44 percent of households across seasonal and non-seasonal highlands reporting bulb onion cultivation.

**Table 2:** Share of households growing and selling vegetables, by study area

| | All HHs | Seasonal High-lands | Non-Seasonal Highlands | Seasonal Low-lands | Non-Seasonal Lowlands | Islands |
|---|---|---|---|---|---|---|
| **Vegetable Production** | | | | | | |
| **Any vegetable** | 93% | 93% | 95% | 90% | 93% | 93% |
| **Fresh Beans** | 64% | 69% | 72% | 63% | 57% | 64% |
| **Leafy Greens** | 89% | 90% | 88% | 86% | 92% | 91% |
| **Squash (pumpkin)** | 51% | 59% | 37% | 66% | 56% | 26% |
| **Bulb Onion** | 16% | 24% | 20% | 7% | 1% | 40% |
| **Tomato** | 17% | 9% | 4% | 16% | 12% | 47% |
| **Potato** | 8% | 5% | 32% | 5% | 1% | 0% |
| **Cucumber** | 8% | 6% | 3% | 9% | 13% | 7% |
| **Egg Plant** | 7% | 0% | 0% | 6% | 6% | 26% |
| **Ginger** | 6% | 15% | 4% | 3% | 4% | 7% |
| **Others** | 22% | 17% | 24% | 19% | 25% | 27% |
| **Vegetable Sales** | | | | | | |
| **Any vegetable** | 49% | 53% | 62% | 49% | 44% | 37% |
| **Fresh Beans** | 27% | 28% | 42% | 28% | 21% | 17% |
| **Leafy Greens** | 44% | 48% | 52% | 44% | 41% | 34% |
| **Squash (pumpkin)** | 17% | 14% | 17% | 25% | 16% | 6% |
| **Bulb Onion** | 6% | 8% | 13% | 2% | 0% | 11% |
| **Tomato** | 5% | 1% | 3% | 6% | 5% | 12% |
| **Potato** | 5% | 3% | 21% | 2% | 0% | 0% |
| **Cucumber** | 3% | 3% | 1% | 4% | 6% | 2% |
| **Egg Plant** | 2% | 0% | 0% | 3% | 1% | 7% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Ginger** | 2% | 6% | 2% | 1% | 2% | 1% |
| **Others** | 9% | 7% | 16% | 9% | 6% | 8% |
| **N (HHs that cultivate)** | 2,638 | 451 | 446 | 729 | 565 | 447 |

Note: HH = household. "Others" includes mooli, garlic, cauliflower, chili, leek, zucchini, scallion, corn, lemongrass, moringa, okra, turmeric, carrot, pitpit, broccoli, pepper (capsicum), and mustard. Source: Authors' calculations using 2023 PNG Rural Household Survey

Nearly half of the sampled households engage in vegetable sales, with the highest market participation from seasonal and non-seasonal highlands sample households. A larger share of households across all regions sells leafy greens (44 percent), followed by fresh beans (27 percent). A greater share of households is involved in vegetable sales that are located within 4 hours of their nearest food market, demonstrating the importance of market access for commercial surplus opportunities (see Table C.1 in Appendix C).

### 1.2.2 Vegetable plot characteristics in Highlands

Both production and sales data from the 2023 survey reflect the highland region's importance in fresh produce marketing. The 2023 PNG RHS collected data from five highland survey areas in: Simbu, Eastern Highlands, Jiwaka, Morobe and Western Highlands. Overall, 847 households (94 percent of the highlands sample) cultivate and produce vegetables on their garden. On average, survey households in the highlands own and operate 1.67 hectares of agricultural land to grow vegetables (Table 3). However, total cultivated land size differs across provinces.

At the time of the survey, most households reported cultivating about four agricultural plots to produce vegetables, of which, average plot size across all sampled Highlands households was 0.38 hectares, with the largest average plot size in Jiwaka (0.53 hectares).Compared to other provinces, sampled households in Eastern Highlands report having the smallest average plot size. Given that an important share of rural households cultivate coffee in this region, it is possible that lesser land is devoted to vegetable production to meet short term needs while farmers wait to harvest coffee.

**Table 3:** Vegetable plots cultivated, by highland provinces

| | | Number of plots cultivated | | Plot Size (of households with vegetable plots) | | Total cultivated land in hectares (of households with vegetable plots) | | Highland HHs that produce vegetables (N) | Total HHs households in survey sample (N) |
|---|---|---|---|---|---|---|---|---|---|
| | | **Mean** | **SD** | **Mean** | **SD** | **Mean** | **SD** | **N** | **N** |
| | All Highland HHs | 4.32 | 1.87 | 0.38 | 0.58 | 1.67 | 1.70 | 847 | 897 |
| **Seaonal** | Simbu | 4.64 | 2.46 | 0.44 | 0.57 | 2.03 | 1.92 | 134 | 151 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Highlands** | Eastern Highlands | 4.25 | 1.66 | 0.28 | 0.41 | 1.2 | 0.95 | 141 | 150 |
| | Morobe | 4.10 | 1.86 | 0.38 | 0.74 | 1.55 | 1.94 | 145 | 150 |
| **Non-Seasonal Highlands** | Jiwaka | 4.5 | 2.00 | 0.53 | 0.86 | 2.4 | 2.44 | 136 | 148 |
| | Western Highlands | 4.25 | 1.56 | 0.34 | 0.30 | 1.46 | 1.09 | 291 | 298 |

Source: Authors' calculations using 2023 PNG Rural Household Survey

### 1.2.3 Gendered plot ownership across highland provinces

Given that multiple agricultural plots are owned by rural households, the 2023 PNG Rural Household Survey asked the respondents to mention the household members who owned each plot and those responsible for decisions related to plot management and usage. For this analysis, we focus on vegetable producing plots owned by highland households and evaluate their gendered ownership structure (Table 4). We classify the owners and decision makers into three categories: male, female and joint. Plots owned by both male and female member of the households are classified under joint ownership. On average, greater share of plots across all highland provinces are owned jointly (63 percent). Simbu and Jiwaka have the highest share of vegetable plots solely owned by female members (18 percent), while in Morobe none of the vegetable plots are exclusively owned by women.

While analyzing the gender of decision makers, we find that although a larger share of plots is reported to be male owned, the proportion of plots with male decision makers are significantly low. For example, in Western Highlands, 38 percent of plots are male owned, however, only 9 percent of plots have male decision makers. Across all highland provinces the share of plots with female decision makers is higher than the share of plots solely owned by women, suggesting women's active role in vegetable production in the highlands. These results align with the findings of Curry et al. (2019), who also warn that as fresh produce sector gets commercialized, there is increased risk of men replacing women's participation in horticultural production leaving them marginalized.

**Table 4:** Vegetable plot owners and decision makers disaggregated by gender and highland provinces

| | Owners | | | Decision Makers | | | |
|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Joint** | **Male** | **Female** | **Joint** | **N (Plots that are owned and are used for vegetable production)** |
| **Total** | 29% | 7% | 63% | 10% | 10% | 80% | 2180 |

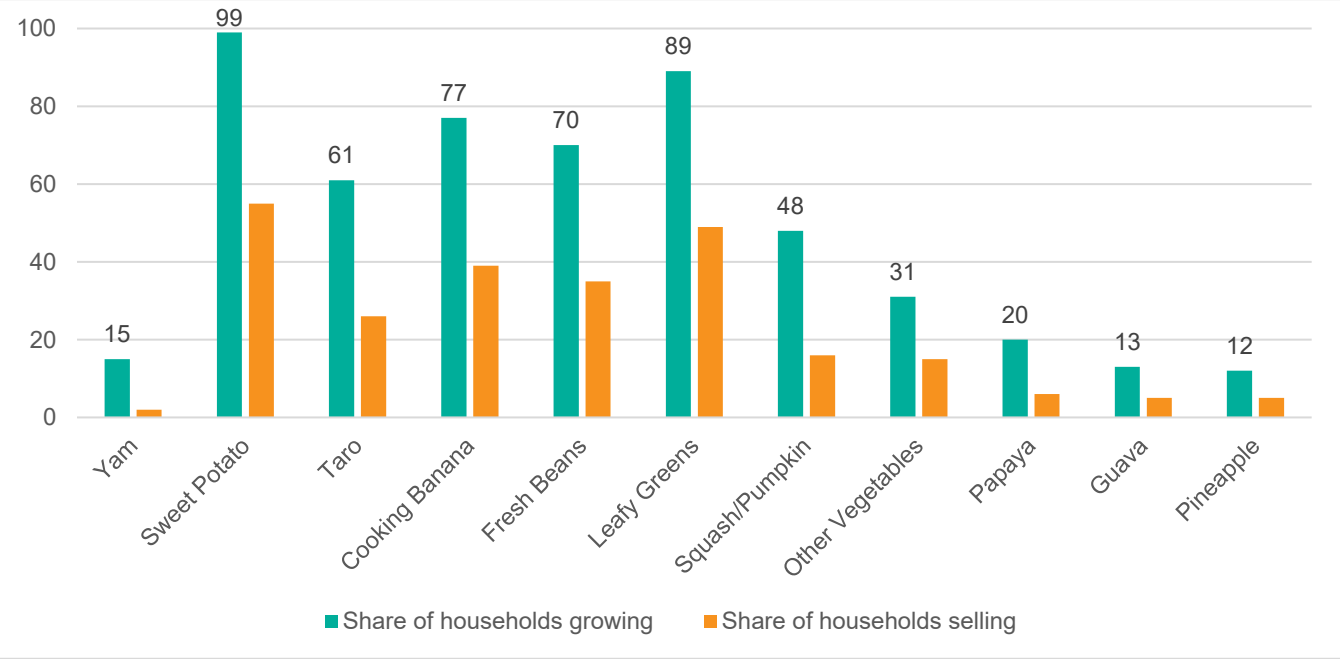
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Simbu** | 16% | 18% | 66% | 11% | 20% | 69% | 348 |
| **EHP** | 20% | 8% | 72% | 12% | 10% | 79% | 417 |
| **Jiwaka** | 37% | 18% | 45% | 15% | 30% | 55% | 253 |
| **Morobe** | 28% | 0% | 71% | 7% | 1% | 92% | 332 |
| **WHP** | 38% | 3% | 60% | 9% | 4% | 87% | 830 |

Note: EHP refers to Eastern Highland Province; WHP refers to Western Highland Province. Source: Authors' calculations using 2023 PNG Rural Household Survey

### 1.2.4 Vegetable production and sales in the Highlands

Survey data suggest that across all highland provinces, after sweet potato, leafy greens are the most widely cultivated (89 percent), followed by fresh beans (70 percent) and squash (48 percent) (Figure 5). However, not all provinces produce these vegetable crops at equal volumes. Irish potatoes are most widely grown in the Western Highlands, reflecting the appropriate agro-climatic conditions for potato production, with 47 percent producing and 31 percent selling (Appendix D).

**Figure 5:** Share of households growing and selling crops across all highland provinces




Source: Source: Author's calculation using 2023 PNG Rural Household Survey Data

It is common for producers to intercrop different vegetables on one agriculture plot.[4] The 2023 PNG RHS asked respondents to report the type of crops grown on each cultivated plot and the share of harvest

[4] In 2023 PNG Rural Household Survey, respondents were asked to report the crops that are commonly grown on each individual agricultural plot. While this data allows us to identify the range of crops cultivated by producers, the questionnaire did not collect plot-level information on which specific crops were intercropped together, nor did it record the seasonal timing of crop combinations. Due to this, we are unable to identify the intercropping practices across sampled households or examine how combination of crops varies across different regions or seasons. We

which they sell in the market. On average, approximately 25 percent of the vegetables grown on a plot is sold (Table 5). This reflects the semi-subsistence production behavior of households, where vegetables are grown for self-consumption and a smaller volume of the harvest is set aside for market activities. Survey households in Eastern Highlands Province are the most commercially oriented (followed closely by Simbu survey households), with 22 percent of agricultural plots planted to sell 100 percent of the production, however their average plot size and total cultivated land is the smallest compared to other highland provinces (as shown in Table 3). Survey households in Jiwaka are the least commercially oriented, even though their average plot size and total cultivated land is the largest compared to other highland provinces.

**Table 5:** Share of vegetable plot, by proportion of harvest sold across highland provinces

| | Seasonal Highlands | | | Non-Seasonal Highlands | |
|---|---|---|---|---|---|
| | **Simbu** | **EHP** | **Morobe** | **Jiwaka** | **WHP** |
| **Less than 25%** | 5% | 4% | 3% | 4% | 3% |
| **About 25%** | 33% | 28% | 39% | 37% | 32% |
| **About 50%** | 30% | 23% | 29% | 31% | 27% |
| **About 75%** | 10% | 12% | 7% | 12% | 12% |
| **More than 75%** | 3% | 11% | 4% | 7% | 13% |
| **All 100%** | 20% | 22% | 18% | 9% | 13% |
| **Total vegetable plots in highland HHs used for sales** | 243 | 278 | 211 | 196 | 694 |

Note: EHP: Eastern Highland Province; WHP: Western Highland Province; Source: Authors' calculations using 2023 PNG Rural Household Survey

### 1.2.5 Acess to inputs across Highland provinces

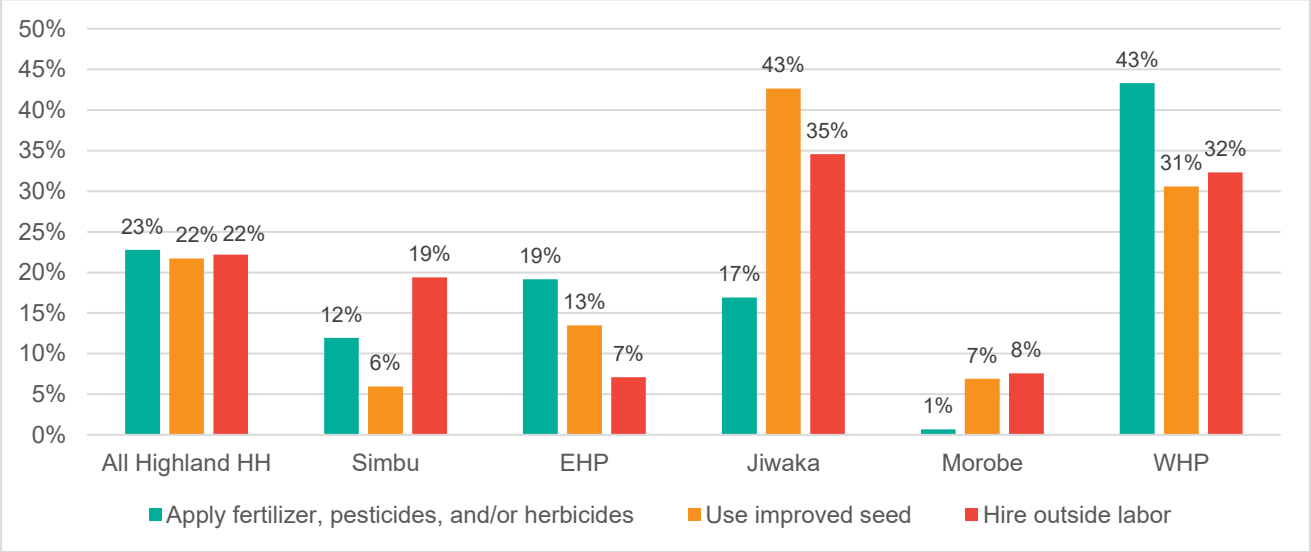
The 2023 PNG RHS included questions on agricultural input use and asked respondents to report whether they used improved seeds[5] or any chemicals (fertilizers, pesticides, and/or herbicides) on their agricultural plot. The survey also asked landowners to report the number of workers used for agricultural activities. Across all highland provinces, almost one-fourth of the surveyed households use chemicals, improved seeds and / or hired outside labor (Figure 6). Relative to other survey areas, surveyed house-

note that future surveys collecting detailed information on crop combinations within plots and across season would allow for a more comprehensive analysis of intercropping systems across households in rural PNG.

[5] Improved seeds are defined as commercially purchased seeds intended for crop production. If households do not use the entire quantity in the season of purchase, they may store the remaining seeds for future planting. In such cases, households are still classified as using improved seeds, even if seeds were purchases in a previous period.

holds in Western Highlands and Jiwaka report a higher utilization of improved seeds, and survey households in the Western Highlands invest the most in fertilizers, pesticides, and/or herbicides. Given that a large share of households in the Non-Seasonal highlands invest in agricultural input, it helps explain the reason behind highest prevalence of vegetable sales in this region compared to other study areas (Table 2).

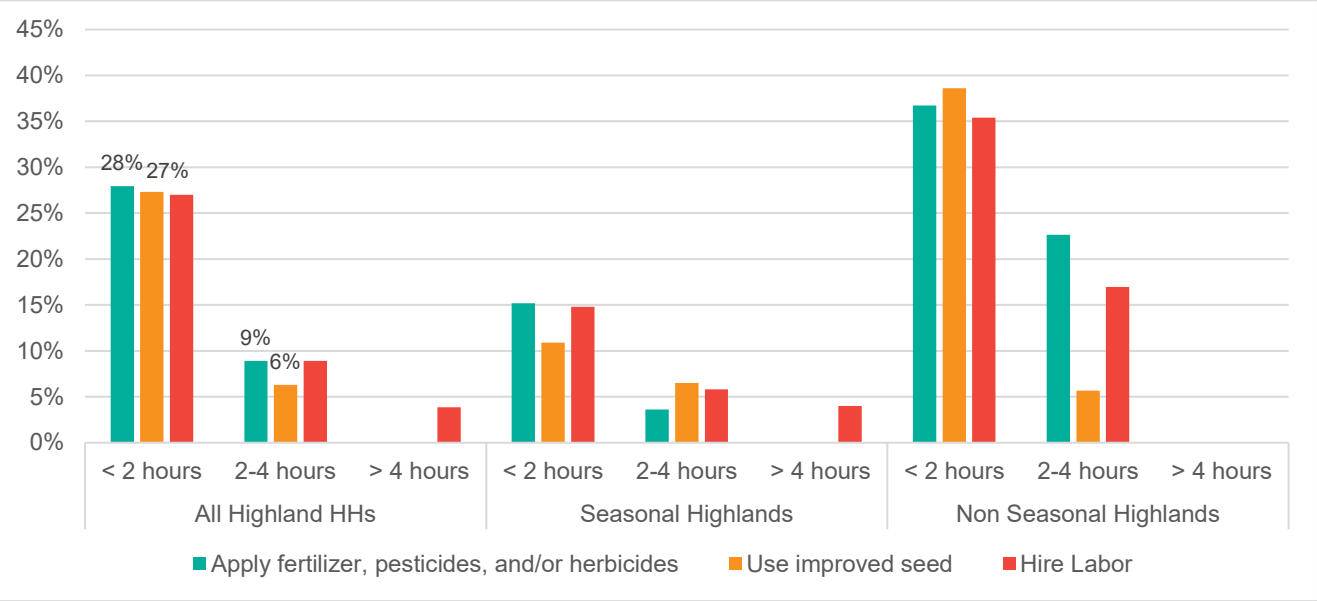
**Figure 6:** Share of households applying chemicals, improved seeds, and hiring outside labor




Note: WHP refers to Western Highland Province, EHP refers to Easter Highland Province; Source: Authors' calculations using 2023 PNG Rural Household Survey

It is important to underscore that the survey sample may not confidently capture high commercially oriented households that invest more resources in yield enhancing inputs. Future research is planned to conduct a targeted fresh produce value chain analysis which will identify, and purposefully sample producer households involved in fresh produce sales. In lieu of a targeted commercially oriented sample, we evaluate input use by distance to the nearest reported market. We find that sample households in the highlands that live under 2 hours from a market are significantly more likely to use inputs. Overall, the share of households within 2 hours of a market are at least 3 times more likely to use chemicals (fertilizers, pesticides, and/or herbicides), improved seeds, and hire in labor compared to those further from a market. None of the households in the survey sample, located beyond 4 hours report to use improved agricultural inputs (chemicals/seeds) (Figure 7). Proximity to market significantly affects input use among highland households, particularly those residing in non-seasonal highlands. Households located within 2 hours of a market are 1.6 times and 6.5 times more likely to use chemicals and improved seeds, respectively compared to those located two to four hours away from a market.

**Figure 7:** Share of highland households using agricultural input, by distance to market




Note: 630 sample households in highlands (seasonal and non-seasonal highlands) were within 2 hours of a market, while 217 were located more than 2 hours away from market and 26 were located above 4 hours away from market. Source: Authors' calculations using 2023 PNG Rural Household Survey

### 1.2.6 Agricultural extension services across Highland provinces

Extension services are crucial to improving knowledge and skills for farmers. However, these services are scarce in the surveyed highland communities (Table 6). Common extension services in the highlands include suggestions of new crops (23 percent), followed by fertilizer application (15 percent) and information of improved seeds (14 percent). A greater share of households in Jiwaka and Western Highlands province receive agricultural extension across all topics, specifically on fertilizer and improved seed usage, which is likely the reason that explains their higher usage of improved inputs as described in Figure 6. In contrast, very few survey households in the Eastern Highlands Province obtained extension services, with about 1 percent of the sample households receiving information on improved seeds, insect infestation and crop diseases.

**Table 6:** Type of extension services received by vegetable producing households, by highland provinces

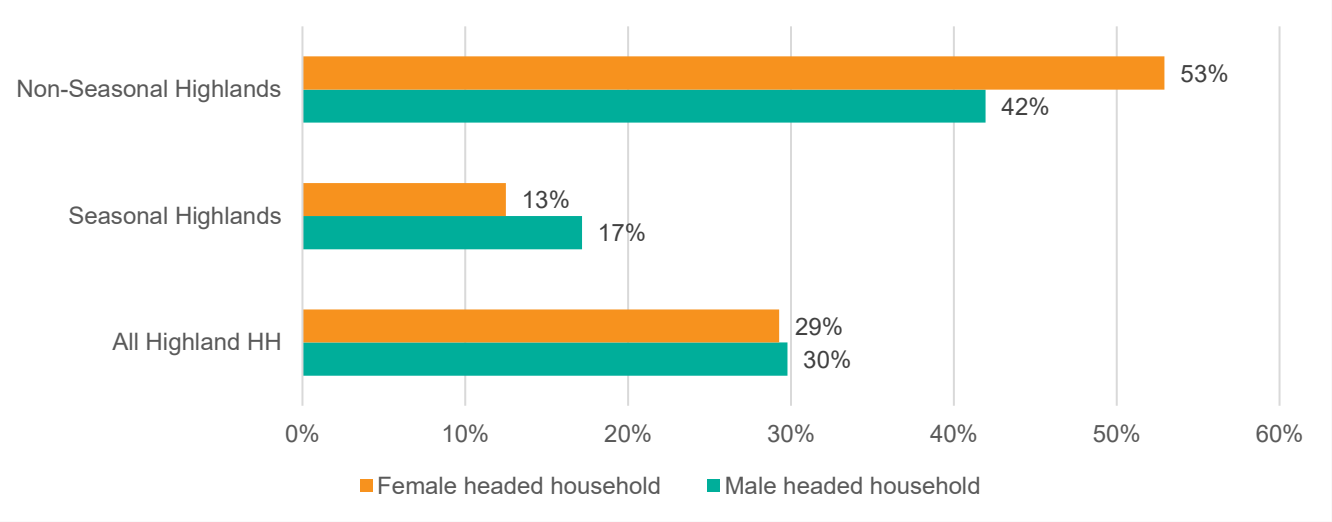
| | | Suggest new crops | Improved seeds | Fertilizers | Insect Infestation | Contain crop disease | Highland HHs that produce vegetables (N) |
|---|---|---|---|---|---|---|---|
| | All Highland HH | 23% | 14% | 15% | 11% | 11% | 847 |
| Seasonal Highlands | Simbu | 16% | 4% | 7% | 6% | 7% | 134 |
| | EHP | 6% | 1% | 2% | 1% | 1% | 141 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Morobe | 11% | 4% | 0% | 3% | 6% | 145 |
| **Non-Seasonal Highlands** | Jiwaka | 35% | 21% | 20% | 13% | 15% | 136 |
| | WHP | 35% | 26% | 30% | 22% | 18% | 291 |

Note: EHP refers to Eastern Highland Province; WHP refers to Western Highland Province; Source: Authors' calculations using 2023 PNG Rural Household Survey

On evaluating access to agricultural extension disaggregated by gender of the household head, we find that on average, an equal share of both male- and female- headed households report having access to extension services. However, difference vary across highland provinces. In seasonal highlands (Simbu, Eastern Highlands, and Morobe), a greater share of male headed households (18 percent) report availing agricultural extension, compared to female-headed households (13 percent) in the region. On the contrary, more than half of the sampled female-headed households in non-seasonal highlands (Jiwaka and Western Highlands) stated to receive agricultural extension training, which was more than the share of male-headed households having access to it. However, it is important to note that the sample size of female-headed households across highland provinces is small (17 households in non-seasonal highlands and 24 households in seasonal highlands), and therefore our results should be interpreted with caution, as it is not representative of the whole population.

**Figure 8:** Share of highland households having access to agricultural extension services, dissagregated by gender of the household head




## 1.3 Summary

The PNG fresh produce sector continues to expand, providing opportunities for farmers to increase yields and commercialize surplus. The remote sensing analysis reveals a net increase (33 percent) in

cropland area along the Highlands highway between 2018 and 2024, indicating a growing demand for fresh produce in PNG. Although the highlands are an important hub of vegetable production, data suggests that surveyed households sell, on average, only 25 percent of their harvest from each plot. On comparing the average share of vegetable plots by proportion of harvest sold across agroecological zones, we find that Highlands rank lower than the lowlands and island regions (see Appendix E). In particular, majority of sampled farmers in Bougainville and lowland provinces (Mandang, Western Province, Gulf Province, East Sepik, Central Province, and Milne Bay) report selling on average, approximately 50 percent of the harvest from each plot. Extension services and access to agriculture inputs are limited in highland provinces. Unsurprisingly, households that are further from a market are less likely to use agriculture inputs and less likely to produce agricultural surpluses.

Considering these challenges, targeted interventions are being designed to improve market access, input use, and extension services. The Market for Village Farmer (MVF) project, spearheaded by the Fresh Produce Development Agency, aims to improve and support the fresh produce value chain through a variety of interventions. The next section discusses MVF's current programming and provides statistics on the production and sales patterns of the project's beneficiary farmers.

# SECTION 2: SUPPORTING FRESH PRODUCE THROUGH THE MARKET FOR VILLAGE FARMERS PROJECT

The Market for Village Farmers (MVF) project, supported by the International Fund for Agricultural Development (IFAD) and The Government of Papua New Guinea (GoPNG), aims to improve the livelihoods of village farming households through interventions that facilitate a transition from semi-subsistence agriculture to market-oriented production. The project focuses on activities related to fresh produce and galip nut value chains across diverse provinces: Western Highlands, Jiwaka, Simbu, Eastern Highlands and Morobe for fresh produce and East New Britain and Madang for galip nut production.

The MVF program comprises three components: 1) Inclusive Business Partnership, 2) Supportive Value Chain Investments, and 3) Collective Governance and Project Management. Through these interventions, it is envisioned that fresh produce farmers will benefit by improving their access to market and support services, and facilitating buyers to source produce from local producers for urban and other markets. A detailed description of Component 1 is provided in Appendix F, along with definitions of key actors including contact farmers, lead farmers, lead partners, etc.

## 2.1 Data and Sample

As part of MVF's Monitoring and Evaluation (M&E) strategy for Component 1, each Contact Farmer (CF) and Lead Farmer (LF) are responsible for collecting monthly data on production and sales

volume of their harvested produce. We use the monthly lead farmer report data from March 2024 – August 2025 collected by MVF to conduct descriptive analysis of production and sales volumes of contact farmers with an aim to learn from MVF interventions and generate insights to guide future operations. [6]

Currently, MVF has 344 LFs, however this data contains information of 460 CFs supervised by 74 unique LFs, who successfully submitted their report at least once during the previous year. Table 7 provides information on the share of contact and lead farmers by region and shows the average and median number of contact farmers per lead farmer. Most of the farmers that submitted their MVF report are located in Jiwaka (38.7 percent), followed by the Western Highlands (29.35 percent). Jiwaka also reports the highest number of contact farmers per lead farmer, while Simbu has the least number of contact farmers per lead farmer.

### Table 7: Share of farmers, by province (%)

| | | | Contact farmer per lead farmer | |
|---|---|---|---|---|
| | Contact farmers | Lead farmers | Average | Median |
| **Eastern Highlands** | 23 | 22 | 9.25 | 9 |
| **Jiwaka** | 38 | 30 | 11.29 | 11.5 |
| **Simbu** | 10 | 16 | 4.7 | 5 |
| **Western Highlands** | 29 | 32 | 6.36 | 6 |
| **All Sample Observations** | 460 | 74 | 8.75 | 8 |

Source: Authors' calculation using MVF Lead Farmer Monthly Report data

The MVF template also asks respondents to report their gender, age, whether they identify as marginalized and whether they are a part of the MVF program. Table 8 describes the demographic characteristics of the contact farmers who submitted the report. Most of the sampled farmers are a part of the MVF project (91 percent), the remainder are farmers who supply their produce to lead farmers when needed, however they are not associated with the project. Overall, the sample consists of 30 percent female farmers, with a higher share of female farmers from Jiwaka (39 percent) and Western Highlands (33 percent) province. Eastern Highlands province has the highest share of young farmers aged 16-35 years, compared to other provinces in MVF target areas. Additionally, 6 percent of farmers in Jiwaka consider themselves marginalized (defined as with disabilities, and / or divorced or widowed.

[6] Although the data consists of farmer entries for the period 2024-2025, 93 percent of the total submitted reports are from 2025.

### Table 8: Demographic characteristics of contact farmers

| | Female | Marginalized | Youth | Part of MVF | Number of contact farmers |
|---|---|---|---|---|---|
| **Eastern Highlands** | 15% | 1% | 18% | 74% | 102 |
| **Jiwaka** | 39% | 6% | 7% | 96% | 178 |
| **Simbu** | 24% | 0% | 7% | 88% | 45 |
| **Western Highlands** | 33% | 0% | 2% | 100% | 135 |
| **Total** | **30%** | **2%** | **8%** | **91%** | **460** |

Note: Marginalized farmers include persons with disabilities (PWDs), widows, divorced individuals, and others who may be vulnerable ;
Source: Authors' calculation using MVF Lead Farmer Monthly Report data

## 2.2 Horticultural Production across MVF Provinces

The reporting template asks lead farmers to list the crops produced by their contact farmers and sold to LPs and open markets during the month of the report submission. The most commonly grown fresh produce crops across all MVF farmers are potato (34 percent), followed by citrus (14 percent), cabbage (13 percent), and broccoli (13 percent). [7] Variations in crop production are noted across target provinces (Table 9). For example, farmers in Simbu specialize in bulb onion production with 56 percent reporting to cultivate onion. Perishable and higher altitude horticulture products like broccoli and potato are predominantly grown by Western Highlands and Eastern Highlands contact farmers.

Given that MVF project focuses on fresh produce crop, most reported crops are vegetables and fruits. However 16 percent of MVF participants in Jiwaka produce sweet potatoes (i.e. staple crop), while approximately 6 percent and 1 percent grow taro in Western Highlands and Jiwaka, respectively. [8]

### Table 9: Share of fresh produce crops and sweet potato grown across MVF provinces

| | Broccoli | Cabbage | Potato | Citrus | Sweet Potato | Bulb Onion | Tomato | Others | Number of contact farmers |
|---|---|---|---|---|---|---|---|---|---|
| **Eastern Highlands** | 22% | 25% | 55% | 0% | 2% | 6% | 0% | 8% | 102 |
| **Jiwaka** | 0% | 6% | 1% | 37% | 16% | 15% | 10% | 25% | 178 |
| **Simbu** | 2% | 9% | 20% | 0% | 0% | 56% | 0% | 16% | 45 |
| **Western Highlands** | 27% | 16% | 65% | 0% | 1% | 0% | 3% | 36% | 135 |

[7] During the scoping trip, farmers reported cultivating potatoes primarily because they had received training and extension services for this crop and could access the seeds through the MVF's matching grant program (as explained in Appendix F).

[8] MVF data includes information for only two staple crops – sweet potato and taro – that are grown by MVF participant across region. While share of farmers producing sweet potato are reported in Table 9, results suggest that taro production was reported by MVF farmers from Western Highlands (6%) and Jiwaka (1%).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total** | 13% | 13% | 34% | 14% | 5% | 7% | 5% | 23% | 460 |

Note: A single farmer can report growing multiple crops. 'Others' includes Eastern Highlands: carrot, lettuce, spring onion; Jiwaka: capsicum, carrot, cucumber, eggplant, lettuce, parsley, peanut, pineapple, spring onion, taro, watermelon, zucchini; Simbu: carrot, cauliflower; Western Highlands: banana, capsicum, carrot, cauliflower, French beans, lettuce, parsley, pumpkin, taro, zucchini.; Source: Authors' calculation using MVF Lead Farmer Monthly Report data

Of the 460 contact farmers, 207 submitted their reports indicating zero production. These represent the set of farmers whose crops were still at planting stage (with no harvest) at the time of data collection and thus prevented farmers from recording sales data in the reporting template. Because these farmers lack the data on sales, for the remainder of the analysis, we drop these respective data submissions from the analysis. As a result, the sample size reduces to 253 contact farmers. It is important to note that not all 253 farmers submit their reports monthly. Submissions are only accounted when farmers plant a particular fresh produce crop or have harvested crops at the end of their planting cycle. Between March'24 – August'25, 176 farmers submitted their report once, 48 submitted their report twice, 12 submitted their report for three months, and 14 and 3 farmers submitted report for 4 and 6 months, respectively.[9] Given that multiple monthly reports were submitted by some contact farmers, the total farmer – month observations are 382.[10]

## 2.3 Production and Sales Volume of MVF Contact Farmers

For each data submission, lead farmers visit each contact farmer that they work with to note their volume of production, sales, consumption and estimated wastage. Additionally, contact farmers are asked to report their sales volume disaggregated by sales channel. This includes sales to lead partners through the MVF mechanism or directly to customers at the wet market or selling wholesale to market vendors. Using the MVF data, we evaluate the volume of production and sales for each report month's submission (Table 10).[11] While our analysis is indicative, it should not be generalized as the data has not been adjusted for outliers but rather is an aggregation of MVF's raw data, whereby for some months, there are less than 5 report submissions. For example, only 2-3 reports were submitted in total from June 2024 – November 2024. With expansion of sample size, increased consistency in report submission, and additional rounds of data collection, future work can allow for a more robust analysis.

[9] There is room for improvement in the submission of reports to allow for more robust analysis of MVF programming.

[10] (176 CF * 1month data) + (48 LF*2 month) + (3 CF*3 month) + (12CF*3 month) + (14 CF * 4 months) + (3CF * 6 months) = 382 farmer month observations

[11] We report the average production and sales per reporting MVF farmer in Table 10 because the number of farmers submitting monthly reports varies substantially across reporting period (i.e. between 2 – 10 farmers in FY2024 and between 31- 101 farmers in FY2025). Using total figures would therefore reflect changes in reporting participating rather than actual changes in production or sales behavior. For example, the total volume of production across all months is 351,836 kgs whereas the average production is 921 kgs. The average values allow for a more consistent comparison across months by controlling for variation in the number of reporters. To improve clarity, we have explicitly reported the number of farmers submitting data for each month in Table 10.

Across all report submissions, MVF farmers grew an average of 921 kgs of fresh produce. Data suggests that most produce is sold through other sales channels (596 kgs) compared to lead partners (157 kgs) in the MVF program. This could be because of several reasons. First, contact farmers reported they have less interest in selling produce to lead partners who purchase products at long-term fixed prices, not accounting for current prices in the nearby wet market. Second, during the scoping exercise we learned that delayed payments or poor trust or relationships may further deter sales to lead partners. Lastly, lead partner's ability to accept products from contact farmers depends on the volume of the order requested by their clients.These orders are not communicated to contact farmers before they plant, and most of the contact farmers reported they do not have a written agreement with the lead partner to buy a fixed volume of harvest.[12] This informal arrangement can leave contact farmers with surplus produce, that they then seek to sell in wet markets.

### Table 10: Average production, sales, consumption and wastage volume (in Kgs), by report month

| | Production (kg) | Sales to LP (kg) | Sales to Others (kg) | Consumption (kg) | Volume Wasted (kg) | Number of contact farmer data submissions |
|---|---|---|---|---|---|---|
| **Mar-24** | 1143 | 280 | 776 | 41 | 46 | 7 |
| **Jun-24** | 345 | 120 | 225 | 0 | 0 | 2 |
| **Jul-24** | 1150 | 0 | 0 | 17 | 67 | 3 |
| **Sep-24** | 1427 | 40 | 1200 | 67 | 120 | 3 |
| **Nov-24** | 500 | 390 | 45 | 40 | 25 | 2 |
| **Dec-24** | 1081 | 43 | 1033 | 3 | 3 | 10 |
| **Jan-25** | 2706 | 843 | 90 | 12 | 22 | 7 |
| **Feb-25** | 819 | 12 | 719 | 50 | 38 | 16 |
| **Mar-25** | 937 | 352 | 419 | 21 | 29 | 101 |
| **Apr-25** | 1021 | 39 | 939 | 16 | 18 | 44 |
| **May-25** | 815 | 37 | 733 | 23 | 22 | 54 |
| **Jun-25** | 682 | 108 | 524 | 26 | 24 | 66 |
| **Jul-25** | 476 | 93 | 342 | 9 | 9 | 31 |
| **Aug-25** | 1339 | 28 | 756 | 12 | 13 | 36 |

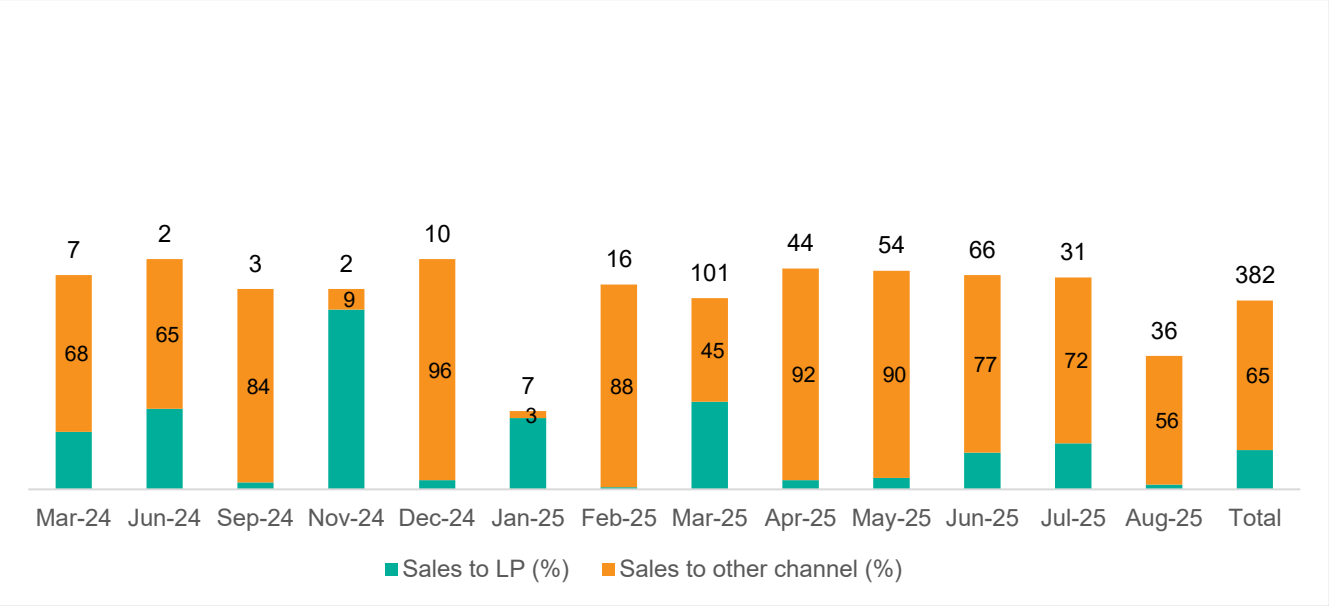
[12] Contact farmers and lead farmers are only contacted by the lead partner when they receive an order from their client.

| | | | | | | |
|---|---|---|---|---|---|---|
| **Total** | 921 | 157 | 596 | 21 | 23 | 382 |

Source: Authors' calculation using MVF Contact Farmer Monthly Report data

During the month of March 2025, MVF received the maximum report submissions. By evaluating the share of produce sold across channels, data suggest that 45 percent of the produce grown during March 2025 was sold via other channels, while about 38 percent of total production was sold to lead partners (Figure 9). Approximately 2 percent of the produce was consumed by the farmers themselves, and 3 percent was wasted.[13]

### Figure 9: 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

Given that farmers record the revenue received from lead partners and other channels, we can calculate earnings per kg for various fresh produce crops across all reporting months. Overall, farmers earn a similar amount per kg from both lead partners (2.44 PGK/Kg) and other channels (2.32 PGK/Kg) (Table 11). However, the rate that farmers receive from the two sales channels differ by crop type. For most crops, lead partners pay a higher amount per kg, compared to other sales channels. However, for vegetable crops like cabbage, broccoli, potato and spring onions, the price received from the open market remains higher on average. These results should be read with caution as for some crops we have limited

[13] The total shares of sales to lead partners, sales to other channels, consumption, and wastage in the month of March 2025 do not add up to 100 percent. This is because there are 10 contact farmers who submitted reports in March 2025 for whom the reported production volumes (in kg) do not match the aggregated totals of consumption, wastage, and sales. On average, there is a discrepancy of 1,171 kg, with a median difference of 441 kg. This suggests that farmers may be overreporting production volumes or underreporting wastage, sales or consumption volumes.

report submissions (i.e. less than 10 submissions).[14] Despite higher prices received from lead partners, contact farmers sell a greater share of their produce at the open market as depicted in Figure 9.

## Table 11: Sales price per Kg, by sales channel and fresh produce crop

| | Avg sales price per kg to LPs (PGK) | # of contact farmer data submissions reporting to sell LPs | Avg sales price per Kg to others (PGK) | # of contact farmer data submissions reporting to sell others |
|---|---|---|---|---|
| **Banana** | 1.5 | 1 | 6 | 1 |
| **Broccoli** | . | 0 | 2.73 | 24 |
| **Bulb Onion** | 2.95 | 6 | 2.36 | 8 |
| **Cabbage** | 1.91 | 7 | 2.23 | 15 |
| **Capsicum** | 2.8 | 9 | 2.06 | 10 |
| **Carrot** | 2.56 | 8 | 2.37 | 14 |
| **Cauliflower** | 2 | 2 | 2 | 1 |
| **Chinese Cabbage** | 2.25 | 4 | 1.83 | 3 |
| **Citrus** | 2.87 | 13 | 2.34 | 92 |
| **Cucumber** | . | 0 | 1.83 | 2 |
| **French Beans** | 2 | 2 | 5 | 2 |
| **Lettuce** | 3.5 | 9 | 1.6 | 18 |
| **Parsley** | 1.75 | 2 | 1.5 | 1 |
| **Peanut** | . | 0 | 10 | 1 |
| **Potato** | 2.13 | 23 | 2.44 | 106 |
| **Pumpkin** | 3.25 | 2 | . | 0 |
| **Spring Onion** | 2.25 | 2 | 2.76 | 3 |
| **Sweet Potato** | 2 | 2 | 1.6 | 17 |
| **Taro** | 2.5 | 4 | 2.5 | 4 |
| **Tomato** | 2.47 | 11 | 2.136 | 11 |
| **Zucchini** | 1 | 5 | 1.35 | 11 |
| **All crops average** | 2.44 | 112 | 2.32 | 344 |

Source: Authors' calculation using MVF Contact Farmer Monthly Report data

[14] For example, for spring onion, only 2 reports were submitted during Mar'24 – Aug' 25 capturing the sales to lead partners, while 3 reports mentioned the sales to other channels.

In summary, the MVF's monthly reporting data suggests patterns of crop specialization across provinces. For example, data suggest the prevalence of citrus and potato production in Jiwaka and Western Highlands, respectively. While MVF aims to establish a sales mechanism through the LP contracts, most contact farmers still rely on other sales channels (such as street vending, open wet market, and sales to other intermediate traders or aggregators operating outside of project partnership). Further research should evaluate whether farmer preference (e.g., previously established sales networks), information asymmetries across value chain actors, or other conditioning factors drive production decisions and sales location choice among contact farmers.

# SECTION 3: INSIGHTS FROM A FRESH PRODUCE VALUE CHAIN SCOPING STUDY

The research team conducted two scoping studies for this report. The first (conducted in June 2025) maintained a broad scope to understand all actors in the fresh produce value chain, interviewing producers (contact farmers), lead farmers, lead partners / wholesalers, aggregators, shipping and transporting actors and input suppliers. The second scoping study (conducted in November 2025) was more focused, with targeted questions for contact farmers and lead partners associated with the MVF project. These interviews included specific modules on cold chain infrastructure and challenges associated with post-harvest losses.[15]

Formal supermarkets in Port Moresby, Lae and Mt. Hagen were visited, during the first scoping activity, to investigate produce availability and price differences, however the scoping team was unable to meet with supermarket managers for specific interviews on challenges and opportunities within their operations, though their inputs were provided and captured at the MVF's Value Chain workshop in Lae. Several wet or open market vendors were interviewed and are included in the discussion. These include vendors from Lae, Mt. Hagen, Gordons, and Boroko open markets selling produce without refrigeration. Thus, for this report, we define contact farmers as the 'upstream' actors in the fresh produce value chain; lead farmers are defined as 'midstream' actors, however they also produce an important share of fresh produce delivered to wholesalers (i.e. lead partners) and are also considered in the 'upstream' discussion. Finally, the 'downstream' discussion of this scoping study draws insights from interviews with wholesalers, with the Market Authority in POM, and a small selection of market vendors, as well as an interview with one of the shipping companies in Lae. Future work is planned to evaluate final consumer and retailer preferences and perceived challenges and opportunities of retail operations.

[15] Interviews during the second scoping were conducted by a joint IFPRI and FPDA team, who travelled along the Highlands Highway (Goroka, Simbu, Jiwaka and Mt. Hagen) and interviewed 35 contact farmers across 8 lead partnerships.

## 3.1 Upstream: Increasing agricultural output, reliability, and quality

### 3.1.1 Pricing for success

A wide breadth of research has demonstrated that rural farmers are economically efficient in choosing the appropriate production techniques to maximize benefits (Tittonell et al. 2007; Benny et al. 2022; Culas & Pombre 2023). Farmers allocate their available labor, land, and other factors of production up to a level at which the benefits outweigh the costs (labor, land, capital investment etc.). An example of this careful balance from the Highlands of PNG is the shifting labor allocation that occurs following fluctuations in coffee prices. During our scoping exercise, many wholesalers lamented that they were unable to meet customer orders because contact farmers shifted to tending and harvesting their coffee trees to reap greater income from coffee production due to rising world prices for coffee.

Growing market demand and related price increases for fresh produce will continue to be an important driver for expanding production and improving quality at the upstream production node of the value chain. Demand for domestically grown fresh produce in PNG is increasing in urban areas, mining camps and other more densely populated areas. However, for some food products (e.g., onions and carrots), less expensive imports compete with (relatively costly) domestic production given high transaction costs incurred between PNG farmgate and domestic retail markets. These imported produce are not only cheaper but also of good quality and have a longer shelf life compared to local products. This underscores the need for enhanced post-harvest techniques and greater producer knowledge to improve quality across the various nodes of the fresh-produce value chain.

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). If producers don't foresee a consistent and sufficient return (income stream) for their fresh produce, it will be difficult to convince them to take on more costly production practices to expand yields. Improved production reliability and quality at a competitive retail price is necessary to attract greater demand for domestic goods, however stable price incentives at producer level are critical to ensure consistent production supply.

The domestic-oriented, fresh produce value chain in PNG is relatively short, characteristic of sales occurring predominantly in local wet markets and with small, localized retail sellers (street vendors, producer sales to vendors at wet market gate, etc.). Fresh produce destined for urban markets (such as Lae and Port Moresby), given challenges further downstream in the value chain (explained in more detail below), can be somewhat ad hoc, leaving contact farmers with less clarity on demand for marketable produce. Lead partners reported that when they receive an order from buyers (such as urban retailers, mining companies, etc.), they immediately call their lead farmers who then reach out to contact farmers

to place orders with them to prepare the estimated bags required by the buyer. Lead partners provide a day or two for the contact farmers to supply their produce which they collect from their farm on a scheduled day and time.

As per our interviews, there seems to be no consistent mechanism across lead farmers (or lead partners) to secure a pre-agreed volume of specific fresh produce that will be purchased from contact farmers. Often these orders are made verbally, based on trust and good Wantok connectionsbetween the two parties. This lack of future volume demand makes it difficult for contact farmers to efficiently scale up production or invest in greater quality and yield output. In times when growers have surplus produce and receive a limited order from the lead farmer/lead partner, they are required to spend extra resources to travel to sell their produce in informal markets, wholesale to market vendors, or set up stalls in the open wet market. The MVF data (Figure 8) reflects the diverse sales strategies of contact famers, where a greater share of produce was sold via 'other sales' channels (73 percent) compared to those marketed to lead partners (15 percent).

### 3.1.2 High cost of inputs

"If you can get broccoli right, you can do anything." During interviews with contact and lead farmers, the high cost of inputs was repeatedly reported 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. Diverse input retailers explained that even if they offer broccoli seeds for free to a producer, they will refuse them because they know the required high input costs (fertilizer, pesticide, and labor) to successfully produce the crop. 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 purchase also varies based on the crops grown by the farmer.[16]

Wholesalers also mentioned the increasing cost of rental land to expand production operations within accessible areas along the Tambul Nebilyer – Goroka corridor of the Highlands Highway. This may be due to limited land availability, as well as an indication of the growing profitability of fresh produce production in the area. Likewise, a variety of contact farmers and lead farmers explained the high cost of labor to prepare a garden plot, detailing the costs needed to accomplish soil preparation and drainage construction, planting, weeding, spraying pesticide (multiple times depending on crop), applying fertilizer (multiple times depending on crop), and harvesting. Based on interviews with MVF contact farmers, on average, producers hire 6-10 workers. Daily wage differs by task whereby garden preparation, weeding,

[16] 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.

planting and harvesting pays K10-20 per day; and loading and unloading pays K5-10 per day. Male workers are more involved in tasks related to preparing drainage, packing, loading and unloading while females are usually involved in planting, weeding, harvesting, and sorting. On average, workers are engaged around 3-5 hours per day and are expected to work on average 3-5 days per week in one production cycle (on plots measuring 0.5-1 hectare). The number of weeks workers are engaged depends on the workload, ranging from 2 to 10 weeks per production cycle.

### 3.1.3 Access to foreign exchange, credit, and input

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[17]. Access to foreign exchange has become a particularly serious challenge in recent years. This creates significant delays in procuring improved seed and other inputs that should normally be available for sale in agricultural outlets throughout the year. 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 because she was still waiting for the seeds. A variety of farmers echoed her frustration on continuous seed shortages for fresh produce. Fang et al. (2025) documented the major gap in seed provision and other agricultural inputs throughout the fresh vegetable value chain in Papua New Guinea, suggesting opportunities to improve input supply for rural farmers.

The Government of PNG is aware of the domestic credit bottleneck for the agriculture sector and has funded programs through commercial banks to expand agricultural loans, however several stakeholders suggested that the funds allocated for this support have been inaccessible due to collateral requirements and other commercial bank pre-requisites.[18] Domestic credit is generally provided on a short-term basis with comparatively high interest rates that are commercially non-viable for agricultural companies in PNG. Lack of access to credit affects everyone in the value chain. Farmers demand cash payment on delivery, while traders require a large sum of money to assemble a consignment. Similarly, wholesaling businesses between the Highlands and Lae have also cited difficulties in expanding their business due to inability to access credit to invest in cold storage, transportation vehicles, and other inputs. To address

[17] During the scoping, 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.

[18] While MVF is aware of women's challenges in accessing credit and has taken steps to address them, significant gaps remain and require further effort. Women-led groups such as the PNG Women in Agriculture have expressed womens' struggles in opening or maintaining bank accounts due to lack of formal identification, limited ownership of assets used as collateral, and difficulty in meeting minimum balance and fee requirements. Long distances to banking facilities, safety concerns and time constraints linked to household responsibilities further limit women's access to banking services. As a result, women farmers have fewer opportunities to access loans, receive digital payments or participate in grant and loan programs that require a bank account, reducing their ability to invest in farming inputs and expand production.

some of these production costs, the MVF program has offered a portfolio of small grant opportunities to contact and lead farmers (see Table F.1 in Appendix F). 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.

### 3.1.4 Addressing increasing market volatility

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.

Price fluctuations vary by product, location and packaging methods. For example, an aggregator in Mt. Hagen reported that sweet potato prices ranged from 35 PGK per 40kg bag during periods of high supply to 80 PGK per 40kg bag when supply was low, more than double. At the time of our visit in June 2025, prices were around 50 PGK per 40 kg bag. Similarly, bulb onion prices were reported to fluctuate in 2025 between 90 PGK and 200 PGK per 20 kg bag, again more than twice the low price. Seasonal, social and cultural trends were also noted: prices are generally lower at the end and beginning of the calendar year, and higher from May to October. The most dramatic variation was observed for cabbage, which sold for 20 PGK per bag in November 2024 but rose to 130 PGK per bag by June 2025.

Part of this increasing price volatility is attributed to increasing weather variability. In the Mt. Hagen area, stakeholders noted that weather has become much more unpredictable in the past two years. Previously, companies such as Hilans Fres could fix prices for extended periods without adjustments. However, this practice has become untenable due to dramatic price swings. Unpredictable rainfall has caused issues such as delayed transplanting and crop losses from flooding, while droughts are increasingly disruptive. Additionally, incidences of crop diseases—particularly affecting potatoes and cabbage—are becoming more frequent and severe.

Seasonal fluctuation in prices are also driven by farmers’ ad-hoc participation in farming. Respondents from Mt. Hagen reported that farmers commonly cultivate crops based on their immediate needs. For example, many farmers grow crops to pay school fees, as a result a larger share of households sell and harvest crops at the same time (i.e. during end and beginning of the year), surging supply and lowering prices of vegetables. Similarly, in the Highlands, rural households focus on coffee cultivation from May-October, resulting in lower supply and higher fresh produce prices.

## 3.2 Midstream: Meeting the needs of wholesalers and producers

### 3.2.1 Price pressure on lead partners

Lead partners / wholesalers face significant pressure to meet fresh produce volume demands while contending with high transaction costs along the value chain. 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, contact farmers have their own price that fluctuates based on wet market prices. If I don’t have a good price for them, they will sell at the wet market or outside the wet market gates to the vendors there.” This results in lead partners losing money on specific crops, paying farmers more for their produce than is budgeted, to meet volume demand (and maintain aggregator contracts).

A selection of wholesalers we spoke with explained that while lead partners may lose money on some crops due to long term fixed prices, they would earn profits on other crops if local market prices were low and earlier fixed prices for specific produce result in above market positive gains. It is unclear whether lead partners follow this same philosophy in their operations, particularly given the difficulty that wholesalers have in meeting retail volume orders.

Across our scoping interviews, the issue of fixed prices in the fresh produce value chain was identified as a major challenge. Each producer and aggregator node in the value chain (after the retailer sets their price), is squeezed to meet production demand that may not correspond with appropriate market price incentives. During the scoping activity, we watched as wholesalers scrambled to meet quantity demands due to fixed price pressures from downstream (supermarkets). In doing so, they were repositioning staff to procure fresh produce at farmgate to meet their volume demand (rather than focusing on the job they were trained to do of receiving farmer produce, checking quality, and handling and packaging of fresh produce at their depot for shipment).

At times, wholesalers were also going to the wet market to purchase produce to meet their wholesale needs. While wholesalers mentioned their food safety certification status as an important indicator of produce quality, last minute aggregation activities call into question the amount of oversight that occurs to uphold food safety standards, particularly during production and harvest activities on farm, where wholesalers are seeking any farmer willing to sell their produce rather than working through contracted and certified farmer partners.

From discussions with all actors, there seems to be a clear disconnect with quantity demanded and quantity supplied, with lead partners unable to meet volume demands from wholesalers, and wholesalers unable to meet full orders of retailers (supermarkets, hotels, etc.). One medium-size wholesaler

related “I don’t want to have contracts with supermarkets or hotels because then I would be required to fill them!”. Several lead partners mentioned that supermarkets have high quality requirements which raises the likelihood of high wastage when supplied produce do not meet these standards. Compared to supermarkets, hotels and catering companies have lower quality requirements. However, lead partners are less interested in working with catering companies citing fixed pricse with limited scope for price adjustment.

### 3.2.2 Transaction costs

Given the difficulty in meeting quantity demanded among lead farmers/aggregators, wholesalers and retailers, we asked lead partners to enumerate the number of transactions that they face to bring their product to larger aggregators or wholesalers. These include:

1. Collection of contact farmers’ produce at farmgate: lead partners employ a driver and truck to travel to the farm plot.
2. Contracting packers and carriers to walk to the farm plot to to sort, grade and check quality of the supplied produce.
3. Procuring packaging materials such as net bags, boxes, sticky tape and rope.
4. Transporting farmers’ produce from farmgate (often by foot via carriers) to the access road
5. Loading produce into truck at access road point
6. Transporting produce from access road point to rural depot or wholesaler
7. Unloading produce from truck into wholesaler container or collection point depot

For medium-larger lead partners, that also have a depot area where they can aggregate larger volumes of produce and wholesale in urban areas, they can forego some of the above produce collection activity by organizing contact farmers to bring their produce to a designated depot (owned by the lead farmer). However, as mentioned above, given difficulty in meeting volume demanded from retailers, both small and large wholesalers are obligated to travel to farmgate to find produce from farmers and wet markets to fill their retail orders.

If the lead farmer transports produce from the Highlands to a depot in Lae, they face several other logistics and costs including:

8. Rental of container truck for transport from Highlands to Lae
    a. Chiller container (also known as reefers)
    b. Dry container
9. Truck rental (if not owned by lead partner) from Highlands to Lae
10. Fuel and driver payments from Highlands to Lae
11. Unloading truck at depot or wharf

Occasionally, lead partners also contract wholesalers in Port Moresby, at which point, they also face costs of:

12. Unloading the container truck from Highlands and re-loading produce into a sea container
13. Payment for ocean containers on barge to Port Moresby (the cost of which is occasionally shared between lead partner and Port Moresby supermarket)
14. Unloading the sea containers at the POM Wharf or depot

## 3.3 Downstream: Investing in reliable quantity and quality

Three major challenges of wholesalers that were repeated throughout the scoping activity were: 1) lack of consistency and quantity of supply; 2) inadequate produce quality; and 3) high transaction costs including storage, handling and packaging, and transportation. Below, we describe how wholesalers operating in the highlands function within the overall fresh produce value chain to Port Moresby, as also documented in other literature (Spriggs et al. 2004; Martin & Jagdish 2006; Haguluha et al. 2007; Worinu 2007; Spriggs et al. 2013; Okrupa et al. 2017; Gena 2021; Kosec et al. 2022; Fang et al. 2025), followed by a discussion focusing on how wholesalers are maneuvering to address their business constraints.

### 3.3.1 Understanding the growing domestic fresh produce terminal markets

The largest terminal markets for fresh produce from the Highlands are mining sites, and the cities of Lae and Port Moresby (POM). While reliable data on the relative importance of these end markets is lacking, one key informant in Mt. Hagen estimated that about 70 percent of produce marketed in Mt. Hagen ends up in POM, while others suggested closer to 40 percent, with the remainder going to Lae or mining areas such as Porgera. One supplier to mining towns in Mt. Hagen described the stable demand for high-quality produce in Porgera, noting that they source from regular contact farmers and send weekly shipments from Mt. Hagen by road.

POM is the country's largest purchaser of fresh produce in the country. It is estimated that about 15 open markets operate in the city, selling produce primarily from the Highlands and Central Province. Different regions supply different products to POM.[19] The Market Authority estimates that in a typical week, about 50 containers arrive from the Highlands by ship, while 60 to 80 trucks—each carrying roughly a quarter of a container—arrive daily from Central province and surrounding areas, suggesting that about one-third of POM's fresh produce supply originates from the Highlands. Shipping companies (Bismark

[19] 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. In contrast, the Highlands primarily supply sweet potatoes, Irish potatoes, cabbage, bulb onion, carrots, broccoli, and similar crops.

and Consort) report slightly higher figures for their shipments, at 55 and 15 containers respectively. Container volumes fluctuate seasonally, with larger shipments during festive periods such as Christmas and at the start of the New Year due to social obligations such as payment of school fees

In Port Moresby, the Gerehu Wholesale Market plays an important linking role in the fresh produce system, connecting large shipments from the Highlands through Lae port to the city's open markets. Produce arriving by ship mainly from the Highlands is brought to Gerehu, where it is grouped, broken down and sold in bulk to traders of wet markets in POM. These traders then supply open wet markets such as Gordons, Boroko, Tokara, Waigani and wet markets across the city. Trading at Gerehu usually happens early in the morning, allowing traders to restock retail or wet markets on the same day and week. Through this process, Gerehu connects long distance supply chains with urban consumers and plays a key role in shaping daily supply levels and prices and market availability in POM.

Open wet markets in POM—such as Gordons Market, Boroko Market, and Waigani Market—remain the primary source of fresh produce for most urban consumers in POM.[20] Trucks typically arrive overnight, with wholesale transactions occurring early in the morning and retail sales continuing throughout the day. Modern retail outlets, such as RH Hypermarket, Stop 'N' Shop, Eliseo, and Boroko Foodworld, along with top-end buyers like international hotels, have grown quickly in POM and now account for an estimated 20% of the high-end fresh produce market. These buyers impose stricter quality standards and pay significantly higher prices for fresh produce than open markets. To meet these requirements, they often contract directly with modern suppliers such as Hilans Fres and NKW Fresh. This high-end segment also relies more on air freight and refrigerated containers than traditional markets, which rely more on dry containers. Stakeholders believe this niche market, catering to wealthier consumers, is now saturated and unlikely to grow significantly.

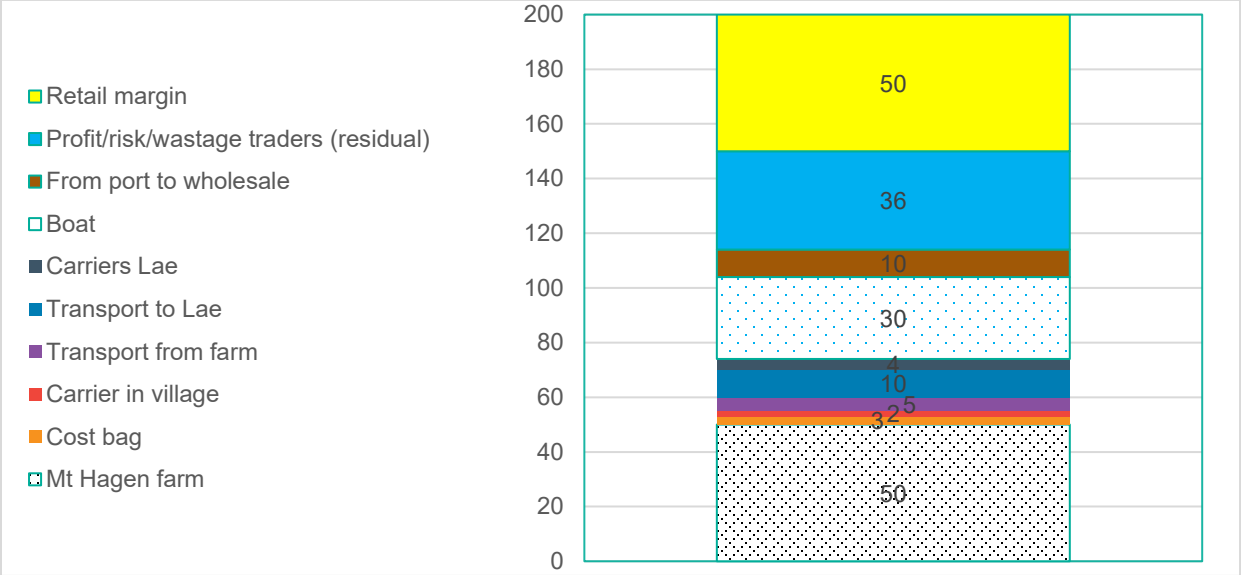
A cost composition exercise was conducted using price and cost data reported by traders in Mt. Hagen, aggregators in Lae, and wholesalers and retailers in POM during our visit in June 2025. Note that these figures are based on only a few interviews and are therefore non-representative, but they remain illustrative of overall cost trends. We focus on a 40 kg bag of the Wahgi Besta sweet potato variety from Mt. Hagen (Figure 10). At that time, such a bag— sold in small quantities (in heaps)—retailed for about 200 PGK at the Boroko Market (a large wet market). Producers received about 25% of the final price, while 75% was absorbed by costs and profits along the value chain. Transport by boat between Lae and POM contributed roughly 15% to the retail price.[21] Some of the largest cost components were, however, retail margins (25%) and trader profits (18%), which compensate for risks, trading services delivered, and

[20] Roadside markets are increasingly banned in the city.

[21] Consort charged, at the time of the survey, a cost of 5,000 PGK per container. Assuming 170 bags in a container, this amounts to approximately 30 PGK per bag.

significant wastage in fresh produce value chains. One trader in sweet potato reported losing approximately 2–3 containers per 100 shipped due to damage while two other large traders reported losses as high as 30% and up to one-third in fresh value chains overall. Note that this cost composition reflects the case of sweet potato, a relatively low-priced commodity in POM's retail markets. Other fresh produce commodities are likely to exhibit different price structures.

**Figure 10:** Price composition of Wahgi Besta sweet potato bag in POM (PGK/bag), as reported by stakeholders




Source: Authors' scoping interviews

### 3.3.2 Incentives to promote increased output

A variety of strategies are employed to incentivize contact farmers, lead farmers and lead partners to increase and maintain production volumes. Several of the larger wholesalers provide farmer support through extension and outreach. Extension services included activities to support farmers with crop planting calendars, input application, and education on production costs. For one wholesaler, part of this support included monthly discussions with individual farmers to demonstrate the costs and sales of the farmer's output to calculate and demonstrate net income and savings options. Another wholesaler provides each farmer that delivers the required quantity of produce at the specified quality (monthly volume) with an award of 0.1 percent bonus at the end of the month.

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, a wholesaler is using an opportunity to provide banking services to incentivize farmers to invest in inputs and improved seeds for greater vegetable yield. According to the wholesaler, in return for supporting contact farmers to receive small loans, these farmers are more inclined to sell their surplus to this wholesaler, regardless of

fixed pricing. Under this strategy, the wholesaler explained that lead farmers can serve as MiBank agents who can vouch for farmers to be able to open a bank account using their SIM card.[22] 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 the wholesaler, 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 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.

The MVF program includes a component to defray some of these costs via a set of diverse grant schemes (refer to Appendix F for details). Qualitative interviews reveal that most contact farmers have used their grants to purchase farm equipment and inputs such as seeds and fertilizers. [23] While contact farmers use the 30:70 funds for operational and farm needs, the cost sharing scheme differs for lead partners. Lead partners self-fund 60 percent of the expense and receive 40 percent support from the grant component of the project. Seed capital received by lead partners includes creation of seedling nurseries, purchase of mechanized agricultural inputs, and purchase of transportation such as twin-steer trucks or refrigerated chiller containers (also known as reefers).

### 3.3.3 Opportunities to promote higher quality

Fresh vegetable quality deteriorates at several points in the value chain and opportunities exist at each node to improve quality. At the producer level, improved access to inputs is crucial to improving overall fresh produce output (as described above). However, 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 and tools (e.g., wheelbarrows to carry produce from farmgate to access roads and rural road construction and rehabilitation). We describe each in turn.

#### *3.3.3.1 Packaging and Handling*

An important share of fresh produce that moves from farmgate to aggregator depots, wholesalers or regional wet markets is transported via lead partner trucks or contact farmers that transport their harvest using available public transportation (public motorized vehicles / minivans) methods. Wholesalers

[22] 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.

[23] It is recommended that MVF systematically track the types of investments requested and received by the beneficiaries to assess impact and measure accountability.

lamented that quality is severely impacted by poor packaging, handling and transport prior to arriving at wholesaler depots. One wholesaler described a major success of his operation has been to discourage contact and lead farmers from bringing produce to the depot in billums or other makeshift carrying bags.

Packaging materials such as re-usable 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. For those who have invested in plastic crates, several 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. Assuming that crates become more widespread and less spoilage occurs between farmgate and wholesaler depot, lead farmers would receive greater payments for their produce and could transfer some of that gain to contact farmers to incentivize improved quality in the production node of the fresh produce value chain.

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. Another potential cost reduction for wholesalers that distribute crates to lead farmers is that produce arriving in plastic containers at the depot, in theory, would require less inspection and repackaging. Rather than unloading the large bags of produce, inspecting quality, and repackaging produce into cardboard boxes or other packing supplies owned by the wholesaler; if trained properly, both lead and contact farmers could directly package fresh produce into the plastic crates from the farmgate, which could then be inspected and weighed within the crate and directly loaded into the sea freight container. 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.

Wholesalers who have invested in the interlocking plastic crates outlined several parallel challenges that they have overcome when investing in plastic crates. Initially, when the crates were distributed to farmers, these crates were used for all household purposes including carrying laundry to wash, storing other household goods, etc. and crates were rapidly damaged and unusable. Wholesalers resolved these issues by only providing crates to trusted lead farmers, and keeping strict accounts of the number of crates supplied to each lead farmer with repercussions (e.g., loss of contract) if crates were unduly damaged or lost. Another important consideration of this investment is the plastic crate recovery after shipments have reached their destination in (for example) Port Moresby. One wholesaler, who is using plastic crates negotiated with one of the shipping companies to have the empty crates returned to Lae on an open pallet for a small fee when space was available on the ship returning from Port Moresby

to Lae. The wholesaler then retrieved the crates from the port when they are in Lae while organizing a future shipment. This type of low-cost arrangement may not continue if greater shares of crates were being shipped to Port Moresby.

*3.3.3.2 Cold Storage*

There is limited to no cold storage infrastructure for fresh produce in production areas and aggregation points (depots) in the Highlands. While modern high-end suppliers such as Hiland Fres and NKW Fresh rely heavily on maintaining cold chains to ensure the quality of their fresh produce, within the MVF project only three out of 31 lead partners have invested in cold chain infrastructure using the cost sharing grants provided to them.

The lack of cold chain facilities affects all actors in the fresh produce value chain and creates a weekly scramble to harvest, pack, and transport fresh produce at last minute to ship to final location. Lead partners that ship produce to Port Moresby explained their operation schedule as such, working backwards from when the ship in Lae leaves the port:

- There are two shipping companies, and ships leave Lae port on Saturday or Sunday.
- Consort shipping can receive containers 48-72 hours before departure whereas Bismark shipping can accept containers 24 hours before departure.
- Wholesalers who are shipping with Bismark organize their aggregation of produce to be complete and loaded on a truck on Friday night so the driver can drive the truck to Lae port to arrive on Saturday morning. Most truck transport from the highlands to Lae is not refrigerated, so traveling at night is necessary to maintain a cooler temperature in the container.
- Lead partners race to collect the quantity requested one or two days before Friday's transport to Lae. In doing so, they wait until last minute to collect the most perishable fresh produce.
- Contact farmers also wait until last minute to harvest their produce to take to the depot. Or they wait for the lead farmer to harvest and package their produce at last minute.
- As the hour of trucking to Lae nears, lead partners scramble to fill the remainder of the order (when they haven't received enough produce) before the truck must depart to reach Lae in time for repacking the produce into a shipping container destined to Port Moresby.
- If the lead partner manages to procure all of the produce on time, then necessary steps are undertaken to pack the produce as per the preferences of the buyer. However, if they run out of time, then they send the dry container with bags of vegetables in their original packaging.
- The produce is again graded and re-sorted at the Lae port before shipping to POM using Bismark or Consort shipping.

While the above harvesting and aggregation strategy seeks 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 (at best) before it arrives in Lae.

### *Cold chain infrastructure and service availability*

During the second scoping exercise, the research team conducted in-depth interviews with the three lead partners in the MVF program that have invested in cold chain infrastructure to understand the challenges, benefits, and tradeoffs (see interview guide in Appendix G) Each of the lead partners owned differing quantity and storage capacity of cold storage. For example, one lead partner owned two reefer containers having the capacity to store 6 tons of produce, while another owned one reefer container that can store 18 tons of fresh produce. Apart from reefer containers, two lead partners have also invested in a cool storage room with a 5-ton storage volume. While one storage room is located at the aggregator's depot in the Highlands, the other lead partner invested in a cold storage room in Port Moresby near the wharf.

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. For example, one of the lead partners owns two reefers that are in Mt. Hagen and Lae. Since most of his contact farmers are located in Jiwaka, he uses dry containers to transport the produce from Jiwaka to Mt. Hagen, after which, the produce is loaded in the chiller to travel to Lae. Similarly, another lead partner transports fresh produce bought in bulk from the open market from the highlands to Lae in non-refrigerated trucks. By the time it is loaded into reefers in Lae, a share of the vegetables spoil because of the heat generated from the vegetable bags and the non-refrigerated transport in the truck. This lead partner is currently seeking finance to replace the dry container with a 6-ton-reefer truck with portable electricity generator which maintains refrigerated transport from the highlands to Lae.

Investment in cold chain infrastructure is costly. Although the grants offered by the MVF project help the lead partners to defray costs, most 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.[24]

For highly perishable crops, such as cauliflower, tomato, lemon, capsicum, chili, asparagus, lettuce, garlic,and spring onion, lead partners use air freight to decrease post-harvest loss and ensure higher quality.[25] However, frequent flight cancellations and delays between the highlands and Lae, increases the risk of spoilage. Lead partners do not receive any refund or compensation from the airline company for flight delays or cancellations. While air freight can provide a (costly) solution to shipping highly perishable produce, lead partners report preferring transporting fresh produce using reefers via the Highlands highway to Lae and then POM because they have more control of loading, packaging and storage in transit.

In general, lead partners take around two to three days to fill in a reefer container with fresh produce. However, they feel that one reefer is not sufficient given the current demand from wholesalers and urban buyers. One of the lead partners wished to own four reefer containers for their business. They currently receive weekly orders from their buyer to whom they supply 6 tons of fresh produce; however, they see potential to expand the business if they can secure finance to purchase more reefers.

### *Benefits and Opportunities*

Lead partners reported that the spoilage rate of fresh produce has significantly dropped with cold chain usage. A lead partner in Simbu who used dry containers to transport produce from Simbu to Lae lost on average 6 tons of fresh produce in February 2025. Alternatively, when the produce was stored in the cooling room at Lae and then transported to POM in chiller containers, they reported losing almost 0 kgs of produce. Another lead partner reported reducing their post-harvest losses from 30 percent to 15 percent.

The number of storage days before transporting produce to the buyer has marginally increased with cold storage. Responses from lead partners suggest that the fresh produce can be stored at their depot or collection point in cold rooms for maximum 1-2 days, compared to earlier times, when it had to be immediately put on ship or air freight to minimize wastage. 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

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

[25] While on the truck from the highlands to Lae, reefer containers do not maintain the appropriate temperature required for such crops because most do not have a portable electricity generator, hence lead partners may choose to send highly perishable via airplane.

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, at which point the cold chain depot would be responsible for transporting the produce to the location of the final buyers. 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.

### *Cost and constraints of cold storage*

The cost and reliability of electricity present a major challenge to cold storage.[26] A smaller wholesaler who purchased two chiller containers and used the public electricity grid to maintain container temperature has faced significant challenges due to blackouts on the electrical grid. More recently, the wholesaler hypothesized that the reason for the two chiller containers malfunction was due to power surges on the public grid, suggesting that they may not use the containers (assuming they are repairable) if they aren't able to secure a generator to power them.

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."

Another major expense is the rental cost of cold containers used for shipping fresh produce from Lae to POM. Lead partners reported spending approximately 5,000-7,000 PGKfor a round trip from the highlands to a chiller depot in Lae, in addition to insurance that costs around 5,000 PGK per year.[27] Additionally, one of the lead partners transports the produce from Hagen to Lae in a reefer, however it operates without active cooling system as it does not have a portable generator. He reported spending 1600 PGK on fuel for a round trip and 1000 PGK for driver's salary, which is paid fortnightly.

Future research could evaluate the willingness to pay (of lead farmers or small holders) for membership to cold warehouse facilities, 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

[26] 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.

[27] Consort raises prices to cover costs of renting wharves at PNG Ports and to manage operations that must strictly adhere to tight port schedules whereas Bismark's prices range between 3000 to 4000 PGK because they own the wharves. Additionally, fluctuations in foreign exchange rates can increase shipping costs further. Together with insurance and other handling fees, these expenses make a large part of the total costs of moving produce from Lae to POM, creating a heavy financial burden for both farmer and wholesaler.

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.

### 3.3.4 Priorities for rural road infrastructure

Lead farmers and aggregators underlined the lack of rural feeder roads in general. In addition, they underscored the cost of poorly maintained rural feeder roads to connect producing areas to the primary highways. Lead farmers explained that the lack of rural roads requires that they hire carriers to transport, on foot, bags of produce for hours (in some cases) before they arrive at the access road. While carrying on foot, produce must be loaded into large gunny sacks to ease carrying large volumes. Given the heavy weight of the bags, carriers shift produce from one shoulder to another, dropping bags on the ground to readjust weight and bulk of the bagged goods. This method inevitably damages produce almost immediately from the moment farmers have harvested, lowering incentives for producers to grow quality fruits and vegetables. Further spoilage occurs as the produce remains outside of refrigeration facilities.

Major arteries of transportation are also in need of ongoing maintenance, however throughout our interviews with wholesalers, the upgrading of the Highlands Highway was secondary to the priority of rural road construction and improvements. Surprisingly, few stakeholders identified vehicle damage due to poor road surfacing or insecurity along the Highlands Highway as a major constraint to their operations.

## 3.4 Promoting inclusive domestic fresh produce value chain growth

A first step in fostering competitiveness in the export market is improving efficiency in the domestic market. Improving domestic market efficiency also provides an opportunity for supporting targeted import substitution of competitive domestic crops. The increasing urban demand for store bought food crops can only be (domestically) met if rural producers shift to higher quality output to meet urban preferences in quality, variety, and taste. Meeting domestic urban demand preferences will also be necessary to attract export demand for domestic crops in the region. Currently, given the challenges in midstream packaging and handling, storage, and transport, producers take on considerable risk when investing to produce agricultural surplus for regional markets. They take on even more risk if they produce at more costly levels of quality output to meet urban demand preferences.

Greater (and reliable) urban demand for domestic produce could replace the increasing demand for cheaper imported goods such as rice, instant noodles and other less costly urban staple foods. Similarly, expanding fresh produce that is rich in recommended micro and macronutrients can also improve rural consumption patterns in PNG which are currently lacking dietary diversity to lead a healthy lifestyle. In addition, for the case of domestically marketed foods, women are the primary producers and retailers.

This direct link to women's income support may have positive spillovers to greater family nutrition outcomes, provided the appropriate nutrition extension is provided in tandem with agricultural extension support. Most agricultural sector attention (development programming, and research and development) and funding (both PNG government and international donor) has focused on cash crop production and marketing with the aim of export promotion. While these investments may have incorporated gender elements to promote greater inclusiveness, they do not target the segment of the agriculture sector that women are most involved: domestic food crops.

Given that women are almost absent from the mid-stream nodes of the fresh produce value chain, they have limited direct access to information on intermediate costs (of labor and services of transport, handling and trade) and final (long-distance) market retail prices. Part of this lack of information is structural; both rural men and women (at farmgate) face significant barriers (e.g., poor price information transmission, and inadequate transportation, packaging, handling, and storage infrastructure). However, women are generally at a disadvantage to negotiate prices for mid-stream service providers (e.g., transport, or loading and unloading produce at market), which has a direct impact on their revenue stream. Women's more limited access to information on prices at various markets is also exacerbated by lower average literacy levels, narrower social networks, or less (compared to men) access to information communications technology (ICT) (Udry, 1996; Kosec et al., 2021; Hidrobo et al., 2022).

Policies and programming that can ease information asymmetries for women, while facilitating safe and secure locations where they can interact with midstream and downstream aggregators and retailers are important to building an inclusive agricultural system. This includes targeted training to provide women with skills to read and digest market information, seek higher output prices, and negotiate intermediate service costs to reap greater revenues.

# SECTION 4: FINAL REMARKS

The Government of PNG aims to increase food commodity exports, including fresh fruits and vegetables, as an avenue to support agriculture as an economic growth engine for the country. This will require decreasing costs of production and marketing and incentivizing quality improvements at all nodes of the fresh produce value chain. It is crucial that the farmers that consistently supply higher quality output are remunerated appropriately and transparently for improved quality output. It is equally important that village aggregators / lead farmers and wholesalers are also remunerated appropriately for consistently meeting volume demands and maintaining quality standards. Access to: appropriate tools (interlocking plastic crates, wheelbarrows – that fit plastic crates in place, etc.), inputs (reliable provision of improved seeds etc.), and cold storage facilities are sorely needed to improve basic fresh produce

infrastructure. These tools should be paired with transparent grading systems and price incentives that reward each actor in the value chain for maintaining quality within their node.

Investments could be considered to promote rural cluster development through a portfolio of geographically focused investments. Cluster development reduces the costs of production, packaging, transportation, and marketing whereby different actors along the value chain are concentrated in or near a geographic area (Fang et al. 2024). Mt. Hagen or Goroka could be good candidates to support a fresh produce cluster given these towns already have several successful wholesalers operating in the area. Evaluating local government interest and cooperation in cluster development will inform investment viability and allow for negotiating opportunities for local government to invest and / or facilitate key infrastructure upgrades (such as rural road networks). Similar cluster developments have been implemented in other Asian and African countries where irrigation, electricity, and rural road development are significant hurdles. Studies suggest significant positive income effects, while investment in such infrastructure and associated maintenance is less cost-restrictive in a cluster setting (Zhang, Moorman and Ayele, 2011; Zhang and Hu, 2014).

While there is much to do to create an efficient and effective fresh produce sector within PNG, the country's vast production potential in combination with its unique regional resource base provides a strong foundation for agricultural transformation. Given that agriculture remains the backbone of the PNG economy, policies and investments to ensure that rural smallholders are supported and incentivized to invest in higher value production activities will be necessary to maintain PNG's economic growth trajectory. These investments must be designed to promote greater inclusion of women in value-added nodes of the fresh produce value chain, as well as continually be evaluated to ensure investments evolve to remain resilient to unexpected shocks and the effects of ongoing climate change.

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# APPENDIX

## Appendix A: LULC data compilation, analysis and validation

### Data compilation

This land use/land cover change analysis uses Sentinel-2 imagery from Copernicus/S2_SR collection processed in Google Earth Engine (GEE) using JavaScript code. In tropical environments like PNG, persistent cloud cover poses challenges to acquire high temporal resolution (weekly, monthly, etc). To address this, median annual composites were used, despite their limitation to capture seasonal dynamics. For both study areas, a 5km buffer was constructed from the main highways to form the corridors for Tambul-Goroka and Kerema-POM-Kupiano. Remotely sensed images were retrieved within the 5km buffer along the corridors. However, for the Kerema-POM-Kupiano corridor, the majority of potentially agricultural areas were found to be covered by clouds which make the classification impossible.

In addition to evaluating the 6 bands (B2, B3, B4, B8, B11, B12) during the LULC analysis, an additional 6 spectral indices were used to support feature identification. Figure A1 through A3 display derived index outputs showing various landcover features.

**Table A.1**: Spectral Index formulations for Sentinel-2 imagery

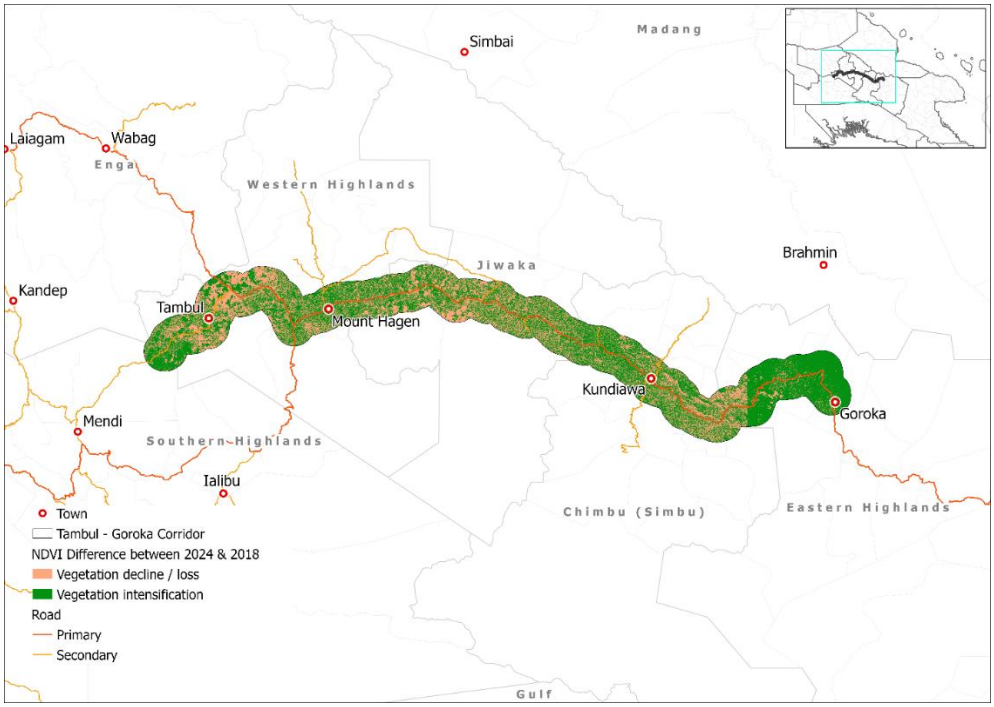
| Index | Formula | Purpose |
|---|---|---|
| **Normalized Difference Vegetation Index (NDVI)** | (B8 - B4) / (B8 + B4) | Vegetation vigor |
| **Normalized Difference Water Index (NDWI)** | (B3 - B8) / (B3 + B8 | Moisture content |
| **Normalized Difference Built-up Index (NDBI)** | (B11 - B8) / (B11 + B8) | Built-up areas |
| **Soil Brightness Index (SBI)** | $\sqrt{[(B2^2 + B3^2 + B4^2)/3]}$ | Soil brightness |
| **Normalized Burn Ratio (NBR)** | (B8 - B12) / (B8 + B12) | Burn/disturbance |

| | | |
|---|---|---|
| **Enhanced Vegetation Index (EVI)** | 2.5 × [(B8 - B4) / (B8 + 6×B4 - 7.5×B2 + 1)] | Canopy structure |

Source: Awesome Spectral Indices for Google Earth Engine (readthedocs/pdf)

Figure A.1 was created by subtracting the 2018 NDVI image from the 2024 image to visually explore vegetation health or density. Positive values indicate vegetation intensification that can be interpreted as gains in biomass or crop intensification. Whereas areas showing decline or loss have negative values.

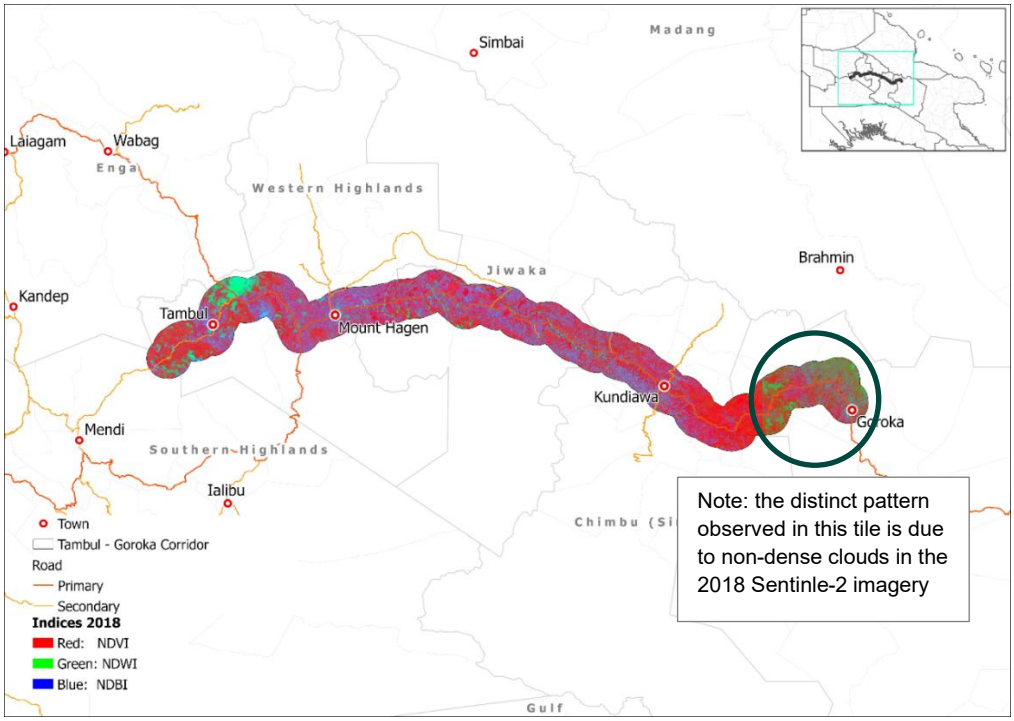
**Figure A.1:** NDVI difference (2018 vs 2024) in the Tambul-Goroka corridor




Source: Sentinel-2 satellite imagery analysis on Google Earth Engine (GEE) comparing multi-temporal data from 2018 and 2024

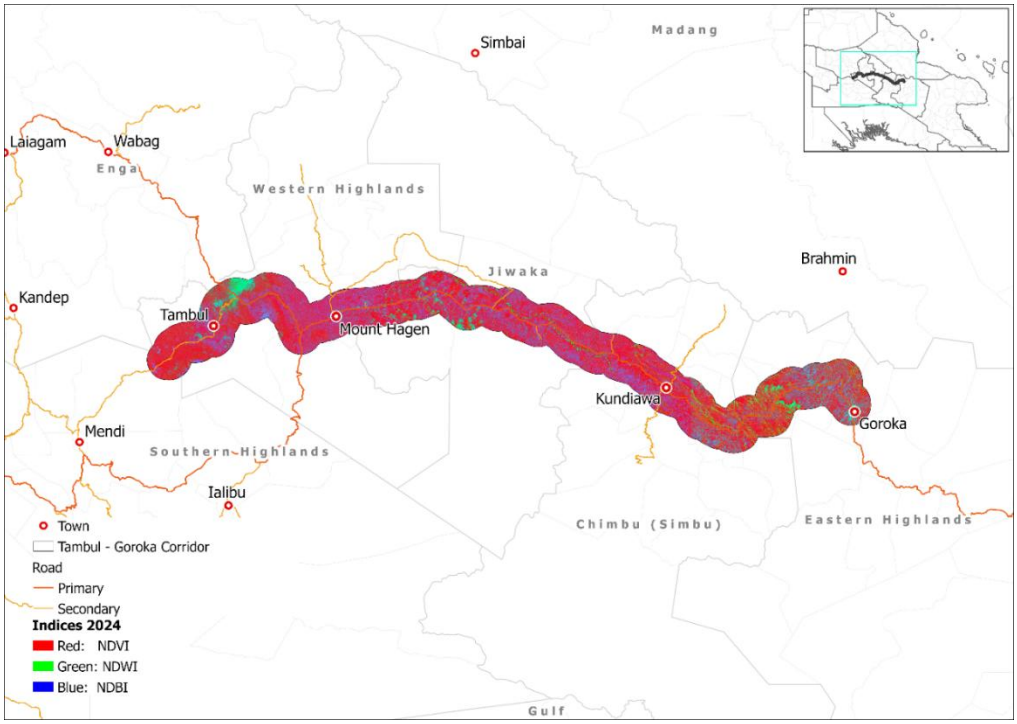
Figure A.2 and A.3 show derived indices to visually interpret the image, a three-band false-color composite was created by assigning the NDVI to the Red channel, the NDWI to the Green channel and the NDBI to the Blue channel. This composite allows for distinction of vegetation (red), water/moist (green) and built-up areas (blue) based on additive color theory.

**Figure A.2**: False-colour composite of spectral indices (NDVI, NDWI and NDBI) for the Tambul-Goroka corridor (2018)




Source: Spectral indices derived from Sentinel-2 imagery using Google Earth Engine (GEE) (2018)

**Figure A.3:** False-colour composite of spectral indices (NDVI, NDWI and NDBI) for the Tambul-Goroka corridor (2024)

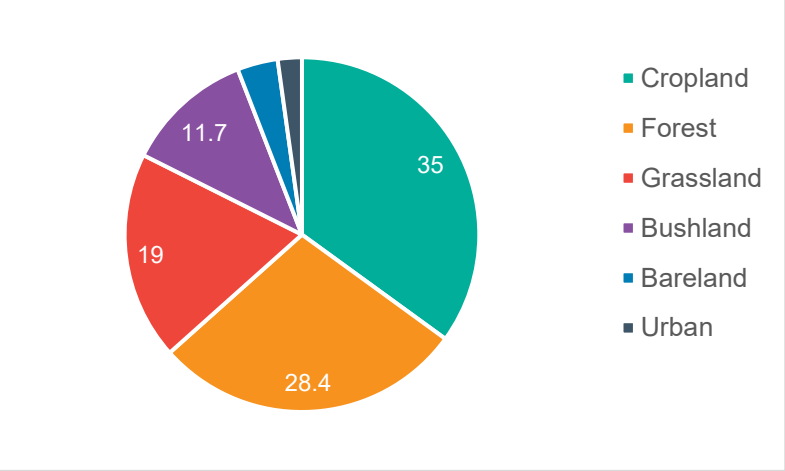



Source: Spectral indices derived from Sentinel-2 imagery using Google Earth Engine (GEE) (2024)

### Classification methods

For land classification, a Random Forest model was employed using a training dataset digitized using Google Earth Pro high-resolution imagery from a public historical archive. With careful visual interpretation, 6 land use/land cover classes were digitized and labeled accordingly. During the manual training area digitization, a set of preidentified clustered points were utilized from the unsupervised classification to create a sufficient training sample. Overall, 200,064 training points for 6 LULC classes were generated (Figure A.4) to train the classifier algorithm. To validate the classification, 1000 random points (500 cropland and 500 non-cropland) were randomly selected and removed from the training dataset to assess the classification accuracy. In doing so, we calculated producer and user accuracy using 3 key analyses: a confusion matrix, Overall Accuracy (OA) percentage, and a Kappa coefficient for each analysis year (2018 and 2024). Results show that for 2018 the Kappa coefficient is 0.114 (slight agreement) which reflects limited separability due to spectral overlap in fallow and cropland classifications, respectively. For 2024, the Kappa coefficient was 0.36 (fair agreement), indicating an improved classification performance mainly attributed to a combination of more accurate training data (attributed to spatial shifts in the digitized training areas between 2018 and 2024) and index fusion (Table A.2 and A.3). Figures A.5 and A.6 present the classified cropland extent.

**Figure A.4**: Share of training area LULC classes (points)




Source: Author's calculations

**Table A.2**: 2018 Classification accuracy

| | Reference cropland | Reference non-cropland | User's accuracy |
|---|---|---|---|
| **Predicted Cropland** | 459 | 403 | 53.30% |
| **Predicted non-cropland** | 41 | 97 | 70.50% |
| **Producer's Accuracy** | 91.80% | 19.40% | **OA: 55.7%** |

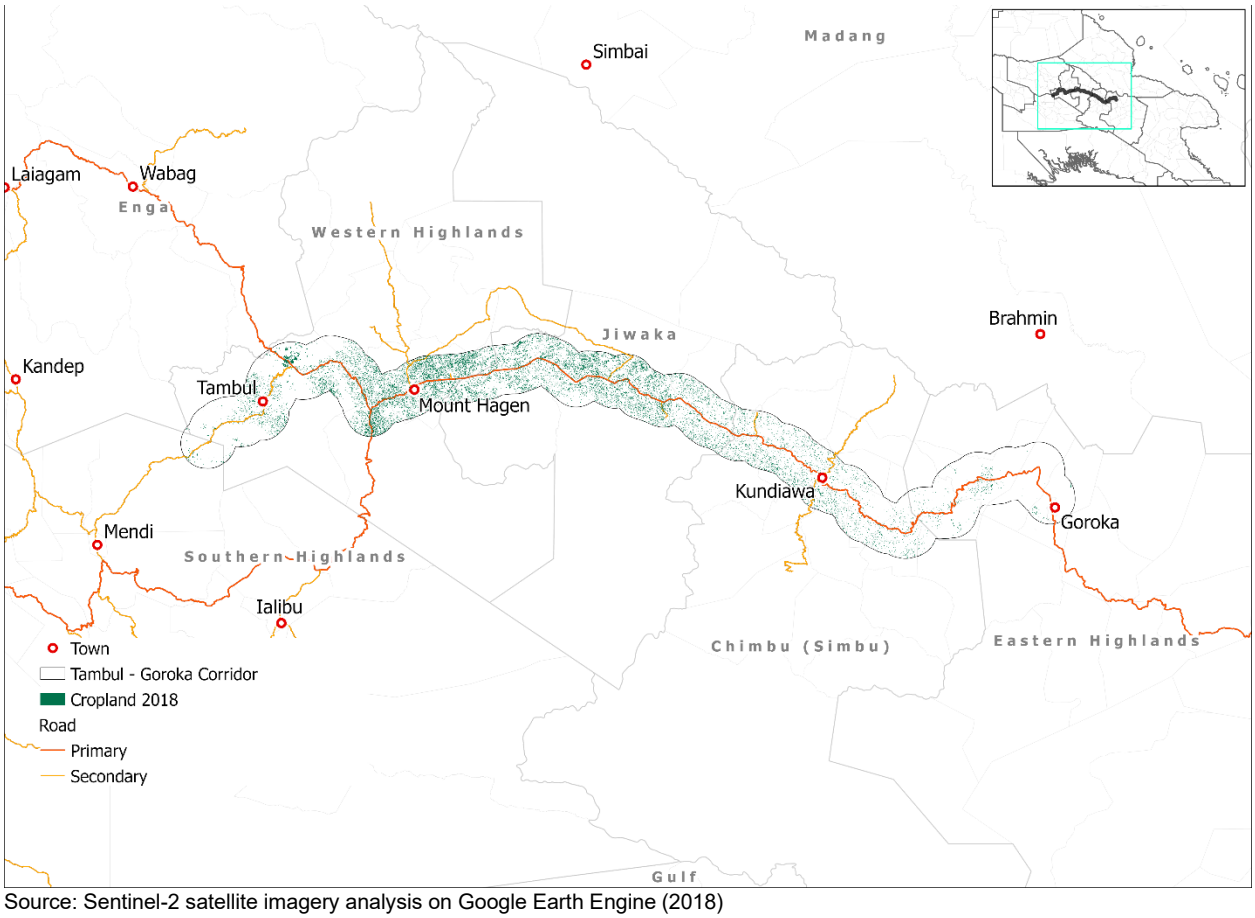
Source: Author's calculations

**Table A.3**: 2024 Classification accuracy

| | Reference cropland | Reference non-cropland | User's accuracy |
|---|---|---|---|
| **Predicted Cropland** | 411 | 231 | 64% |
| **Predicted non-cropland** | 89 | 269 | 75.1% |
| **Producer's Accuracy** | 82.2% | 53.8% | **OA: 68.0%** |

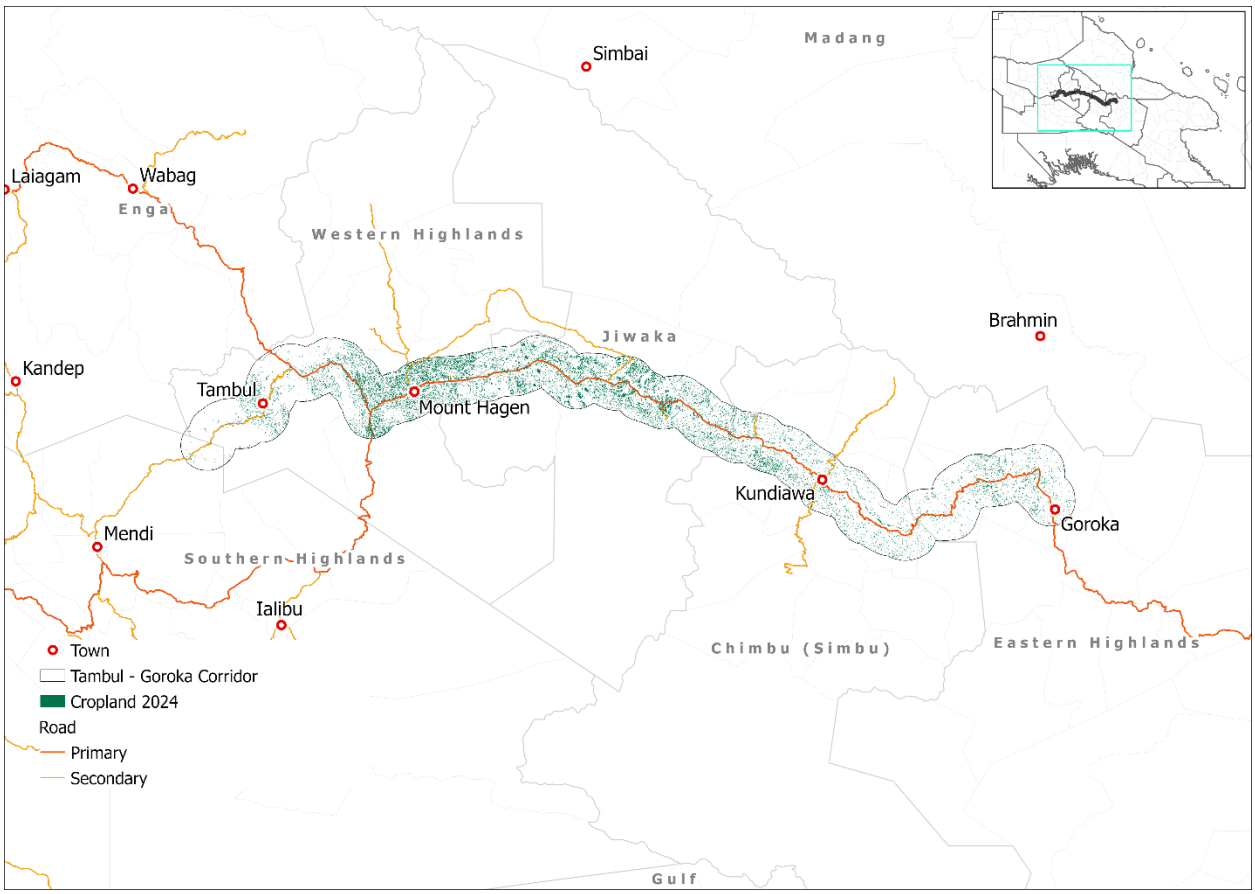
Source: Author's calculations

**Figure A.5:** Cropland distribution in the Tambul-Goroka corridor (2018)




Source: Sentinel-2 satellite imagery analysis on Google Earth Engine (2018)

**Figure A.6:** Cropland distribution in the Tambul-Goroka corridor (2024)




Source: Sentinel-2 satellite imagery analysis on Google Earth Engine (2024)

## Appendix B: Share of households growing and selling staple crops by study area

| | All HHs | Seasonal High-lands | Non-Seasonal Highlands | Seasonal Low-lands | Non-Seasonal Lowlands | Islands |
|---|---|---|---|---|---|---|
| **Staple Production** | | | | | | |
| **Any Staples** | 97 | 99 | 100 | 100 | 99 | 99 |
| **Yam** | 51 | 20 | 10 | 79 | 71 | 54 |
| **Sweet Potato** | 92 | 98 | 100 | 85 | 87 | 94 |
| **Taro** | 79 | 76 | 46 | 88 | 92 | 86 |
| **Cooking Banana** | 90 | 93 | 61 | 95 | 97 | 97 |
| **Cassava** | 77 | 76 | 39 | 83 | 85 | 96 |
| **Potato** | 8 | 5 | 32 | 5 | 1 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Sago** | 18 | 0 | 0 | 25 | 30 | 26 |
| **Staple Sales** | | | | | | |
| **Any Staples** | 62 | 58 | 80 | 63 | 56 | 53 |
| **Yam** | 16 | 1 | 4 | 34 | 19 | 9 |
| **Sweet Potato** | 44 | 44 | 66 | 43 | 36 | 37 |
| **Taro** | 31 | 22 | 30 | 41 | 35 | 19 |
| **Cooking Banana** | 44 | 41 | 37 | 53 | 44 | 41 |
| **Cassava** | 26 | 15 | 21 | 41 | 24 | 19 |
| **Potato** | 5 | 3 | 21 | 2 | 0 | 0 |
| **Sago** | 7 | 0 | 0 | 12 | 13 | 2 |
| **N (HHs that cultivate)** | 2,638 | 451 | 446 | 729 | 565 | 447 |

## Appendix C: Prevalence of sales practices by distance to food market

**Table C.1 :** Share of households selling vegetables, by distance to food market (for all sampled households cultivating vegetables)

| | Under 2 hours | 2-4 hours | Above 4 hours |
|---|---|---|---|
| **Any vegetable** | 50% | 49% | 35% |
| **Fresh Beans** | 28% | 27% | 20% |
| **Leafy Greens** | 45% | 42% | 31% |
| **Squash (pumpkin)** | 17% | 17% | 10% |
| **Bulb Onion** | 6% | 7% | 1% |
| **Tomato** | 6% | 4% | 1% |
| **Potato** | 5% | 3% | 3% |
| **Cucumber** | 3% | 4% | 3% |
| **Egg Plant** | 3% | 1% | 1% |
| **Ginger** | 2% | 1% | 1% |
| **Others** | 9% | 10% | 2% |

| | | | |
|---|---|---|---|
| **N (HHs that cultivate)** | 2013 | 482 | 143 |

**Table C.2 :** Share of households selling vegetables, by distance to food market (for all highland households cultivating vegetables)

| | Under 2 hours | 2-4 hours | Above 4 hours | Under 2 hours | 2-4 hours | Above 4 hours |
|---|---|---|---|---|---|---|
| | Seasonal Highlands | | | Non-Seasonal Highlands | | |
| **Any vegetable** | 58% | 45% | 48% | 60% | 76% | 100% |
| **Fresh Beans** | 31% | 23% | 24% | 40% | 58% | 0% |
| **Leafy Greens** | 53% | 40% | 48% | 50% | 64% | 100% |
| **Squash (pumpkin)** | 15% | 12% | 16% | 15% | 34% | 0% |
| **Bulb Onion** | 8% | 8% | 8% | 12% | 25% | 0% |
| **Tomato** | 0% | 3% | 4% | 3% | 2% | 0% |
| **Potato** | 4% | 0% | 8% | 21% | 21% | 0% |
| **Cucumber** | 2% | 5% | 4% | 0% | 2% | 0% |
| **Ginger** | 6% | 4% | 4% | 2% | 0% | 0% |
| **Others** | 7% | 6% | 8% | 13% | 33% | 0% |
| **N (HHs that cultivate)** | 280 | 146 | 25 | 390 | 55 | 1 |

## Appendix D: Share of households growing and selling crops by highland provinces

| | All Highland HHs | Simbu | EHP | Jiwaka | Morobe | WHP |
|---|---|---|---|---|---|---|
| | | | Production | | | |
| **Vegetable** | 94% | 89% | 93% | 92% | 97% | 97% |
| **Fresh Beans** | 70% | 73% | 74% | 70% | 59% | 72% |
| **Leafy Greens** | 89% | 81% | 93% | 83% | 96% | 90% |
| **Squash** | 48% | 54% | 67% | 36% | 56% | 37% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Onion** | 22% | 20% | 33% | 11% | 19% | 24% |
| **Tomato** | 7% | 9% | 15% | 7% | 5% | 3% |
| **Potato** | 19% | 6% | 9% | 2% | 1% | 47% |
| **Cucumber** | 5% | 1% | 8% | 6% | 10% | 1% |
| **Egg Plant** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Ginger** | 9% | 11% | 21% | 9% | 13% | 2% |
| **Others** | 21% | 5% | 15% | 5% | 32% | 34% |
| **N (HHs)** | 897 | 151 | 150 | 148 | 150 | 298 |
| | | | **Sales** | | | |
| **Vegetable** | 58% | 51% | 57% | 55% | 52% | 66% |
| **Fresh Beans** | 35% | 30% | 27% | 39% | 27% | 43% |
| **Leafy Greens** | 50% | 42% | 53% | 47% | 49% | 54% |
| **Squash** | 16% | 13% | 13% | 13% | 16% | 19% |
| **Onion** | 10% | 7% | 11% | 6% | 6% | 17% |
| **Tomato** | 2% | 1% | 1% | 3% | 2% | 3% |
| **Potato** | 12% | 4% | 5% | 1% | 0% | 31% |
| **Cucumber** | 2% | 0% | 5% | 1% | 4% | 1% |
| **Egg Plant** | 0% | 0% | 0% | 0% | 0% | 0% |
| **Ginger** | 4% | 3% | 11% | 3% | 3% | 1% |
| **Others** | 11% | 2% | 9% | 1% | 9% | 23% |
| **N (HHs)** | 897 | 151 | 150 | 148 | 150 | 298 |

Source: Authors' calculation using 2023 PNG Rural Household Survey Data. Note: EHP stands for Eastern Highland Province, WHP stands for Western Highland Province.

## Appendix E: Share of vegetable plot, by proportion of harvest sold across island and lowland provinces

| | Seasonal Lowlands | | | | Non-Seasonal Lowlands | | | Islands | |
|---|---|---|---|---|---|---|---|---|---|
| | **Central** | **East Sepik** | **Western** | **Oro** | **Madang** | **Gulf** | **Milne Bay*** | **AROB** | **ENB** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Less than 25%** | 17% | 12% | 9% | 17% | 18% | 13% | 6% | 6% | 8% |
| **About 25%** | 38% | 25% | 29% | 41% | 29% | 30% | 24% | 16% | 40% |
| **About 50%** | 38% | 30% | 49% | 28% | 43% | 36% | 46% | 32% | 31% |
| **About 75%** | 3% | 1% | 9% | 7% | 6% | 8% | 13% | 21% | 10% |
| **More than 75%** | 3% | 0% | 3% | 4% | 2% | 6% | 1% | 14% | 5% |
| **All 100%** | 1% | 32% | 1% | 4% | 3% | 7% | 3% | 12% | 7% |
| **Total vegetable plots used for sales** | 230 | 172 | 260 | 232 | 118 | 215 | 161 | 327 | 166 |

Note: (*) About 6.83% sampled households in Milne Bay reported to not know the share of harvest sold from their vegetale plot. AROB: Autonomous Region of Bougainville. ENB: East New Britain

## Appendix F: Detailed description of Component 1 of MVF program

Under the Fresh Produce Business Partnership (a subcomponent of Component 1), partnership agreements are signed with the Lead Partners (LP) and Farmers who receive grant contributions through the project once they fulfil their own share of grant commitments. Table F.1 describes the different grant categories under MVF along with its cost sharing rules which differ based on the scale of operations of the lead partner.

**Table F.1:** Grant categories and cost sharing rules

| Category | Description | Example of Eligible Expenses | Cost Sharing |
|---|---|---|---|
| **Seed Capital 1a: Lead Partner Investments** | Grant support for investments aimed at strengthening the lead partner's productive capacity and business operations | Investments related to land preparation, nurseries, purchasing agronomic supplies, irrigation and water management, and machinery or equipment for improved production, processing, storing, processing, conditioning, packaging and transporting | 40% (MVF) : 60% (LP) |
| **Seed Capital 1b: Partnership Coordination** | Grant support to the lead partners for the cost of managing the partnership | It includes the salary and operations of the Lead Partner Coordinator who is responsible for liaising between farmer group and lead partner. Additionally, it also includes all the operational costs related to business. For example: banking charges, vehicle running cost, fuel cost, mobile charge, internet usage, stationary etc. | For Medium and Small LPs: 50% (MVF) – 50% (LP)<br>For Micro partnerships: 70% (MVF) – 30% (LP)<br><br>Salaries of Lead Partner Coordination paid 100% by MVF for all partnerships. |
| **Seed Capital 2: Household Investments.** | Grant support for household investments to strengthen households/farmer groups productive capacity. | It includes planting materials such as vegetable seeds, fertiliers (organic, inorganic), chemicals (herbicides, fungicides, insecticides), garden tools, transport and movement, and miscellaneous farm support | 70% (MVF) – 30% (LP) |
| **Seed Capital 2b: Lead Farmer Seed Capital** | Grant support for lead farmer investments to strengthen group productive | Investments related to introducing innovative agriculture and/or reinforce the lead farmer as a model farmer and provider of | 70% MVF grant – 30% (LF) |

| | | | |
|---|---|---|---|
| | capacity and promote innovation and leadership. | services to his/her farmer group following the FPDA VEW model. Eligible expenses include nurseries establishment, irrigation equipment, tractor, training expenses etc. | |
| **Lead Partner Capacity Building** | Grant support for goods and services to strengthen partnership management. | Service provider fee, cost of LP or LPC training workshop, offsetting field visit cost of partnership accountants to train LP and LPCS | 100% MVF grants |
| **Household Capacity Building** | Grant support for training of households. | Training cost of farmers | 100% MVF grants |
| **Lead Farmer Stipends** | Monthly stipend for Lead Farmers (Champions) who provide farmer group reports and group training | Monthly salary of lead farmers | 100% MVF grants |

Note: LP stands for Lead Partner

While the LPs are responsible for developing business plans and leveraging grant amounts to carry out significant investments based on their own and other farmer needs, they are often supported by a Lead Partner Coordinator (LPC) and their Lead Farmers (LF) who help coordinate and manage the group of Contact Farmers (CF). The MVF framework follows a tri-fold hierarchal system where generally, the LPs source the produce from the LFs who collect and manage vegetables from CFs.

For the contact farmers to leverage the grant money, each associated farmer pays their contributions by depositing their share to the Lead Partnership bank account. The Lead Partner Coordinator then verifies the amount deposited by the member farmer and informs them about the value of goods they can claim in lieu of their contributions. They let the farmer know about the three options of suppliers which they can choose from to place an order. Accordingly, the farmer visits each supplier and collects quotations for the goods required for their farming activities which should be equal to or below the sum of farmer contribution (i.e. 30%) and the amount provided by MVF (70%). Once the quotations are collected, the LPC prepares a list of inputs requested by category and gets it approved by MVF's Provincial Coordinator (PC) or Provincial Monitoring and Evaluation Officer (PMEO) who ensures that the requested items are for farming purposes and approves it for payment. After the payment is received by the supplier, farmers along with their respective lead farmers visit the store to collect farm goods at a scheduled time from the supplier. The process ends when the contact farmer signs the distribution sheet provided by the LPC as acknowledgment and confirmation of receipt of goods.

**Appendix G: Cold chain storage interview guide**

Basic Information:

| | |
|---|---|
| Respondent type: | Aggregator/ Cold Chain Service Provider/ Lead farmer or lead partner with cold storage containers |
| Gender : | |
| Age : | |
| Location: | |
| Interview Date: | |

Cold chain infrastructure and service availability:

Do you use any cold chain storage facilities to store fresh produce?

If yes, what type of cold chain infrastructure/facilities do you have?

- Cold containers?
- Refrigerated truck?
- Cold storage depot?
- Other?

Are these facilities

- Owned by you?
- Provided by MVF/any other project?
    - Bought through MVF grant contribution, if yes how do you raise your share of contribution? (loans?) Are there any difficulties?
- Rented or leased by you?

Where is this located in the village? (at your farm / other premises?)

In which year did you start these services?

Why did you invest in cold chain storage facilities?

If they rent/own cold containers or refrigerated trucks:

How many cold containers/reefers do you rent or own?

Where do you rent these cold containers from? (From Lae? Are there any rental companies in the highlands that rent out cold containers / trucks?)

For how long do you rent these cold containers?

How much does it cost to rent a cold container for XX days /weeks?

What is the storage capacity? (xx number of bags, tons or kgs)

Do you transport these cold containers to Lae?

Can the same container that is used to transport produce from highlands to Lae be used to transport produce from Lae to POM on boat? Is this your responsibility?

Users of cold containers?

Who uses these cold containers? (contact farmers, other farmers not associated with MVF etc.)

Do you go to the farms of contact farmers and collect produce, or do they travel to your storage facility?

How do you check the quality of the vegetable crops supplied by contact farmers?

How do you coordinate with the contact farmers supplying produce to you? (regular supply contracts, informal verbal arrangement, spot purchase when needed, others)

Out of all the farmers who you purchase the produce from,

- What share are MVF contact farmers? And how far are these located? (10 mins, 2 hrs…)
- What share are non MVF farmers? And how far are these located? (10 mins, 2 hrs,…)
- Do they have to pay to store their produce in your container, or are you purchasing produce from them? If they pay, then how much?

Packaging and Storage

What kind of vegetable crops are stored in these cold containers? List them.

How do you pack the fresh produce in these cold containers? (bags, boxes, cardboard boxes, plastic trays, crates etc.?)

Which crops go into bags? Why? (more perishable, higher value??)

Which crops go into crates? Why? (more perishable, higher value??)

[Mention the crop from above response and ask] How many vegetable crops or Kgs fit?

- in one box? ___
- in one bag? ___
- in one crate? __

Do you follow any standard rules while storing fresh produce in cold containers? (For example, arranging crops in a specific order/leafy vegetable stored away from root crops etc.)

Do you train the contact farmers or lead farmers or advise them on how to pack, sort or pre-cool before they supply their produce to you?

What challenges do the contact farmers or lead farmers face when trying to use cold storage facility (high transportation cost to reach the cold storage premise, lack of knowledge of pre-cool etc.)

Supply/Demand

Do you have enough demand/supply to fill an entire container?

How long does it take to fill in the entire container? (a day, 2 days, a week, two weeks?)

Do you think if you have more cold containers, you would be able to fill them with more produce? How about 2 cold containers? How about 3?

Do you think if you have more cold containers, you would be able to sell all of the extra produce?

Is there seasonality in supply/demand?

How are contact farmers or lead farmers paid (Immediately after delivery, monthly, etc.)? Cash, through bank account, mobile phone payments,…?

Sales

On average, how much do you pay for the contact farmer per bag of [vegetable crop]?

On average, how much do you sell a bag of [vegetable crop] to the buyer? Who is this buyer? (market vendor/aggregator in Lae/supermarkets/hotels etc.)

Benefits / Opportunities

Why do you use cold storage? (less wastage, more shelf life, higher price negotiated, better inventory management, etc.). Multi-select.

Do you think buyers have started paying you more once you started to use cold chain facilities? How much extra? (I have started to earn 10% more, earnings have increased by 50%, no change in earnings..)

Now think of the time when you did not have cold containers, answer the following questions and compare them with the current times. Ask the following questions for each crop type.

| | Type of crop (Leafy green / root vegetables etc.) | Before using cold chain | After using cold chain |
|---|---|---|---|
| Average selling price of [CROP] (kina/kg or kina/bag) | | | |
| Number of bags or volume supplied to buyer? | | | |
| Spoilage rate (bags lost or % of total bags) | | | |
| Storage days possible before spoilage and transporting it to buyers (shelf life?) | | | |
| Transportation cost to and from Lae - Highlands | | Dry container transport cost ___ | Cold storage container / reefers transport cost _____ |

What are some other benefits? (cost savings, improved price, better able to fulfill contracts, less risk of default, attract more buyers)

Did you change crops grown because of access to cold storage?

If so, which crops did you switch to?

<u>Costs Associated</u>

Now we will discuss the costs associated with operating your cold chain storage facility.

Could you tell me the average kina amount spent per month or per shipment for each expense item?

| Cost item related to cold storage | Kina/month or kina/shipment |
|---|---|
| Rental or ownership cost | |
| Electricity or generator fuel | |
| If they use public grid, what is the cost? | |
| If they use genset, what is the cost? | |

| | | |
|---|---|---|
| Maintenance or repair cost? | | |
| Labor (loading, unloading, monitoring etc.) | | |
| Packaging materials (crates, boxes, etc.) | | |
| Could you tell us about the other costs you incur as an aggregator? (if any) | | |
| Cost | PGK | Unit (per container/bag etc.) |
| Transporting produce from farm to depot | | |
| Unloading from farmer truck at depot | | |
| Loading into chiller at the depot | | |
| Transport to Lae | | |
| Unloading in Lae | | |
| Transport to POM | | |
| Unload in POM | | |
| Driving to supermarkets/hotels/etc. | | |
| Unload at the supermarket/hotel etc.(carrier cost?) | | |

Electricity

Do you use public electricity grid or a genset to cool your reefer or cold storage?

Why [electricity grid or genset]?

How reliable is the electricity supply? (very reliable, 1-2 blackouts a week, frequent blackouts)

Do the reefers get damaged due to power failure? If yes, how?

What do you do if the reefers get damaged? Do you call for maintenance? Who do you reach out to?

How long do you have to wait for the reefers to get fixed?

Transportation to Lae/POM

While transporting the reefers/refrigerated trucks from highlands to Lae, have you experienced any kind of challenges? (for example -temperature failures, unreliable electricity, security, theft etc.)

If so, how often do these problems happen?

After reaching Lae, does the same reefer get on the ship to reach POM? Or do you hand the produce to the big aggregators in Lae?

If not, have you experienced any challenges transporting the produce from Lae to POM using reefers on ship?

If so, how often do these problems happen?

Do you use any other tools or ways to monitor temperature of the reefers/ refrigerated trucks when it is in transit from Highlands to Lae and/or Lae or POM? If yes, what? How much do you spend on these tools per shipment?

Availability of reefers and comparison with dry containers

Are the chiller containers easily available?

Is it easy to get a dry container or chiller container? Where do you get dry containers from? Where do you get the chiller containers from?

How much time do you have to wait to retrieve a chiller container? (days, months, weeks)

How much time do you have to wait to retrieve a dry container?

If the chiller container is not available, do you use dry containers for storage and transportation?

When you procure the cold container from Lae (or anywhere else). Does it come empty to Highlands, or do you fill the container in Lae to bring products to highlands? If yes, then which products

Do you think your labor cost has increased since the time you have started to use cold storage containers or is it the same when you were using dry containers? Why?

Other

Based on your experience, do you think the benefits of using cold containers outweigh the cost associated with it? Why?

What would make cold containers operations more profitable or sustainable? (lower rental fee, more reliable electricity, better access to shipping, better road conditions, government or project support, more availability of cold containers, a greater number of buyers, insurance (explain), etc.)

If given an opportunity, would you expand your cold chain operations? If yes, what would you expand (buy new cold containers, buy gensets for cold containers, store new crops, increase number of suppliers, increase number of buyers etc.)

Do you think more investment is needed in cold chain for your region? Where should these investments be made?

Would you prefer to have a cold chain depot in your area where you can drop off the aggregated produce from your premise , and then the depot takes care of transporting it to buyers in Lae or POM. This would imply that your work will end once you deliver the produce to depot.

Why do you think other lead farmers or aggregators NOT invest in cold storage? (high investment cost/ final buyers do not care if the lead farmer uses cold containers to transport produce/ not needed for certain crops etc.)

Can different lead farmers share the cost of one cold container? Why or why not?

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