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Meeting the Demand for Fresh Produce from the PNG LNG Market: Opportunities and Challenges

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Abstract

The US\$15 billion investment in the PNG LNG project has been making headlines since its inception in 2006. The Project was forecast to generate significant export revenues and to generate much positive impact on the PNG economy for the coming 30 years. The demand for fresh produce was forecast to increase significantly to feed the substantial labour force at the project sites as well as in other supporting sectors. The objectives of this study were to estimate the requirements of the LNG project for fresh produce and to determine the potential for PNG farmers and supply chain operators to supply the Project. In this study, we estimated that demand for fresh produce from the PNG LNG market to be in the order of 130 tonnes a week (or 20 tonnes a day) at the peak of the construction period from 2012-2013, valued at 500,000 kina (or A\$250,000) per week to local communities *if* the LNG market for fresh produce could be captured completely by local supplies. However, during the construction phase, nearly 80% of this demand would most likely to be met by imports because of concerns over quality, variety and consistency in supply of local produce. In addition, after the initial construction phase and by 2014, demand for fresh produce from the PNG LNG market would be reduced to around 2 tonnes a week during the operational phase due to a significant reduction in labour force. This means the impact of the PNG LNG project on the local fresh produce industry is not only short-term but uncertain, depending on the ability of local suppliers to meet buyers' requirements for quality, variety and consistency in supply, which, in turn, will depend on whether long-standing supply chain issues can be addressed adequately and quickly by government and industry. Failing to do that, local suppliers will miss the opportunity to supply to the huge LNG market in the same way they have missed supplying to higher value formal markets.

Key words: PNG LNG project, demand, fresh produce, supply chain

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Introduction

The US\$15 billion investment in the PNG liquefied natural gas (LNG) project has been making headlines since its inception in 2006. The Project was forecast to generate enormous export revenues and to impact significantly and positively on the PNG economy over the coming 30 years (2010-2043). The demand for fresh produce was forecast to increase significantly to feed the substantial labour force at the project sites as well as in other supporting sectors. The objectives of this study were to estimate the requirements of the Project for fresh produce and to determine the potential for PNG farmers and supply chain operators to meet those requirements. The specific objectives of the study were:

- to estimate the demand for key fresh produce items from the LNG market;
- to identify potential supply sources (highlands produce, local produce, imports, etc);
- to identify main supply chain issues; and
- to derive policy implications for the PNG fresh produce sector.

Methodology

Both qualitative and quantitative methods were used in this study. They included: desktop research; field research; and personal interviews of key supply chain players. The literature review focused on the operations of the PNG LNG Project and its projected socio-economic impacts and lessons learnt from previous mining projects in PNG. Field research was conducted to better understand the agricultural environments and the potential of the Southern Highlands, especially in the Project Impacted Areas of Hides/Komo, to supply the nearby LNG Project sites.

We also interviewed the following groups and organisations: fresh produce buyers and wholesalers in the Hagen market; drivers of delivery trucks; catering companies at the Ok Tedi Mines in Tabubil and at the University of Papua New Guinea (UPNG); National Catering Services and The Alliance Group (TAG) in Port Moresby; and two landowners companies (Komo Umbrella Joint Venture Ltd in Komo and Laba Holdings in Laba). In addition, we also collected and analysed data on actual fresh produce purchases by UPNG, Nogoli Camp, Porgera Mines and Ok Tedi Mines, as well as demand forecasts produced by TAG and the Laba Alliance, the two major catering services to the PNG LNG project.

Overview of the PNG LNG Project

The PNG LNG Project is operated by Esso Highlands Limited (EHL), a subsidiary of Exxon Mobil Corporation. The co-venture partners are: Exxon Mobile (33.2%); Oil Search (29%); Santos (13.5%), Nippon Oil (4.7%); Eda Oil (Petromin PNG Holdings, 0.2%); Mineral Resource Development Corporation (MRDC, landowners, 2.8%) and Independent Public Business Corporation (GoPNG, 16.6%) (EHL, 2008). The equity share of the PNG government and landowners accounts for a little less than 20 per cent of total investment in the PNG LNG Project. This means that although the potential returns from the direct investment in the PNG LNG project could be quite high, it is also of high risk and high cost to the PNG economy given the precarious nature of resource development projects.

As proposed, natural gas will be extracted from the Southern Highlands and Western Provinces of PNG, especially the Hides, Angore and Juha gas fields and the Kutubu, Agogo, Moran and Gobe Main oil fields. Natural gas will be conditioned in the PNG Highlands and then transported by gas pipeline to an LNG plant located approximately 20 kilometres northwest of Port Moresby, where the gas will be liquefied. Figure 1 shows the locations and facilities along the LNG pipelines from the highlands to Port Moresby.

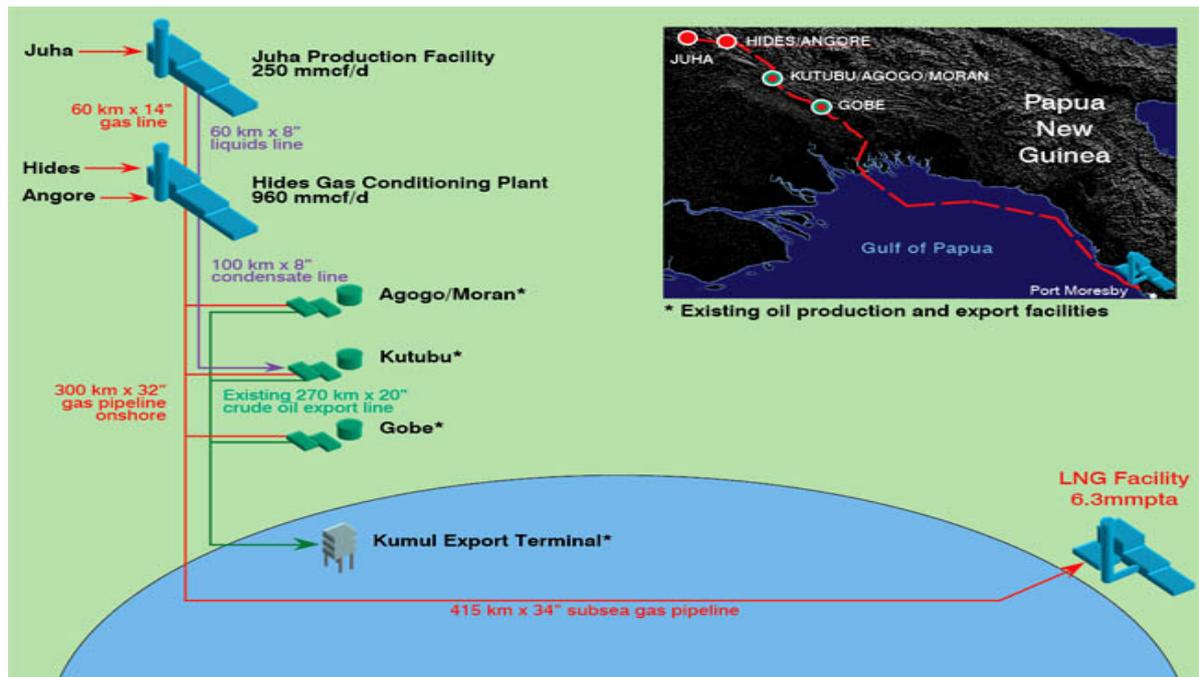


Figure 1. Locations and facilities of the PNG LNG project

Source: EHL (2008).

Liquefied natural gas (approximately 6.3 million tonnes per annum (MTPA)) will then be loaded onto ocean going LNG tankers and delivered to four major international buyers, including Chinese Petroleum Corporation (Taiwan, 1.2 MTPA), Osaka Gas Company (Japan, 1.5 MTPA), Tokyo Electric Power Company (Japan, 1.8 MTPA) and Unipac Asia Company (Sinopec of China, 2.0 MTPA).

The construction of necessary physical infrastructure commenced in March 2010 and is due to be completed by 2013 and the first LNG deliveries are scheduled to commence in 2014. The Project will have an expected operational life of 30 years. It will transform the PNG economy, boost the country's GDP and export revenues, and create significant employment and business opportunities for PNG people (ACIL Tasman, 2009). Projected impacts on the PNG economy and the agricultural sector are highlighted below:

Macroeconomic impact

The macroeconomic impacts of the PNG LNG project are expected to be very large and mainly positive (ACIL Tasman, 2009). They include:

- GDP: an increase in the range of 97 to 99 per cent;
- Private and public consumption: an increase in the range of 85 to 107 per cent;
- Aggregate employment: an increase in the range of 42 to 45 per cent;
- Foreign currency exports: an increase of around 106 per cent;
- Inflation¹: will increase (but no specific number was reported); and
- Exchange rate: an increase in the range of 9 to 11 per cent.

Impact on the agricultural export sector

The impact on agriculture is also large, but not positive. Agricultural outputs and rural employment were forecast to decrease quite significantly, except for food processing. Specifically, the potential impacts on agricultural outputs are:

- Food processing: an increase in the range of 16.2 to 31.5 per cent;
- Smallholder coffee: a decrease of 13.4 per cent;
- Plantation coffee: a decrease in the range of 7.4 – 9.2 per cent; and

¹ Inflation in PNG was 6% in 2010 and was 8.4% in 2011 (IMF, 2012).

- Smallholder and plantation cocoa, palm oil and copra: a decrease in all cases.

Impact on rural employment:

- Rural skilled labour: a decrease of 10-12 per cent; and
- Rural unskilled labour: a decrease of 22-23.5 per cent.

Unfortunately, there is no report on the subsistence or the fresh produce sectors.

The main reason for the projected downturns in the agricultural export sector is the appreciation of the PNG Kina due to capital inflows. This makes tradable goods, notably agricultural export commodities in PNG (coffee, cocoa, palm oil and copra), less competitive in the world market. This is because a strong PNG Kina will make PNG exports appear to be more expensive to overseas buyers when prices in Kina are converted to foreign currencies. The decrease in agricultural exports and consequently even greater dependence on the natural resource sector will leave the PNG economy vulnerable to resource commodity price changes in the world market. These potential adverse effects are typical of the so-called “Dutch Disease” that has been noted in several countries (e.g., Netherlands, Saudi Arabia, Nigeria, and Mexico), where large resource projects have led to strong capital inflows and exchange rate appreciation which hurt commodity exports and the manufacturing sector (Perkins, et al., 2001, pp.643-651). The Australian resources boom in recent years, whereby the Australian dollar appreciated more than 45 per cent between 2009 and 2011, from 0.75 cents to over parity against the US dollar, is a case in point. Both the Australian agricultural and manufacturing sectors have suffered greatly as a result. These potential economic stresses will need to be anticipated and managed effectively through government programs that provide direct assistance to the agricultural sector and facilitate structural adjustment (ACIL Tasman, 2009).

Impact on the fresh produce sector

No specific information on the fresh produce sector was provided in the ACIL Tasman report. However, several observations can be made, including:

- Demand for fresh produce will increase both from the employment directly related to the Project and from the general population due to increases in national and personal incomes and spending.
- A strong Kina and general inflation are expected to make imported products cheaper, and hence, encourage imports.
- The increase in demand for fresh produce will be met both by locally-produced and imported products.
- Imported inputs (seeds, fertilisers, agrochemicals, farming equipment and machinery, etc) will become cheaper and hence there will be an increase in the demand for those inputs (if the savings are passed on to farmers), which, in turn, will increase the supply of fresh produce.
- Lower commodity prices and surplus rural labour from the export sector would re-direct resources into fresh produce production, thus increasing the supply of fresh produce.
- An increase in fresh produce production can lead to a drop in price, *if* the supply increase is not absorbed by an increase in demand.

There is no doubt that demand for local fresh produce will increase during the construction period of the LNG Project. What is less certain is: From where will the majority of fresh produce be sourced? Can local produce compete with imported products in terms of price, quality, variety and consistency in supply? Will issues of lack of basic infrastructure continue to be a major constraint to the improvement needed in fresh produce supply to enable it to be competitive with imports?

Overall assessment

The LNG project was forecast to have a significant impact on the PNG economy as a whole. However, its social and environmental impacts are less clear. Several reports have reviewed the track records of previous extractive activities in PNG and found negative and distressing results (eg, CIDSE, 2009; The World Bank Group, 2002; Membup and Macintyre, 2000). These reports found that in the majority of cases examined local communities had not benefited economically from mining and oil projects, while also suffering hugely on environmental and social fronts.

The main issues identified included:

- compensation and loyalty payments were often mis-managed by landowners and government and not invested in social and economic development programs as planned;
- environmental damage and loss of biodiversity due mainly to pollution of waterways;

- mining transformed the community from subsistence farming to a consumer economy with many people ceasing farming as a result;
- extra and “unearned” income and idle labour led to excessive alcohol consumption that fuelled alcohol-related crimes and violence (often against women);
- welfare dependency mentality with an expectation that the mining company should provide for all their needs;
- law and order problems resulting from the arrival of outsiders seeking jobs and other (illegal) opportunities; and
- sustainable agricultural and community development projects if and when implemented were not initiated early in the project life but towards the stage of mine closures when irreversible damages had already been done.

These comments are consistent with our observations made from our field research in Hides/Komo, confirming that most village people living in and around the project impact sites are not better-off economically because of the inequitable distribution of benefits, while their quality of life has been greatly reduced. As one elderly woman living right next to the camp in Hides 4 put it simply, “My life is disturbed”, shaking her head in despair. This is because of the constant noise and dust around her house. In return, she received little except some food rations (rice and tinned fish), and some vegetable seeds, which she said she did not know how to use.

There is also concern about the resource curse falling upon PNG. “Resource curse” (Paradox of Plenty) refers to the paradox that countries and regions blessed with abundant natural resources tend to have less economic growth and worse development outcomes than countries with fewer natural resources (Weinthal and Luong, 2006; Togolo, 2006). This is specifically true for countries rich in non-renewable resources like minerals, precious metals, and oils. Reasons behind the resource curse include: a decline in the competitiveness of other economic sectors (caused by the appreciation of the real exchange rate), volatility of revenues from the natural resource sector due to exposure to global commodity market swings, government mis-management of resources, and weak, ineffectual, unstable or corrupt institutions. The latter two often allow resource revenues to be diverted from their intended use to less productive programs and projects or other unlawful activities for personal gains (Fischer, 2007).²

Regarding the potential impact of the PNG LNG project on PNG, ACIL Tasman (2009) concluded that:

“... in order to successfully manage the impacts and sustain the very large net benefits associated with the LNG project, the Government will need to accelerate reforms in the area of governance. Large resource projects create opportunities for rent-seeking and corrupt behaviour amongst stakeholders, government bureaucrats and politicians which, if not properly addressed, can result in conflict, discord and, in extreme cases, civil war... This implies a need for transparency in the disbursement and use of revenues accruing from the project. Finally, fiscal discipline, sound monetary policy and structural reform will be required if the recent improvements in the economy are to be maintained and full advantage is to be taken of the opportunity for sustained economic development offered by the PNG LNG project.”

² It is believed that a sovereign wealth fund (SWF) in resource rich countries can help avoid the resource curse. An SWF is a state-owned investment fund typically created when governments have budgetary surpluses or when governments are unable to spend the money immediately because of capacity constraints or concerns over overheating the economy if too many funds are injected into the economy all at once (Department of Treasury and Bank of Papua New Guinea Joint Sovereign Wealth Fund Working Group, 2010). This is especially the case when a nation depends on raw material exports like oil, copper or gold. SWFs funds are normally invested globally in financial assets, stocks, bonds, property, business, precious metals, foreign currencies and other financial instruments. The main reason for creating an SWF is for stabilisation purposes because of the uncertainties surrounding resource revenues, such as high volatility of resource prices, unpredictability of extraction and exhaustibility of resources. Whether an SWF will work for PNG or not will depend largely on how it is designed and managed (Department of Treasury and Bank of Papua New Guinea Joint Sovereign Wealth Fund Working Group, 2010; IMF 2010).

The Southern Highlands

According to Papua New Guinea's national 2000 census, the total population of the Southern Highlands is 546,265 spread across 23,800 square kilometres (9,189 square miles), which makes it the most highly populated province in the country (Hanson, et al., 2001).³ Its provincial capital is the town of Mendi.

The regions and districts

The Southern Highlands Province is divided into roughly four distinct geographic regions:

- The West: includes the districts of Tari, Koroba, Kopiago and Komo - the home of the Huli, Duna, and Hewa peoples.
- The Centre: includes the districts of Margarima, Nipa, Mendi and the Lai Valley, and is the home of the speakers of dialects of the Anggal Heneng language.
- The East: includes the districts of Kagua, Lalibu, Pangia and Erave, and is the home of the speakers of the Imbongu, Kewa, and Wiru languages, and home to the second highest mountain in Papua New Guinea, Mount Giluwe.
- The Lowlands: stretching across the southern part of the Southern Highlands Province from the volcanic peaks of Mount Bosavi to include the oilfields of Lake Kutubu, and includes the language groups of Biami (shared with Western Province), Foe, and Fasu.

The Project Impacted Areas are located in the West and the Lowlands regions.

Supply potentials to the PNG LNG fresh produce market

In this section, a simple SWOT (strengths, weaknesses, opportunities and threats) analysis is used to assess the potential for the Southern Highlands/Hela Provinces to supply fresh produce to the LNG camps in the Hides/Komo areas. Given its proximity to the demand areas, local people appear to have a marketing advantage (clearly a strength), compared with suppliers in the Western Highlands and Enga Provinces, which are at least 7-9 hours drive away. However, on closer examination, the prospects for the locals to be potential fresh produce suppliers to the PNG LNG project do not appear promising.

The main problems (weaknesses and threats) are:

- Low to very low land potential and limited potential for agricultural development (except the Tari plains): rugged mountains and steep slopes, altitudes (600-3500m), high rainfall (2400 to 4000 mm per year), poor soils, frequent cloud cover and low temperatures (Hanson et al. 2001). Because of these environmental constraints, the Southern Highlanders are not farmers traditionally. The supply issue is evident at the Tari or Mendi market where little marketable surplus was available for sale.
- Southern Highland communities generally lack the technical knowledge to grow vegetables for marketing purposes, especially introduced (temperate) vegetables. Transforming non-farmers into commercial farmers is no easy task. It involves improvements in technical skills, as well as a change in mindset from production orientation to market orientation. The natural progression seems to be from subsistence farmers selling marketable surpluses (most likely starting at the local open market), to gradually becoming sufficiently skilful both in commercial production and marketing, usually after some considerable time, to be able to meet stringent market requirements for quality and consistency in supply. There does not seem to be enough resources or time to allow for such transformation in the LNG project-impacted areas.
- Compensation payments and food rations provided by the mining companies provide no incentive for the locals to learn and to grow fresh produce, perhaps for the first time. This state of affairs has been demonstrated by what has happened to Porgera, Ok Tedi, Lihir and Misami mines and the Kutubu oil project where locals have abandoned little agriculture that existed before and live mainly on store goods. As discussed earlier, one aspect of the resource curse is that landowners

³ In July 2009, the PNG Parliament passed legislation to create two new provinces by 2012. One of these is to be created by removing the districts of Tari-Pori, Komo-Magarima, and Koroba-Kopiago from the Southern Highlands Province to form the new Hela Province, where the main LNG project impacted areas are located.

in most cases have little economic incentive to work or to produce vegetables (either for themselves or for the market) because of easy cash on hand. There is no reason to expect the Southern Highlanders to be an exception.

- Women and women's groups are potential fresh produce suppliers, but they have no ready access to land or support from the family, especially the men, and at present they do not have the technical skills required to grow quality produce for marketing purposes.
- The region is sparsely populated with scattered homes and there is little indication of communal society. Strict boundaries between neighbours marked by meters-high mud walls and surrounding ditches will limit the potential for collective action to access the market and for increasing fresh produce production beyond the need for subsistence.
- Law and order and safety concerns. The highway between Mendi and Tari has been frequently blocked by criminal activities and tribal fighting and hence interrupting the deliveries of supplies and mining equipment to the project areas. The law and order problems pose serious threats to the stability of fresh produce supply to the project areas.

Given that the problems (weaknesses and threats) facing Hides/Komo and nearby communities seemingly far outweigh the opportunity being created by the PNG LNG Project and their locational advantage, it can be concluded that the potential for local residents to supply fresh produce to the PNG LNG project in sufficient amounts would be quite limited. However, the lack of a competitive advantage in supplying fresh produce does not rule out other potential business opportunities for the locals to benefit from the PNG LNG project, such as large-scale broiler, egg or pig production (Lutulele 2010), or some other non-agricultural activities, e.g., accommodation and tourism.

Demand for fresh produce from the PNG LNG market

There are several methods by which demand can be estimated. For example, demand equations can be estimated econometrically based on historical data and used to forecast future demand using some assumed values for key variables, such as income, population, prices, and demographic variables. Another choice is the use of equilibrium displacement models, either partial or general equilibrium. In this case, the model would have sets of stylised demand and supply equations for each of relevant commodities and sectors. Changes in demand (and supply) can then be forecast through simulations using baseline data and estimated demand and supply parameters, such as price and income elasticities. A third alternative, which is less time-consuming and requires less data, is extrapolation. An example of extrapolation is the Feeding Port Moresby Study (FPDA, 2008), whereby total fresh produce demand in Port Moresby was derived based on the average per capita consumption of fresh produce in urban areas (Gibson 2001) and projected population in Port Moresby. Using extrapolation, the essential information required for this study is the average per capita consumption and the population of interest.

Estimating the labour force at the PNG LNG Project sites

Employment from the PNG LNG Project in the highlands (the upstream area) was estimated to be up to 7,500 full-time jobs during the initial construction phase and around 20% of them would be for PNG nationals while at the operational phase, around 850 full-time equivalent positions would be required with the majority of those positions being held by PNG nationals (ACIL Tasman, 2009). The initial construction phase of the LNG Project in the upstream area began in March 2010. The size of the workforce was forecast to increase gradually in the period 2010-2011 and then to increase rapidly in the period 2012-2013 when there will be up to 8500 beds in camps in the upstream area. Projected employment in the upstream area during the construction period from 2010-2013 is shown in Figure 2. Note the changes in the employment figures as the project progresses. Based on the figure, the current employment level in the highlands would be around 5000.

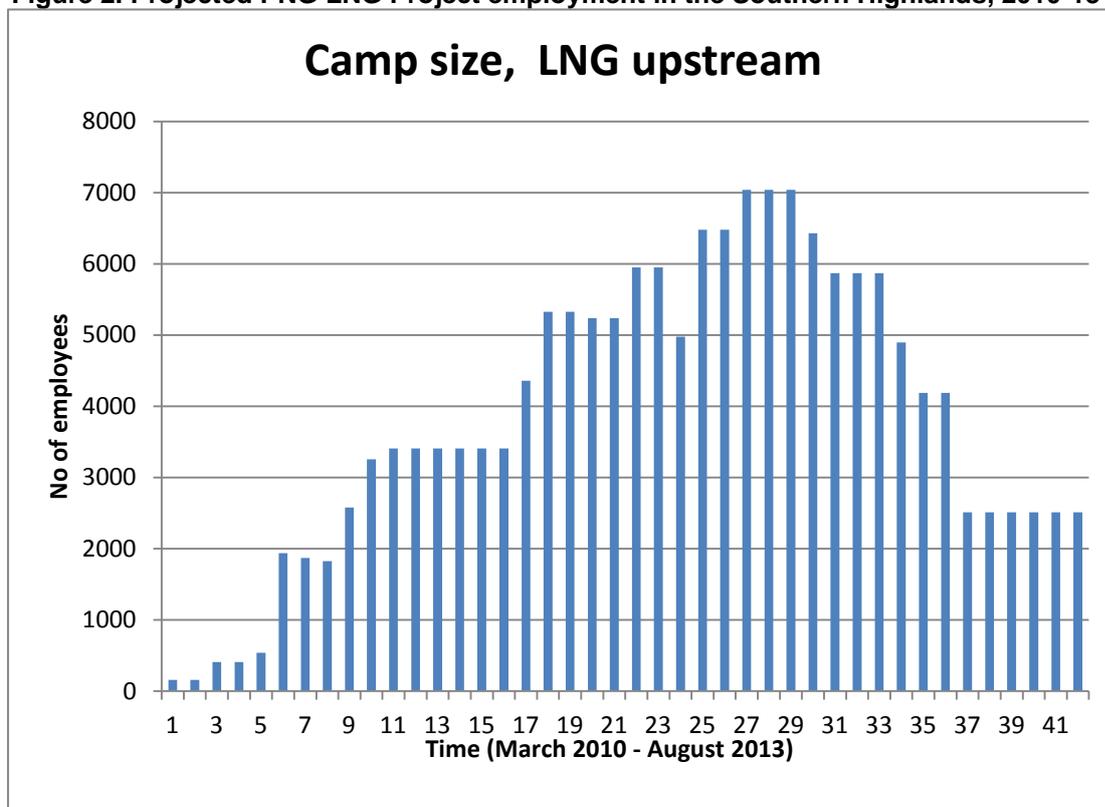
At the Port Moresby LNG Plant Site (the downstream area), the demand for labour in the peak construction period of 2012-2013 was estimated to be 10,000-12,000 of camp residents (The Alliance Group, 2011).

In total, during the peak period of 2012-2013, there would be up to 20,000 camp residents to be fed 3 meals a day, plus an additional up to 4500 day workers who would require only lunch. At the operational phase, the employment will drop significantly to around 1000 at the Port Moresby LNG Plant site and around 850 in the highlands.

Estimating per capita demand for fresh produce

To estimate per capita demand, actual purchases data from several existing camps were collected and analysed. Catering services and mine sites from which data have been collected include: Nogoli Camp (Eurest PNG), Kutubu (Eurest PNG), Porgera (iPi Mountain Catering), Ok Tedi (Fubilan Catering), and UPNG (Eurest PNG).

Figure 2. Projected PNG LNG Project employment in the Southern Highlands, 2010-13



Source: ACIL Tasman (2009).

Nogoli camp in Hides. The catering services at the Nogoli Camp are managed by Eurest PNG. The total quantity of fresh fruit and vegetables supplied to Nogoli per week is 1,150 kg for 180 people. This means the average per capita consumption per week is 6.39kg.

Kutubu camps. There are three camps in the Kutubu area that are run by Oil Search and EHL. These Kutubu camps, catered also by Eurest, purchased about 10 tonnes of fresh produce per week to feed 1600 people. This means the average per capita consumption per week is 6.25kg.

Porgera Mines. Porgera is catered by the iPi Mountain Catering. Its fresh produce requirement is around 20 tonnes a week for about 3000 people.⁴ These figures translate into 6.67kg/person/week.

Ok Tedi Mines. Ok Tedi camps are catered by Fubilan Catering – a landowners’ company. In January 2011, 54.3 tonnes of local produce was received by Fubilan Catering. This is supplemented by container loads from Port Moresby (originating from Hagen or Australia/New Zealand). There were approximately 2000 camp residents. This translates into an average per capita consumption per week of 6.78kg. Table 1 summarises the results for estimated per capita fresh produce consumption.

Table 1. Fresh produce demand at Nogoli, Kutubu, Porgera and Ok Tedi

	Total demand	No. of people	Average/week
Nogoli Camp	1,150kg/week	180	6.39kg/week
Kutubu	10,000kg/week	1,600	6.25kg/week
Porgera	20,000kg/week	3,000	6.67kg/week
Ok Tedi	54,300kg/month	2,000	6.78kg/week

⁴ In 2009, there were 2,500 employees and 500 contractors, with approximately 87% of them being PNG nationals (Wikipedia, n.d.).

Total	44,725kg/week	6,780	6.60kg/week
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Estimating total demand for fresh produce from the PNG LNG Project

Based on the data collected, we obtained the two key parameters required to estimate the total demand, i.e.,

- Average per capita consumption of fresh produce per week is 6.6kg; and
- Total employment at the peak period during the construction period is up to 20,000 camp residents plus up to 4500 day workers.

By multiplying the two numbers together, we have an estimate of 120 – 130 tonnes/week

Table 2. Estimated total demand for fresh produce from the PNG LNG project

Per capita demand	Number of camp residents ⁵	Total demand
6.6kg/person/week	18,000-20,000	120 – 130 tonnes/week

These estimates are comparable to those provided by main catering companies to the PNG LNG project, as well as other sources. For more details, see Appendix A.

As indicated in Table 2, the total demand for fresh produce from both the upstream and downstream areas of the LNG Project at the peak period would be close to 130 tonnes per week, or a little less than 20 tonnes per day. The estimated value of supply of this volume is around K500,000 per week (around A\$250,000/week at an exchange rate of A\$1=K2), assuming an average value of K3.50-K4.0/kg (approximately A\$1.75/kg to A\$2/kg). Based on the relative size of camps in upstream and downstream camps, forty percent of total demand will go up to the Highlands (roughly 50 tonnes/week) and the remaining sixty percent (roughly 80 tonnes/week) will be delivered to Port Moresby.

The next questions of great interest are: What items would be purchased? And from where would the supply come? To help answer these questions, again we look at what could be learned from existing mine sites.

Fresh produce supplies to existing mining camps

Types of fresh produce purchased

Actual fresh produce purchases from Porgera, University of PNG, Ok Tedi and Nogoli Camp are presented in Table 3. The data have been ranked so that the main items, in terms of volume, appear on the top of the table. For example, for Porgera, the top 5 items are: eating banana (E/babana), potato, sweet potato, cabbage and broccoli. For UPNG, the top 5 items are: potato, cabbage, pawpaw, pineapple and sweet corn. For Ok Tedi, the top five items are: cabbage, cooking banana (C/banana), pineapple, Chinese cabbage (Chi/cabbage) and sweet potato.

Table 3. Actual fresh produce purchases at Porgera, UPNG, Ok Tedi and Nogoli

Porgera	%	UPNG	%	OK Tedi	%	Nogoli	%
E/banana	18.02	Potato	16.44	Cabbage	23.57	E/banana	17.39
Potato	14.41	Cabbage	13.24	C/banana	13.50	Pawpaw	13.04
Sweet potato	11.53	Pawpaw	9.25	Pineapples	10.24	Potato	10.65
Cabbage	7.21	Pineapple	9.14	Chi/cabbage	9.62	Sweet potato	6.52
Broccoli	6.49	Sweet Corn	8.01	Sweet potato	7.54	Pumpkin	5.35
Carrot	5.41	E/banana	7.01	Carrot	5.20	Taro	5.00
Oranges	5.05	C/banana	6.19	Pumpkin	3.96	Guava	4.35
Pumpkin	4.32	Sweet potato	5.77	E/banana	3.08	Cabbage	3.91
Tomato	3.24	Carrot	4.17	Watercress	3.07	Pineapple	3.91

⁵ Note that demand for fresh produce from the day workers is not presented separately in Table 2. This is because it is assumed that their requirements are already included in the average per capita consumption for camp residents (since the data we have do not make the distinction). In addition, it is assumed that the number of day workers is in fixed proportions to the number of camp residents so that they increase by the same proportions.

Pineapple	2.88	Taro	4.06	Spring onion	2.78	Aibika	3.48
Taro	2.88	Bulb onion	2.78	Lettuce	2.74	Choko fruit	3.48
Cauliflower	2.88	Tomato	2.15	Aibika/ Pitpit	2.08	Watercress	3.48
Bulb onion	2.16	Broccoli	1.38	Cabbage red	2.02	Lettuce	3.04
Lettuce	1.73	Watermelon	1.31	Broccoli	1.90	Onion	3.04
Cucumber	1.59	Pumpkin	1.15	Cucumber	1.45	Carrots	2.61
Chi/cabbage	1.44	Oranges	1.00	Choko tips	1.09	Tomato	2.17
Spring onion	1.30	Melon	0.98	Corn	1.07	Zucchini	1.52
Pawpaw	1.08	Capsicum	0.92	Pawpaw	0.96	Chi/cabbage	1.30
Mandarin	1.08	Spring onion	0.86	Chinese taro	0.65	Silver beet	1.30
Silver beet	0.94	Cucumber	0.78	Potatoes	0.54	Eggplant	1.22
Eggplant	0.65	Cauliflower	0.70	Celery	0.51	Capsicum	1.09
Capsicum	0.58	French bean	0.64	Zucchini	0.51	Corn	0.87
Avocado	0.54	Aibika	0.55	Tomatoes	0.37	Spring onion	0.65
Tamarillo	0.50	Sugar fruit	0.52	Beans	0.30	Lemons	0.43
White radish	0.43	Cassava	0.43	Capsicum	0.30	Ginger	0.09
Zucchini	0.36	Lettuce	0.23	Lillia	0.22	Parsley	0.09
Sugar fruit	0.29	Eggplant	0.06	Passion fruit	0.22	Asparagus	0.00
Asparagus	0.29	Zucchini	0.06	Avocado	0.11	Basil	0.00
Choko tips	0.29	Chi/cabbage	0.00	Local orange	0.11	Bean, broad	0.00
Ginger	0.22	Mandarin	0.00	Tamarillo	0.10	Green bean	0.00
Lemon	0.22	Silver beet	0.00	Parsley	0.09	Bean, winged	0.00
Sweet corn	0.00	Avocado	0.00	Spinach	0.07	Broccoli	0.00
Watermelon	0.00	Tamarillo	0.00	Ginger	0.01	Brus/sprouts	0.00
French bean	0.00	White radish	0.00	Lemon	0.00	Cauliflower	0.00
Celery	0.00	Asparagus	0.00	Cauliflower	0.00	Celery	0.00
Chilli pepper	0.00	Choko tips	0.00	Eggplant	0.00	Choko tips	0.00
Choko fruit	0.00	Ginger	0.00	Leeks	0.00	Cucumber	0.00
Garlic	0.00	Lemon	0.00	Radishes	0.00	Garlic	0.00
Guava	0.00	Celery	0.00	Turnip	0.00	Lemon grass	0.00
Kang Kong	0.00	Chilli pepper	0.00			Peas	0.00
Leek local	0.00	Choko fruit	0.00			Radish	0.00
Green peas	0.00	Garlic	0.00			Avocado	0.00
Parsley	0.00	Guava	0.00			Mandarin	0.00
Rhubarb Local	0.00	Kang Kong	0.00			Oranges	0.00
Saladia	0.00	Leek local	0.00			Passionfruit	0.00
Strawberry	0.00	Green peas	0.00			Raspberries	0.00
Sugarcane	0.00	Parsley	0.00			Rockmelon	0.00
Cherries	0.00	Rhubarb local	0.00			Strawberries	0.00
Watercress	0.00	Saladia	0.00			Sugar fruit	0.00
Wongbok	0.00	Strawberry	0.00			Tree tomato	0.00
C/banana	0.00	Sugarcane	0.00			Watermelon	0.00

For Nogoli Camp in the PNG LNG project area, the purchase order consists of 21 types of vegetables and five types of fruit. The major items in terms of volume are: eating banana, pawpaw, potato, sweet potato, pumpkin, taro, aibika, cabbage, choko fruit, lettuce, onion and carrot. Clearly, the menu of this kind caters mainly to PNG nationals as it contains a significant amount of traditional PNG staple foods, such as sweet potato and taro, and local vegetables, such as aibika, pumpkin tips and choko tips. By comparison, introduced or salad vegetables that are featured more prominently in the Western diet, such as lettuce, tomato, celery, carrots, mushroom, cucumber, broccoli, capsicum, cauliflower, etc. seem to be lacking. Also lacking, as shown at the bottom of Table 3, are citrus fruit and spices such as ginger, chilli pepper, garlic, etc.

Sources of supplies

Fresh produce supply to the Nogoli Camp in Hides is supplied by a middleman from the Hides who sources mainly from wholesale markets in Western Highlands, Enga and Simbu Provinces through his buying agents located in those areas, especially in Mt Hagen. The areas from which fresh produce originates include the following:

- Western Highlands Province: Dei Council area, Kelawi, Baiyer Valley, Banz, Hagen Central, Kindeng, Avi, Kudjip, Christian Leaders Training College (at Banz).
- Enga Province: Wapenamanda and Sirunki Plateau.
- Simbu Province: upper Chimbu Valley.

Some sweet potato, Chinese taro, taro, and pawpaw are sourced from the local Nogoli area.

Fresh produce supplies to Porgera and the Kutubu/Moro areas again came mainly from the Western Highlands Province, rather than locally. For Ok Tedi, supplies were flown in from Telefomin/Oksapmin/Bimin/Gana (10-15 tonnes/week) and Hagen (2-3 tonnes/week).

These results are not surprising since people in the Project Impacted Areas of Porgera, Ok Tedi and Kutubu are not vegetable growers by tradition, except for the production of sweet potato. Not only are they not familiar with vegetable production in general terms, but also they have no incentive to engage in it to supply themselves or the mines once compensation payments are received from the mines. Similar outcomes can be expected from the people in Hides/Komo/Laba along the PNG LNG pipelines. This means that the majority of fresh produce supplied to the PNG LNG market would continue to come from the established production areas in Western Highlands, Chimbu, Eastern Highlands, and Enga Provinces.

Fresh produce supplies in the Mt Hagen market

A survey was conducted in the Hagen Market in May 2011. Thirteen (13) wholesalers and buying agents who supply vegetables to various project areas and institutions around the country were interviewed and the type and amount of vegetables they bought recorded. Of these 13 buyers, three buyers have been supplying to the Hides/Komo PNG LNG Project areas, five supplying Kutubu camps, three to Porgera mines and two to Port Moresby supermarkets. The buyers interviewed were either using their own vehicles or hired vehicles for the transportation of produce to various catering services at the project sites. Buyers supplying the Hides/Komo areas hire vehicles for K 3,500 one way for a three-tonne truck, while those supplying Porgera and Kutubu camps hire at rates between K2,500 and K3,000 a trip depending on the tonnage and the size of the truck. Vegetables and fruit supplied at the Hagen market, ranked in terms of volume, are provided in Table 4.

Table 4. Weekly fresh produce supply at the Hagen Wholesale Market, WHP

Items	Kg	%
Potato	5849	14.82
Eating banana	3250	8.23
Sweet potato	2974	7.54
Cabbage	2419	6.13
Tomato	2219	5.62
Broccoli	2000	5.07
Carrot	1760	4.46

Chinese cabbage	1750	4.43
Pumpkin	1610	4.08
Pineapple	1530	3.88
Bulb onion	1399	3.54
Lettuce	1336	3.39
Taro	1299	3.29
Cauliflower	1260	3.19
Oranges	1250	3.17
Pawpaw	860	2.18
Capsicum	754	1.91
Cucumber	720	1.82
Spring onion	655	1.66
French bean	560	1.42
Mandarin	550	1.39
Zucchini	549	1.39
Eggplant	409	1.04
Watercress	300	0.76
Choko tips	290	0.73
Silver beet	290	0.73
Avocado	245	0.62
Ginger	220	0.56
Cooking banana	200	0.51
Lemon	195	0.49
Sugar fruit	159	0.40
Watermelon	150	0.38
Asparagus	145	0.37
Sweet corn	100	0.25
Tamarillo	70	0.18
Parsley	62	0.16
White radish	60	0.15
Garlic	20	0.05
Celery	0	0.00
Chilli	0	0.00
Choko fruit	0	0.00
Guava	0	0.00
Kang kong	0	0.00
Leek local	0	0.00
Green peas	0	0.00
Rhubarb local	0	0.00
Saladia	0	0.00
Strawberry	0	0.00
Sugarcane	0	0.00

Weekly Total	39,468	100
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As can be seen, the weekly supplies from these 13 buyers totalled a little less than 40 tonnes. Clearly there are a few more buyers in the Hagen area that have not been accounted for in the survey. Based on other information sources, there are close to 20 tonnes of fresh produce delivered to Port Moresby weekly, another 12 tonnes to Ramu NiCo while the total supplies to Porgera are around 20 tonnes per week (normally from five to six suppliers rather than the three interviewed). There are also significant amounts being supplied to Wewak and other city centres/mines/PNGDF around the country. When these additional tonnages are accounted for, the total supply of fresh produce from WHP, handled through the formal channel using wholesalers/buying agents (versus through farmer-marketers), was estimated to be around 80-100 tonnes per week. If we also consider the volumes that pass through the Mt Hagen retail market and those sent down to Lae and Port Moresby by farmers themselves, it is likely that the WHP alone has the capacity to meet the peak demand from the LNG market of 120-130 tonnes/week.

In the Mt Hagen market, the top five produce items supplied accounted for 42.34% of the total volumes supplied and included: potato (14.82%), eating banana (8.23%), sweet potato (7.54%), cabbage (6.13%) and tomatoes (5.62%). These were followed by broccoli (5.07%), carrots (4.46%), Chinese cabbage (4.43%), pumpkin (4.08%) and pineapple (3.88%). Together these 10 items account for nearly 65% of the total volumes supplied. On the other hand, as shown at the bottom of Table 4, there is a lengthy list of items that are either not supplied at all, or supplied in small quantities, such as asparagus, celery, chilli pepper, leek, and green peas. These results imply that there is a lack of variety in supply.

Looking at those figures presented in Table 3 and 4, one may wonder: Are the actual purchases demand-driven or supply-driven? That is, whether the high-volume items reflect the demand from the camps, or merely what is available in the market. Why are some items in constant short supply? It appears that some items are in short supply (mostly salad vegetables and spices) because they are not traditional food crops in PNG. Most smallholder farmers would not know how to grow the so-called "introduced" or "exotic" vegetables. In addition, those introduced vegetables are mostly temperate vegetables and are not suitable for hot and humid climate in the tropical lowlands, and hence supplies are limited to certain parts of PNG highlands, especially WHP and EHP. Also, these crops are more difficult or expensive to produce and require purchased inputs (seeds, fertilizers, chemicals), which are relatively expensive and often unavailable when needed. For leafy vegetables, there are added challenges in terms of postharvest management because of lack of warehousing and cool chain facilities. By comparison, traditional food crops such as sweet potato and some introduced vegetables, such as potato, carrot and cabbage, are often in abundant supply, and hence relatively inexpensive, because they are easy to grow and hardier and can better withstand rough handling and long distance transport. As shown in Tables 3 and 4, it is clear that cabbage is among the most supplied produce from the highlands. But, is it really the most preferred vegetable? Or, is it because it is relatively inexpensive and easy to handle?

The tendency to produce traditional and low-cost products is understandable, given that most smallholder farmers are cash poor and lack technical know-how. However, such practices are supply-driven (sell what one can grow), rather than demand-driven (grow what the market wants). It is a concern that what they produce is not what the market wants.

Based on the fresh produce import data supplied by the National Statistics Office (NSO), the major fresh produce items being imported into PNG in 2010 were: onions and shallots, garlic, carrot and turnip, cauliflower and broccoli, peas, tomato, sweet corn, capsicum, celery, lettuce, beans, potato, cucumber, mushroom, leek, asparagus, Brussels sprout and eggplant. It is clear that whatever are lacking in local supplies, they will be filled by imports.

Supply chain to the PNG LNG Project and key players

The fresh produce supply chain to the LNG market appears to be similar to that for the supermarkets in Port Moresby. That is, produce is sourced in bulk mainly from the wholesalers either from the Hagen wholesale market or at their own packing sheds. Once the purchase orders are filled, fresh produce is delivered to the buyers. On the surface, this seems to be how fresh produce is purchased and delivered to the LNG market. However, this is not quite the case. Behind the scene, there is a complex web of politics and private deals that determine who can participate in the supply chain. Landowners' companies, catering companies (e.g., National Catering Services, Eurest Catering, and

iPi Mountain Catering), and their joint venture partners and suppliers are identified as major players in the fresh produce supply chain to the PNG LNG Project.

Landowners' companies

At the top of the supply chain are umbrella (representative) landowners' companies (Lancos). These umbrella landowners' companies represent a number of incorporated landowners' groups (ILGs)⁶ from identified geographic areas within the Project Impacted Areas. ILGs, in turn, represent their local communities. Eight umbrella Lancos have been awarded the Service Outline Agreements with Esso Highlands Limited and therefore have exclusive rights to provide essential services to the PNG LNG project.

These service agreements are an important step for the Lancos to secure business opportunities with the PNG LNG Project. The service agreements also provide the basis for the Project's contractors and sub-contractors to negotiate with umbrella Lancos to provide the reserved services, as stipulated in the Coordination Procedures and National Content Plan. The purposes of the "National Content Plan" are: to create local jobs; purchase local goods and services from local suppliers (when they are competitive with international suppliers); educate and train national employees, contractors and suppliers; transfer knowledge and skills to local businesses; and assist local communities to make strategic investments in communities (EHL 2009). Under the Service Agreements between EHL and the project umbrella Lancos, each project umbrella Lanco is authorised to perform the reserved services in its respective geographic location, especially in labour hire, catering, camp management, security and freight services. Outside these business lines, opportunities are open to competition from other Lancos and suppliers generally.

The two largest umbrella landowners' companies for the PNG LNG Project are the Hides Gas Development Corporation Ltd (HGDC) in the Hides/Komo/Angore/Juha areas in the highlands (the upstream end of the PNG LNG project) and the Laba Holdings at the LNG Plant site (the downstream end of the project). The business lines that are reserved for these two Project umbrella Lancos are labor hire, camp catering, camp maintenance and site security. More information on Lancos is provided in Appendix B.

Catering companies

In terms of camp catering, rather than performing the services themselves, both HGDC and the Laba Holdings have formed joint ventures with The Alliance Group (TAG). TAG is itself a joint venture between National Catering Services (NCS) and the GCC Services⁷, and is formed specifically to bid for contracts from the LNG project. The resulting new companies, the Hides Alliance and the Laba Alliance, respectively, will be the two largest service providers for catering to the PNG LNG project.

Given that NCS is already the biggest catering company in PNG before its involvement in the LNG project, its LNG project involvement gives it a commanding market position and buying power, especially at the construction phase, and its potential influence on the development of the PNG fresh produce sector must not be overlooked. This is because if NCS/TAG decides to source more fresh produce from the local supply, rather than overseas, such a decision would be most beneficial for PNG farmers. The reverse is also true. That is, if the local produce is to be considered as of high cost or lacking in quality, variety or consistency in supply, NCS/TAG may decide to buy more imports despite their intentions to comply with the national contents requirements and to support local suppliers. It appears that, in the past, and also likely in the future, imports could account for nearly

⁶ In PNG and in the Melanesian tradition, land is owned by clans and tribes, not by individuals. Ninety-seven percent of land in PNG is held under customary tenure (Mugambwa, 2007). This land tenure system has not been a serious problem in traditional societies whereby land was used mainly for subsistence farming and housing. However, it has become problematic in the modern world when the need for land to be used for economic or social development increases, e.g., roads, airfields, markets, parks, and public buildings (administration, schools and hospitals), commercial farming, mining, and logging. In PNG, the Land Groups Incorporation Act was passed in 1974, which recognises an "incorporated" customary landowner group as a legal entity. Once registered, the incorporated land group (ILGs) becomes the representative of the clan or sub-clan in the formal legal system and is able to enter into agreements and make decisions on behalf of the customary group (Power, 2008). Traditional landowners in Papua New Guinea have been using this type of legal vehicle for receiving royalty and compensation payments from mining and forestry companies.

⁷ GCC Services is part of the Agility Logistics Group, one of the world's leading logistics supply service corporations.

80% of total supplies to various project sites. Therefore, the threat of the LNG project importing fresh produce in large amounts from overseas to meet their various requirements is real and imminent.

In addition to NCS/TAG, there are Eurest Catering and iPi Mountain Catering which also provide catering to camps in the Hides/Komo/Kutubu areas, either independently or in joint venture with Lancos. But their operations are on a smaller scale compared with NCS/TAG. Nevertheless, they are also key players and their role could become more substantial at the operational phase given their involvement in the Hides/Kutubu areas with the Oil Search oil and gas project. For more information on NCS and TAG, see Appendix C.

The suppliers

The lower levels of the supply chain also appear to be “monopolised” by individuals who gain “privileges” to supply to the catering companies through their connections to the Lancos. It is possible that these privileged positions will be mis-used or abused, leading to anti-competitive or rent-seeking behaviour. For instance, supply contracts may not necessarily awarded to individuals or companies that can provide the best products or services, but to those with whom they have personal connections, or to those from whom they can collude and extract “rents” or “extra benefits”. During the stakeholder consultation, “corruption” and “politics” are common complaints from suppliers who have been shut out of the supply chain, or who have lost out to those who have better connections to key players. In theory, monopoly or undue market power, acquired through exclusive contracts or social connections, can lead to inefficiency and unfairness because business transactions are not based on costs, quality, or performance.

There are numerous complaints from farmers about payments not being made on time or not being made at all. Smallholder farmers and suppliers are often disadvantaged when payment problems occur because there are no written agreements and no recourse for dispute resolution. It also highlights problems of management and governance in the supply chain. These structural and institutional issues must be better understood and addressed to ensure efficient and equitable outcomes for all supply chain players in the PNG LNG market.

Summary of results

Key findings and main supply chain issues identified in this study are summarised below:

- Average per capita consumption of fresh produce for camp residents is around 6.60kg per week.
- During the peak of construction phase (2012-2013), there will be up to 20,000 camp residents and 4500 day workers, with total demand for fresh produce reaching as high as 130 tonnes per week (valued at A\$250,000). This demand will be reduced to 2 tonnes a week during the operational phase (from 2014 onward for the next 30 years).
- The top ten produce items supplied to the existing camp, in volume terms, were: potato, eating banana, sweet potato, cabbage, tomato, broccoli, carrot, Chinese cabbage, pumpkin and pineapple. There was a lengthy list of fruit and vegetables that are either in very low supply or are not being supplied at all, especially salad vegetables and spices. The make-up of the purchase orders could be supply-driven, rather than demand-driven.
- Most produce supplied to the existing camps in the Southern Highlands was sourced from the Western Highlands Province, particularly the Hagen wholesale market. Total fresh produce supply from the Hagen wholesale market and other parts of WHP was estimated to be around 80-100 tonnes a week.
- Supply from the Project Impacted Areas is, and will be, minimal because the local residents are traditionally not agriculturalists and, because there will be plenty of cash around, but not much incentive for them to learn how to produce fresh produce either to supply themselves or to supply the LNG market. This is evident from other mining projects in PNG.
- Depending on supplies from WHP could be problematic. A range of issues have been identified, including: lack of access to, and high costs of, inputs; poor transport infrastructure and feeder roads; inadequate marketing infrastructure for the storage and transport of perishable fresh produce; supply disruptions due to tribal fights/disgruntled landowners/road blocks/landslides/law and order/bad weather; lack of technical know-how on postharvest handling and quality control; lack of business skills in financial management, marketing, contracting, etc.
- The supply chain to the PNG LNG market is quite complex. The umbrella landowners' companies seem to have the overall control over supplies of goods and services to the Project, including fresh produce. Catering companies, in particular NCS/TAG, who are in joint venture with the

largest two umbrella Lancos to provide camp catering to the PNG LNG project, are influential in terms of determining what is on the menu and what and how much to buy from local suppliers.

- Supply disruptions to the LNG market seem unavoidable because of problems of road conditions/landslides/bad weather, law and order (road blocks and tribal fighting), and disputes between the mining companies and landowners over a range of issues from compensation payments to community development, environmental damages, accidental deaths, etc and the resulting stopwork and even mine closures. Fresh produce suppliers are most vulnerable to these events because of perishability of their goods. Risk management strategies must be put in place to protect the farmers' interests and to minimise the adverse effects of these events on all players in the supply chains.
- Fresh produce marketing is awash with risks and uncertainties for smallholder farmers because of the reluctance of buyers to give standing orders, fluctuating prices, and delayed or no payments.

Some of the supply issues identified in this study are not new. Rather, they have been identified in numerous studies undertaken in the past decades (e.g., Chang, et al., 2012; Chang, 2011; Chang and Griffith, 2011; FPDA, 2008, Wilson, 2008; Global Development Solutions, 2008; Martin and Jagadish, 2006; McGregor et al., 2003; Peter, 2001; Epstein, 2000; Burdon, 1998; Daysh, 1995). This means the constraints to supplying the LNG market are the same as those for supplying the formal markets in Port Moresby and other city centres in PNG. The main difference is that there will not be much time to respond as far as meeting the demand from the LNG market at the construction phase (2010-2013) is concerned because the opportunities, although tremendous, will be short-term. In addition, because of the large volumes that need to be delivered to feed two or three thousands of people three meals a day in remote project sites (versus into main city centres), the concerns over quality, variety and consistency in supply, and hence the need for resorting to imports, is understandable. Therefore, it is up to the PNG government and the industry to decide whether and how to respond.

Implications for the PNG fresh produce sector

Given the substantial economic growth expected from the PNG LNG project, as well as another half dozen resource development projects that are on the pipeline, in the years to come, demand for variety and high-quality, high-value crops, especially the exotic types, will increase, not only from the mining sector but also from the general population. Furthermore, an increasing proportion of fresh produce will be sold through supermarkets, replacing or reducing the role of traditional markets (the wet markets or the open-air markets). According to Reardon and his colleagues (e.g., Reardon and Berdegue, 2002; Reardon, et al. 2003; and Reardon, et al., 2004), a supermarket revolution has swept developing countries in the past 2 decades, spreading as much in that short time as they had in 5-6 decades in developed countries.

They observed that, "the diffusion typically occurs in sets of three waves: first in big cities then medium cities then even in rural towns; first among the richer consumers, then middle class, then the working poor; first in processed foods and rice, then semi-processed foods like meat and dairy, last in fresh produce. Alongside that diffusion are waves of impacts on food supply chains. First is on consumers (pulling down food prices, pushing up quality) and on traditional retail (displacing small shops and, gradually, wet markets) – then on the food processing and wholesale sectors (in which sectors the impacts are strongest and most immediate, and symbiosis or co-evolution of modernization in retail and processing and wholesale very important), and finally, on farmers. Farmers and processors face opportunities in the rise of supermarkets having their market broadened and deepened. But the rise of supermarkets also presents farmers and small processors, especially small-scale, asset-poor firms, with stark challenges of meeting tougher market requirements that demand new upgrading investments and a rise in government regulations for food safety."

The global rise and impact of supermarkets, as described by Reardon and his colleagues, is likely to reach PNG in the coming decades. This means the PNG fresh produce sector must be prepared for those opportunities and challenges. The ability of the PNG fresh produce sector to meet the demand from the PNG LNG market not only will generate income for smallholder farmers in the short term, but also it will help pave the way for meeting future demand from the general population and a modern food retail sector to be dominated by supermarket chains in the longer term. For this to happen, farmers, as well as other supply chain players, must be better educated on market demand for quality, variety and consistency in supply and costs and returns to help them satisfy market demand while making a profit.

Conclusions

The PNG LNG project will have a significant impact on the PNG economy and the agricultural sector. Some analysts have shown that, while the agriculture export sector (oil palm, coffee, cocoa and copra) will suffer significant losses in production and export revenues due mainly to the appreciation of the PNG kina, there are significant opportunities for the fresh produce sector. Demand for fresh produce from the LNG project was estimated to be in the order of 130 tonnes a week (or 20 tonnes a day) at the peak of the construction period of 2012-2013. This would equate to a sales value of 500,000 kina per week to local communities *if* the LNG market for fresh produce could be captured completely by local supplies. However, during the construction phase, nearly 80% of fresh produce demand could be met by imports because of concerns over the price, quality, consistency in supply and variety of local produce. In addition, after the initial construction phase and by 2014, demand for fresh produce will be reduced to around 2 tonnes a week during the operational phase.

This means the impact of the PNG LNG project on the fresh produce industry is uncertain. Although substantial opportunities have been created by the PNG LNG project, long-standing problems of quality deterioration, inconsistency in supply and lack of variety, if unresolved, will prevent the opportunities being realised. Supply disruptions and quality deterioration due to poor and inadequate transport infrastructure and law and order problems, poor packaging and postharvest handling, and lack of planning and coordination along the supply chains, which have been identified previously as the major reason for importing fresh produce from overseas, must be addressed adequately and quickly by government and industry. Failing to do that, local suppliers will miss the opportunity to supply to the huge LNG market in the same way they have missed supplying to higher value formal markets.

From the policy perspective, the PNG government must provide an enabling environment (e.g., law and order, basic marketing infrastructure, contract laws, extension services, market information, etc.) which facilitates fresh produce marketing and fosters collaboration between smallholder farmers and fresh produce supply chain operators. For the management perspective, technical and business skills of key supply chain operators must be improved to ensure planning and risk management strategies for both production and marketing are put in place to minimise the impact from supply disruptions and demand fluctuations.

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Appendix A.

Demand estimates from the Laba Alliance and The Alliance Group

According to the Laba Alliance (a joint venture between The Alliance Group and the Laba Holdings), peak demand for labour at the Plant site is to occur in 2012-2013. There will be 10,000 – 12,000 camp residents plus 2,000-2,500 day workers. Total food requirements for Laba are shown in Table A (second column).

Table A. Projected demand for food from the PNG LNG project

	Lab a Alliance	TAG
Camp site	LNG Plant Site	LNG Plant Site and Hides/Komo
Number of labour force	10,000-12,000 camp residents and 1,500-2,000 day workers	Numbers at the LNG Plant + 5,000-6,000 camp residents and 1,000-1,500 day workers
Vegetables	11 tonnes/week	15 tonnes/week
Eggs	48,000 pieces/day	50,000 pieces/day
Chicken	12 tonnes/week	12 tonnes/week
Fish	5 tonnes/week	8 tonnes/week
Beef	--	8 tonnes/week
Pork	10 tonnes/week	8 tonnes/week

The Alliance Group (a joint venture between the National Catering Services and the GCC Services), that caters for LNG camps in both upstream and downstream areas, also provides their estimated food requirements for a total of 15,000 camp residents and 3000-4000 day workers during the peak period (see Table A, third column). Presumably these figures combine the requirements from the LNG Plant near Port Moresby and from parts of the Hides/Komo areas in the Southern Highlands.

The estimates of 11 tonnes/week of vegetables for 10,000-12,000 people (from Laba) and 15 tonnes/week for 15,000 people (from TAG) are rather low compared to the data we have collected so far from the Nogoli camp (3.89kg/person/week). They are also low, compared to the per capita vegetable consumption of around 3kg per week in Australia. This number is derived from an estimate of 162kg per person per year in 1998-99 (Apted et al., 2006). Of this, potato accounted for 42% of total vegetable consumption; tomatoes, 15%; leafy and green vegetables, 12%; other root and bulb vegetables 15%; and other vegetables, 16%. More than half of all vegetables consumed in Australia are carrots, onions, lettuce, cauliflowers, broccoli, cabbages, pumpkins, beans and green peas. These items can be expected to feature more prominently on the menu for expatriates (Crooks, 2010).

Lab a and TAG's estimates are also lower than the 375g of vegetables and 300g of fruit per day recommended by the Australian Guide to Healthy Eating. The Guide recommends adults consume a minimum of 5 serves per day of vegetables and two serves per day of fruit. This number ensures at least 70% of the requirements of protein, vitamins and minerals are met (National Health and Medical Research Council (NHMRC), 2003).

Based on the Australian Guide to Healthy Eating, recommended serving sizes are as follows:

One serve of vegetables is 75g, or:

- ½ cup of cooked vegetables or legumes (beans)
- 1 cup of salad vegetables
- 1 medium potato

One serve of fruit is 150g, or:

- 1 medium-sized piece (e.g. apple)
- 2 small pieces (e.g. mandarin)
- 1 cup canned or chopped fruit
- ½ cup 100% fruit juice
- 1 ½ tablespoon dried fruit

A minimum of 5 serves per day of vegetables and two serves per day of fruit, as recommended, equates to 675g per day.

Another source of data has revealed that the estimated vegetable requirements for the LNG Plant for 15,000 people were 14.5 tonnes/day, plus 3 pieces of fruit per person per day. These figures are

more in line with our previous estimates of 6.25 - 6.78kg per person per week, with an average of 6.6kg/person/week.

The discrepancy between different estimates may be explained by the assumption about the makeup of the camp residents, i.e., whether they are expatriates or PNG nationals and how "vegetables" is defined. It is likely that the estimates provided by the Laba Holdings and TAG were based on the assumption that the majority of their camp residents will be "expatriates", as previously indicated by ACIL TASMAN that during the construction phase only 20% of the workforce will be PNG nationals. If this is the case, the "vegetables" that was referred to is most likely to be fresh salad vegetables, such as lettuce, tomatoes, cucumber, zucchini, red onions, red cabbages, carrots, mushroom, capsicum and the like, rather than potato, sweet potato, cabbages, pumpkins, etc. that tend to dominate the menu for PNG nationals. However, more detailed data could not be obtained due to the proprietary nature of the data.

Appendix B.

Landowners groups and companies

To streamline business operations associated with the PNG LNG Project, Esso Highlands Limited has signed Service Outline Agreements with eight landowners companies. These companies represent the local communities from identified geographic areas within the Project Impacted Areas. They include seven in the area of the upstream onshore facilities in Southern Highlands/Western Province (Hides-Angore, Komo-Juha, Kutubu, Gobe and Moran) and one in Central Province (LNG Plant site near Port Moresby). They include:

1. Hides Gas Development Company Ltd
2. Maka Investment Corporation
3. Kutubu Security Services
4. Kutubu Catering Limited
5. Kawaso Ltd
6. Mananda Umbrella Joint Venture Ltd
7. Gobe Field Engineering
8. Laba Holdings Limited.

The Service Outline Agreement documents the terms and conditions under which Lancos and Esso Highlands Limited agree to do business, and set out business activities each Lanco can perform in its respective geographic location such as labour hire, catering, camp management, security and freight services.

The two largest umbrella landowners companies for the LNG Project are the Hides Gas Development Corporation Ltd in the Hides/Komo/Angore/Juha and the Laba Holdings at the LNG Plant site.

Hides Gas Development Corporation (HGDC) is the umbrella landowners company representing the Juha, Hides, PDL 1, PDL 2, Angore, Komo Airstrip and Penaria Pipeline landowners groups in Western and Southern Highlands provinces. Participating landowner companies and shareholders under the umbrella of HGDC are:

- Tuguba Development Corporation Ltd
- Kewapa Development Corporation Ltd
- Gigira Development Corporation Ltd
- JP Karai Hides Ltd
- Tugu Tapira Ltd
- Hides 4 Holdings Ltd
- Timalia Kangulu Hahai Construction Ltd
- Komo Umbrella JV Ltd (Managing Director is Alois Francis)⁸
- Angore Corporation Ltd
- Bebahoya Limited
- Juha Joint Venture Ltd
- Kobalu Camp Joint Venture Ltd and JV Wako Hides 1,2,3 and Hiwa Group
- Tuguba Holdings Ltd.

⁸ During our field research, we visited the Komo Umbrella JV Ltd (KUJV). KUJV itself is an umbrella landowners company with its own landowners groups and shareholders. It, too, is given special privileges to bid for service contracts in the Komo area.

Laba Holdings Ltd is the umbrella company representing the villages of Papa, Boera, Lea Lea and Porebada at the LNG Plant site 20 km NW of Port Moresby. The four landholder companies of Laba Holdings are:

- Papa Resource Development Cy Ltd
- Boera Holdings Ltd
- Buria-Rearea Caution Bay Ltd
- Porebada Holdings Ltd.

Given that these companies were formed specifically to benefit from the LNG project, the majority of them do not have the business or management background to conduct business with the LNG project developers and contractors. To ensure Lancos conduct their business with high standards, Esso Highlands Ltd provides support in establishing these companies, including developing a company constitution, registering the company, developing a sustainable business plan, recruiting a management team, establishing core policies, procedures and processes such as payroll, invoicing, accounts payable, and assisting with basic infrastructure. In addition, Lancos are encouraged to form alliances with established service companies to help building their business capacity. Two good examples are the Hides Alliance Group and the Laba Alliance Group, which are the joint ventures between The Alliance Group (a joint venture between NCS and GCC Services) and HGDC and the Laba Holdings, respectively, to provide camp-management and catering-services to the LNG project.

Together, the Hides Alliance Group and the Laba Alliance Group will feed up to 15,000-20,000 residents in the LNG project camps both in the highlands and in Central Province. They, therefore, are the most important players in the fresh produce supply chains to the LNG market.

Appendix C.

Catering companies and their alliance partners

National Catering Services (NCS) was established in 1994 by the Anitua Group, which was established in 1983 to provide mining and mine support services to the Lihir Gold Project. NCS operates through a series of subsidiary and associate companies. Currently it provides catering services at 22 sites around PNG, serving over 11 million meals each year. NCS's businesses include:

- NCS Holdings Limited
- NCS Lihir Limited
- NCS Morobe Limited
- NCS PNGDF Limited
- NCS Kainantu Limited
- NCS Hidden Valley Limited
- NCS Raibus Limited
- NCS Property Limited.

NCS also operates several fresh Food Depots, including

- Kumul Fresh Foods Limited
- Wau Fresh Produce
- NCS Farms.

The Alliance Group (TAG) is a joint venture formed between NCS and GCC Services, specifically to provide services for the LNG project. GCC SERVICES is part of the Agility Logistics Group, one of the leading logistics and catering service organisations in the world. It provides customised services and operations in:

- Remote site construction
- Camp Management and Catering
- Support services
- Labour supply
- International supply chain management.

Hides Alliance and Laba Alliance. Hides Alliance Limited is the joint venture between the Alliance Group and HGDC (Hides Gas Development Corporation) in the Southern Highlands. Hides Alliance Limited is authorised to tender directly for all LNG contracts for camp management and catering services in the Hides, Komo and Juha areas. The Laba Alliance Limited is the joint venture between the Alliance Group and the Laba Holdings in the Central Province; it has been given the rights to tender directly for all LNG contracts for camp management and catering services at the LNG Plant site. Together, they provide meals to 15,000 camp residents.