VCA4D
VALUE CHAIN ANALYSIS FOR DEVELOPMENT

agrinatura for European Commission

Value Chain Analysis of vanilla in Papua New Guinea

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October 2019

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Value Chain Analysis for Development (VCA4D) is a tool funded by the European Commission / DEVCO and is implemented in partnership with Agrinatura.

Agrinatura (http://agrinatura-eu.eu) is the European Alliance of Universities and Research Centers involved in agricultural research and capacity building for development.

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The report was produced through the financial support of the European Union. Its content is the sole responsibility of its authors and does not necessarily reflect the views of the European Union.
The report has been realised within a project financed by the European Union (VCA4D CTR 2016/375-804).

Citation of this report: Coote, C., Bue, V., Farrall, H., Lamboll, R. 2019. Vanilla value Chain Analysis in Papua New Guinea. Report for the European Union, DG-DEVCO. Value Chain Analysis for Development Project (VCA4D CTR 2016/375-804), 145p + annexes.

VCA4D Project Management Unit Support
Heval Yildirim, Marie-Hélène Dabat | Methodology
Olimpia Orlandoni, Sara Baumgart| Project Management and Graphic Design

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ACKNOWLEDGMENTS

The team would like to thank stakeholders in the PNG vanilla value chain who provided valuable information for this study. In particular, thanks are due to the many vanilla farmers, traders, exporters and government officials who availed themselves for interview. We also acknowledge the inputs provided by enumerators from the University of Technology, Lae and the support provided by colleagues at the PMU. We are grateful to the EC directorate-General for International Cooperation and Development (DEVCO) and the EU Delegation in Papua New Guinea for funding and providing valuable feedback during the study.

Notwithstanding the above, we state that the conclusions, views and recommendations given in this report are those of the authors and do not necessarily represent the views of EC DEVCO or the EU Delegation in Papua New Guinea.

ACRONYMS

AFA	Agri-food Chain Analysis (software)
BPNG	Bank of Papua New Guinea
BSP	Bank South Pacific
AU$	Australian dollars
CBO	Community-based organisation
CIF	Cost, insurance and freight
DAL	Department of Agriculture and Livestock
DPI	Department of Primary Industry (now DAL)
DRC	Domestic resource cost
EAT	Enabling Agricultural Trade
FAO	Food and Agricultural Organisation of the United Nations
FGD	Focus group discussion
FOB	Free on board (shipping
FU	Functional unit
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GST	General Service Tax
IC	Intermediate consumption
IFEAT	International Federation of Essential Oils and Aroma Trades
IGS	Intermediate goods and services
ILO	International Labour Organisation
IPA	Investment Promotion Authority
ITC	International Trade Centre
kg	kilogram
LCA	Life cycle assessment
LLG	Local-level government
NARI	National Agricultural Research Institute
NAQIA	National Agriculture Quarantine Inspection Authority
NEC	National Executive Council
NSO	National Statistics Office
PGK	Papua New Guinea Kina (currency)
PHAMA	Pacific Horticultural & Agricultural Market Access Program
PMU	Project Management Unit
PMV	Public Motor Vehicle
PPAP	Productive Partnership in Agriculture Project
PNG	Papua New Guinea
SABL	Special Agricultural Business Lease
SIB	Spice Industry Board
US	United States
UNHRC	United Nations Human Rights Commission
VA	Value added
VAT	Value Added Tax
VC	Value chain
VCA4D	Value Chains Analysis for Development
VVC	Vanilla value chain

Exchange rates (September 2018)
PGK1: €3.86
PGK1: US$ 3.24

EXECUTIVE SUMMARY

Overview of the vanilla industry in Papua New Guinea

The vanilla world market is a small niche market with an annual global demand of between 2 000 to 3 000 tonnes, of which 80% is normally produced in Madagascar. Smaller producing countries include India, Indonesia, Uganda, Mexico and Papua New Guinea (PNG). Vanilla is the world's second most expensive spice (after saffron), but its prices are highly volatile due to the impact of supply-side shocks - particularly cyclones in Madagascar.

The main markets for PNG vanilla are Indonesia, followed by Australia, by volume; and Switzerland, France, Germany and the USA, by value. The highest unit value per tonne in 2018 was paid by Switzerland at US$ 500/tonne (CIF value). The average unit value of exports to Indonesia was US$ 75/tonne (CIF value).

Vanilla in PNG was promoted as a smallholder crop by the Department of Agriculture and Livestock, development projects and private individuals from the early to mid-1990s. Annual exports of vanilla in PNG increased rapidly from an estimated one tonne in 1999 to a recorded amount of 202 tonnes in 2003. Within five years PNG had become the third largest vanilla producer in the world, contributing around 10% of world production between 2003 and 2004.

Early PNG production coincided with a shortage of global vanilla supplies in the late 1990s and growers benefitted from prices of over PGK 700/kilogram (US$ 220). Papua New Guineans became involved in trading and setting up exporting businesses to sell the crop they bought from specific producer groups or clan areas, having obtained an export licence from the Spice Industry Board. Vanilla initially found a ready market across its land border with Indonesia and then sales gradually expanded to higher value markets in the USA, Europe and Australia. Some entrepreneurs made contact with external buyers in these countries to ascertain what the market wanted and how to ensure the vanilla beans were cured to meet quality requirements. The sector went through a very rapid development stage, a bust and a rebirth in the space of 10 years. As a result of the global price crash in 2004 PNG production was virtually abandoned between 2005 and 2015. Then as world prices began to rise in 2016, farmers began to revive or (re)plant vines and production levels are now higher than in the 2000s. Prices prevailing since 2016 have begun to match those obtained during the earlier vanilla boom years. The global value chain is characterised by extreme fluctuations in price and small producing countries like PNG are price takers but developing relationships with buyers has helped maintain prices received. International buyers indicate that good quality PNG vanilla has similar characteristics to that of Madagascan vanilla.

Vanilla is grown in at least half of the country's 22 provinces, but an estimated 80% is produced in East Sepik province with production concentrated in Maprik and Ambunti-Dreikikir districts. Two vanilla species (Vanilla tahitensis; Vanilla planifolia) are virtually exclusively produced for export of cured beans which are processed by the growers themselves. In 2004 the Spice Industry Board estimated that 50 000 people were growing vanilla. The current number of growers is not recorded. In this analysis we estimate that just under 17 000 households are involved in vanilla production; several people in one household may have their own plot, so the total number of people engaged on vanilla could again be close to 50 000. The exact area under vanilla is also unknown. In 2017 an area of 1 918 hectares was given in the FAOSTAT database, based on an FAO imputed calculation which considerably overstates the average yield that was obtained from a 2018 survey of 100 vanilla growers. FAOSTAT provides a production figure of almost 500 tonnes for 2017, but the main vanilla buyers indicate that between 240 and 250 tonnes was produced in 2018.

Virtually all the vanilla grown is exported but the quantity and value of these exports are not officially published. According to data obtained from the National Statistics Office (NSO), formally recorded exports amounted to 110 tonnes in 2017, although the International Trade Centre (ITC) Intracen database gives a considerably higher figure of 229 tonnes in 2017, and 235 tonnes in 2018. Furthermore, the ITC mirror data reports vanilla exports to Indonesia of 104 tonnes (recorded by Indonesia), compared to 40 tonnes from the NSO data in 2017, and 133 tonnes in 2018. Cross-border exports to West Papua Province were between 75 and 80% of formal exports, according to key informants in PNG. In this analysis we assume that 240 tonnes were exported in 2018.

In terms of the value of exports there are also discrepancies between data sources. The NSO data indicates that exports were worth PGK 75 million, FOB (US$ 23 million) in 2017. The ITC data indicate that exports were worth in the region of PGK 136 million, FOB (US$ 35 million) in 2018. According to our estimates, the value of production is PGK 235,5 million (FOB) in 2018.

At current high world prices vanilla production is highly profitable for farmers if they have access to free family labour (vanilla is an extremely labour-intensive crop, in particular hand pollinating, but also harvesting, curing and plot security). A key challenge, well recognised by provincial governments, Department of Agriculture and Livestock (DAL) staff and exporters, is the need to improve and ensure consistent quality i.e. producing a greater proportion of A grade beans through better husbandry and curing practices as well as improving prices obtained through promotion of the attributes of PNG vanilla. As there are so few buyers in the value chain reputation for quality and consistency is paramount. Sensitivity analysis indicates that vanilla production and trading is still profitable if the international selling for A grade vanilla fell by 50%, to around US$ 200/kg, but were prices to fall by 75%, to just under US$ 100/kg, all the three trader categories would make a loss, even though there buying prices would also reduce substantially.

There has been a considerable price increase in the last five years, as high as US$ 500 per kilogram in PNG. However, industry observers are suggesting that the global price could settle around US$ 100 per kilogram in the next three to four years. This could have a profound impact on vanilla production in PNG.

Functional analysis of the vanilla value chain

A simplified representation of the vanilla value chain in PNG is shown in Figure ES 1 (for a detailed flow map and explanation see section 3.3.1). The chain consists of two to four levels: the producers, assemblers who purchase vanilla on behalf of others, and traders, who can also be exporters. Around 1 000 producers have received, or are in the process of receiving, organic status via the main Lae-based large-scale vanilla exporter. A few associations and cooperatives have their own export licences and export directly to overseas buyers or via the cross-border market in West Papua.

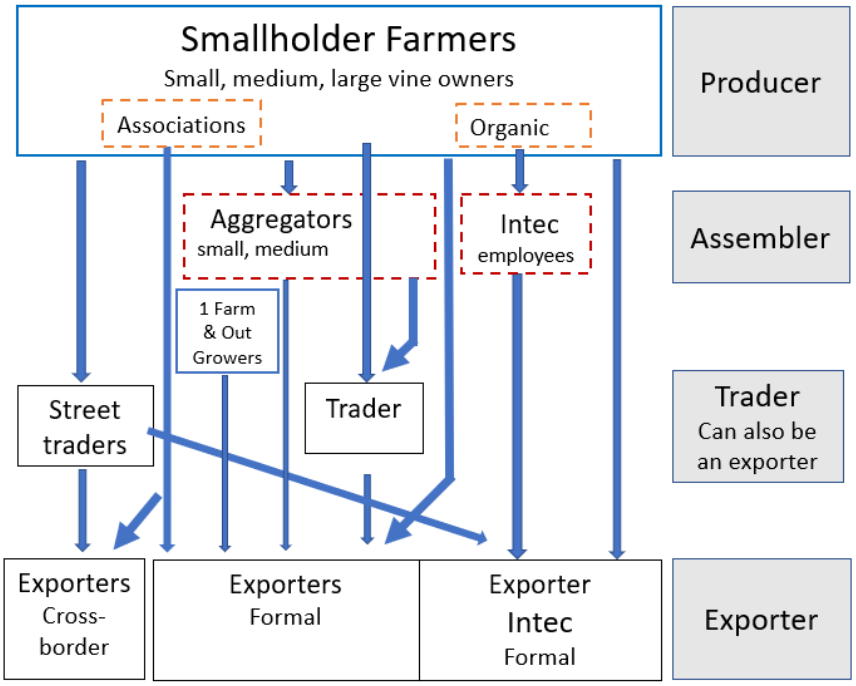

FIGURE ES 1 OVERVIEW OF THE VANILLA VALUE CHAIN

The vanilla value chain is small compared to those of PNG's major export crops (oil palm, coffee, cocoa, coconut, rubber and tea). However, it is still significant in terms of foreign exchange earnings, with export values similar to cocoa and 50% that of coffee) and its contribution to poverty reduction for many smallholder

producers living in remote areas. In addition, the domestic part of the trading sector supports numerous informal traders, and vanilla exporters and service providers such as freight forwarders and airlines.

Three main marketing chains were identified. Firstly, smallholder farmers selling to street traders who operate in Maprik town. These traders sell their highest quality beans to the large exporter at their buying point in Maprik town, and the remainder they either directly sell to a trader who transports the beans to the cross-border market on the border with West Papua or sell themselves to a buyer at the border. Much of the vanilla in this chain is hand carried by the producer from their village to Maprik by foot or by public transport using a PMV (Public Motor Vehicle). The trader who has a vanilla export licence, takes a consignment to Wewak airport by PMV/ shared vehicle, then by plane to Vanimo and from there by vehicle to the border crossing point at Wutung.

The second main chain is where the smallholders sell directly to a trader/exporting company or via an aggregator who purchases vanilla on the exporter's behalf. This consignment will be transported to Wewak for sorting and packing and phytosanitary certification, then sent as air cargo to Port Moresby for an onward international flight connection. A few export companies, which source from East Sepik, are based in Port Moresby and the preparation for export and certification is done there.

One company, based in Central Province, combines production from its farm with an out-grower system and exports internationally. NGIP Agmark Ltd, a cocoa exporter, exports vanilla from growers in East New Britain. A Bougainville-based company exports vanilla grown by local smallholders.

The third main chain is that of the one main vanilla exporting company, which has dominated this sector for over ten years, based in Lae in Morobe Province with a major sourcing operation in Maprik. It has two buying centres in Maprik town and owns a fleet of vehicles in which its employees go out to the villages to buy vanilla, both around Maprik and around Wewak. It has set up an organic vanilla programme and organic vanilla growers signed up to its programme receive a higher price per kilogram.

This study proposes a typology of three groups of vanilla growers based on the number of vines that are owned by a household. It should be noted, however, that there is a wide variation in number of vines and vine productivity and systems are complex. Vanilla vines may be intercropped with other cash or food crops. Households may have other income sources, from crops, livestock or off-farm activities and their small number of vines may be more intensively farmed. Vanilla may be grown as a sole stand and be the sole source of income for the household with a large number of vines and grown in several plots. Some farmers may have several thousand stands over a large area but not all of the plants may be actively managed – they may be used as a source of cuttings or as a way of securing a piece of land for, another, future use. The three groups established from the household survey are as follows:

Small-scale Vine Owning Households, with between 70 and 300 vines, with an average of 193 vines. The vines tend to be well looked after and produce a relatively good average yield compared to the other two groups, but the quality of the cured beans is mixed and only a small proportion (22%) of the cured beans are in the top category (A grade). The overall unit value of their sales is the lowest of the groups. The majority of the crop is sold to street traders in Maprik.

Medium-scale Vine Owning Households, who have between 301 and 927 vines, with an average of 599 vines. The vines are reasonably well looked after but production is low with the lowest average production of the three groups, possibly due to the higher labour requirement to look after this number of vines and/or less availability of mulch which is the main determinant of yield. However, the quality of the cured beans is very good and a high proportion are A grade and the average price received is the highest. The majority of the crop is sold to the large-scale exporter.

Large-scale Vine Owning Households, who have between 928 and 5 000 vines, with an average of 1 729 vines. As little as 25% of the vines may be actively managed to produce vanilla. This could account for why overall yield is low. However, the quality of the cured beans is good and a high proportion are A grade (farmers with large vine numbers tend to be more experienced at growing and curing vanilla; good curing techniques

results in high vanillin content – a measure of quality). Just over half of the production is sold to the large-scale exporter.

The main technical characteristics estimated for each of the three producer groups are summarised in Table ES 1.

TABLE ES 1 FARMER TYPOLOGIES AND MAIN CHARACTERISTICS

Main characteristics		Small-scale vine owning households	Medium-scale vine owning households	Large-scale vine owning households
Number of farmers	No	5 081	6 834	5 081
Area under vanilla	Ha	1 350	4 500	25 800
Average vines	No/household	192	599	1 883
Average production	Kg/household	12.52	10.63	20.41
Vanilla yield (kg cured beans/ha)	Kg cured beans/ha	122.9	26.2	28.7
Membership of cooperatives	%	43	53	86
Pesticide, herbicide and fertiliser use		None	None	None
Total vanilla production	Tonnes/year	64	73	103

Source: Calculated from the Vanilla Household survey

The vanilla value chain is relatively simple and is characterised by two products: A grade vanilla (or Gourmet beans) and mixed beans, known as 'extract' or 'mix' which includes grades, B, C, D, E and reject beans, and two export chains - gourmet beans and extract vanilla. Vanilla grades are based on length of the cured bean, its vanillin content and visual appearance. Prices paid for A grade vanilla tend to be considerably higher than extract grade. However, the price per grade can vary according to where and when it is sold. Indonesian buyers reportedly pay higher prices for lower grade vanilla and are an important outlet for PNG growers and traders, particularly for lower-grade produce. In this analysis we assume the price for A Grade international sales is PGK 1 200 per kg; for cross-border sales for A Grade the price is PGK 950 per kg and PGK 850 per kg for mix grade.

Responses to the four framing questions

FQ1 What is the contribution of the vanilla value chain to economic growth?

Framing Question 1: What is the contribution of the VC to economic growth?		INDICATORS	RESULTS
CQ1.1	How profitable and sustainable are the VC activities for the entities involved?	Net income by type of actor	Small-scale vine owner: PGK 8 282 Medium-scale vine owner: PGK 7 594 Large-scale vine owner: PGK 13 741 CBT: PGK 115 932 Medium exporter: PGK 207 548 Large exporter: PGK 21 737 070
		Benchmark of farmers' net income with minimum wage and/or job opportunities	Minimum annual wage = PGK 7 322 At prices prevailing in 2018, VVC is highly profitable. If global prices fall and Indonesia does not buy PNG low-grade vanilla margins will tighten and some producers will leave value chain
CQ1.2	What is the contribution of the VC to the GDP?	Total VA and components	Total VA= PGK 227 million (€ 59 million) Wages: PGK 7 million Financial charges: PGK 15 000 Taxes: PGK 26 million Gross operating profit: PGK 189 million
		VA share of the GDP	GDP (2018) = PGK 76 billion Total VA in the VC= PGK 227 million Total VA / GDP (%) = 0.3%
		Rate of integration into the Economy (total VA/VC production)	Total VA= PGK 227 million VC Production= PGK 236 million Rate of integration = 96%
CQ1.3	What is the contribution of the VC to the agriculture sector GDP?	VA share of the Agriculture sector GDP	Agricultural sector GDP 2018 = PGK 22.6 billion (€ 5 858 million) Total VA= PGK 227 million VA/Agricultural sector GDP = 1%
CQ1.4	What is the contribution of the VC to the public finances?	Public Funds Balance	Value of total taxes in the VC = PGK 26 million (€ 6.5 million) There is no subsidy The balance is positive.
CQ1.5	What is the contribution of the VC to the balance of trade?	VC Balance of trade	Value of exports in the VC = PGK 236 million Value of imports in the VC = PGK 4 million Balance of trade is positive with an amount of PGK 232 million
		Total imports / VC production	
CQ1.6	Is the VC viable in the international economy?	Nominal Protection Coefficient (NPC)	The VC is competitive. 0.5 and 0.6 for grade A 0.8 for grade B
		Domestic Resource Cost Ratio (DRC)	DRC= 0.43 The VC creates gain for the national economy.

FQ2 Is this economic growth inclusive?

Framing Question 2: Is this economic growth inclusive? (See also Social Analysis results)		INDICATORS	RESULTS
CQ2.1	How is income distributed across actors of the VC?	Total farm income	Small farmers ≈ PGK 42 million Medium Farmers≈ PGK 53 million Large farmers≈ PGK 71 million Total farm income ≈PGK 165 million
		% final price at farm gate	Grade A: % final price (Indonesia market) at farm gate (via CBT) = 94% % final price (International market) at farm gate (via medium exporter) = 83% % final price (International market) at farm gate (via large exporter) = 79% Extract grade: % final price (Indonesia) at farm gate (via CBT and medium exporter) = 76% % final price (Indonesia) at farm gate (via large exporter) = 68%
		Total wages and salaries	Wages at farm level = PGK 1.4 million Wages at trader level = PGK 1.2 million
CQ2.2	What is the impact of the governance systems on income distribution?	Income distribution	Income at farm level: PGK 165 million Income at trader level: PGK 52 million
CQ2.3	How is employment distributed across the VC?	Number of jobs and self-employment	No of jobs: Permanent: 82 (Large exporter) Casual: 1 280 days (Medium-scale exporters) Self-employment: 17 022 workers + family member inputs + employment created in service providers

Under current conditions, of very high global vanilla prices, vanilla appears highly profitable for smallholder producers if they access to sufficient household labour. The value chain is short and highly dependent on cross-border exports to Indonesia which provides an outlet for lower grade produce, and for one main vanilla exporter who exports large amounts of A grade and organic vanilla. Trading margins appear to be tight, as there is significant transport, particularly airfreight, costs, involved between the main purchasing centre of Maprik and the final exit airport but a number of small- and medium-scale traders are attracted to the value chain due to the prevailing high world market prices. There are a lot of risks in international trading that can seriously affect the margins.

FQ3. Is the vanilla value chain socially sustainable?

CQ3.1 Are working conditions throughout the VC socially acceptable and sustainable?

The International Covenant on Economic, Social and Cultural Rights (ICESCR), the International Covenant on Civil and Political Rights (ICCPR) and the eight fundamental ILO international labour conventions are "in force" in PNG. However, most of the activities and benefits in the VC are in rural areas, where regulation on working conditions is not necessarily applied and certainly not monitored. Children are involved in the VC, particularly contributing to pollination, which is labour demanding. However, no specifically harmful jobs were identified. Returns to vanilla production were relatively high at the time of the study. Youths were attracted to both vanilla production and trading. The most important risk is probably that of theft and personal injury during travel associated with vanilla trading.

CQ3.2 Are land and water rights socially acceptable and sustainable?

Under PNG's customary title laws, land is owned communally by a specific lineage, clan or tribal group and usage rights are allocated within the group. Sale of customary land to foreigners is prohibited. Almost all landowners are indigenous and 97% of land remains under customary title. However, the United Nations Human Rights Commission and others have expressed concern at the alienation of land held under customary title through the granting of Special Agricultural Business Leases. What is being overlooked is the struggle between indigenous smallholders and indigenous large holders and investors. However, no large-scale acquisition of land for vanilla production was identified. High labour demands for pollination means that even managing five hectares of vanilla is a major challenge.

CQ3.3 Is gender equality throughout the VC acknowledged, accepted and enhanced?

PNG ranked second lowest (159 out of 160 countries) on the Gender Inequality Index (2017). In general, women in PNG derive limited benefit from the formal economy and those engaging in business mainly operate small-scale informal enterprises. Women have limited rights over the vast majority of land in PNG that is held under customary tenure. They have very limited access to credit. They have less access to extension services than men, but access is very limited generally. In East Sepik and Morobe, women are involved in vanilla production and postharvest activities, including trading and in some cases export. They are mainly involved as producers, managing vanilla plots by themselves or jointly with their husbands. Many women (both married and heads of households) reported having their own vanilla plots. Generally, women reported that they have at least some control over the income from their own vanilla plots but allocate a bigger portion of the income to the household budget for important family goals. They are more likely to belong to groups and Community Based Organizations than larger organizations such as cooperatives and are much less likely to be in leadership positions than men. In general, women's workload is disproportionally high compared to men and risks of women being subject to strenuous work are not being minimised.

CQ3.4 Are food and nutrition conditions acceptable and secure?

The food and nutrition situation in PNG is complex and serious. One in two children have stunted growth due to chronic malnutrition and PNG has the world's fourth highest child stunting rate. Causes of undernutrition are regionally variable due to a complex interplay of poverty, disease, food-security, cultural, environmental and socio-political issues requiring a complex mix of solutions by governments, health systems and local communities. Vanilla does not appear to be competing with food crops, but literature stresses that subsistence food systems are not providing all nutritional needs, such as protein. This may be achieved through changing the farming system, trading or selling cash crops and purchasing food. Part of the solution appears to lie with improving the socioeconomic situation of rural households and vanilla can contribute to achieving this in years when prices are good, such as in 2017 and 2018. However, other causal factors include diseases, poor health and childcare, lack of safe water and improved sanitation, hygiene and housing, rural roads adversely affecting access to health centres and schools. In this study, women often appeared to be knowledgeable about food and nutrition but face significant time constraints. To enhance their contribution to food and nutrition security at household level, empowerment and time constraints facing women need to be addressed.

CQ3.5 Is social capital enhanced and equitably distributed throughout the VC?

PNG cooperatives face challenges such as incompetent management, misappropriation of funds, abuse of processes and competition with Investor Owned Firms. Over 400 cooperatives in East Sepik are registered as being involved in vanilla, however few appear to be active. Trust appears to be lowest between farmers and large exporter Farmer capacity at individual and organizational level varies considerably. In many ways farmers that we met were very knowledgeable, and in some cases innovative, with regard to vanilla. There is limited public sector capacity in terms of service provision to farmers and where there is, it tends to be commodity focused (e.g. cocoa). This makes a holistic approach to improving farming/livelihoods systems challenging. Planting vanilla as part of a diverse (food & cash crop) system can contribute to reducing the shock of fluctuations in global vanilla prices.

CQ3.6 To which standards are major social infrastructures and services acceptable and do the vanilla value chain operations contribute to improving them?

Health facilities varied significantly with location, but the majority of people involved in the vanilla VC are not getting access to primary health care services; centres are closing and drugs are not available. Vanilla proceeds did have an influence on people's health, but mainly in terms of improving their ability to access and pay for services. However, reports from the Healthy Island initiative operating in some vanilla-growing areas suggest that gains in health (malaria, pneumonia, diarrhoea and skin diseases) were moving in reverse since 2014. Water and sanitation are a significant issue, with more than half of the population not having access to safe water and improved sanitation, increasing the risk of diarrhoea, malnutrition, and stunting. There was less evidence of vanilla income improving access to quality water and sanitation facilities. In general, education in PNG is characterised by low levels of attainment and literacy, poor school attendance and retention rates, and high levels of gender inequality. The majority of household survey respondents reported using vanilla income on education. A range of other uses were made of vanilla income, particularly solar equipment.

In the previous PNG vanilla boom, Sullivan et al. (2005) reported major negative social impacts (retail stores raising their prices; prostitution, adultery, domestic violence; theft of green beans; land disputes; food insecurity). In this study, male heads of households reported that the changes resulting from engagement in the vanilla value chain were either completely (35%) or mainly (45%) positive. A further 9% regarded the changes as equally positive and negative. The negative aspects in the previous boom and bust do not appear to have occurred to the same extent this time. However, major negative elements which were reported were alcohol abuse and domestic violence. The main suggestion to minimize the negatives and enhance the positives was to change social behaviour through enforcing law and order and working through churches and village leaders.

General findings on social sustainability of the vanilla value chain are summarised in the radar diagram (Figure ES 2). While working conditions and land rights are of concern in PNG, they are not major issues in the vanilla value chain. Within the major challenges of gender inequality in PNG, women are participating in and benefiting from the vanilla value chain. While prices are good, vanilla income appears to be contributing to improving household nutrition security and living conditions. However, there are concerns regarding health and negative social outcomes, such as alcohol abuse and domestic violence. Social capital is generally weak in the value chain.

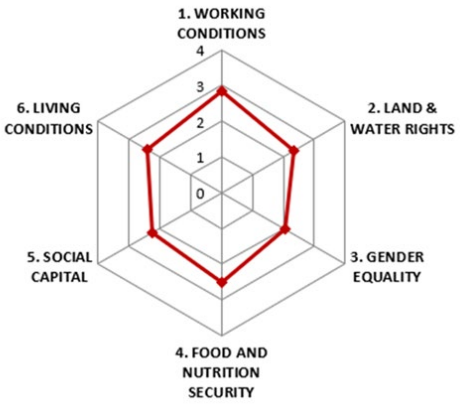

FIGURE ES 2 PNG VANILLA VALUE CHAIN SOCIAL ANALYSIS RADAR CHART

FQ4. Is the vanilla value chain environmentally sustainable?

The environmental sustainability analysis of the vanilla VC in PNG was developed following a Life Cycle Analysis (LCA) methodology. Three specific areas of protection were evaluated: the impact on depletion of natural resources, the quality of ecosystems and human health.

CQ4.1. What is the potential impact of the VC on resources depletion?

Potential impacts on resource depletion result only from fossil fuel consumption, mainly from transport, as the vanilla VC is a low input system - no fertilization, no irrigation, no chemical pest protection. The formal export channel is the major contributor to resource depletion, mainly due to the medium exporters' business activity, while cross-border trading has a relatively small contribution to this indicator.

CQ4.2. What is the potential impact of VC on ecosystem quality?

The main potential cause of ecosystem degradation is land use related to vanilla cultivation. The classes of large and medium vine owning households are the highest contributors to vanilla VC impact on ecosystems, while the class of small vine owing households contribution is comparatively quite small. Potential losses derive mainly from land occupation, due to a lower richness in species in vanilla plantations than in a non-anthropogenic use of land, and from natural forest conversion, due to habitat loss and habitat fragmentation.

CQ4.3. What is the potential impact of the VC on human health?

Potential impacts on human health result mainly from global warming linked to land use change, from forest to vanilla plantation. This impact is due to the release of carbon stored in the natural forest areas that were transformed into vanilla plantations, resulting in a lower total carbon stock per hectare. Although this impact is subject to a high degree of uncertainty, it prevails over other possible impacts on human health. Large and medium vine owning households are by far the main contributors to vanilla VC impacts on human health, while the group of small vine owning households account only for a small part of these impacts.

In the PNG vanilla value chain (VVC), the major environmental impacts are Global Warming, affecting Human Health and Ecosystems, and Land Use, affecting Ecosystems - these environmental impacts occur during the cultivation/farming phase. The secondary environmental impacts are Fine Particulate Matter Formation affecting Human Health and Fossil Fuel Scarcity affecting Resources - these impacts occur during the transport and packaging stage. Impacts are summarized in Table ES 2.

TABLE ES 2 QUALIFICATION OF ENVIRONMENTAL IMPACTS IN THE VALUE CHAIN AND SYNTHESIS OF RECOMMENDATIONS: VANILLA IN EAST SEPIK (PNG)

Impact (Characterization category)	Global Warming	Global Warming	Land Use	Fine Particulate Mater
Damage Category (endpoint)	Human Health	Ecosystem	Ecosystem	Human Health
Level of Impact	**Very High**	**Very High**	**Very High**	**High**
Value Chain Stage	Vanilla Farming (Agricultural production)	Vanilla Farming (Agricultural production)	Vanilla Farming (Agricultural production)	Transportation
Cause of Environmental Disfunction	Land use change	Land use change	Very low yields	Emissions from fuel consumption
Recommendation	Increase productivity /Agroforestry	Increase productivity / Agroforestry	Increase productivity / Agroforestry	Road improvement
	Land sparing	Land sparing	Land sparing	Vehicle inspection

To improve the sustainability of vanilla VC and reduce environmental impacts of a production expansion, three main factors must be considered:

Land use change is a complex process. Vanilla expansion appears to be very high and it is done mainly to the expense of primary/secondary forest. The traditional PNG agricultural rotation system - 3 years of food crops after forest clearance, before planting a perennial crop – seems to be replaced, in the case of vanilla, by a system where the perennial crop is planted immediately after clearing. This deforestation, implicit in the vanilla expansion rate, is the main cause of the high environmental impacts (Human Health and Ecosystem Quality) of the PNG vanilla cultivation system

Average **vanilla yield** is very low in East Sepik/PNG - an increase in yield will cause a reduction of the environmental impacts of vanilla farming through lower land use impact per 1 kg of vanilla produced and eventually through land sparing. Improving the quality of vanilla produced by households (*e.g.* only top quality: Grade A) will contribute to a reduction in environmental damage, as quality is associated with a higher weight of vanilla pods and therefore an increase in yield.

Small vine-growers are by far the most eco-efficient type of producers in the sense that their production of 1 kg vanilla has the smallest environmental impact of the three classes of vanilla farmers. Medium vine-growers are the less efficient (their production of 1 kg of vanilla causes the highest environmental damage), closely followed by the large vanilla producers.

The vanilla value chain is a low input system and the depletion of resources is basically associated with the transportation of the vanilla to the point of export, through Wutung and Port Moresby.

The ground **transport of vanilla**, from the place of production to the point of export, is characterized by a system in which only one of the actors (the large exporter) moves quantities that justify the use of freight lorries, with the lowest environmental impact per kilogram transported. The other actors use collective means of transport (VWPs for vanilla farmers) or 4WD vehicles (in the case of traders and agents of producers' associations). Despite not being environmentally planned and practiced only for reasons of safety and cost reduction, car sharing on journeys to the border with Indonesia proved to be important and effective in reducing the environmental impacts of vanilla transport.

Vanilla, considered either as an annual crop or as a perennial crop, does not store more carbon than the PNG forests. Integrating vanilla into agroforestry systems, which includes several other economically important species, will benefit both the vanilla system - since the diversity of plant species will improve the ecological services provided by that system (including carbon storage) – and diversify the sources of income making the farmer more resilient to price fluctuations in the vanilla market.

What are the key factors, internal and external that are favourable or unfavourable to vanilla value chain development?

Internal	STRENGTHS • Strong capability of numerous individuals along the vanilla VC in producing, curing and marketing • Areas of PNG are agro-ecologically ideal for vanilla production • Growing reputation as a contender to Madagascar Bourbon vanilla • Very high value to weight ratio • High returns per hectare and per workday when prices high • Good mechanisms via social media for farmers to access domestic price information	WEAKNESSES • Individual access to finance for trading and access to global market information • Collective capacity generally low; particularly in marketing PNG vanilla as a brand • Low capacity of farmer organisations • Food safety may be an issue along medium-scale and informal vanilla VC • Poor roads in main producing areas • Perceived unfair allocation of portion of export levy revenue attributed to province where packing occurs rather than production • Low productivity • Not easy to access global daily prices • No one (stop-shop) organisation representing the vanilla sector
External	OPPORTUNITIES • Global demand for natural vanilla and Tahitensis species growing • Specialised online retailers highlighting provenance and unique characteristics • Markets looking for socially and environmentally responsible production	THREATS • Global price volatility • Climate change could affect agro-ecology and increase disease risk • Food safety requirements in the USA and EU • Negative perception of PNG as dangerous, difficult and expensive place to do business • Natural vanillin substitutes • New/up and coming producers – Florida, Tanzania, Comoros, Cook Islands, Samoa

Cross-cutting CQ: Which risks may affect the performance of the vanilla value chain?

Risks which may affect the performance of the vanilla value chain were identified and are summarised in table below.

Risks	Probability	Severity
Price trends: Increase in global prices since 2015 but peak prices considered to have been reached and likely to decline in next 2-3 years.	High	High
Price volatility: Most volatile of all agricultural products.	Very high.	Very high
Logistics and infrastructure: Poor roads increase the risk of traders facing higher procurement costs; farmers and traders exposed to risk of theft in holdups partly due to poor road conditions.	Low	Low
Policies: No specific vanilla policy, limited recognition of challenges and ways to address them along VC increases risk of an unsupportive policy environment.	Low	Medium when prices are low
Governance and institutions: No public sector organisation with responsibility for vanilla development. One company has positioned as lead agency but not transparent about its operations. Lack of appropriate governance increases risk of vanilla not being viable during periods of lower prices.	Medium	Medium
Social relations: Lack of trust in vanilla VC; particularly between certain farmers and large exporter; farmer organisations generally not functioning well. Increases risk of vanilla not being viable during periods of lower prices	Medium	High when prices low.
Gender and youth: Risk is that women's participation in vanilla VC increases their workload, but does not result in equal access to income and benefits.	Medium	High
Weather and climate change: Risk of increase of average air temperature and in annual and seasonal mean rainfall. Intensity and frequency of extreme rainfall expected to increase. Possible risk in shift of vanilla-growing areas; humid conditions will favour spread of diseases; vanilla sun curing process might be affected; variable localized mud and/or landslides in vanilla gardens planted in steep slopes; inundations in flat areas; soil erosion.	Very high	Medium to High
Natural environment: Land use change; risk of conversion of forest (primary/secondary) areas into vanilla gardens.	Very high	Medium (compared to other cash crops)

Conclusions and recommendations

1. **The vanilla VC is underperforming but current high prices are supporting viability particularly at the producer level.** All three categories of vanilla farmers are financially sustainable at current high prices, with net profit rate ranging from 91 to 96%. For traders, margins are much tighter, with return on turnover ranging from 3 to 14%. One company dominates but competition from smaller exporters help to improve prices received by farmers. The overall poor quality of vanilla being produced has an impact on prices received. The study was conducted at the height of global prices which has produced windfalls for thousands of farmers. There is risk that these benefits will not be sustained if prices fall to the levels of the early 2000s.

   Recommendation: Increase focus on product quality to build PNG's recognition and reputation; consider crop certification *e.g.* organic and geographical indication and branding and ensuring food safety.

2. **Vanilla is a high-risk and high value business in PNG**. The risks include theft of beans, theft of trading capital, physical attacks and trading fraud. This is a result of weak infrastructure and logistics, inadequate policing and a lack of due diligence. This has implications for the reputation of PNG in its ability to attract international buyers.

Recommendation: Support initiatives to improve infrastructure and logistics such as increased investment in roads and promotion and uptake of electronic payments by mobile phone companies. Strengthen capacity in due diligence arrangements.

3. **Vanilla is not sufficiently recognised by central government to be a valuable contributor to the national economy**. There is no up-to-date specific vanilla policy and there appears to be a limited common understanding within government of the challenges along the value chain and how they might be addressed.
   Recommendation: Improve the collection of accurate statistics (production, financial, international trade, social, environmental) on the sector. Develop appropriate national, provincial and LLG policy processes. Provide an updated national vanilla policy.

4. **Vanilla makes a major contribution to the East Sepik economy**. 80% of PNG's vanilla is produced in East Sepik and the province should be receiving 60% of the export tax on vanilla. Under current arrangements, the province exporting a commodity receives 60% of the export tax revenue. Currently up to 75% of vanilla grown in East Sepik is taken to Lae for processing and packaging prior to export and hence East Sepik province does not receive a share of this income.

   Recommendation: A system needs to be devised to capture the value of vanilla as it leaves East Sepik province so that it can receive its fair share of the tax revenue generated from vanilla production.

5. **There is weak governance of the sector and weak institutions that support farmers, traders and exporters**. Stakeholders consulted did not comment favourably on the role and operation of the Spice Industry Board (SIB). The SIB is responsible for supporting the sector but they don't currently have the capacity to do this.

   Recommendation: Improve trust and relationships through dialogue and action between actors (farmers, farmer organisations, traders, exporters) in the value chain. This needs to be facilitated by an honest broker, such as an international NGO or equivalent, in collaboration with provincial and Local-level government (LLG) DAL officers. An entity is needed to provide functions such as oversight, guidelines, information, promotion, advice, market linkages. The PHAMA project staff could do a capacity assessment which should include detailed stakeholder consultations on how such an entity could be strengthened to support the vanilla sector.

6. **Gender and inter-generational inequality are major challenges, but not unique to the vanilla value chain.** PNG ranks second lowest in gender equality globally. There is a risk that women's participation in the vanilla VC does not result in equal access to income and benefits. Low entry costs and current high returns make the vanilla VC attractive to youth, but proceeds may fuel excessive alcohol consumption and lack of access to land may lead to theft of beans.

   Recommendations: The role of women and youth in the vanilla VC needs to be recognised and appropriately supported. Interventions to strengthen the vanilla VC should partner with organisations with experience in supporting gender and inter-generational equality, such as international and national NGOs and CBOs working in vanilla-growing areas.

7. **Food safety and traceability are not currently an important issue for buyers but this is likely to become more important in the future, particularly for certified vanilla**. Food safety of exported beans may not be a significant issue for PNG as we understand that the main exporter treats its vanilla to minimise microbial and physical contamination. It was unclear whether any treatment is done by the medium-scale exporters. In 2008 a consignment exported to the USA was rejected due to the presence of physical contaminants. This harmed the image of PNG as a high-quality vanilla producer and has taken exporters a long time to mitigate the impact.

Recommendation: National Agriculture Quarantine Inspection Authority (NAQIA) to continue to be vigilant in its inspections as it is the key organisation in managing reputational risk of PNG vanilla. Vanilla stakeholders should consider means of improving traceability, including technology such as blockchain.

8. **Vanilla production is likely to be affected by climate change alongside other factors.** There are no research programmes and limited agricultural support services to support stakeholders in this vulnerable VC and strengthen its resilience, including adapting to climate change and protection from pest and diseases.

   Recommendation: Vanilla growers are likely to need techniques adapted to wetter soil conditions as well as for diversified production systems *e.g.* agroforestry, food and cash crop intercropping. NARI could investigate genetic selection for varieties more tolerant to wetter conditions. This could be through collaboration with other vanilla growing countries in the region. Cost-effective pest and diseases surveillance systems will be important.
   There needs to be appropriate agricultural extension service support which takes account of the balance between current, limited, government extension capacity, farmer cooperatives and the motivation of the private sector with the type of information they could provide. Such interventions should consider partnerships involving public, private and civil society organisation to maximise synergy from their specific interests.

9. **There has been a major increase in the area of land planted to vanilla over last 20 years (over 98% in East Sepik) and it is done mainly at expense of primary/secondary forest.** The average vanilla yield is very low in PNG (estimated at little over 56 kg/ha.year for cured vanilla beans). The vanilla value chain is a low input system (no fertilization, no irrigation, no chemical pest protection).

   Recommendation: Improve vanilla productivity and quality (land sparing) through low input management practices targeting organic vanilla markets. Encourage vanilla growing as part of a biodiverse socio-ecological system involving agroforestry and food/cash crop intercropping.

10. **This value chain study has provided an opportunity for a Papua New Guinean expert from a national university to gain considerable insight into the country's vanilla value chain from a multi-disciplinary perspective.** It would be beneficial to build on this to support the capacity of young researchers to contribute to the understanding of issues in the vanilla, and other, value chains from an economic, social, environmental and organisational perspective.

    Recommendation: Donors and the government to consider ways in which they could provide funding to enable young researchers (MSc students) to undertake field studies of aspects of the vanilla value chain as part of their degree programmes.

1 INTRODUCTION

1.1 Background to the study

This vanilla value chain study in Papua New Guinea forms one of a number of studies commissioned under the "*Value Chain Analysis 4 Development*" (VCA4D) programme on which EC DEVCO and Agrinatura are collaborating. The four-year VC4D programme aims to generate evidence-based, largely quantitative, analytical information on selected value chains in developing countries. It involves application of a holistic and multidisciplinary methodology to generate evidence which can inform decisions as well as policy dialogue. The adoption of the same methodology across countries and different value chains is also intended to allow for learning relevant lessons.

The objective of the study is to generate information to support policy dialogue between the European Union (EU), the Government of Papua New Guinea (PNG) and key stakeholders in the vanilla value chain (VVC). It is anticipated that it will contribute to the formulation of policies and strategies which will drive sustained and inclusive growth in the vanilla value chain in PNG. The EU Delegation is in the process of developing a project to "*Support to Rural Entrepreneurship, Investment and Trade in Papua New Guinea*" that includes the vanilla sector.

Past development operations have often focused on increasing agricultural production, whilst often ignoring the market and livelihood drivers involved. Production activities are part of a wider network of interdependent businesses and it is therefore critical to examine them from within the value chain (VC) as a whole. Development interventions in agriculture have rarely paid much attention to the related social and environmental impacts. By investigating and setting out the many effects of value chain operation, the likelihood of unintended consequences occurring may be reduced.

Value chains are a major channel for agricultural development due to their trans-sectorial capacity to create economic value and employment in an inclusive and sustainable way. They represent an operational framework for engaging with farmers and businesses. Value chain analyses can help support decision making by assessing appropriate indicators or informing on the changing situation of those involved.

In line with similar studies commissioned under the VC4D project, this study of the vanilla value chain (VVC) in Papua New Guinea responds to four framing questions:

1) What is the contribution of the VC to economic growth?
2) Is this economic growth inclusive?
3) Is this VC socially sustainable?
4) Is the VC environmentally sustainable?

The report investigates and informs on 19 core questions that help to shed light on actual dimensions of impact and provide answers to the four framing questions.

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Cross-cutting CQ. Which risks may affect the performance of the VC?

Scope: The main boundary for analysis of data relating to the vanilla value chain is from the clearing of ground and planting of support trees and vanilla vines to the export cured vanilla beans by trading companies. The economic, social and environmental analyses focus on small-scale to large-scale vanilla vine owning households and informal/cross-border traders and medium-scale vanilla exporters and one large-scale exporter. Data used for the analyses relates mainly to responses received from a survey of 100 vanilla-growing households in five main vanilla-growing villages in East Sepik province plus information from focus groups, traders and farmer associations operating in the province.
Methodology: The team used generic methodologies and tools developed for the VC4D project. Specific data collections methods used included online literature review, analysis of customs data, semi-structured interviews with officials, farmers, traders and exporters, a structured questionnaire survey for vanilla-producing households and traders and farmer associations and women's focus group discussions. Statistical analysis was used to provide information for the functional and economic analysis, mainly using spreadsheet calculations. The Social Analysis Framework and spreadsheet was applied, as was the Life cycle Analysis (LCA) and a software platform (SimaPro) for analysis of environmental sustainability and impact assessment. Regular consultations were used between team members to confirm the study scope and agree on categories of vanilla producers and traders.</td></tr>
</table>

The study team consisted of the following members:

- Claire Coote, team leader and agricultural economist, Natural Resources Institute, University of Greenwich
- Richard Lamboll, social development expert, NRI, University of Greenwich
- Helena Farrall, environmental expert, Instituto Superior de Agronomia, University of Lisbon, Portugal

- Veronica Bue, specialist in agricultural extension and rural sociology, national expert, University of Technology, Lae, Papua New Guinea.

1.2 Study methodology and limitations

The team adopted the following methods during the study:

- Collection of data and information from online secondary sources, including publications on vanilla production, the global market for vanilla, history of vanilla production in PNG; key players particularly exporters, researchers and extensionists[1]; production information, export statistics, environmental data, social studies, social media entries
- Semi-structured interviews with key actors in the VVC, including sessions with the whole team and others where sub-teams or individual team members met respondents relevant to their specialist area
- Focus group discussions in eleven villages (10 in East Sepik and 1 in Morobe province) with men, women and youth participants. The number of participants in each FGD ranged from 4-31.
- Measurements, photographs and data relating to environmental aspects of production
- A survey of 100 vanilla producing households in 5 top vanilla producing villages in two districts in East Sepik
- A survey of eight traders in two districts and three associations in two districts in East Sepik
- Analysis of vanilla export data (PNG Department of Customs)
- Data analysis and information processing undertaken by the team members using software developed under the VC4D project: the framework developed for social analyses; environmental sustainability and impact assessment analysed using a Life Cycle Analysis (LCA) methodology and a proprietary software platform (SimaPro)
- Regular skype discussions between team members on issues for which convergence is required, including for example:
    - Categorisation of vanilla producers because there is no database classifying numbers of farmers, plot size and vine numbers.
    - Trends and patterns observed in the development of the vanilla value chain.
    - Identifying ways to overcome the lack of data relating to the value chain. A lot of calculated estimates have been made to try to corroborate production figures ventured by stakeholders.

[1] The team were sad to learn that two people who had worked a lot on vanilla in the first boom – Gadi Ling, a senior national agricultural scientist and vanilla researcher and trainer at NARI, and Nancy Sullivan, a rural sociologist from the University of Divine Light, Madang, who led the vanilla socio-impact study in 2005 – had both passed away, in 2012 and 2015 respectively.

Vanilla is a recent cash crop in PNG. There are very few statistics collected and officially produced on the sector and this proved a serious challenge for the economic analysis. The first exports took place in the late 1990s though recordable quantities of formal exports were not collated by the Department of Customs until 2001. After the price crash in 2005 exports virtually stopped for ten years and National Agriculture Quarantine and Inspection Authority (NAQIA) staff have had to become re-accustomed to dealing with large quantities of vanilla exports since the resumption of exports in 2015.

All export shipments are recorded by NAQIA staff based at each port and airport. The data is handwritten into a ledger. This then is typed up and sent to the Department of Customs in Port Moresby for data entry. The team were able to obtain vanilla export data from the Department of Customs and the National Statistics Office on vanilla export data from 2001 to 2017. These are not normally published in official publications although they are included in the 'other' category of agricultural export values. During scrutiny of this data several serious anomalies were identified, probably the result of mistakes in data entry transcription, which make a huge difference to the export figures and their interpretation.

Vanilla production was the subject of several publications, on its economic and social aspects, between 2004 and 2005 by a few researchers. These publications were used as reference information on the sector. There are very few scientific or technical publications although evidence was found of several training guides on vanilla production and curing produced by various authors in PNG since 2000. Overall, there are very few formal publications on the vanilla sector.

At a macro level GDP figures have not been produced since 2014. In the absence of adequate data from PNG public agencies, statistics compiled by or extrapolated by the World Bank and other international agencies were used.

Vanilla is a highly under-researched value chain and there is a lack of availability of information in both published and grey literature. There are virtually no statistics at national level on numbers of vanilla farmers, the number of plants, area planted, yields obtained, labour inputs and costs of production. There is no farmer survey data on economic and environmental aspects and only historic information on social aspects of the vanilla value chain, collected in 2005. There is now no national research programme on vanilla. Through key informant and focus group discussions we collected indicative information around all three areas and the four framing questions, but this information is also partial and incomplete. Farmers stated their number of vines but did not know the area on which they were grown. Because not all the vines had started bearing or were only starting to produce or were very old vines which had been more or less abandoned, bean yield data estimates are very variable.

Key informants provided a good narrative of the vanilla value chain but very few figures. Many of their experiences dated back to the previous boom and they had yet to become fully operational again.

The challenge of the lack of data at provincial, district and local government (LLG) level and the reliability of all data was highlighted by the FAO representative.[2] Several other stakeholders regretted the lack of statistics on the sector and how this hampered decision making and action.

In order to substantiate views obtained during the team's visit from vanilla growers in the main, but very remote, vanilla growing areas of Ambunti-Dreikikir and Maprik districts a survey of one hundred vanilla-growing households, and of eight traders and three farmers' organisations, was designed and carried out in April 2019. This provided much greater detail on the challenges, benefits and disadvantages of vanilla production and trading.

1.3 Activities undertaken

The study consisted of the following phases:

[2] In March 2019 the FAO rep made similar remarks at a national inception workshop on agricultural statistics jointly organised with the DAL and NSO to launch a project to improve collection and use of statistics in the agricultural sector https://www.agriculture.gov.pg/reliable-statistics-crucial-for-agricultural-development/.

- Brussels: VC4D PMU Training of economists in AFA (Agri-food chain Analysis) software to be used for economic analysis, November 2017
- Brussels: Team briefing at VC4D PMU, 7-8 June 2018
- Scoping mission by national expert 27 July-4 August 2018 in Port Moresby, Lae and East Sepik
- First fieldwork mission, 24 August-13 September 2018
- Household field survey and focus groups in East Sepik, April 2019
- Data entry, analysis and reporting, May-October 2019

The national expert initially gathered information from meetings, interviews and observations with various players along the value chain that had been identified by Agrinatura team from internet searching. The information generated provided further insights and helped the team prepare for their mission to meet stakeholders in the capital and in the two selected producing provinces.

The full team mission took place between 24th August and 13th September 2018 and involved consultations with over 50 stakeholders and with groups of vanilla farmers (with more than 100 farmers, at five production sites (see Annex 2 for detailed list of stakeholders consulted). The team undertook considerable online information searching on the sector to identify online reports, journal articles, books, newspaper articles, market reports and Facebook pages, such as the Vanilla Farmers in PNG group3 to provide a background to the value chain. Activities undertaken also included searches of key players, critical data and identifying gaps in knowledge and understanding of developments in the chain.

The team visited vanilla growers and stakeholders in Wewak, Yangoru-Saussia and Maprik districts of East Sepik and interviewed the brother of one of the original vanilla promoters in Ambunti-Dreikikir district – said to be the oldest and largest vanilla producing area. The team visited Lae, the capital of Morobe province, and the country's industrial hub and went to Situm, about 30 minutes from Lae where vanilla was introduced in 1995 by the district agricultural officer. Focus Group Discussions were held separately with women and men in three communities in East Sepik and separately with women, men and youth in one site with several communities in Morobe. Unfortunately, in spite of repeated efforts we were not able to arrange a visit to meet large exporter in Lae. However, we did interview a manager in its Maprik office.

The Vanilla Household survey took place in Maprik and Ambunti-Dreikikir districts. Dreikikir has been promoted on a Facebook site as 'the home of PNG vanilla - Green gold'. In-depth, follow on surveys of 100 vanilla growing households and 11 traders/trading organisations as well as a further five focus group discussions with women were carried out by the national expert and a team of enumerators from the University of Technology (UniTech), Lae in the two main vanilla producing districts in East Sepik in April 2019 (see Annex 1 for a summary report).

1.4 Value chain actors consulted

During the mission the team interviewed the following stakeholders who, directly or indirectly, have an interest in the value chain:

- The governor and officials of the East Sepik Provincial government and Maprik district
- Officials of the Ministry of Agriculture and the PNG Spice Industry Board, Port Moresby; provincial and district vanilla officers in Wewak province, Maprik and Situm districts
- Officials of the National Agriculture Quarantine and Inspection Authority (NAQIA), the Department of Customs and the National Statistics Office, Port Moresby
- Pacific Horticultural & Agricultural Market Access (PHAMA) Program
- FAO, Port Moresby
- Ministry of Trade and Commerce, and the Ministry of Women and Youth, Port Moresby

[3] https://www.facebook.com/pg/Vanilla-Farmers-in-PNG-501884409976692/posts/

- Ministry of the Environment and the Department of Forestry, Port Moresby
- Vanilla growers in Turubu LLG, Wewak district; Holik 2 village, Wosera, Yangoru-Saussia district; Jame village, Bainyik village; Urita village and Walahuta village, Maprik district; Yambes village, Samark village and Yawerng village, Ambunti-Dreikikir district, East Sepik province and Situm district and Finschhafen district, Morobe province
- NGOs - Save the Children, Water Aid and Family for Change, East Sepik council of Women, World Vision, Wewak; Women's Crisis Centre, Maprik and Women in Agricultural Development Foundation, Hayfield and Port Moresby; Oxfam and Save the Children, Port Moresby
- Organic vanilla scheme manager, Intec Vanilla Niugini Ltd, Maprik
- Vanilla street traders, and occasional exporters, Maprik
- Established vanilla exporters, Port Moresby and Wewak
- Bank of the South Pacific and PNG Airfreight, Wewak
- Representatives of four farmers' associations in East Sepik.

A full list of the stakeholders consulted is given in Annex 2.

2 THE FUNCTIONAL ANALYSIS

2.1 Strategic importance of PNG's agricultural sector and agriculture to the East Sepik economy

Agriculture contributed an estimated 22% of overall GDP in 2017 (Table 2-1) increasing to 25% in 2018. The share of industry, the dominant sector, was an estimated 42,9% in 2017. Agriculture was the backbone of the economy for over 70 years but in recent decades its importance has been dwarfed by the minerals, oil and gas sectors. Following the collapse of oil prices in 2014 more attention is being given to reviving the agriculture sector, which is now recognised as being of strategic importance to PNG's economy and to food security and nutrition. The main challenge is to shift the economy dominated by mining and energy extraction to one in which agriculture, forestry, fisheries, eco-tourism and manufacturing make major contributions, by 2050.

TABLE 2-1 PNG MACROECONOMIC AND OTHER INDICATORS

Indicator	2017
Population (million)[4]	8.25
Land area (km^2)	462 800
Agricultural land (% of land area)	25
Population density (people/km^2) [5]	17 (>50 in a few areas)
Population living in rural areas (%)	85
GDP (US$ billion) estimate[6]	20.54
GDP growth (estimate)[7]	2.5
Agricultural sector contribution to GDP (%)[7]	22.1
Inflation (%)[7]	5.4
Formal employment	465 000
Unemployment rate (%)[7]	2.5

The sale of agricultural commodities is the most significant source of income for rural people, both in terms of total income and the number of people involved; producing cash crops is one of the few opportunities for rural people to gain a regular and/or sizeable income. This is extremely important as many households earn less than € 30 per year and 80% of the population live on less than US$ 1.25 per day. Households are largely able to produce enough staple foods, but malnutrition and stunting is prevalent due to lack of access to protein. Fluctuating commodity prices, access to land and the poor transport infrastructure are major deterrents to agricultural expansion.

The agricultural sector encompasses two main sub-sectors: food crops (roots and tubers, rice, bananas, sago and fruits and vegetables) mostly for household consumption and domestic sales, and industrial tree crops (cocoa, coffee, oil palm, rubber, copra, coconut oil, tea, spices) for export. Around 70-80% of cocoa, coffee and coconut production is produced by smallholders, and this subsector generated around 13% of total merchandise exports in 2017.

A key determinant of agricultural competitiveness for export markets is the exchange rate. Until 1994, PNG maintained a 'hard Kina' exchange rate policy, in which the exchange rate between PNG's currency, the Kina, and the US dollar was maintained at a high level (McGregor, 2005) to keep the cost of imports low - most capital and consumer items are imported. In 1994, the Kina was allowed to float causing it immediately to fall in value. This stimulated agricultural cash crop production as produce became more competitive in international markets. Vanilla exports, which started in the late 1990s, benefited from advantageous exchange rates. Today, PNG faces a worsening foreign exchange situation. The vanilla industry is a net generator of foreign exchange.

[4] World Bank Population Indicator.

[5] Allen (2003) quoted in McGregor (2005).

[6] World Bank https://data.worldbank.org/country/papua-new-guinea.

PNG's agricultural exports benefit from free access to overseas markets, but producers, traders and exporters face many constraints including poorly maintained transport infrastructure; inadequate access to credit and working capital; poor produce quality and insufficient knowledge by producers of market requirements; inadequate security for traders and producers, who are vulnerable to robbery and assaults, poor dissemination of information and planting material (Oxford Business Group, 2017).[7]

The long-term development objectives for the agricultural industry are expressed in the National Agricultural Development Plan, the PNG Development Strategic Plan and the PNG Vision 2050 document. Beyond increasing production through better and innovative agricultural practices, these are aimed at promoting both downstream processing and replacement of agricultural and food imports. PNG Vision 2050 and the 2017 Alotau Accord also stress the need to promote commercially-oriented agriculture to counteract the impact of falling mineral, oil and gas prices. In its Agriculture Sector Plan 2018-2037 the need to develop support services and infrastructure, such as roads, river and other water transport modes and related infrastructure, improved technology, information and extension, improved access to credit and enhanced human resource development is recognised. The Government has indicated[8] that it will continue to invest in national infrastructure programmes to reduce the cost of doing business and improve market access for rural farmers.

In August 2017 PNG launched its first national trade policy, PNG Trade Policy 2017-2032, whose goal is to maximise trade and investment by increasing exports, reducing imports and to increase foreign direct investment. Increasing agricultural production and processing, and exporting value added agricultural produce is an important part of this strategy.[9] As the largest employment sector and the third-largest export revenue generator, agriculture is recognised as the country's best means of diversifying its basket of goods and easing reliance on extractive industries (Oxford Business Group 2017 quoted in Lescuyer et al., 2018). Although vanilla currently contributes a very small proportion of agricultural sector value, it fits in well with these plans and objectives. The government regards vanilla as a promising new crop. However, many issues have to be addressed to ensure that the vanilla sector is able to thrive. These are addressed in this report.

As the economic analysis in chapter 3 shows, the contribution of the vanilla value chain is very small but it is having a larger impact on the economy of East Sepik province, the second largest province by land area. It is relatively undeveloped and is isolated from the rest of the country with no road connections to Madang and Morobe provinces, although it is the most visited province (60% of visitors to PNG visit East Sepik). Agriculture is a major part of the economy; there is no formal mining activity in the province though alluvial gold panning generates incomes for some inhabitants. Key cash crops include coffee, oil palm, cocoa, betel nut and vanilla. No provincial economic data is published but if the 2017 PNG GDP estimate of US$ 20.54 billion is divided by 22 (number of provinces) the average provincial GDP figure is US$ 933 million. This figure probably overstates the value for East Sepik as it has no mining or oil and gas extraction activities. If 80% of the value of the formal vanilla exports recorded to the country is taken as the value to the East Sepik economy (PGK 60 000 000 / US$ 18 518 518), vanilla's estimated contribution to the East Sepik GDP is 1.98%. This is likely to be a considerable underestimate as it does not include many of the cross-border exports, which could be in the region of 130 tonnes.

The main direct source of income from vanilla is the export levy collected on vanilla exports, at 10% of the FOB value. With export sales of around 240 tonnes and estimated export values of PGK 236 million, the amount generated should be in the region of PGK 24 million.

Government rules allow the producing (and exporting) province to retain 60% of this income. In the case of vanilla 80% is produced in East Sepik. Currently around 40% of vanilla grown in East Sepik is taken to Lae for processing and packaging prior to export and registered with NAQIA at Lae. 60% of the tax revenue generated is retained by Morobe province. East Sepik province does the province does not receive a share of this income. Table 2-2 shows the number of shipments, quantities and values of vanilla exports registered at the four NAQIA offices, between January and August 2018 as well as average unit values and the amount of export duty chargeable. Although the quantity of vanilla exports registered in Wewak is slightly larger than that

[7] Quoted in Lescuyer *et al*. (2018).

[8] National Budget 2018 Vol 1.

[9] PNG Telephone Directory, 2018.

registered in Lae, the value is much less due to the lower unit price obtained. 85% of the exports registered in Wewak were destined for Indonesia and the price obtained tends to be lower than that achieved for sales to the USA and Europe. The tax revenue generated is also significantly lower. This is a point of contention for the East Sepik Provincial Government, which feels that it should be able to retain a much larger proportion of the tax income from value created in its province.

Very small quantities of vanilla are registered by NAQIA in Port Moresby (at Jacksons international airport) and at Vanimo (at the Wutung border crossing). The difference in the unit values obtained for vanilla exports in these two locations highlights the range in qualities that are exported.

TABLE 2-2 -AMOUNTS AND VALUES OF VANILLA EXPORTS REGISTERED AT THE FOUR MAIN EXIT LOCATIONS, JANUARY TO AUGUST 2018

	No of shipments	Quantity (t)	Value (PGK)	Unit value (PGK/t)	10% export tax (PGK)
Lae	165	60,05	80 309 753	1 337 381	8 030 975
Wewak	145	61,57	55 066 611	894 374	5 506 661
Port Moresby	9	0,97	1 232 511	1 277 213	123 251
Vanimo	6	1,29	498 258	386 246	49 826
Total	**325**	**123,88**	**137 107 132**	**973 804**	**13 710 713**

Source: Calculated by data provided by the National Statistics Office, 2018

2.2 The world vanilla market

The vanilla world market is a small niche market with an annual global demand said to be around 2 000 to 3 000 tonnes[10], of which 80% is normally provided by Madagascar. Smaller producing countries include India, Indonesia, Uganda, Mexico and PNG. It is difficult to obtain information about the market from one source and it is well-known for its opacity. Vanilla is also known for the volatility of its prices, which are illustrated in Figure 2.1.

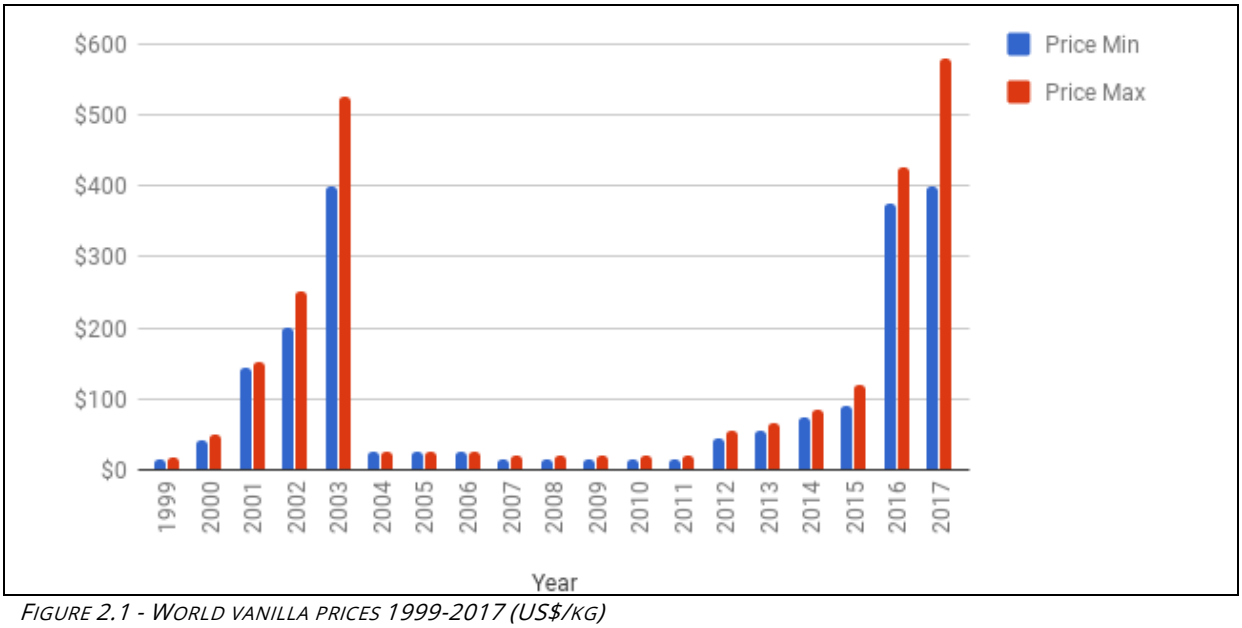


FIGURE 2.1 - WORLD VANILLA PRICES 1999-2017 (US$/KG)
Source: https://www.cooksvanilla.com/make-homemade-vanilla-extract/

The pattern of world vanilla production is characteristic of the 'cobweb' price theory which describes cyclical supply and demand in a market where production takes place over several seasons - particularly the case

[10] Ultra international BV Spring Market report 2018.

with the long lag between planting and harvesting vanilla. The price pattern is the result of highly inelastic demand (natural vanilla is used in luxury/gourmet foods of which it makes up a very small proportion of costs and whole bean consumers are largely unresponsive to price changes within a reasonable price change[11]), large random shifts in supply that trigger disproportionate changes in price and a large price increase which triggers a disproportionate supply response. The greater the initial supply response the larger the overreaction and the longer and more depressed the subsequent price trough.

Despite substantial increases in the global vanilla price since 2016, demand for vanilla has sustained in part due to increasing consumer preference for natural foods and beverages. In 2015, several global food brands announced their intention to use only natural flavours and remove artificial ingredients, including manufactured vanilla, from their products. This coincided with a substantial downturn in natural vanilla production, particularly by the dominant, but cyclone-prone, producer Madagascar, leading to a dramatic increase in prices.

Vanilla is one of the most favoured flavouring and fragrance ingredients. An estimated 18 000 global products contain vanilla as a flavour, although much of this would be from artificial vanilla flavouring. It is widely used in commercial and domestic baked goods, ice cream, carbonated beverages (Coca Cola, Pepsi), confectionary, perfume manufacture and aromatherapy and been used as an aphrodisiac for centuries. It is also used to disguise unpleasant chemical aromas in paint, rubber types and cleaning products.

"Most flavour blends benefit from the addition of vanilla. Its notes add richness and body to the flavour or fragrance, which is often not recognised in the finished product. Vanilla is critically important in beverages, baking, dairy and confectionary to name but a few food categories".[12]

Natural vanilla is sold as whole (gourmet) beans, extract, powder, paste and flavoured sugar. The majority of these are produced from Vanilla planifolia, grown in Madagascar.

In addition to the massive price fluctuation that characterises the sector and about which producers can do little, another issue is the lack of value capture or share of the final retail price received by the producers. Using the average prices obtained by the three groups of farmers in the household survey and comparing these with the average FOB price of PNG exports for the first eight months of 2018, the three groups received between 57 and 73% of this, depending on the quality offered. A few large flavouring companies in North America and Europe dominate the market. Work by Light Years IP for the Department of International Development, UK has highlighted the very small amount of the final value of a distinctive product that accrues to the initial producers. In its examination of vanilla from Uganda[13] which has a similar size industry to PNG, it highlights how producers still retain only a very small proportion of the final retail price despite the distinctiveness of their produce and its inherent quality (in 2018 one small (15cm) vanilla pod retailed for £ 2.50 in the UK; the price received by a PNG farmer for one bean was equivalent to £ 0.74).

Commodity producers also tend to experience the highest levels of price fluctuation. Strategies such as investing in an overseas distributor or setting up a brand in a major market and then outsourcing processing in that market have been used for commodities such as cocoa.

2.3 Geographic focus of the vanilla value chain in PNG

Vanilla production and trading are concentrated in East Sepik province with increasing production coming from Morobe province (see Figure 2.2). Parts of these particular districts are highly suited to vanilla growing and farmers responded to initiatives that were implemented up to 50 years ago to grow the crop (see Annex 3). Around 80% of the vanilla is produced in East Sepik province by producers with varying number of vines planted in several plots. In the most recent boom, Maprik town, the capital of Maprik district in East Sepik province, has become the vanilla trading centre for mainland PNG. Vanilla then has to be transported to the provincial capital, Wewak by road, for onward travel as accompanied airfreight to Vanimo and sold at the

[11] McGregor, 2005.

[12] Colin Ringleib, IFEAT World, September 2013

[13] Light Years IP (2008) Distinctive values in African exports http://lightyearsip.net/wp-content/uploads/2015/07/Distinctive_values_in_African_exports.pdf

Indonesian border (at Wutung, a major cross-border trading area on the border with West Papua province), or to Lae and on to Port Moresby or direct to Port Moresby for international export.

Sandaun province also has vanilla-producing districts, particularly Nuku and Aitape/Lumi close to the border with East Sepik. Much of the vanilla produced in these districts is brought to Maprik, as there are few roads in the province. Sandaun province is the second largest producing province according to information collected by the Spice Industry Board (see Table 2-4) but access is difficult.

Morobe province is a much smaller producer although vanilla was introduced and initially established there in the 1960s in several districts but then virtually disappeared after the price collapse in 2004. Vanilla is now providing a livelihood opportunity to growers in the more remote districts, particularly the Huon peninsular and Finschhafen district – the first district to revitalize vines in 2104 - where market access for bulky agricultural commodities is restricted, as well as areas closer to Lae, such as Situm village, Labuta LLG, Nawae district where vanilla production has been taken up again after having been abandoned for ten years. In both cases there have been active promoters of vanilla. In Situm, the vanilla growers were settlers on leased blocks and vanilla was grown on flat land. In Finschhafen, vanilla is grown on very steep slopes.

The largest vanilla exporter is based in Lae, the provincial capital and main industrial city.

A small amount of vanilla processing is undertaken in the national capital Port Moresby but the team were not able to visit the main company concerned.

FIGURE 2.2 MAP OF PNG SHOWING KEY VANILLA PRODUCING PROVINCES AND MAIN EXPORT ROUTES
Source: https://smartraveller.gov.au/Maps/Papua_New_Guinea.pdf
Key: Red arrows indicate the direction of flow of vanilla from the main producing areas, indicated by a red circle or pointed circle, to the country's exit points – Port Moresby for airfreight, Lae for sea freight and Vanimo/Wutung for cross-border trade. The thicker red line to Lae indicates that most of the country's vanilla is sent to Lae for conditioning and packing by the large exporter and then airfreighted to Port Moresby for onward carriage to destinations in the USA, Europe, Asia and Australasia.

2.4 Vanilla production in PNG

Vanilla is a climbing epiphytic orchid which is usually grown up the trunk of a support tree, normally *Gliricidia sepium*. It takes three years for the vine to start bearing flowers and nine months for the hand-pollinated

flowers to become mature pods which then are harvested and undergo around a three-four month curing period. An established vine produces for 12 to 14 years.

Two species of vanilla are grown in PNG – *Vanilla planifolia* (Bourbon type) and *Vanilla tahitensis* or Tahitian vanilla (Table 2-3). This latter species has traditionally been considered inferior by global vanilla buyers. However, it is more widely suited to PNG conditions and most of the vanilla grown in PNG is the Tahitensis type. It is one of the few countries where both varieties are grown. In East Sepik, 80% of vanilla planting is Tahitensis and buyers encourage its production. Planifolia grows well in cooler areas, such as in Finschhafen in Morobe province. Buyers are aware of PNG Tahitensis and its qualities, highlighting its "greater potential as the flavor and fragrance profile is completely unique to this origin". Due to the lack of V. *planifolia* on the world market, manufacturers are changing their formulae to use Tahitensis, which is an advantage for PNG.

TABLE 2-3 COMPARISON OF VANILLA PLANIFOLIA AND VANILLA TAHITENSIS ATTRIBUTES

Vanilla planifolia 'Bourbon' Big leaf	*Vanilla tahitensis* 'Tahitian vanilla' Little leaf
Needs longer dry period to induce flowering – suited to narrower range of agro-ecological conditions Better for cooler climates and low altitudes, between 0 and 600m Grows well in Madang, Finschhafen, Nuku	Needs shorter dry period to induce flowering – suited to wider range of agro-ecological conditions Grows well on coast; likes more sunlight Particularly suited to East Sepik
Considered to have higher vanillin content Beans are longer (up to 22cm) A grade in PNG is 18cm	Similar or higher vanillin content obtained in East Sepik (3-4%) Bean length 18 cm and under; A grade in PNG is ≥16 cm
Wider market - considered more suitable for industrial extract; 40% used for fragrance;	Buyers now less fussy; have modified their recipes Higher demand in France and Italy, mainly for ice cream manufacture
Obtains higher prices though not in East Sepik	Produces more fruit
Production is seasonal	Flowers year round and produces fruit earlier; farmers harvesting and pollinating at same time
Harder to cure – needs to water killed; requires fuel source and equipment	Can be sun killed; cheaper and safer

Source: Stakeholder interviews

Vanilla establishment costs are minimal in terms of purchased inputs. The main input is family labour. Gliricidia tree stakes must be cut and inserted into the ground. When these are established, in about three weeks, a one to two metre length of vanilla vine is buried into mulch (rotting logs, coconut husks, grass cuttings) at the base of the stake. The only costs are a bush knife and the vines, which, if purchased, cost PGK 1 to 5 each (some producers can take cuttings from their old plots). After one year the vines are long enough to be looped back over a branch; in the second year they are looped again and then will begin to flower. The vines need regular addition of mulch to provide nutrients as this is a main determinant of productivity. Coconut husks, rotting wood, grass cuttings are all used. Hand pollination is a necessary, time-consuming, laborious job and growers often invite family members or groups of youths to help with the task and provide cooked food in return school children also get involved in pollination on their parents' and their own plots. Pollination must be done in the morning before the pollen dries up. Once flowers are pollinated small pods start to form which must be thinned, from 15-20 down to 8-10 to enable good length beans to be produced. After nine months the pods are ready to be harvested. They then swiftly need to be killed. For *V. planifolia* this, ideally, involves immersion in boiling water while for *V. tahitensis* they are laid out in the hot sun for a few hours. For both types the curing process involves alternating sun drying with sweating – wrapping the pods in a blanket and keeping them warm. A plastic insulated cool box is commonly used. During the process vanillin is produced. After about three to four months the beans are ready for sorting and sale. Well-cured vanilla pods do not perish rapidly and can be stored for at least a year.

2.5 Developments in the vanilla value chain in PNG

One of the reasons for vanilla's extensive take-up is its high value to weight which makes it easy and relatively cheap to transport in areas where there are no, or poor, roads. A few kilograms of vanilla can be worth several tonnes of a bulkier commodity like cocoa. Air transport is the only link between most of the provinces and the capital and most of PNG's vanilla has to be transported by air between the production area and Port Moresby from where it is exported by air. Some low-value shipments are made by sea from the port of Lae. Substantial quantities of lower grade vanilla are flown, or taken by boat, from Wewak to Vanimo and then taken by vehicle to the Indonesian border at Wutung.

Vanilla production is almost entirely smallholder grown. Vanilla was promoted by the Department of Agriculture and Livestock, development projects and private individuals from the early to mid-1990s. Annual production and export of vanilla in PNG increased rapidly from an estimated one tonne in 1999 to just over, a recorded amount of, 202 tonnes by 2003. Within five years PNG had become the third largest vanilla producer in the world, contributing about 10% of world production between 2003 and 2004.
Vanilla initially found a ready market across its land border with Indonesia in West Papua and then sales gradually expanded to higher value markets in the USA, Europe and Australia. The sector went through a very rapid development stage, a bust and a rebirth in the space of 10 years. Prices obtained since 2016 have begun to match those obtained during the vanilla boom years, from 2001 to 2003, and to contribute a similar amount to export revenue. In 2017, vanilla exports contributed an estimated 2% by value of total agricultural exports[14].

Production of some of the first harvests coincided with a shortage of world vanilla supplies in the late 1990s exacerbated by the effects of three cyclones and frost in Madagascar. Papua New Guineans became involved in trading and setting up exporting businesses to sell the crop they bought from specific producer groups or clan areas, having obtained an export licence from the Spice Industry Board. Producer groups also made contract with external buyers in the USA, Australia and New Zealand to find out what the market wanted and how to ensure their beans were cured in such a way to meet quality requirements.

Existing cocoa trading companies, such as NGIP Agmark, were persuaded to get into vanilla buying. The rapid development of the PNG vanilla sector was a remarkable success story (McGregor, 2005), providing a high income-earning opportunity to many rural semi-subsistence households in some of the most economically depressed and isolated parts of the country. The vanilla boom coincided with the appearance of cocoa pod borer in the East Sepik and farmers were receptive to a new, remunerative crop. The large exporter trading company also started vanilla buying and has become the main buyer and exporter.

PNG's farming systems are very diverse and adapted to the wide range of agro-ecological zones which make it possible to grow many tropical and temperate-climate crops. Vanilla fits into one of these ecological niches.[15] Vanilla production is carried out on land held under customary tenure. One of the main producing districts, Maprik, also has very high population densities (>50 persons/km). Access to land for vanilla planting is said to have had an impact on traditional social systems and relationships during the previous boom (Sullivan, 2005) though this was not highlighted in the household survey and it was observed that there was a lot of land available.

Table 2-4 gives estimated production for 2017-mid-2018 (18 months) based on district reports supplied to the PNG Spice Industry Board by DAL provincial and district vanilla officers, of just under 189 tonnes. This implies that production in 2017 was in the order of 125 tonnes. It is possible there is both under and over reporting from the districts – the Spice Industry Board officer mentioned that information on production in Finschhafen district is not being notified to the Board. Government information suggests that production was around 150 tonnes/year in 2017.[16] However, the SIP officer mentioned that the largest exporting company exported 150 tonnes in 2017 and the company itself has stated, in 2018, that it exports between 120 and 200

[14] Calculated from official export statistics and Bank of PNG Quarterly Economic Bulletin, 2017 and adjusted for suspected data entry error.
[15] McGregor (2005).
[16] PNG Telephone Directory 2018.

tonnes/year[17] with hopes to increase it to 400 tonnes in the future. In this report we use the figure of 240 tonnes for 2018, the figure given in International Trade Centre statistics.

TABLE 2-4 ESTIMATED VANILLA PRODUCTION BY PROVINCE AND DISTRICT, 2017-MID 2018 (KG)

Province	District	Production (kg)	% of total
East Sepik	Ambunti-Dreikikir	20 000	10.6
	Maprik	120 000	63.6
	Wosera-Gawi	4 000	2.1
	Yangoru-Saussia	4 500	2.4
	Angoram	1 500	0.8
	Provincial total	**150 000**	**79.5**
Sandaun	Nuku	7 000	3.7
	Aitape-Lumi	1 000	0.5
	Telefomin	800	0.4
	Vanimo-Green	500	0.3
	Provincial total	**9 300**	**4.9**
Morobe	Finschhafen	2 000	1.1
	Nawae	300	0.2
	Kwabum	220	0.1
	Tewai-Siasi	158	0.1
	Wau-Bulolo	134	0.1
	Menyama	97	0.1
	Provincial total	**2 909**	**1.5**
Madang	Rai Coast	3 000	1.6
	Provincial total	**3 000**	**1.6**
Central	Kaiuku-Hiri	780	0.4
	Abau	560	0.3
	Rigo	390	0.2
	Provincial total	**1 730**	**0.9**
Western	Middle Fly	8 000	4.2
	North Fly	2 300	1,2
	Provincial total	**10 230**	**5,5**
Milne Bay	Esa'ala	9 000	4,8
	Provincial total	**9 000**	**4,8**
Oro	Sohe	1 700	0.9
	Provincial total	**1 700**	**0.9**
Simbu	Karimui/Salt Nomane	700	0.4
	Provincial total	**700**	**0.4**
Total PNG		**188 639**	**100**
East New Britain	Not recorded		
Manus	Not recorded		
Bougainville	Not recorded		

Source: PNG Spice Industry Board, 2018

Between 2000 and 2003 prices rocketed to record global levels and unheard-of sums of money in a PNG context. The boom in the world vanilla market coincided with some of the lowest exchange rates of the PNG Kina against the US dollar, which further increased Kina prices. Prices received per kilogram went as high as PGK 800 (US$ 264).

By 2004 global vanilla prices had plummeted and PNG's production declined rapidly after 2004 when producers were offered substantially lower prices, down to PGK 20/kg and below (US$ 6/kg). The slump in

[17] https://postcourier.com.pg/papindo-propping-lucrative-vanilla-industry/

the world vanilla market continued until around 2014-15. Efforts to revive interest in PNG were led by donor-funded projects, such as EU project support to vanilla groups in Morobe province, and mining company initiatives, such as the Highlands Vanilla project, but farmers, who had received unheard of sums of money for their vanilla, were disheartened at the massive drop in prices and many tore up their vines and replanted them with tree crops. In 2011 PNG vanilla production was practically non-existent – 80% of the plots were abandoned – with only negligible quantities of very poor-quality extraction grade beans available. Exporters were forced to dump their stocks which had begun to deteriorate. Aust and Hachmann, a large Canadian vanilla buying house, reported that not more than 50 tonnes of very poor-quality grade vanilla, that was only suitable for extraction rather than sale of gourmet grade whole beans, was expected in 2011[18].

The vanilla sub-sector, or value chain, comes under the auspices of the PNG Spice Industry board. The SIB was established by the Spices Industry Act in 1989. See section 2.7.2.

Four years later, in May 2015, Aust and Hachmann were noting signs of recovery in the PNG vanilla sector due, in part, they surmised to support for the industry from Australian and New Zealand buyers, such as links between producers in Madang and a buyer in Australia and between the New Zealand company, EquaGold, that had set up links with the Torricelli Vanilla Cooperative in Sandaun province and paid prices similar to those of earlier years to support the growers.

In December 2014 it was reported that thousands of farmers in East Sepik working in partnership with the provincial DAL Vanilla and Rubber Coordinator, and the former PNG Spice Industry Board chairman, and the East Sepik provincial government, were trying to revive vanilla farming. Under the theme, 'Fall once, rise up and lead forever' farmers were being encouraged to bring the industry back to what it had been through provision of training aimed to improve and standardise vanilla production.[19]

Producer interest revived in 2015 as world vanilla prices started to pick up and some producers, who had not removed their vines, were able to quickly capitalise on these. It was anticipated that production would exceed 100 tonnes in 2016 (and 110 tonnes of formal exports were recorded). Aust and Hachmann noted that PNG vanilla had been a major factor in the food service and retail trade during the 2002 to 2004 global shortfall and that this quality was again making major inroads in the trade in both Europe and North America. Buyers' views of PNG vanilla having a unique flavour and fragrance profile had led it to taking the gourmet market (black) vanilla beans' share from Madagascar during the previous boom and it was considered they were likely to continue to do so again.[20] In 2018 the highest price paid per kilogram was PGK 1 500 to farmers in East Sepik.

The government, in line with its Export Driven Strategy, is keen that value is added to vanilla as it is concerned that it is currently being exported unprocessed. However, the highest value product is the gourmet grade whole bean, which is often sold in the same state at international retail level. Vanilla extract has been produced in PNG but it may not be economic to do so for export, due to the considerably higher transport costs. However, it might increase overall returns if value could be added to all grades of produce. An in-depth feasibility study would need to be carried out, including food safety and testing requirements that must be observed for supplying export markets. In the short to medium term, farmers need to be supported to produce higher yields of grade A vanilla for which prices are highest. Virtually all the vanilla is exported as cured beans in 20 and 50 kg packs. A very small quantity of beans is sold to restaurants and hotels and it is infrequently processed into vanilla extract (vanilla extract was on sale at the international airport in Port Moresby but there is no record in the Customs data of any commercial exports). Vanilla syrup, liqueurs and vanilla-based ointments are made in the country and vanilla is used to perfume artisanal soap.

The unique selling points (USP) of PNG vanilla are its reputation for high quality gourmet beans with a very distinctive aroma[21]. East Sepik, the major production area, is not affected by cyclones, which periodically wipe out production in Madagascar. The country predominantly produces *V. tahitensis* but *V. planifolia* is also

[18] Aust and Hachmann Vanilla Market Report no. 38 May 2011 http://www.austhachcanada.com/may-2011/

[19] The National. Farmers take part in vanilla rehab plan 2.12.14 https://www.thenational.com.pg/farmers-take-part-in-vanilla-rehab-plan-plan-for/

[20] Aust and Hachmann Vanilla Market Report no. 46 May 2015 http://www.austhachcanada.com/may-2015/

[21] https://www.thenational.com.pg/farmers-pushed-lift-quality/

available. PNG has the largest availability of *V. tahitensis* in the world. The vanilla industry has been built up by villagers and local entrepreneurs. PNG, particularly Sepik, farmers are hardworking, good farmers and responsive to market opportunities.

PNG stakeholders are aware of the need to create a strong brand identify for its vanilla – East Sepik and its vanilla is considered to have a strong identity. Many vanilla-selling company websites in Europe, the USA and Australia stress its propensities but may not be prepared to share the benefits its name evokes in terms of offering more stable prices to producers, many of whom they may have long-term trading links.

The president of the European Flavour Association (EFFA) highlighted, at the Food Integrity conference in France in November 2018, the need for the flavour industry to widen its source of supplies to include the new vanilla pod-growing countries of India, PNG and Uganda.[22] Many large users of vanilla support efforts to assist vanilla farmers and communities in Madagascar but there have been few initiatives in these other countries. Now awareness seems to be growing of the need to do this.

The challenges are the limited understanding among service providers and ministries of the nature of the value chain and its needs. It is very different process from exporting a bulk commodity. A French vanilla house buyer visited East Sepik in 2018 and her advice, given in an TV interview, was to fix the roads. But there are many other needs, explored in this study, that have to be addressed if this fledgling niche value chain is to sustain and PNG's remote smallholder households continue to benefit.

2.6 The PNG vanilla value chain

The vanilla chain is a very simple one with a few minor periodic permutations. Vanilla is grown and cured by farmers with no purchased agricultural inputs – none of the 100 farmers surveyed used pesticides, herbicides or fertiliser. Some simple equipment is used for grass cutting (usually a hand tool but a diesel brush cutter is used in some locations) and for curing (cool box, plastic sheets and blankets). The cured, sorted vanilla is then either sold directly to an exporter or to an intermediate trader or aggregator who then sells to an exporter (there is one large exporting company and several smaller ones). After sorting and conditioning the vanilla is exported. Very little vanilla is sold in its green bean form and this is strongly discouraged by the government. A small amount of vanilla is directly exported by associations and cooperatives but this tends to be episodic. There is one instance of an exporter with a vanilla farm buying from out growers in Rigo district, Central province where a local family has long been involved in vanilla production and promotion.

Vanilla has four grades, based on length of the cured bean: Grade A is 16 centimeters and above; Grade B is 14-16 centimeters; Grade C is 12-14 centimeters and Grade D covers split, spotted and scarred beans. In practice there are two main grades: A grade and Extract grade also known as 'Mix'. High prices tend to be paid for A grade vanilla while the extract grade price is often considerably lower. However, Indonesian buyers pay higher prices for the lower grade vanilla and are an important outlet for PNG growers and traders. PNG growers have always been encouraged to cure their own vanilla pods. The curing phase alternates sun drying with sweating in an insulated container, which causes the vanillin to develop and turn the beans black which takes around three months. Farmers, who have invested considerable amounts of time in husbanding their crop can get impatient and either harvest pods before they're ripe or sell incompletely cured beans. Some Maprik street buyers and Indonesian cross-border buyers are said to buy green (wet) beans, which is linked to theft of pods from farmers' plots. Other traders in Maprik try to discourage the sale of green and incompletely-cured beans as thery're aware of the impact on bean quality and achieveable price.

Figure 2.3 shows the permutations of how vanilla is exported to the main formal export markets and how it is exported sometimes formally, sometimes informally to West Papua, Indonesia.

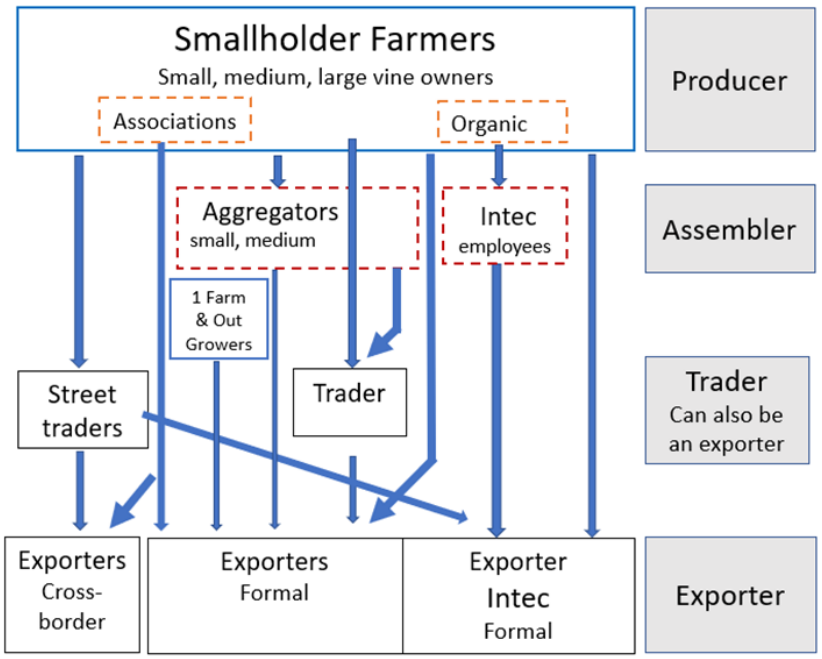
The first vertical blue line (left side) shows how vanilla is sold by farmers to small-scale traders who have or borrow an export licence and take the vanilla to Wutung on the border. Estimates of the amount of vanilla sold over the border ranged from 50 to 80 to 95% of the amount exported formally. There is risk of some double counting as vanilla sold at the Wutung border, commonly referred to as *Batas*, is supposed to be recorded by PNG Customs. Exporters are required to have an exporter's licence, a phytosanitary certificate

[22] https://www.foodnavigator.com/Article/2018/12/04/EFFA-on-ensuring-steady-supplies-of-vanilla-flavour

and to pay the 10% export tax. It is likely that only a proportion is traded this way and so not all exports are recorded by NAQIA. Some vanilla is transported by boat between Vanimo and Jayapura to avoid payment of the tax. The cross-border trader/exporter may sell some of their grade A vanilla to the large exporter in Maprik to improve their returns and provide cash to buy more vanilla to take to the border.

The second vertical line shows smallholder farmers who are members of a cooperative which has an export licence selling their vanilla either to an exporter or directly exporting. The third, fourth and fifth lines indicate how smallholder farmers sell to an exporter with an export licence, sometimes via an aggregator, a trader or directly to the exporter. The two far right lines show the main selling route. The smallholders, including the certified organic producers, sells directly to large exporter or its agents. The company then transport the vanilla by air from Wewak to Lae for sorting, conditioning and export. The different routes and actors involved are described in the following sections.

FIGURE 2.3 THE PNG VANILLA VALUE CHAIN



2.6.1 Smallholder farmers

It is not accurately known how many people are growing vanilla in PNG. A survey undertaken by the District Administration in Maprik district in East Sepik in May 2018, indicated that 33,354 people were growing vanilla. The area grown is also not known accurately. Farmers are rarely aware of the area they are growing vanilla on (plot size in hectares) but do know how many plants they have, their age and the planting spacing – space between each plant - used. Plants are grown at different spacings, depending on the topography and whether plants are intercropped. At the DAL-recommended spacing of 2m x 2,5m 2.000 plants can be established on one hectare; at the commonly used 2,5m x 2,5m, 1.600 plants can be grown and at 2m x 2m spacing, 2.500 plants can be grown. Land areas available for, and planted to, vanilla are often considerably less than one hectare and very rarely more than three hectares.

The DAL in East Sepik recommends that 250 plants per farmer (or 150 with other crops and income sources) and a maximum of 1 000 plants as a sole crop. A household can have several vanilla plots, with different plots managed by a wife or youth.

The Vanilla Household survey sought to capture information on number of vines owned by a household and among the 100 households, vine ownership ranged from 70 to 4 500 on up to seven distinct plots (Table 2-5). However, not all the vines are productive. Some may have been recently planted and are not yet bearing while others may be old and not worth investing time for pollination, the most time-consuming aspect of vanilla growing. Of the largest vine-owning households only a small proportion of their plots (<25%) were

actively productive and these plots may be a way of holding on to land to pass on to children, use at a later date or as a source of vanilla cuttings.

Women are involved in vanilla farming but male farmers predominate. Over 75% of plots (77%) were managed by male farmers, with 14% managed by female farmers and 9% being jointly managed.

TABLE 2-5 TYPOLOGY OF VANILLA PRODUCING HOUSEHOLDS

	Group 1: Small-scale vine-owning households (n=31)	**Group 2:** Medium-scale vine-owning households (n=40)	**Group 3:** Large-scale vine-owning households (n=29)
Vine ownership range	1-300	301-927	928-5.000
Vanilla Yield (kg cured beans/ha)	122.9	26.2	28.7
Number of Vines/ha	1 840	1 658	2 669
Average vine spacing	2m x 2.7m	3m x 3m	2m x 1.7m
Vanilla cured beans/vine (kg)	0.06683	0.01581	0.01076
Average number of vanilla vines per household	192	599	1 726
Average plot size per household (ha)	0.1	0.36	0.65
Proportion of A grade vanilla (%)	22	55	40

Source: Vanilla Household survey

It is difficult to obtain information on yields obtained per plant. In 2005, in Situm, Morobe province, a DAL extension officer prepared a proposal for the Sigo Spice Growers cooperative based on data collected from its 66 members. These farmers had 60.800 vines on 24.32 hectares planted at 2m x 2m, giving an average of 921 plants per farmer on 0,37 hectares. In 2004 the plants had reached maturity and produced 1 400 kg of cured vanilla, equivalent to 57.57 kg/ha (0.58 t/ha) or 0.025 kg per plant. This is low but may reflect the situation in Situm. McGregor (2005), using information from Bianchessi in Vanuatu, gives an average yield of 0.12 kg of cured beans/plant.

Information for ascertaining vine yields were included in the household survey, and average yields for each of the three farmer types varied from 0.011 to 0.067 kg cured beans per plant (cf. Table 2.5). These villages were purposively selected as top vanilla producers and their yields may be above average for the country. Understandably, given the labour-intensity of production, farmers with fewer vines can give each vine more attention and this results in much higher production. However, the Vanilla Household survey also highlighted that the farmers included in this group (Group 1) produce less than half as much grade A production than farmers in Group 2, with more than three times the number of vines. The survey identified a wide variation between categories of vine-owning groups; for larger-scale vine ownership the yield is much lower. During the household survey, vanilla growers mentioned that some vanilla plots are used as 'seed' gardens rather than actively husbanded and the plants pollinated. If the 50 000 producers obtain 0.011 kg/vine, this equates to 550 vines per grower and fits in with the figures obtained from the survey.

This variation and uncertainty in all the parameters cause problems for calculating typologies of vanilla farmers for the operating accounts and the data for the economic analysis.

Farmers have several ways to sell their crop, via an aggregator and/or a farmgate buyer buying on behalf of an exporter, a Maprik street buyer and the large exporter. Some villages have an aggregator who has a vanilla export licence and sells on behalf of fellow growers at the *Batas* cross-border market or to formal vanilla exporters. Some street buyers go to the villages to buy vanilla which saves growers having to carry their vanilla to Maprik to sell either to the street buyers or to the large exporter buying office in Maprik, which buys most of the higher-grade produce. If farmers produce more A grade, this tends to be bought by the large exporter, and the supply of reject beans is reduced for sale to the street markets. Some farmers wanted to

reap the best benefits of their labour and try to maximise their A grade production while others go for quantity.
Farmers keep in touch with relatives and traders in Maprik by mobile phone to get information on the current buying rates. When the price of vanilla has dipped, farmers keep their beans at home for the chance of a future price increase.

> "Dried vanilla beans are like our bank savings. We do not take all of them to the market to sell at once. We keep them in the house and wait for the price to increase (for A grade the preferred price would be ≥ PGK 900). However, if there is a need in the household, we take a little bit and sell to meet that need." Woman vanilla farmer in Samark, 2019.

2.6.2 Farmer groups, cooperatives, associations and business groups

Producer cooperatives have been encouraged as part of government policy to improve efficiency in the agricultural sector through bulking of produce and use limited extension resources more effectively. Business groups and grower associations have also been encouraged at different times. The Department of Commerce and Industry is responsible for registering cooperatives, training office holders and reporting, while the Investment Promotion Authority is responsible for registering associations. Many vanilla cooperatives are listed on the Department of Commerce and Industry's database in Maprik district but few are thought to be active. Ministry of Trade data indicates 400 cooperatives as being involved in vanilla in East Sepik province although one vanilla exporter estimated that there were only 200 vanilla cooperatives or associations operating in the whole country and that only 25% of farmers are organised into groups of which 15% of members are active. Some are quite active and organised and have their own export licence enabling them to deal directly with overseas importers. Others are not formally registered and act as aggregators to provide bigger amounts for specific exporters.

Farmers in Yambes village, Ambunti-Dreikikir, one of the first places to plant vanilla under the guidance of Alfred Jambram, started a cooperative in 2015 called the Dreikikir Vanilla Farmers of which Alfred Jambram is the chairman and his brother Jacob is the secretary and there are four other committee members, three of whom are women. Its purpose is to boost vanilla production and to increase the price received. In 2018 the Association had a contract with Queen Fine Foods in Australia[23]. They were able to obtain AU$ 1 500/kg (PGK 3 600/kg) of which the Association retained 25% for administration and handling. By September 2018 the Association had sent six consignments to Australia via DHL in Wewak. The proceeds go into the Association's bank account and once cleared the directors give out cash to the contributing farmers. For overseas exports they have strict guidelines – each consignment should not be under one tonne. They also supply the large exporter in Maprik with whom they can bargain over the price received as they are able to supply large quantities. They would like to set up an extraction plant to process the lower quality beans. However, the cooperative is no longer regularly trading, finding it difficult to maintain momentum and to function continuously rather than in a sporadic and opportunistic manner.

In 2012 the Torricelli Cooperative Society Ltd in Sibilanga, Nuku District, Sandaun province had 500 members and a link with EquaGold, a vanilla importer in New Zealand. Under their agreement the Cooperative members receive the going rate for their produce and a share of the profits. The company provided advice on quality control and traceability to the growers and helped with ways they could package the product. EquaGold had a formal agreement with the Cooperative to be its main distributor in Australasia.[24]

Sigo Spice Producers in Situm in Nawae district in Morobe province were registered with the Investment Promotion Authority and SIB in 2004 and are now trying to revive their organisation. Finschhafen vanilla growers in Morobe province are setting up a Family Business Group with 100 members to be registered with the IPA office in Lae.

Many of the households interviewed in the survey said they were members of an organisation but in spite of the foregoing none of the households mentioned that they had sold their vanilla overseas via the organisation. The challenges of meeting export orders from remote villages (see Annex 1 for details) should not be underestimated. One of the uses mentioned by a member of an organisation with their vanilla

[23] https://queen.com.au/product/queen-finest-vanilla-bean-pods-2pk/

[24] https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=10829433

proceeds was the renewal of their export licence. This would not just be the cost of the licence but also the cost of travelling to and staying in Wewak to obtain it.

2.6.3 Organic production

Although most of PNG's vanilla production is produced without the use of chemical inputs only a very small proportion is certified organic. PNG does not have a certifying agency. The large exporter is trying to meet export market demand for certified organic vanilla and has established a scheme for farmers to enable them to be certified. According to the manager responsible for this programme, many of the farmers were unclear about the importance and implications of organic production. Although it is assumed that farmers use only organic mulch to nourish their vanilla plants, a vanilla production handbook produced by the National Agricultural Research Institute (NARI) in 2003 recommends applying super phosphate in granular form to the base of Planifolia vines two months after shade reduction to improve flower induction.[25] It may be the case that some farmers do apply fertiliser to their plants though this was not mentioned in discussions or recorded in the household survey.

The large exporter works with Australia Certified Organic (ACO) and, as of September 2018, a total of 220 farmers were fully accredited while a further 880 were being supported to work towards certification. The large exporter is working with farmers in Maprik, Wosera in East Sepik province and in Morobe province. The certification process requires each plot be surveyed, GPS coordinates recorded, and ownership established. Then farmers receive three training courses, once a month, on mulching, shading, pollination, bunch thinning. The large exporter pays the cost of accreditation which requires that auditors visit from Australia once a year. Growers must have a minimum of 50 plants but farmers tend to have between 200 and 1.500 plants, which can be *V. planifoli*a and *V. tahitensis*. Once a farmer is certified he (fewer than 2% of the initial 220 growers are women) is obliged to sell all his vanilla to the company. In September farmers were being paid PGK 950/kg for A grade certified organic vanilla compared to PGK 920/kg for conventional vanilla. Lower grade organic vanilla is accepted for vanilla extract but the price is lower. In theory, the training should enable farmers to produce a large proportion of A grade vanilla and thus benefit from higher prices.

Farmers who were aware of the scheme but not accepted to join it felt they would be locked in to selling all their vanilla to the large exporter and unable to take advantage of higher prices offered for extraction grades offered by other buyers, particularly those buying to sell in the Indonesian (cross-border) market where prices tended to be higher. The manager did acknowledge that side-selling was an issue. The large exporter operates a specific buying window at its store in Maprik for organic vanilla so that the farmers do not have to wait in the general vanilla buying line.

William Yanei Ltd.'s website mentions that his vanilla plots have been certified by one of his main buyers, Kestrel Growth Brands in the USA, as organic though it is not independently verified.

Concern has been voiced by buyers that organic vanilla in Madagascar has been found to contain permethrin above permitted levels. Permethrin, a class 1 Pyrethroid, is applied to mosquito nets to kill mosquitoes and was finding its way on to vanilla pods. EcoCert, a major European organic certification agency, found permethrin above the 0.02 mg threshold permitted by EU and the 0 mg permitted by US authorities for organic vanilla in 2014[26] [27]. Permethrin-soaked nets are widely used in PNG.

2.6.4 Traders and Exporters

2.6.4.1 Aggregators

Intermediaries along the chain include aggregators, small traders, formal and informal exporters. Figure 2.3 shows the various permutations of the vanilla value chain.

[25] NARI TokTok, 2003 http://www.nari.org.pg/sites/default/files/publications/toktoks/keravat/KER002E_Species_of_Vanilla_and_where_to_grow_them_in_PNG.pdf

[26] http://www.vanille.com/authenticproducts/en/organic-vanilla-market/

[27] http://www.austhachcanada.com/may-2015/

An aggregator is someone who buys or sells produce on behalf of others and receives a payment for this activity. They do not take ownership of the commodity. Paradise Spices, a Port Moresby-based vanilla exporter and processor now part of Paradise Foods Ltd, announced its plans in April 2018 to use an East Sepik-based aggregator to help solve its vanilla supply and quality issues[28]. The aggregator, 'a local man with significant knowledge of the vanilla sector and market, will buy cured beans directly from farmers who are often based in remote villages and arrange transport to Port Moresby from Wewak by airfreight'. An aggregator with a good relationship with particular farmers eases the procurement problem for a company like Paradise Spices because few farmers have bank accounts which make buying risky and difficult for a company based in the capital. The aggregator is expected to provide training on producing and curing the crop and in financial literacy to provide skills for the farmers to manage their incomes. Pending success of this venture, the company says it hopes to develop a group of aggregators to work with in the future.

An aggregator met by the team was a young farmer with 200 vanilla plants whose secondary income source was selling phone cards, mobile phones and Sim cards in Maprik. After selling his own vanilla (up to 25 kg, at PGK 900/kg equivalent to PGK 22 500 (US$ 6 176) he purchases vanilla from other farmers and sells to the big middlemen/women for PGK 50-100 per transaction. Another aggregator, who took part in the trader survey, had purchased 180 kg of vanilla from farmers in Yambes village in 2018 and had gone three times to Jayapura to sell it to an Indonesian importer. He received PGK 100 from each of the farmers to cover his travel and trading expenses (he had a vanilla export licence and paid all the necessary fees and taxes), and some remuneration for his time. Vanilla trading is not a full-time occupation for him; he also sells SIM and phone cards and mobile phones (possibly purchased in Indonesia).

2.6.4.2 Informal/cross border traders

Margaret (not her real name) is an informal vanilla street buyer in Maprik. She lives in Wingei village in East Maprik, about 45 minutes' drive away by PMV. Traders from Wingei are said to dominate vanilla trading in Maprik – there are about 45 of them (15 women and 30 men who have buying stands). She started vanilla trading in 2016 with PGK 2.000 that she had assembled from selling stationery and clothes in Sandaun province. She buys vanilla as a licenced street trader in Maprik (PGK 500 per year plus weighing scale), from smallholder farmers and aggregators, over four days (Tuesday, the busiest day, to Friday) starting at 6am each day.

Farmers have vanilla for sale throughout the year, as a result of the three pollination seasons per year, and it could be expected that there would be continuous supply to the Maprik street market but this is not the case. Sometimes there is not enough supply coming to Maprik to enable the cross-border traders to purchase enough. There are a lot of street buyers and competition is very high. If one trader does not offer a good price the seller will go to other buyers who offer higher prices.

In mid-September 2018 Margaret paid PGK 600 to PGK 750 per kg to farmers for good quality beans. She spends PGK 20.000 per day for each of the four weekly trading days on vanilla, procuring between 27 and 33 kg). She said that the other traders are doing similar amounts of business; there were several hundred people trading that week[29]. She sold the highest A grade beans to the large exporter (Maprik) at PGK 1.000/kg. Although farmers can sell direct to the large exporter, they have often travelled from Dreikikir, three hours away, and are keen to quickly obtain cash and purchase items to take back rather than spend time queuing to sell at the company buying office. She can make PGK 300 to PGK 400 per kg on grade A vanilla, usually for between 2 and 10 kg/day, which she or her young sister assistant takes to sell two or three times to the large exporter (Maprik) buying point. The rest she buys is destined for sale at the *Batas* market, to which she made around 40 visits in 2018. On Saturdays she grades her purchases and on Sunday travels to Wewak airport with four bags of vanilla weighing between 70 and 120 kg (she sometimes carries an additional 40 kg for a relative). She always travels with other traders who are close relatives for security reasons. The vanilla is weighed at the cargo office and costs between PGK 5,70/kg with Air Niugini and PGK 6,60/kg with PNG Air. Once at Vanimo she takes a pre-booked hired vehicle to take her to the border – Wutung Trade Centre (vehicle hire cost is shared between the traders). Her buyer, who lives in Jayapura, is waiting. She must load the vanilla

[28] https://www.businessadvantagepng.com/papua-new-guineas-vanilla-sector-success-relies-on-education-and-regulation/

[29] This video shows how vanilla is traded on the streets of Maprik https://www.youtube.com/watch?v=vNIjFm_r1lk&fbclid=IwAR0s-bhMERQaNuq6ltuuVvu_3sBOT5g4lq04Ll1lk56KANbfEcbaOW51EK8&app=desktop

into a wheelbarrow and meet the buyer at the buying point. The buyer examines the different bags, sorts the contents into two piles, good quality beans and lower grade (usually between 30 kg and 50 kg; 20-35%). In September 2018 the buyer was offering her PGK 800/kg for the quality beans and PGK 600 for the lower grade beans - a total of PGK 88 000 for 120 kg. If she hasn't brought much vanilla she has to accept the two prices. If she has a large amount she will bargain for one, higher price. The amount looks large but the margins are slim (see operating accounts, chapter 3).

She needs to show her export licence to the NAQIA officer who produces a phytosanitary certificate to release her beans for sale and is supposed to get a receipt from Customs showing the weight she is exporting. The buyer also gets a copy of the two receipts which s/he takes to the Indonesian Customs. Import duty on vanilla is 40% but it is not clear whether this is payable here. The PNG exporter is supposed to pay the 10% export levy. Some exports are recorded but not all so it is likely that the revenue from exports is less than it should be. This is a key issue for Papua New Guinea. The trader returns to Vanimo and gets the flight back to Wewak. If she misses it, she stays overnight at a guesthouse and has to pay a penalty if she misses her pre-booked flight. Most of the time the traders sleep over in guest houses/hotels and gets on the first flight out of Vanimo. After the trade, when Margaret has the chance to visit *Batas* (shopping area in Indonesia situated near the border) she buys cigarettes and small housewares to sell back in Maprik (she enters Indonesia through a permit letter processed by the Indonesian Immigrations after seeing her passport). It is highly possible that this back trade is the one that generates most of her income. Concern has been voiced about the amount of duty and VAT lost to the government through such trading methods.

Cross-border trading issues

A key concern of the government and exporters is the amount of vanilla traded across the land border with Indonesia and the effect of a ready market, willing to pay high prices, for poor quality produce. When vanilla production was originally encouraged the Indonesian vanilla buyers at the cross-border market at Wutung proved to be willing buyers. The Maprik district agricultural officer and the district commerce officer took a vanilla trader to Wutung Trade Centre expressively to find markets. Eventually exporters were able to link up with more remunerative overseas markets and the large exporter started buying a range of grades. However, the Indonesian buyers still form a sizeable and relatively easy market to access, particularly for lower quality grade. which is thought to be destined for Indonesian spice grinding plants at Sorong in the west of West Papua. There is concern that the existence of this market encourages farmers not to observe the exacting crop management, pollination, bunch thinning and curing process that is required to produce high quality A grade gourmet beans for which PNG exporters want to build the country's brand and reputation.

A further question is whether exporting high grade vanilla to Europe/US and exporting lower grade vanilla to Indonesia is more beneficial for farmers and the environment. There is considerable political antipathy towards allowing Indonesia to take control of PNG vanilla although it appears to offer a reasonable outlet for poor quality vanilla. In theory, vanilla exported cross border is subject to the 10% export tax but it is not always recorded. Possibly because Indonesia has a 40% import tax on vanilla smuggling by sea from Vanimo to Jayapura is reportedly common. The PNG government is concerned about loss of export tax revenue as it is likely that not all the export levy is collected on all exports crossing the border, although clarification is needed on whether this is applicable at the supposedly duty-free border area, and it also loses out of duty collected on cigarette sales as vanilla traders bring back duty-free cigarettes for sale on their return.

2.6.4.3 Small and medium-scale international exporters

Representatives of five vanilla exporting companies - William Yanei Ltd., Wewak/Port Moresby; Global Village Exports, Port Moresby; Nelson Kurufher, Wewak; Bangui Bio Products Ltd, Wewak; Ramoi Trading Ltd, Wewak - were met during the visit. All had started trading during the first boom. The quantities they now export are variable, depending on opportunities arising; none of them depend solely on vanilla exports and all have other businesses. Their exports are sporadic and depend on receiving an export order and the availability of vanilla. Export quantities are also limited by the exporter's availability of capital. Exporters tend to use their own capital though Westpac Bank, Wewak branch, was credited on Facebook by William Yanei in 2017 as having provided credit for vanilla purchases.

Vanilla is exported on a Free-on-Board basis (FOB), which means the importer pays for insurance and freight from the point of exit from the country. For each consignment there is the cost of procurement from farmers (plus weighing scales) and road transport between Wewak and Maprik, the cost of airfreight from Wewak to Port Moresby, the 10% Government Export Tax payable on each kilogram exported, the cost of a phytosanitary certificate obtained from NAQIA, certificate of origin labels supplied by the Department of Trade and export packaging (cartons, plastic shrink wrap) and the annual export licence fee. This can represent a considerable amount to find upfront. Some exporters only partially pay the farmers on delivery and make a second payment once they have received the money from the importer. The business is high risk and there are lots of opportunities for loss and fraud. One part-time exporter tried to fulfil an export order with a company in Japan. Initially the company wanted 100 kilograms, but the farmers could only supply 50 kilograms. The order was sent to Japan by air with its phytosanitary certificate but lacking the label of origin. The consignment stayed at the airport in Japan for two weeks before it was released and it had rotted. An experienced vanilla exporter explained they had been duped by a very sophisticated fraud by someone in a freight company in Australia and lost a considerable amount.

Nelson Kurufher began vanilla trading in 2002 but withdrew between 2004 and 2016. In between time he traded rubber to Indonesia and scrap metal to India. He has had to find some new farmers to supply him in addition to some of his old suppliers to whom he introduced vanilla (his suppliers are aged 7 to 70). He also works with aggregators. He considers that the large exporter has cornered the market and that he had to offer PGK 10/kg more than the price they offer when buying in Maprik to guarantee supplies. He goes to remote areas of Dreikikir and pays PGK 700/kg when buying price in Maprik would be PGK 900. The poor state of, and lack of roads contributes to the lower farm gate buying price. His main expenses are the cost of driving to Maprik (PGK 200 for fuel for return trip), payments to farmers and aggregators, and labour for sorting and packing and the annual renewal of his export licence. He uses his own capital.
Gabriel Ramoi, a former MP, of Ramoi Trading/Ramoi Vanilla Ltd also based in Wewak, exports vanilla and other commodities. He started trading vanilla in 2001. He has farmers he buys from regularly and to whom he gives training on curing and grading. He also has to pay more than the large exporter (Maprik) is offering to obtain vanilla. If the large exporter is paying PGK 900 and the export price is US$ 400 (PGK 1.340) he will pay PGK 1.200. He pays this amount in two instalments, with PGK 500 for the first payment in cash and then the balance into farmers' bank accounts after his payment is received from the importer. Trading vanilla is a good way to maintain links with farming communities in the province – "It is an enjoyable business; it is not a way to make money."

Joanne Bird, Bangui Bio Products Ltd, Wewak was one of the earliest vanilla traders. She originally worked with 700 farmers, which eventually increased to 5-6.000 farmers. The biggest garden has 750 plants (though one farmer allegedly has 25.000 vines and two wives to pollinate them). When Bangui wants to buy vanilla, they call farmers and meet them at a specified point, which farmers may have to walk for several hours to reach. Farmers are aware of prevailing prices via Facebook. They are paid in cash (though there is risk of theft, the previous week a trader had been robbed of PGK 250.000 of vanilla money). Bangui Bio regularly sold vanilla to Germany and Canada during the first vanilla era. Their exporting costs include carton boxes specially made in Lae, which are lined with wax paper to retain the vanilla aroma, which are then shrink wrapped before being exported. Each vanilla consignment is sent by plane from Wewak, where it is registered and cleared, to Port Moresby and then transferred to the evening flight to Singapore/Hong Kong and then on to its destination in Europe or North America. A concern raised is that cartons get opened while the vanilla is in transit at the airport in Port Moresby and vanilla is stolen.

William Yanei also highlighted the risks involved in vanilla exporting and the lack of any support or export rebates to offset high air freight rates. He started planting vanilla in 1998 and then got into processing and buying vanilla which had been a challenging process but through the efforts of a few actors the country now has an industry that is globally recognised.

2.6.4.4 Large-scale exporter

The main vanilla buying and exporting company is Intec Vanilla Niugini Ltd, a fully-owned subsidiary of the Papindo Trading Company Ltd, a private business based in Lae with Indonesian and Asian links and with

reportedly between 100 and 200 employees[30]. Its stated aim is to becoming Papua New Guinea's leading exporter of vanilla products[31], and to cultivate sustainable long-term relationships with local vanilla farmers and buyers. In 2017 it exported an estimated PGK 61,8 million (82% of total vanilla exports by value), and 66 tonnes (59% of vanilla exports by volume) out from Lae (to Port Moresby for onward export). This does not include vanilla that was exported via Vanimo for Indonesia. The SIB officer estimated that Intec exported 150 tonnes of vanilla in 2017 but without any data to substantiate this. According to the Maprik District Administrator, a survey they carried out estimated that Intec and the small exporters exported 141 tonnes out of Maprik district in 2017. Intec does buy from other provinces and farmers from Finschhafen sell directly to Intec in Lae.

The large exporter started trading in vanilla beans in 2004/2005. Stakeholders at that time felt it focused on purchasing low quality beans. A former DPI manager, Maprik, quoted by Sullivan (2005), claimed that Papindo did not follow DPI procedures for training vanilla growers on how to cure good quality beans and went ahead buying low quality, unripe beans that extension staff had told farmers not to sell. It was alleged that a lot of the poor-quality vanilla was sold to Indonesia. Farmers possibly conflated the dramatic decline in prices in 2004 with Papindo's buying strategy which they felt adversely affected the PNG brand. Some farmers still have bad feelings about the large exporter though several industry stakeholders credited it for being the only company that continued to buy vanilla during the bust years when all the over buyers had left the market. The large exporter purchased at PGK 60/kg which probably reflected world market prices but was a huge dip from the PGK 700/kg paid at the height of the boom in 2003.

The large exporter's website indicates that it is making a concerted effort to obtain certification of its beans under internationally-recognised organic and fair-trade standards. It claims that a 'big proportion' of its farmers are already certified under the ACO scheme. According to the company's organic manager in Maprik, as of September 2018, a total of 220 farmers were fully accredited while a further 880 were being set up for accreditation.
The company has a buying centre in Maprik where farmers and traders can sell their produce; it also operates vehicles which go out buying vanilla from farmers in their villages, particularly those producing organic vanilla under the its programme. The beans are sorted into grades by length and then weighed and the seller receives a receipt which indicates their name and district, grades, weight and price received. The company tends to pay quite a high price for grade A vanilla while much lower prices are paid for lower grades. The vanilla is transported from Maprik to Wewak by road and then by air to the company's warehouse in Lae. There it is said to be washed in ethanol, obtained from Ramu Sugar Industries, Morobe Province, then sun dried; graded, bundled according to length; sterilised; measured and then conditioned for two months prior to vacuum packing for export by air via Port Moresby, or by sea, from Lae, for larger quantities.

Other selling methods

Vanilla growers and exporters use Facebook, see for example Sepik Vanilla[32] and Vanilla Farmers in PNG[33]; Alibaba and their own websites to promote and sell their vanilla. WhatsApp is also used for communications between cross-border traders and Indonesian buyers.

Some exporters have longstanding relationships with international buyers. William Yanei Ltd has a relationship with Kestrel Growth Brands in the United States who market Singing Dog Vanilla from PNG and Indonesia[34]. Other companies have links with Vanilla Saffron also in the USA and with Aust and Hachmann in Canada. Aimandu Agricultural Commodities Ltd in Wewak recently developed links with a Turkish trading company to sell vanilla.

2.6.5 Vanilla processors

[30] www.sell147.com/company/Papua-New-Guinea/828999.htm

[31] Some people interviewed expressed reservations about the dominance of one company in the sector.

[32] https://www.facebook.com/sepik.vanilla.com.au/posts/supporting-png-vanilla-farmers-by-importing-organic-vanilla-beans-directly-from-/1136051259763213/

[33] https://www.facebook.com/Vanilla-Farmers-in-PNG-501884409976692/

[34] https://www.singingdogvanilla.com/about-us/

Virtually all vanilla is exported as whole cured beans. A very small amount is exported as ground vanilla in some years (239 kg in 2017; 263 kg in 2018). Small quantities are used in local restaurants.

In 2009 William Yanei set up a vanilla extraction plant in Wewak with support from a food technologist, which produced about 4.000 litres. He bought ethanol from Ramu Sugar industries in Morobe province. The steel tanks were fabricated in Port Moresby and the pumps made locally. He sent samples to cake-making companies in Canada and Lae but his plans to set up a bottling plant failed; by then global prices had fallen and he found that the large exporter had captured the local market.

Vitis Industries, which produce Mosin vanilla syrup and a vanilla liqueur in Port Moresby are planning to venture into downstream processing of vanilla and various coffee and other products in Wau, Bulolo district, Morobe Province[35] from 2018. "The right climate here in Wau has prompted us to diversify from our main coffee operations into vanilla … The company will also produce vanilla extract, which can be used in food products such as biscuits, ice cream and beverages." Some 1.000 jobs are expected to be created.

In 2010, Paradise Spices Ltd, then owned by Micky Puritau, won PGK 200,000 from the Australian government-sponsored Enterprise Challenge Fund (ECF) and the Spice Industry Board for a vanilla solvent extraction plant[36], with a capacity to process ten tonnes of vanilla beans a month, a massive increase from the 500 kg of vanilla beans previously processed using an old press extract method. Since the business changed hands in 2017 production of vanilla extract has stopped.

Sonia Ramoi of Ramoi Trading in Wewak developed a powerful antifungal skin ointment from vanilla, Golden 7, which she produced using small-scale equipment to produce the extract. It was exported to China via Hong Kong as well as sold around the country.

2.6.6 Service Providers

2.6.6.1 Department of Agriculture and Livestock

The DAL is responsible for the vanilla sector and for the Spice Industry Board. At national level it has little involvement. In the main growing provinces, there is a provincial agricultural officer with oversight of vanilla. Dong Manuk, Provincial Statistics and Marketing officer and Coordinator for Rubber, Vanilla, Eaglewood, Soya Bean and Masoli bark, in East Sepik does a lot to support farmers and exporters. He provides training to farmers on how to grow vanilla and works with Alfred Jambram who provides training on curing. Between 2014 and August 2018 he had organised 14 trainings in Dreikikir (for 54 female and 1 088 male vanilla farmers); two in Sandaun province for four women and 898 men, and one in Wewak district for 15 women and 34 men. He also undertakes Due Diligence on behalf of East Sepik exporters – particularly farmer groups. He obtains the contacts of an importer and send them an email. He also contacts the consulate of the country concerned *e.g.* Indonesian consulate and asks for confirmation that it is *bona fide* company. This can be an expensive process which he often ends up paying the connection charge from his own pocket.

DAL is also the department responsible for food safety. Its Science and Technology Branch houses the Agrofood Safety and Codex PNG Unit and the Codex focal person. Currently no formal monitoring of the vanilla production system, to ensure compliance with international standard for food safety and quality parameters, is understood to be undertaken.

Ideas for making the DAL a useful and relevant organisation that fulfils its mandate are given in a blog published earlier in 2018[37]. Michael Bourke, a blogger and long-time researcher in PNG, highlighted the need for marketing information and prices on both domestic and export market crops. He also draws attention to the problem of incorrect and incomplete data currently collected by an array of different organisations.

[35] Post-Courier 19.6.18 https://postcourier.com.pg/vitis-opens-doors-wau-bulolo/

[36] https://www.thenational.com.pg/vanilla-buyer-gets-own-extraction-plant/

[37] http://www.devpolicy.org/revamping-pngs-agriculture-department-20180604/

An issue was recently raised in the press regarding differences between published prices and prices being paid to farmers. Care needs to be given to explain how FOB export prices will always be higher than those offered to farmers as a number of expenses have to be covered apart from the vanilla purchase.

2.6.6.2 PNG Spice Industry Board

The vanilla sector comes under the jurisdiction of the PNG Spice Industry board (SIB) which was officially created under the 1989 Spice Industries Act and became operational in 2001. Its mandate covers a variety of spices, herbs and essential oils. The SIB first received government funding in 2003 in response to the vanilla boom. It operated for three years until 2006 when the vanilla industry declined. Its operating income comes from vanilla export licensing fees (PGK 1.000 per annum). It is also supposed to be able to collect a Spice Fund levy of PGK 10 on each kilogram of vanilla exported though arrangements to do so were not in place in 2005 (McGregor, 2005) and are still not in 2018. The SIB is, apparently, waiting for the Minister of Agriculture to sign the policy. Half of the amount raised would go to the producing province and half would go to the SIB to fund its operations.

The SIB is supposed to be run by a seven-member board with four members representing smallholder spice growers (from different regions), two members representing the larger commercial spice growers or exporters and one member being the head of the Department of Agriculture. Its first chairman was Alfred Jambram, one of the vanilla sector's founding fathers, and he is still a member of the Board. The functions of the Board are to:

a. Control and regulate the processing, marketing and export of spices; and
b. Promote the consumption and export of spices; and
c. Promote research and development programmes for the benefit of the spice industry; and
d. Compile statistical data on production, imports and exports of spices and to be familiar with production trends throughout the country and provinces and internationally; and
e. Register buyers, processors and exporters of all or any of the spices; and
f. Keep a register of buyers, processors and exporters of spices; and
g. Formulate a register of processors and of spice grading systems for each of the spices.[38]

The SIB comes under the Ministry of Agriculture and Livestock, which acknowledges that 'the Board continues to face key challenges in terms of resourcing, capacity building and field projects to increase in quality, production and downstream processing.'[39] It currently has two staff members and no offices. The acting secretary is a Vudal University graduate. The SIB issues export licences and collects data on the vanilla sector: farmer groups, number of vines and production, exports by grade and registered exporters. The SIB officer offered to share this data with us but subsequently reneged on this offer. He provides information on the vanilla market, particularly international market prices, to farmer groups though the SIB has no internet access and farmers are advised to search the internet themselves. The SIB is supposed to provide training to farmers but they have no resources to do this. The SIB wants to revise the registration process to include three separate licences with one for buyers, processors (manufacturers) and exporters.

The SIB is generally considered to be ineffective in providing direction for the sector due to its budgetary constraints but that it has a vital role to play. Views were divided on whether it should be strengthened and how to whether some other form of organisation should take responsibility for vanilla.

2.6.6.3 Provincial Governments

Provincial governments are responsible for providing the services of line departments within their provinces from the budget allocated from central government, such as provision of agricultural extension services. Further revenue can be obtained in the form of 60% of the export levy collected on the value of exports from the province (40% is retained by Central government). Because much of the vanilla produced in East Sepik is not directly exported but taken to Lae in preparation for export, it is Morobe province which captures this benefit. The governor of East Sepik has raised this anomaly and is trying to find a way to readdress this

[38] http://www.agriculture.org.pg/PNG%20Spice%20Legislation.htm

[39] https://www.agriculture.gov.pg/commodity-boards-a/spice-board/

problem. It should be easy to ascertain the amount of vanilla leaving the province as it is all airfreighted and cargo records are kept by the airlines. This is a key issue in terms of governance of the value chain.

2.6.6.4 NAQIA

The National Agriculture Quarantine and Inspection Authority, mandated under the National Agriculture Quarantine and Inspection Authority Act 1997, provides quarantine and inspection services at all ports, issues phytosanitary certificates for vanilla exports and collects the 10% General Services Tax charged on the FOB value. NAQIA officers record export weights and values, name of vessel or flight, destination, which is forwarded to the Customs Department, and value and check the beans for moulds and foreign bodies. A phytosanitary certificate costs PGK 44,80; an inspection at a NAQIA office costs PGK 168 or PGK 224 at an exporter's premises. Exporters must notify NAQIA in advance of their need for a certificate; NAQIA officers work on Saturdays. The main offices concerned with vanilla exports are Lae, Wewak and Vanimo. A few small consignments, 6-20 kg, are exported directly from the international airport in Port Moresby once or twice a month by exporters based in the city. Most of the vanilla exported is good quality and only an estimated 0.1% is damaged (M. Areke, personal communication, 2018). NAQIA hosts one of the country's five laboratories that provides independent laboratory sample testing services to ensure food safety of exported produce which is currently being upgraded with EU support. It does not appear that vanilla is tested for possible microbiological contaminants.

2.6.6.5 Banks

Banks have tended to be accused of being unsupportive of smallholder farmers and small-scale traders but this appears to be changing. In 2012 savings accounts and mobile banking were noted as having grown dramatically as means to shielding assets from family and public view and facilitate capital accumulation for the investment which the obligations of the wantok safety net system tends to prevent[40]. In 2011 the Bank of the South Pacific (BSP) introduced the agency concept 'to bring banking services to the unbanked'[41]. This evolved into a payment ecosystem that allowed customers to access their accounts in rural areas. It was piloted with cocoa buyers, sellers and traders. One of the vanilla buyers mentioned in the survey is a BSP agent which may facilitate electronic payments.

However, most vanilla trading is done using cash and traders spend long hours queuing at the bank waiting to deposit cash. This issue was even raised in Parliament in September 2018 as a total productivity loss[42]. In Maprik the BSP is the only bank with a branch and captures considerable sums from vanilla trading. The Provincial manager explained how they wanted to find a way to support the sector. The BSP have launched a loan service for SMEs and the Maprik branch is leading the country in the number of loans made. Loans for a business are based on the number of deposits in the past 12 months for which they can get a PGK 100 000 collateral-free loan. Most borrowers are young men who borrow to operate a store or a PMV service. This indirectly supports vanilla trading. It is possible that vanilla traders could borrow to enable them to purchase greater amounts but this might be considered too risky, by both the trader and the ban.

Some buyers/exporters use bank accounts to pay their farmers. This is becoming more popular and reduces the risk involved of carrying large sums of money around. BSP has developed a phone app to allow its users to pay school fees by phone, although this wasn't successful in 2017 as schools still wanted physical evidence of payment. ATMs don't always function due to breaks in connectivity.

The provincial BSP manger in East Sepik is keen to work with vanilla exporters to see what the bank could do to support them and the farmers they buy from. He also recognised the knowledge and expertise of the provincial agricultural officer in vanilla and recognised they needed to work together to support the sector. The Bank of Papua New Guinea is investigating the use of Blockchain for advancing financial inclusion and making low cost financial systems accessible and easy to use for people living in remote rural areas. BPNG has been working with Julien Bouteloup[43], an entrepreneur and blockchain technology developer, to develop a system for people in villages with no electricity, internet or infrastructure. The result is IDBox, a cost-efficient

[40] http://eatproject.org/docs/USAID-EAT%20AgCLIR%20Papua%20New%20Guinea.pdf

[41] http://www.bsp.com.pg/Personal/BSP-Agent-network/

[42] https://postcourier.com.pg/productive-hours-wasted-bank-traffic-queues-mp/

[43] https://cryptonews.com/exclusives/a-blockchain-lesson-from-papua-new-guinea-1273.htm

device that provides each villager with a unique identity they can use, via finger-print recognition, to access voting systems, health care and remittance services. IDBox can also provide a traceable ledger of property ownership. A trial was conducted in Lalaura village, Central province - a six-hour journey on rough roads, with women selling electricity. Interestingly Lalaura is in a vanilla producing area and the technology might be extendable to vanilla selling.

2.6.6.6 Exporters provide training, finance

The main vanilla trading model is that an exporter establishes links with farmers, who may be fellow clan members, to acquire or purchase vanilla. The exporter is expected to provide training for their farmers on how to produce quality beans. The exporter must register and obtain an export licence from the Spice Industry Board. In 2003 it was recorded (McGregor, 2005) that there were 250 vanilla exporters licenced with the SIB, although only 10 exporters shipped more than 100 kg of vanilla. Now it is common for registered farmer groups (registered with the Investment Promotion Authority) or cooperatives (registered with the Ministry of Commerce, Trade and Industry) to apply for export licences (N. Siri, personal communication, 2018).

2.6.6.7 Transporters/Cargo agents/Freight forwarders

Several companies are involved in airfreighting vanilla within and outside the country, including DHL Global Forwarding and TNT. At Wewak airport, vanilla is the main cargo and is airfreighted to Vanimo, Lae and Port Moresby. The opportunity provided by vanilla has increased the number of daily flights which are now provided by two airlines – Air Niugini and PNG Air. Vanilla freight generates sizeable sums. In September 2018 a theft of the day's cargo takings of PGK 13 000, almost entirely from vanilla, was reported[44].

Flights began in late 2018 out of the rebuilt Hayfield airfield in Maprik district with direct flights to Vanimo. In October it was reported[45] that Air Sanga had switched from a nine-seater single engine plane to a 19-seat twin engine Otter to accommodate the increase in business, mainly from vanilla traders. A one-way passenger ticket from Maprik to Vanimo is PGK 500. The availability of this service reduces the time, costs and risks involved in cross-border trading.

2.6.6.8 National Agricultural Research Institute (NARI)

In 2003 three researchers were working on vanilla-related research and communication, based at NARI's Islands Regional Centre at Kerevat, East New Britain and the Centre still has responsibility for research into alternative cash crops including vanilla. However, there is no active research programme. In 2007, the Wet Lowlands Islands Programme leader, Dr John Moxon, currently leading the PPAP project, presented a paper at the Economics Research Workshop in which he highlighted the need for "adequate industry support and quality standards … coupled with effective extension services to enable farmers to acquire the level of technical knowledge in producing quality beans for export markets … with proper coordination and industry support …"[46].

2.6.6.9 Ministry of Trade, Commerce and Industry

The Ministry is responsible for the registration of and support to cooperatives, according to the Cooperatives Act. A large number of vanilla cooperatives were registered and may have been active during the last vanilla boom but many appear to be no longer functioning. There used to be regional cooperative officers but there are very few now due to budget constraints. The government is keen on revitalising cooperatives as part of its policy focus on non-extractive industries.

Although the vanilla sector is the responsibility of the Ministry of Agriculture and Livestock, some of its activities fall under the Ministry of Trade, Commerce and Industry's mandate. Many of the issues affecting the sector crosscut across ministerial responsibilities. A joint meeting was held in early 2018 on how to support and promote the vanilla industry - vanilla producers need a stable market and the sector needs

[44] https://postcourier.com.pg/officer-shot-four-suspects-captured-wewak-airport-robbbery/

[45] http://www.looppng.com/community/maprik-airline-upgrades-craft-80077

[46] http://www.nari.org.pg/sites/default/files/narinius/2007/NN_vol10_No3_2007.pdf

international investment. For this there needs to be proper regulations in place to manage the sector on a commercial business. The government is aware of the big potential of the vanilla sector and is trying to set up a committee with the Prime Minister's office, the NEC, Department of Commerce under the lead of the Department of Agriculture and Livestock. The lack of data or statistics and the need for this to make recommendations was raised as an issue.

2.6.6.10 PHAMA (Pacific Horticultural and Agricultural Market Access program) in PNG

PHAMA, a programme funded by the Australian government focuses on addressing constraints faced by private and public sector agriculture stakeholders to accessing export markets. Since its inception in PNG in 2016, PHAMA has focused its support for improved markets for the country's most important export commodities – cocoa, coffee, high-value coconut products, fresh produce, handicrafts and fisheries. PHAMA has not been working with the vanilla sector but recognises that it is a good crop for adding value to farming and it fits in well with cocoa. There are plans to include vanilla in its second phase starting November 2018 focusing on exports to Australia. The director said a lot of interest has been expressed by vanilla producers looking for exporters and importers and is aware of opportunities for sales, such as 900 kg sought by an importer in Brisbane. PHAMA would investigate ways to introduce a more formalized trading system, with quality assurance to meet buyers' requirements and testing for food safety and quality (microbial: E. coli, listeria; water quality; vanillin) that NAQIA can do; introducing HACCP into vanilla packhouses and moving away from dealing with cash and providing links to a banking service. Food buyers and manufacturers would like to see vanilla produced in an environmentally friendly way which also allows traceability. The director acknowledged that there is resistance to more formal systems, which involve paying taxes, but he reckoned that incomes from vanilla could generate three to four times the farm revenue currently generated. Part of the work of PHAMA is building up brands and branding produce. This is an area that the vanilla sector could benefit from support and expertise.

2.6.6.11 Universities

Staff from the Department of Agriculture at the PNG University of Technology (UniTech), Lae were involved in this study and gained knowledge of the value chain and key stakeholders, and undertook the household and trader surveys, focus groups and survey data entry.

UniTech also provide laboratory testing services. As part of the EU Trade-Related Assistance programme, state-of-the-art laboratory equipment was commissioned in March 2019 at the National Analytical and Testing Service Ltd (NATSL) laboratory at UniTech. This organisation provides independent testing services to support export trade by providing assurance that exported produce complies with EU market regulations on consumer health and food safety[47].

2.6.6.12 Importers

Although this study was not intended to go beyond what happened to PNG's vanilla after it was exported some information was obtained on key markets and key importing companies. PNG exports to the USA, Canada, Europe, Australia and New Zealand, Indonesia, Israel, Japan, China and Hong Kong and Malaysia. In 2017, Indonesia was largest export destination by volume (40.2 tonnes formally exported); USA by value (PGK 1 216/kg). Key importers include longstanding partners - Vanilla Saffron and Kestrel Growth in the USA; Aust and Hachmann in Canada; Prova in France, and EquaGold in New Zealand among others. In Indonesia, Tripper, which also has a base in California, imports from PNG. It has a spice grinding plant in Jakarta and an extract production plant in Bali. The company is a member of IFEAT.

2.6.6.13 Policy implementers, shapers and issues

In terms of government, vanilla seems to be an orphan crop. Ministry officials in Agriculture and Trade referred to plans to develop a new policy around vanilla but there didn't seem any real urgency for this to be done.

The vanilla sector is a remarkable example of how local entrepreneurs have supported and developed a value chain that provides considerable cash flows to small-scale farmers in some of the poorest parts of the

[47] https://eeas.europa.eu/delegations/papua-new-guinea/59824/european-union-laboratory-equipment-helps-png-improve-consumer-health-and-food-safety_en

country. Compared to other cash crops the role of the public sector has been minimal. This may reflect the speed at which private individuals have been able to respond to economic incentives while by the time a public sector agency may have been able to engage the opportunity was already disappearing but this also has led to quality and reputational constraints. For the country's traditional agricultural exports – cocoa, coffee – commodity boards exist which oversee the quality aspects. This has been almost entirely neglected in the case of vanilla, an observation first made by the Enabling Agricultural Trade (EAT) assessment in 2012[48]. A further point made by the EAT assessment is the

> '*lack of voice and vision that represents the value chains from producer through trader, processor and/or exporter … the stakeholders in each value chain still generally lack a means of convening to work out internally the natural tensions along the chain and to advocate a unified vision for industry development and improvement*.' (p12).

This is still particularly the case for the vanilla value chain. All kinds of allegations and uncorroborated stories are published in the local press about vanilla, which could be damaging for its reputation as a quality vanilla producer. There is no organisation which represents the vanilla value chain and to which journalists and politicians could turn for facts and figures.

When the prices have been high the producers, traders and exporters have benefited significantly. When prices dropped many people were adversely affected, some perhaps by overreaction to what difference the substantial drop in price really represented. There is no public organisation that is collecting information on prices, arranging forward contracts and developing sustainable links with buyers to continue buying PNG vanilla at reasonable prices during the downtimes though it could be argued that the large exporter provides some of these features and that some benefits are passed on to farmers. The company is proud of being the only buyer that continued to buy during the prolonged downturn.

There is no organisation that is undertaking research or routinely providing training courses on improved production methods and shortcuts, shorter curing methods and negotiating better freight prices. There are many things that could be done to upgrade the value chain; to ensure sharing of views and ideas; to learn from practices in other countries; to represent smaller and larger growers and SMEs; to ensure quality exports which follow accepted food safety procedures; to ensure farmers and traders are not at risk when carrying large sums of money and encourage the use of electronic banking and blockchain to support bigger export consignments and reduce costs; to ensure that female farmers and traders are also part of the value chain and reap similar benefits; to support PNG become a go-to source of vanilla and support structures to ensure regular, remunerative supply.

2.7 Typology of vanilla producers

In this value chain analysis, we have identified three smallholder grower types, based on the average number of vines owned by a household, constructed from information provided by a survey of 100 households in East Sepik.

These are small-scale vine owning households (average vine number is 192 vines); medium-scale vine owning households (average vine number is 599 vines) and large-scale vine owning households (average vine number is 1 726 vines). There are discernible differences in the efficiency of production, qualities and proportion of grades produced and incomes generated. Social and environmental differences are also observed.

The farmer typology is based on vanilla farming households, rather than individual vanilla producers. At the household level, all the households in each of the three categories are headed by men, with little difference in the average age of the heads (Small category - 43 years; Medium - 42 years and Large - 39 years). However, within the household men, women, youth and children are managing vanilla plots and here there is more variation between the three vanilla farming household categories. In terms of gender, the percentage of plots managed solely by women increases with the number of vanilla vines owned by the household from 2% in the small farming household category to 16% in the medium and 18% in the large category (see Figure

[48] Such entrepreneurism was also noted in the EAT project assessment http://eatproject.org/docs/USAID-EAT%20AgCLIR%20Papua%20New%20Guinea.pdf

2.4). In terms of age, the average age of vanilla plot managers decreases with the number of vanilla vines owned by the household (Small - 44 years; Medium - 39 and Large -34). In the smallest category 43% are below the age of 40, while 22% are above the age of 60. In the medium group 45% are below the age of 40, but only 7% above the age of 60. Finally, in the large category 65% are below the age of 40 and just 6% above the age of 60 (see Figure 2.5).

It should be noted that the Vanilla Household survey was purposively undertaken in five villages known for the large number of vanilla growers and large production of vanilla. The figures obtained probably overstate the amount of vanilla produced and are not necessarily applicable to producers in other parts of East Sepik and in other provinces.

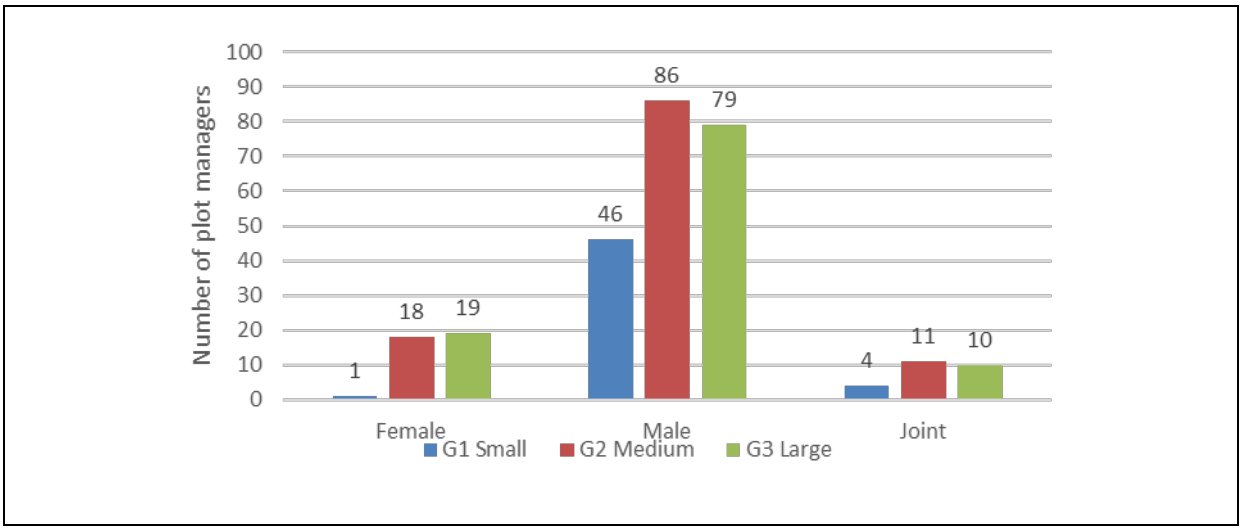


FIGURE 2.4 GENDER OF MAIN MANAGER OF VANILLA PLOT BY FARM HOUSEHOLD CATEGORY

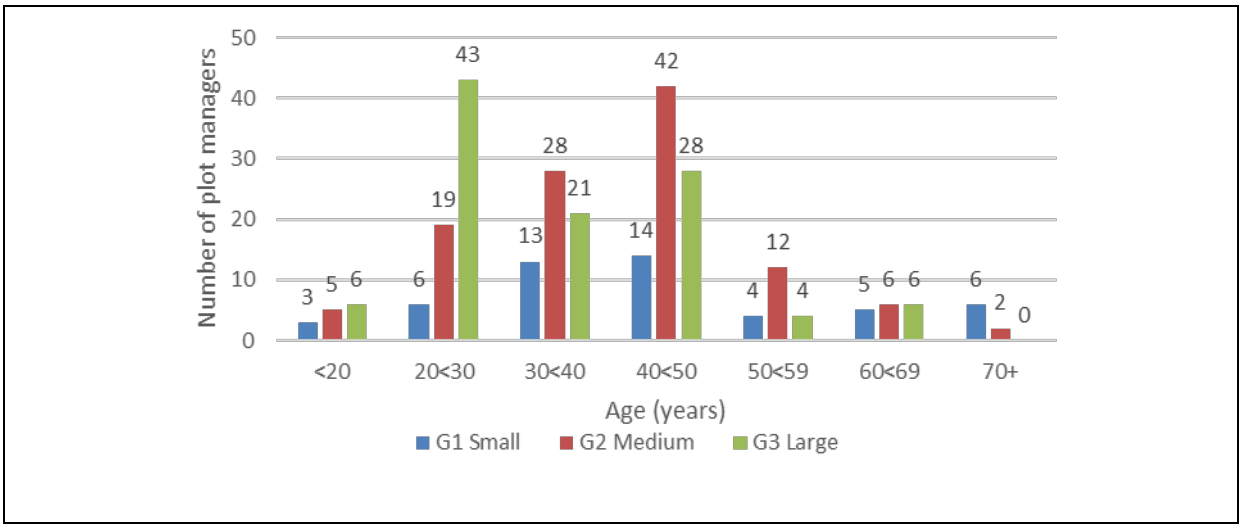


FIGURE 2.5 AGE DISTRIBUTION OF MAIN MANAGER OF VANILLA PLOT BY FARM HOUSEHOLD CATEGORY

2.8 Typology of vanilla traders and exporters

While there are permutations and occasional additions, the most common trader and exporters types are the i) Maprik street trader, who sells to the large exporter and engages in cross-border trading; ii) medium-scale international exporter who engages in up to 40 transactions per year and iii) the large exporter, which exported 156 consignments in 2017. There are instances of exports by farmer organisations, but these are periodic and irregular.

2.9 Technical diagnosis: production and service provider typologies, constraints and risks

2.9.1 Typology, constraints and risks facing small-scale vine-owning households

These producers face similar constraints though these may be offset due to the greater likelihood of having other productive enterprises, such as cocoa; 77% of the households are based in Walahuta and Urita villages in Maprik district where cocoa is also promoted. Having a smaller number of vines appears to result in much higher bean conversion from green to cured beans though quality is still an issue and the average unit prices received are the lowest of all the groups. A smaller number of farmers are members of a cooperative but those that are pay an annual membership fee. When prices are high this represents a small proportion of their income but if prices were to drop this would be harder to cover; currently few cooperatives are exporting regularly so members may not be getting any financial benefit from their membership.

2.9.2 Typology, constraints and risks facing medium-scale vine-owning households

Similar constraints and risks are faced by medium-scale vine-owning households, 52% of which are based in Urita and Walahuta in Maprik, though these households tend to produce higher quality beans, are able to obtain a higher unit price, possibly because they are able to sell most of their beans to the large exporter. However, low yields are still a constraint.

2.9.3 Typology, constraints and risks facing large-scale vine-owning households

Cost risks relating to fluctuating global vanilla prices are the main constraint facing large-scale vine owners who are dependent on vanilla production for their livelihoods in the remote mountainous districts of East Sepik. According to the household survey, 89% of the large-scale vine owning households were based in Dreikikir. Survey findings show how households have invested their incomes in building permanent houses, rainwater tanks, radio/CD players with large speakers, mattresses and bedding, kitchen utensils and big solar panels and solar lights in many houses. Yambes village, in particular, is very different from the other villages in terms of most of the houses being permanent and having water tanks. Vanilla income is also used to pay school and even university fees. Farmers in Dreikikir have experienced the previous boom and bust so may be more astute about investing vanilla income into other enterprises, even perhaps in other parts of the country or overseas. Low yields and poor-quality beans are also a risk, which could be improved through more training and observation of good practices and regular and stronger contracts with external buyers. Pest and disease attacks are currently not reported as an issue but these have been reported in other parts of the Pacific and are a potential risk for PNG farmers.

2.9.4 Typology, constraints and risks facing informal and cross-border vanilla traders

Price drops are the biggest risk to small-scale traders, particularly between the time of buying in Maprik and selling at the *batas*. Although the experienced traders aim to have a buyer and an agreed price before they set off on their journey this is not always honoured and the price offered may not even cover the travel costs incurred. Risks of theft of the large sums of cash carried and of injury are high. The trading margins are small and if more remunerative opportunities were to present themselves, or if cross-border trading restrictions were imposed, it is possible that this market avenue could be much reduced which would also have an impact on the producers. The margins made are small and these traders are also engaged in bringing goods from Indonesia, such as cigarettes, which they sell at Maprik and other markets or from their homes.

2.9.5 Typology, constraints and risks facing medium-scale exporters

Medium-scale traders/exporters are faced with similar vanilla purchasing risks to those above though some are in a better position to protect themselves from theft risk on the highways if they have their own vehicles with window grills and are ready to carry a firearm. Exporting companies are able to work with farmer groups and transfer cash into bank accounts which reduces the risk of theft. Exporting internationally is a risky business.

There are considerable risks involved in exporting vanilla. Trading internationally brings risk of exposure to fraud and scams and non-payment of orders as well as of physical loss of the produce. The East Sepik provincial DAL officer undertakes company assessments on behalf of cooperatives. Established exporters are

able to build relationships with *bona fide* companies which reduces risk of non-payment. For new exporters lack of knowledge of required documentation can mean that consignments don't get cleared and payments are not received. NAQIA says they advise exporters on what documentation is needed but this may not be done systematically with each exporter. The Westpac Bank used to help exporters check the credibility of overseas buyers but no longer provide this service. Doing business in PNG is expensive. Virtually all vanilla exports have to be internally airfreighted which adds significantly to exporting costs. There is no government organisation that helps exporters. There are no export rebates available to offset the high cost of airfreight rates or other costs of operating an international trading business: internet access costs doubled in 2018, from PGK 10/day to PGK 20/day.

Exports are financed from own cash sources which means that vanilla purchasing, and storage, are constrained until payment is received from the importer. Not only is there the risk of non-payment but exporters may not be able to capitalise on rising international prices or may have had to purchase vanilla at a high price and have to sell on quickly rather than to be able to store it until export prices pick up.
Most of the traders in this category have other businesses and do not rely on vanilla trading as their sole business.

Reputational risk is of key concern to traders. In 2008 a consignment exported to the USA was rejected due to the presence of physical contaminants. This harmed the image of PNG as a high-quality vanilla producer and has taken exporters a long time to mitigate the impact.

2.10 Value chain governance: coordination, information flow, regulation and policy

2.10.1 Market governance in PNG's vanilla value chain, coordination and information flow

It is evidence that the dominant market leader is the price setter for A grade vanilla. Virtually all A grade vanilla is sold at the price that they offer at their Maprik buying centre. If other exporters want to procure vanilla, they have to pay equal, if not higher than this, to amass the required amount (G. Ramoi, personal communication, 2018). Given the antipathy of people from PNG towards Indonesians and their activities in West Papua there is some hostility towards the company which is not only the main buyer of vanilla but the main supermarket operator. Some vanilla growers felt that all their efforts in growing vanilla ended up in one company's hands. At one stage it was noted on the company's website (D. Manuk, personal communication, 2018) that the company claimed it owned over 200 hectares of organic vanilla production. This has been removed but its inclusion suggests that the company is not in tune with the intelligence and level of awareness of the farmers and others supporting vanilla production. The company claims that it

> "*is dedicated to becoming PNG's leading exporter of pure vanilla products, and determined to cultivate sustainable long-term relationships with local vanilla farmers and buyers, while simultaneously increasing participation within the different areas of the PNG vanilla supply chain, … [and] increased transparency within the local PNG market, hoping that by doing so we can stabilize prices and ensure long-term quality and business integrity*."

There is a lack of clarity and openness of how vanilla buying prices are set which frustrates established growers and traders and no mention of current buying prices on its website. The team learnt that the prices offered to vanilla growers from Morobe province, who took their vanilla to the large exporter's factory in Lae, received a lower price for A grade than what was offered in Maprik, from which most of the company's vanilla is sourced. The large exporter may broadcast its prices on a radio show it sponsors in East Sepik but this is not likely to be picked up in Morobe province.

For the mainly lower quality grades the price is set by the Indonesian buyers in the cross-border market. This has the benefit for producers and traders of increasing returns for lower quality produce but also means that

the country loses out in terms of formal export revenue. It also may discourage producers from adopting better agricultural and postharvest practices which would increase the proportion of A grade vanilla.

2.10.2 Maintaining an enabling regulatory and policy environment for vanilla production and exports

Unlike other, more established, export crop value chains in PNG, there is no one organisation with specific authority to act on behalf of the vanilla sector, such as the statutory authorities which provide research and development and extension services for cocoa and oil palm producers (World Trade organisation, 2019).

Provisions are made in the 1999 Spice Industry Act for representation by the vanilla sector. The team were informed that this had not been the case since 2006 although Alfred Jambram, the former chairman, did apparently attend a meeting of the board in April 2019. There is no single organisation which provides formal oversight of the sector, such as a producers and traders' association, which could work with ministries, banks and stakeholders to represent grower and trader interests and address common problems, and to represent the PNG vanilla sector in international associations representing vanilla buyers and sellers.

Some of the generic challenges in the vanilla value chain could be mitigated by policy interventions including easing access between vanilla producing areas and exporting locations and improving the image of the country as a safe and straightforward country with which to do business to encourage European buyers to visit and set up schemes to support growers, as they do in Madagascar. Recent publications by the World Trade Organisation (2019) on review of the country's trade policy and the World Bank Group (2019a) on the ease of doing business provide suggestions. PNG ranked 108th (out of 190 countries) in 2018.

The main mechanisms for communication between policy makers and the main stakeholders appears to be largely informal. The East Sepik governor is a former vanilla grower and exporter and he does what he can to talk about and support the vanilla sector which is bringing benefit to his province. A key challenge is the lack of authority on the industry. There are frequent articles in the national press on vanilla, but these are often sensational and raise awareness of things that are not going well rather than the good things that are going on. All these articles are available online and so accessible by overseas buyers as well as the intended audience at home

3 THE ECONOMIC ANALYSIS

3.1 Introduction

The economic analysis reported in this chapter is intended to answer two key framing questions:

FQ1: What is the contribution of the VC to economic growth?

FQ2: Is this economic growth inclusive?

In answering these questions, the following steps were taken in accordance with the standard methodology adopted for the study:

a) Assessment of the financial results of the key actors (farmers, exporters)
b) Assessment of overall effects into the national economy
c) Assessment of the sustainability and viability of the chain within the international economy
d) Assessment of the inclusiveness of growth in the chain.

The analysis is based on market prices. The key actors covered are selected on the basis of defined boundaries for analysis in the study as given in section 2.6 Several assumptions are used to perform these calculations and to make them as homogenous as possible:

- Each operating account is calculated for an average agent, who is representative of a stakeholder group for a full year of production.
    - The assumed number of farming households involved in vanilla is calculated as 16 996 (Group 1: Small-scale vine-owning households – 5 081; Group 2: Medium-scale vine-owning households – 6 834; Group 3: Large-scale vine-owning producers – 5 081)
    - The assumed number of cross border traders is 17 and the number of medium-scale exporters to 8; there is 1 large exporter.
- Net operating profit consists of income from the sale of vanilla. There is no own consumption of vanilla.
- The costs are financial and relate only to actual expenses incurred in cash. They do not include payment for family labour.
- The minimum wage was PGK 3.50/hour in 2018.
- The price paid to farmers for one kilogram of A grade vanilla varied between PGK 900 and PGK 1 000.
- The price paid to farmers for one kilogram of extract/mix grade vanilla was between PGK 550 and PGK 650.
- The price obtained for exports of A grade vanilla to international markets was PGK 1 200 and PGK 850 for A grade vanilla sold to Indonesia.
- Many of the costs, particularly those of the formal traders/exporters have had to be estimated. The resulting analysis is indicative of what may be happening in the value chain rather than an accurate record.
- A sensitivity analysis was undertaken to determine the impact of a 50% and a 75% drop in prices paid to farmers and traders.
- As the household survey was undertaken in established vanilla producing villages in the two main producing districts some of the average data used may not be applicable countrywide.

As no data on the vanilla sector is published it is difficult to verify these assumptions. A further challenge was to pick representative prices for each actor. There can be a large variation in prices obtained and paid. The household survey showed that in 2018 one farmer got the same (high) unit price for grade B vanilla at the border as did another farmer selling A grade to the main buyer in Maprik. As the amount exported in 2018 was 240 tonnes, the picture of the value chain (value added, net incomes, jobs, etc.) will be for this level of production/export.

3.2 FQ1: What is the contribution of the VC to economic growth?

3.2.1 CQ1.1 Are the value chain activities profitable for the entities involved?

The financial analysis involves assessing how profitable the key actors are. The main tool of analysis is the individual operating account, which includes only those flows involving market exchange and applying actual market prices. The main benchmarks used to assess overall financial performance of the actors is net operating profit using information obtained from the household survey, based on recall of expenditure and prices obtained in the second half of 2018, and interviews with traders. The amount of purchased items incurred by the producers is minimal. The main input is household labour.

Consistent with the information in the functional analysis and the data used in the environmental chapter, the accounts are built for three types of smallholder vanilla grower. These are i) the small-scale vine owning household, with between 1 and 300 vines; ii) the medium-scale vine owning household growing between 301 and 927 vines; iii) the large-scale vine owning household has between 928 and 5 000 vines though not all are in production.

Box 3-1 Computation of operating accounts of key actors

Value chain actors' operating accounts have been calculated based on the following outline:

- Production/output
- Street market/ sales price
- Value of production
- Cost of production

  Value addition (direct VA and indirect VA)

- Gross profit

  Net operating surplus/profit

- Base year 2018

Source: Based on Study Methodological Framework

Box 3-2 Average vanilla buying and selling prices (PGK/kg), 2018

The following average prices are used in the calculation of the vanilla value chain accounts.

Buying prices

	Cross-border trader	Medium exporter	Large exporter
Grade A	PGK 900/kg	PGK 1 000/kg	PGK 950/kg
Mix grades	PGK 650/kg	PGK 650/kg	PGK 550/kg

Selling prices

	Indonesia	International
Grade A	PGK 950/kg	PGK 1 200/kg
Mix grades	PGK 850/kg	PGK 700/kg

The financial analysis reported in Tables 3-1 to 3-3 shows that vanilla growing is profitable for all three categories of vanilla producers at prices given above, with high net profit rates between 92 and 96%. This

profit is the remuneration to the large amounts of labour necessary to produce vanilla. These margins are not dependent on any form of subsidy.

Primary production of vanilla by small-scale vine owning household (Group 1)
This producer produces 12.52 kg of cured beans per year from around 200 vines. This producer is relatively efficient at production. However, the quality of this production is low and only 22% of it is A grade. The majority of the produce is extract/mix grade and sold to street buyers in Maprik for which a lower price is obtained.

Production and selling inputs:

- Labour input - years 4 to 10 requires 23 days per year for mulching, weeding, looping, pruning, pollinating and harvesting and security plus curing and drying and packing (data on workdays is based on estimates calculated from McGregor, 2004).
- The producer takes a PMV (public motor vehicle) to Maprik to sell vanilla which costs PGK 20 for a round trip. The producer makes 1.8 trips.
- Very little equipment is used – a bush knife for farming plus a cool box and blanket for curing.
- The producer may be a member of a farmers' group and pay an annual fee.

The operating account for the average small-scale vine-owning household is given in Table 3-1.

TABLE 3-1 OPERATING ACCOUNT FOR THE AVERAGE SMALL-SCALE VINE-OWNING HOUSEHOLD

EXPENSES	Unit	Unit price	No.	Value	SALES	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption									
Equipment purchase	PGK	182	1	182	Grade A to CBT	PGK/kg	900	1,65	1 488
Return transport to market	PGK	20	1,8	36	Grade A to MT	PGK/kg	1 000	0,28	276
Coop membership fee	PGK	150	1	150	Grade A to LE	PGK/kg	950	0,83	785
Total				**368**	Mix grade to CBT	PGK/kg	650	5,90	3 838
					Mix grade to MT	PGK/kg	650	0,98	640
Value added					Mix grade to LE	PGK/kg	550	2,95	1 624
Casual labour/food purchase	PGK	0	0	0	**Total**	**PGK/kg**		**12,60**	**8 650**
Gross profit	PGK			**8 282**					
Depreciation	PGK			**0**					
Net profit	PGK			8 282					
Net profit rate	%			96					

The small-scale vine owning household achieves sales of PGK 8 650 and a net profit of PGK 8 282. It has the highest net profit rate (96%) from the second largest amount of sales. The net profit compares very well with the minimum annual wage of PGK 7 322 as the labour inputs required amount to just over one month's work.

At current vanilla prices the inclusion of 23 days at the minimum wage of PGK 28 per day (PGK 3.5/hour x 8 hours) would reduce the net profit rate to 88%. If this producer could increase the proportion of A grade produce to 40%, total sales would increase by PGK 1 700.

At prices prevailing in 2018, the vanilla activity is highly profitable. If global prices fall and Indonesia does not buy PNG low-grade vanilla margins will tighten and some producers will leave value chain

Primary production of vanilla by medium-scale vine owning household (Group 2)
This medium-scale vine owning household produces 10.63 kg of cured beans per year from 599 vines. It is relatively inefficient at production. However, the quality of the product is high and 55% of it is A grade. The majority (45%) of the product is sold to the large exporter in Maprik.

Production and selling inputs:

- Labour inputs: years 4 to 10 requires 52 days per year for mulching, weeding, looping, pruning, pollinating and harvesting and security plus curing and drying and packing (data on workdays is based on estimates calculated from McGregor, 2004).
- The producer takes a PMV (public motor vehicle) to Maprik which costs PGK 20 for a round trip. The producer makes 2.15 trips.

- Very little equipment is used – a bush knife for farming plus a cool box and blanket for curing.
- The producer may be a member of a farmers' group and pay an annual fee.

The operating account for this type of producer is given in Table 3-2.

TABLE 3-2 OPERATING ACCOUNT FOR THE AVERAGE MEDIUM-SCALE VINE-OWNING HOUSEHOLD

EXPENSES	Unit	Unit price	No.	Value	SALES	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption									
Equipment purchase	PGK			430	Grade A to CBT	PGK/kg	900	0,41	369
Return transport to market	PGK	20	2,15	43	Grade A to MT	PGK/kg	1 000	0,59	585
Coop membership fee	PGK	150	1	150	Grade A to LE	PGK/kg	950	4,86	4 615
Total				**623**	Mix grade to CBT	PGK/kg	650	0,34	219
					Mix grade to MT	PGK/kg	650	0,48	314
Value added					Mix grade to LE	PGK/kg	550	4,01	2 205
Casual labour/food purchase	PGK	10	9	90	**Total**	PGK/kg		**10,68**	**8 307**
Gross profit				**7 594**					
Depreciation	PGK			**0**					
Net profit	PGK			7 594					
Net profit rate	%			91					

This household achieves sales of PGK 8 307 and obtains a net profit rate of 91%. The net profit (PGK 7 594) compares reasonably well with the minimum annual wage of PGK 7 322 as the labour inputs required amount to just over two-and-a-half month's work. At current vanilla prices inclusion of 52 labour days paid at the minimum wage of PGK 28 per day would reduce the net profit rate to 74%.

At prices prevailing in 2018, the vanilla activity is highly profitable. If global prices fall and Indonesia does not buy PNG low-grade vanilla margins will tighten and some producers will leave value chain.

Primary production of vanilla by large-scale vine owning household (G3)

This type of producer produces 20.41 kg of cured beans per year from just under 1 800 vines.

Production and selling inputs:

- Labour input: Years 4 to 10 requires 200 days per year for mulching, weeding, looping, pruning, pollinating and harvesting and security plus curing and drying and packing (data on workdays is based on estimates calculated from McGregor, 2004).
- The producer takes a PMV (public motor vehicle) to market which will cost PGK 20 for a round trip. The producer makes 3.1 trips.
- Some equipment is used – a bush knife for farming plus cool boxes and blankets for curing.
- The producer may be a member of a farmers' group and pay an annual fee.

TABLE 3-3 OPERATING ACCOUNT FOR LARGE-SCALE VINE-OWNING HOUSEHOLD

EXPENSES	Unit	Unit price	No.	Value	SALES	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption					Grade A to CBT	PGK/kg	900	1,77	1 594
Equipment purchase	PGK			659	Grade A to MT	PGK/kg	1 000	1,77	1 771
Return transport to market	PGK	20	3,1	62	Grade A to LE	PGK/kg	950	4,53	4 300
Coop membership fee	PGK	300	1	300	Mix grade to CBT	PGK/kg	650	2,68	1 740
Total	**PGK**			**1 021**	Mix grade to MT	PGK/kg	650	2,68	1 740
					Mix grade to LE	PGK/kg	550	6,85	3 767
Value added					**Total**	PGK/kg		**20,27**	**14 912**
Casual labour/food purchase	PGK	10	15	150					
Gross profit	PGK			13 741					
Depreciation	PGK			0					
Net profit	PGK			13 741					
Net profit rate	%			92					

This household achieves sales of PGK 14 912 and achieves a net profit of PGK 13 741 with a net profit rate of 92%. The net profit figure is just under twice the minimum annual wage of PGK 7 322 although the labour

input required amounts to ten month's work. At current vanilla prices inclusion of 200 labour days paid at the minimum wage of PGK 28 per day would reduce the net profit rate to 36%.
Production of cured vanilla is currently a highly profitable activity. This is mainly due to the informal nature of vanilla production, the need for very few purchased inputs and the use of unpaid family labour. However, the vanilla economy is fragile. Farmers are currently making great windfalls, but their interest may not sustain if prices fall to 2004 levels.

Vanilla trading

Vanilla traders vary in terms of scale and type of trading (see Figures 2.3 and 3.1 to 3.3). Three categories of traders are covered in this analysis (Tables 3-4 to 3-6): cross-border, medium-scale exporters and one large exporter. The analysis indicates that it is a profitable operation for all three types. The net profit is considerably higher than the minimum annual wage in PNG (PGK 7 322). This implies that the households who are dependent on this trade can sustain their livelihood, at the prevailing national and international prices.

Trading/exporting of vanilla by cross-border trader/exporter

The street trader buys vanilla from farmers in Maprik and sells most of their produce at the cross-border market at Wutung. This market provides an opportunity for sales of reject quality vanilla that is not wanted by the international overseas importers. The street trader also sells a small proportion (20%) of their A grade vanilla to the large exporter. The operating account for a cross-border trader is given in Table 3-4.

TABLE 3-4 OPERATING ACCOUNT FOR CROSS-BORDER TRADER/EXPORTER

EXPENSES	Unit	Unit price	No. / Quantity (kg)	Value	SALES	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption					CB to Wutung A	PGK/kg	950	412	391 176
Vanilla purchase from SSVOHH A	PGK/kg	900	494	444 706	CB to Wutung B	PGK/kg	850	2 700	2 295 000
Vanilla purchase from SSVOHH B	PGK/kg	650	1 765	1 147 059	CB to Intec A	PGK/kg	950	776	737 647
Vanilla purchase from MSVOHH A	PGK/kg	900	165	148 235	**Total**	**PGK/kg**		**3 888**	**3 423 824**
Vanilla purchase from MSVOHH B	PGK/kg	650	135	87 941					
Vanilla purchase from LSVOHH A	PGK/kg	900	529	476 471					
Vanilla purchase from LSVOHH B	PGK/kg	650	800	520 000					
Total vanilla purchase	**PGK/kg**		**3 888**	**2 824 412**					
Packaging	PGK	400	1	400					
Scales	PGK	200	1	200					
Return transport Wingei to Maprik	PGK	20	250	5 000					
Return transport to Wewak	PGK	400	40	16 000					
Return flight Wewak - Vanimo	PGK	1 192	40	47 680					
Vanilla cargo charge	PGK/kg	6	3 112	19 137					
Taxi Vanimo - Wutung	PGK	600	40	24 000					
Wheelbarrow hire	PGK	20	40	800					
Accomodation Vanimo	PGK	400	40	16 000					
Phytosanitary certificate	PGK	213	40	8 520					
Airtime	PGK	360	1	360					
Subtotal				**138 097**					
Value added									
Export licence	PGK	2 500	1	2 500					
Trader licence Maprik	PGK	500	1	500					
Export levy (10%)	PGK /kg	0,1	3 423 824	*342 382*					
Total	PGK			345 382					
Total costs				*3 307 892*					
Gross profit				**115 932**					
Depreciation				0					
Net profit				115 932					
Net profit rate				3					

This trader achieves sales of PGK 3.4 million and a net profit of PGK 115 932. The net profit figure compares very well with the minimum annual wage of PGK 7 322. Trading at this level is a full-time activity. The net profit rate (3%) is much lower than those obtained by the producer households. This is explained by the high costs incurred in purchasing the vanilla, transporting it, by air, to the border and payment of the 10% vanilla export levy.

Medium scale trader/exporter

The operating account for a medium-scale trader, based in Wewak, East Sepik province is given in Table 3-5. This trader sells 40% of their vanilla to international high value markets and 60% to Indonesia, mainly at the cross-border market at Wutung.

TABLE 3-5 OPERATING ACCOUNT FOR MEDIUM-SCALE TRADER/EXPORTER

EXPENSES	Unit	Unit price	No. / Quantity (kg)	Value	SALES	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption					Int market A	PGK/kg	1 200	1 800	2 160 000
Vanilla purchase from SSVOHH A	PGK/kg	1 000	175	175 000	Indonesia B	PGK/kg	850	2 738	2 326 875
Vanilla purchase from SSVOHH B	PGK/kg	650	625	406 250	**Total**	**PGK/kg**		**4 538**	**4 486 875**
Vanilla purchase from MSVOHH A	PGK/kg	1 000	500	500 000					
Vanilla purchase from MSVOHH B	PGK/kg	650	413	268 125					
Vanilla purchase from LSVOHH A	PGK/kg	1 000	1 125	1 125 000					
Vanilla purchase from LSVOHH B	PGK/kg	650	1 700	1 105 000					
Total vanilla purchase	PGK/kg		**4 538**	**3 579 375**					
Packaging	PGK	600	40	24 000					
Scales	PGK	200	3	600					
Packhouse rental (50%)	PGK		1	10 000					
Consumables	PGK		1	3 000					
Electricity	PGK	1 000	12	12 000					
Water	PGK	1 000	12	12 000					
Fuel, oil	PGK	500	30	15 000					
Aggregator fee	PGK	1 000	40	40 000					
Vanilla internal air cargo charge	PGK/kg	16	4 500	72 000					
Phytosanitary certificates	PGK	300	40	12 000					
Internet access	PGK/day	20	365	3 650					
Subtotal				**204 250**					
Value Added									
Export licence	PGK	2 500	1	2 500					
Casual labour	PGK/day	30	120	3 600					
Export levy (10%)	PGK/kg	0,1	*4 486 875*	*448 688*					
Goods and services tax (10%)	PGK			10 265					
Subtotal				465 053					
Gross profit				238 198					
Depreciation of equipment									
Pick-up (5 years)	PGK	140 000	1	28 000					
Computer and printer (3 yrs)	PGK	5 000	1	1 650					
Other equipment (5 years)	PGK	5 000	1	1 000					
Subtotal				30 650					
Net profit (earnings per producer)				207 548					
Net profit rate (return on turnover)				5					

This trader achieves sales of almost PGK 4.5 million and a net profit of PGK 207 548. The net profit rate of the medium-size trader is 5%. This exporter obtains the highest unit selling price, particularly for A Grade vanilla sold to high value internatinal buyers, but also has to pay more to the producer to obtain supply as they are less regular buyers than the large exporter and do not maintain permanent buying points. This emporter uses an aggregator, who acts like a broker, to source vanilla for which they receive a fee. The exporter employs casual labour to sort and pack consignments but does not take a salary. Many medium-scale exporters also trade in other commodities or have other business interests.

Large scale trader/exporter

The operating costs of the one large-scale exporter have been imputed to assess profitability (Table 3-6).

TABLE 3-6 OPERATING ACCOUNT FOR LARGE-SCALE TRADER/EXPORTER

EXPENSES	Unit	Unit price	No. / Quantity (kg)	Value	INCOME	Unit	Unit price	Quantity (kg)	Value
Intermediate consumption					Int export A	PGK/kg	1 200	73 600	88 320 000
Vanilla purchase from SSVOHH A	PGK/kg	950	4 200	3 990 000	Indo export B	PGK/kg	850	77 200	65 620 000
Vanilla purchase from SSVOHH B	PGK/kg	550	15 000	8 250 000	**Total**	**PGK/kg**		**150 800**	**153 940 000**
Vanilla purchase from MSVOHH A	PGK/kg	950	33 200	31 540 000					
Vanilla purchase from MSVOHH B	PGK/kg	550	27 400	15 070 000					
Vanilla purchase from LSVOHH A	PGK/kg	950	23 000	21 850 000					
Vanilla purchase from LSVOHH B	PGK/kg	550	34 800	19 140 000					
Vanilla purchase from CB trader	PGK/kg	950	13 200	12 540 000					
Total vanilla purchase	PGK/kg		**150 800**	**112 380 000**					
Packaging	PGK	700	156	109 200					
Premises rental	PGK	2 750	12	33 000					
Consumables	PGK		1	10 000					
Electricity	PGK		1	25 000					
Water	PGK		1	10 000					
Fuel, oil	PGK	5 400	12	64 800					
Phytosanitary certificates	PGK	300	156	46 800					
Vanilla internal air cargo charge	PGK/kg	16	150 800	2 412 800					
Internet access	PGK/day	20	3 650	36 500					
Sub-total				*2 748 100*					
Value added									
Management	PGK	90 000	2	180 000					
Permanent labour	PGK	12 250	80	980 000					
Financial charges	PGK	15 000	1	15 000					
Export levy (10%)	PGK/kg	0,1	153 940 000	15 394 000					
Goods and services tax (10%)	PGK			244 580					
Export licence	PGK	2 500	1	2 500					
Subtotal	*PGK*			*16 816 080*					
Total cost	PGK								
Gross profit	PGK			21 995 820					
Depreciation of equipment									
Vans (5 years)	PGK	140 000	8	224 000					
Equipment (5 years)	PGK	50 000	1	10 000					
Computer and printer (3 yrs)	PGK	5 000	15	24 750					
Subtotal				*258 750*					
Net profit				**21 737 070**					
Net profit rate				14					

This trader achieves sales of PGK 153.9 million and a net profit of PGK 21.7 million. The net profit rate of the large-scale exporter is 14%. The volume traded is considerably greater than the other two exporter types and the value of sales reflects the proportion of produce sold (nearly 60% of sales) to high value export markets.

The net profit of the large-size trader is the highest of all the trader types. This is explained mainly by the size of the activity but also by the large amount of sales of A grade vanilla which offsets the high cost overall cost of salaries, equipment, consumables and export tax payable. The exporter employs 82 people.

3.2.2 Sensitivity analysis

The vanilla market is highly volatile. This section explores the impact of a reduction of the price received by farmers and traders by 50% and 75% of the 2018 prices used in the preceding sections.

Box 3-3 Sensitivity analysis: Vanilla buying and selling prices (PGK/kg): 50% reduction in PNG prices

Buying prices

	Cross-border trader	Medium exporter	Large exporter
Grade A	PGK 450/kg	PGK 500/kg	PGK 475/kg
Mix grades	PGK 325/kg	PGK 325/kg	PGK 275/kg

Selling prices

	Indonesia	International
Grade A	PGK 475/kg	PGK 600/kg
Mix grades	PGK 425/kg	PGK 350/kg

Reducing the price paid to farmers and the price received from buyers by 50%, while holding all other costs and quantities equal apart from a concomitant drop in export levy, indicates that there would be a substantial reduction in net annual profits (Table 3-7). In late 2019, industry observers were already noting that prices paid for Indonesian vanilla had fallen by 50%[49]. The farmers would still receive an income varying from broadly similar to, to double the national annual wage. Even though the cross-border and medium-scale exporters would benefit from lower buying prices, they would no longer make a profit and are likely to have stopped trading long before that point. The large exporter is only making 40% of its previous net annual profit and its net profit ratio also declines. The international grade A price of PGK 600/kg is roughly equivalent to US$ 200/kg.

TABLE 3-7 IMPACT ON NET ANNUAL PROFIT AND NET PROFIT RATIO FOR FARMERS AND TRADERS RESULTING FROM A 50% DROP IN PRICES

Stakeholder	Net annual profit	Net profit ratio %
Small-scale vine owning household	PGK 3 957	91
Medium-scale vine owning household	PGK 3 440	83
Large-scale vine owning household	PGK 6 285	84
Cross-border trader	PGK -12 579	-1
Medium exporter	PGK -155 435	-7
Large exporter	PGK 8 654 070	11

[49] http://www.austhachcanada.com/november-2019-english/

Box 3-4 Sensitivity analysis: Vanilla buying and selling prices (PGK/kg): 75% reduction in vanilla prices

Buying prices

	Cross-border trader	Medium exporter	Large exporter
Grade A	PGK 225/kg	PGK 250/kg	PGK 238/kg
Mix grades	PGK 163/kg	PGK 163/kg	PGK 138/kg

Selling prices

	Indonesia	International
Grade A	PGK 238/kg	PGK 300/kg
Mix grades	PGK 213/kg	PGK 175/kg

Reducing the price paid to farmers and the price received from buyers by 75%, while holding all other quantities equal, would still enable farmers to make a profit though this varies between a quarter and 50% of the national minimum annual wage. However, none of the three trader categories can sustain this level of selling prices, even though there buying prices would also reduce substantially. All would incur higher cost levels than the income received could sustain. As in the previous downturn, the large exporter might choose to continue to buy, high-quality, vanilla at a lower price to sustain the industry while cross-subsidising it from the group's other enterprises.

TABLE 3-8 IMPACT ON NET ANNUAL PROFIT AND NET PROFIT RATIO FOR FARMERS AND TRADERS RESULTING FROM A 75% DROP IN PRICES

Stakeholder	Net annual profit	Net profit ratio %
Small-scale vine owning household	PGK 2,168	83
Medium-scale vine owning household	PGK 2,082	66
Large-scale vine owning household	PGK 3,736	69
Cross-border trader	PGK -160,807	-19
Medium exporter	PGK -376,703	-34
Large exporter	PGK -5,179,610	-17

3.2.3 CQ1.2 What is the contribution of the VC to GDP?

Effects within the national economy - Consolidation of value chain accounts

Consolidation consists of establishing the operating account of the whole VC by merging the individual operating accounts of all the VC actors into one single account (see tables A4-1 to A4-6 in Annex 4).

Figures 3-1 to 3-3 presents the value chain and flows between the main actors for A grade vanilla, Extract or mix grade vanilla and for all vanilla exports combined. The current importance of the Indonesian market for extract/mix grade vanilla is highlighted in Figure 3-2. The values and quantities shown are used in the calculation of the global account (Table 3-9).

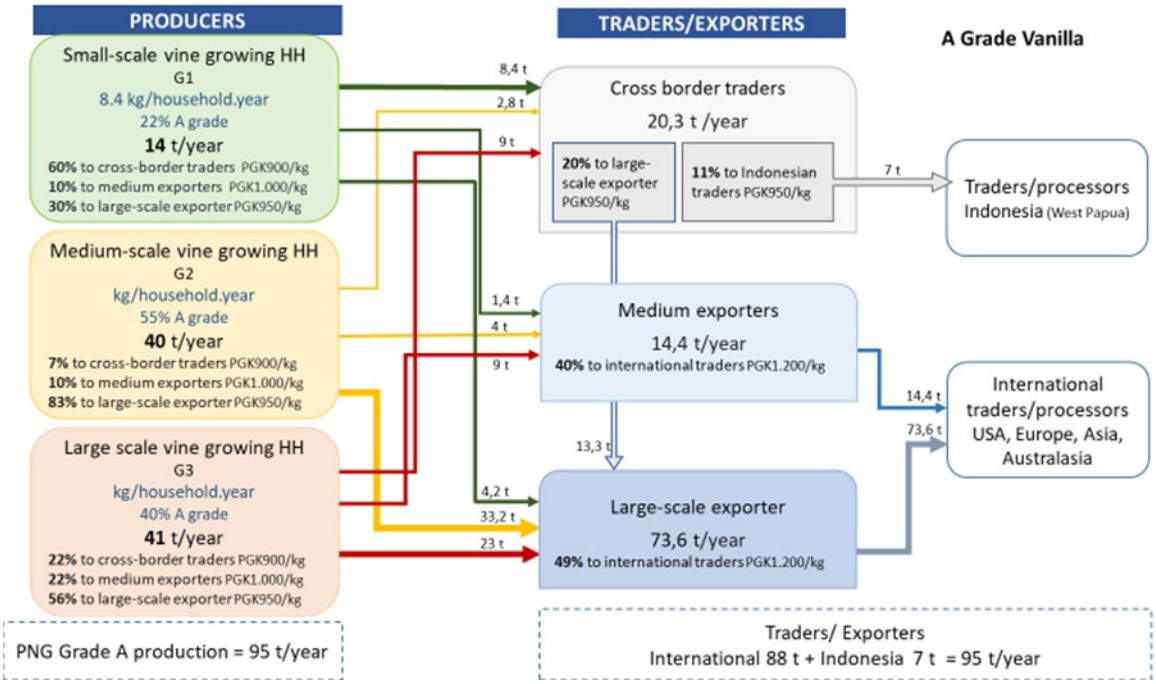


FIGURE 3.1 MAIN VALUE FLOWS FOR A GRADE VANILLA SALES

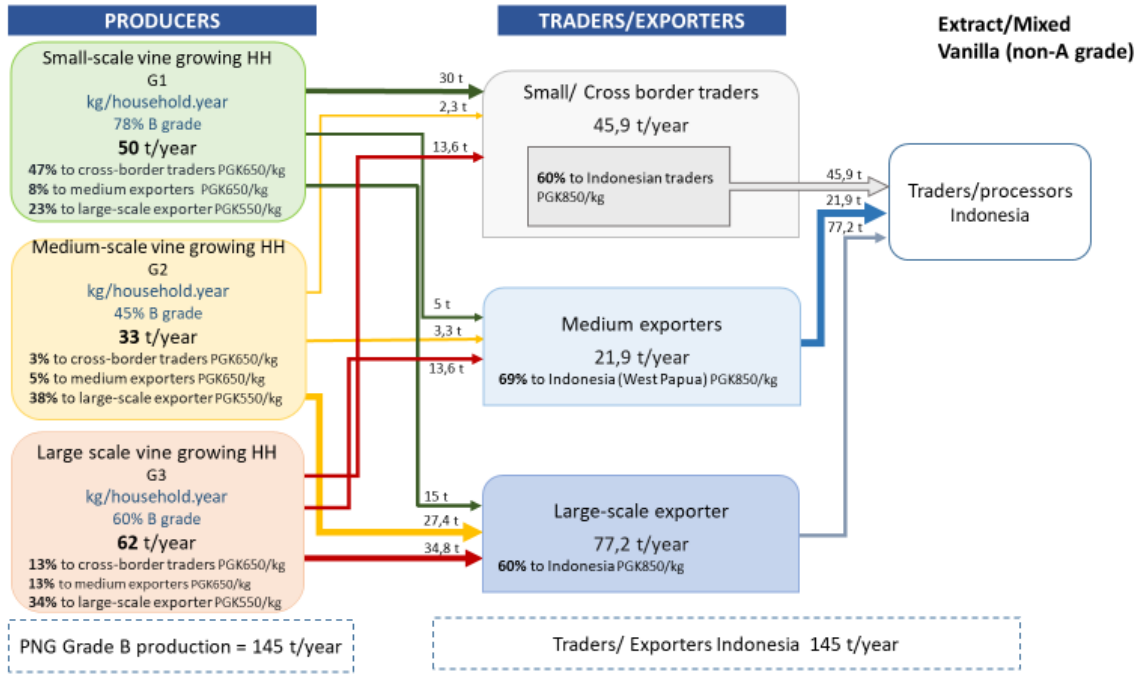


FIGURE 3.2 MAIN VALUE FLOWS FOR EXTRACT/MIX GRADE VANILLA SALES

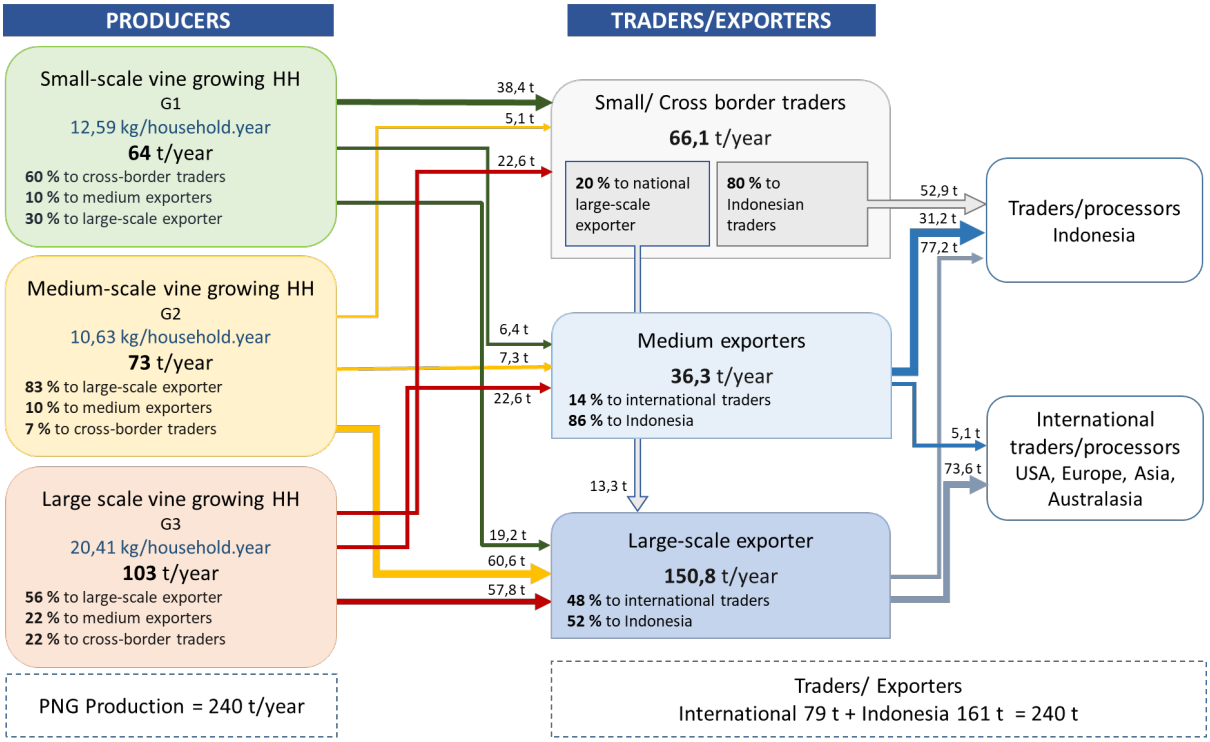


FIGURE 3.3 MAIN VALUE FLOWS FOR ALL VANILLA SALES

TABLE 3-9 OPERATING ACCOUNT FOR THE WHOLE VANILLA VC (PGK)

	IC in VC	IC off VC	Total IC	Taxes	Wages	Financial costs	Capital depreciation	Net Operating profits	Total ValueAdded
Small-scale vine-owning households	0	1 869 808,0	1 869 808,0	0,0	0,0	0,0	0,0	42 080 192,0	42 080 192,0
Medium-scale vine-owning households	0	4 257 582,0	4 257 582,0	0,0	615 060,0	0,0	0,0	51 897 358,0	52 512 418,0
Large scale vine-owning households	0	5 187 701,0	5 187 701,0	0,0	762 150,0	0,0	0,0	69 820 149,0	70 582 299,0
Cross-border traders	48 015 000,0	2 754 170,0	50 769 170,0	5 871 500,8	0,0	0,0	0,0	1 564 329,2	7 435 830,0
Medium-scale traders	28 635 000,0	1 634 000,0	30 269 000,0	3 691 620,0	28 800,0	0,0	245 200,0	1 660 380,0	5 626 000,0
Large -scale exporter	112 380 000,0	2 748 100,0	115 128 100,0	15 641 080,0	1 160 000,0	15 000,0	258 750,0	21 737 070,0	38 811 900,0
Total		**18 451 361,0**	**207 481 361,0**	**25 204 200,8**	**2 566 010,0**	**15 000,0**	**503 950,0**	**188 759 478,2**	**217 048 639,0**
VC production (PGK) (IC off VC + Total Value Added)	235 500 000,0								

Table 3-9 presents the consolidated account at the value chain level, based on amalgamation of the individual stakeholders' operating accounts multiplied by the number of actors involved at three different production levels, for a total production volume of 240 tonnes. It shows that the value of total production was PGK 236 million and direct value added was PGK 217 million in 2018.

Growth is measured by GDP, *i.e.* the total value added produced by the VC. Direct value added is generated by the actors operating within the VC (vanilla farmers and traders). Indirect VA results from the use of intermediate goods and services (IGS) supplied by actors outside the VC limits. This is estimated through computation of backward linkages. The main intermediate goods and services provided by suppliers are equipment and transport (Table 3-10). These represent nearly 75% of the whole goods and services, so the backward linkage calculation of indirect effects is done for these two IGS as these have the most impact for the assessment of the indirect VA. The figure for the cooperative/association membership fee is probably overstated as many farmers are not members and the fees are just deposited, there are no paid officers, premises etc.

TABLE 3-10 GOODS AND SERVICES IN THE VVC

Goods and services	Value (PGK)	%
Equipment purchases	7 219 941	39,64%
Transport and accommodation	6 123 210	33,62%
Coop membership fee	3 311 550	18,18%
Aggregator fee	320 000	1,76%
Packaging	308 000	1,69%
Energy (electricity, fuel oil…)	305 800	1,68%
Phytosanitary certificate	287 640	1,58%
Rental (packhouses, offices…)	113 000	0,62%
Water	106 000	0,58%
Internet access	65 700	0,36%
Wheelbarrow hire	13 600	0,07%
Airtime (telephone)	6 120	0,03%
Other consumables	34 000	0,19%
Total intermediate consumption	**~18,3 million**	**100%**

As all the IGS are provided by domestic suppliers, they are all broken down into indirect value added and indirect imports. Given no more recent information, input-output parameter data from Parker (1974) were used to calculate indirect value added and indirect imports. Table 3-11 presents the indirect effects.

TABLE 3-11 BACKWARD CALCULATION OF INDIRECT EFFECTS (VALUE ADDED AND IMPORTS)

PGK	IC	National economy sector	Wages	Gross operating profit	Net indirect tax	Total VA	Imports CIF
Equipment	7 219 941	Manufacturing	24%	36%	12%	72%	28%
			1 732 786	2 599 179	866 393	5 198 358	2 021 583
Transport and accommodation	6 123 210	Transport	42%	29%	2%	73%	27%
			2 571 748	1 775 731	122 464	4 469 943	1 653 267
Total			**4 304 534**	**4 394 910**	**988 857**	**9 668 301**	**3 674 850**

Total VA is the sum of its direct and indirect components: wages, operating profits of farmers and businesses, taxes and financial charges. These components show the primary impact of the VC operation on income generation. Total VA indicates the level of integration within the economy of all the activities in the VC (Table 3-12).

TABLE 3-12 TOTAL EFFECTS

PGK	Wages	Financial charges	Taxes	Gross operating profit	Value Added	Imports
Direct	2 566 010	15 000	25 204 201	189 263 428	217 048 639	0
Indirect	4 304 534	0	1 021 973	4 374 910	9 668 301	3 674 850
Total	**6 870 544**	**15 000**	**26 226 174**	**193 638 338**	**226 716 940**	**3 674 850**

The total VA (direct plus indirect) is PGK 227 million (€ 59 million) that represents 96% of the value of the national production of PGK 236 million (€ 61 million).

Direct VA constitutes 96% of the total VA which means that vanilla production and trade do not generate intensive economic growth outside the VC limits. Nevertheless, the vanilla VC generates more wages into the other sectors (PGK 4.3 million) than inside the VC (PGK 2.6 million). This is because the majority of labour in the VC is provided by family members and is not paid. The vast majority of direct VA is gross operating profit (87%) showing that there is a high level of remuneration of the household labour involved in vanilla production (assuming it is shared equitably).

The contribution of the vanilla value chain to GDP in 2018 is estimated at approximately 0.3% (PGK 227 million/PGK 76 billion).

Production of vanilla does not need many imports (only PGK 3.7 million at the indirect level), so the level of integration of the activities of the VC in the national economy is very high. The extent to which the vanilla value chain is integrated into the local economy is assessed by dividing total value added in the chain by the value of total production. The above result of 96% indicates that the chain is reasonably well integrated.

3.2.3 CQ1.3 What is the contribution of the value chain sector to the agricultural sector GDP?

The agricultural sector accounts for around 25% of GDP, equating to an estimated PGK 22.612 million (€ 5 858 million) in 2018. The contribution of the vanilla value chain to the agricultural sector GDP is around 1%.

3.2.4 CQ1.4 What is the contribution of the VC to the public finances?

The main contribution is the generation of revenue from the levy on exports (10% of FOB value) paid by the exporters, GST (General Services Tax) paid on inputs plus payment of the Spice Industries Board export trader licence and the street trader licence in Maprik, an estimated PGK 25.2 million in 2018 (approximately € 6.5 million). A further PGK 1 million is generated from indirect effects of the operation of the vanilla value chain.

Other contributions include the foreign exchange generated from export sales and tax revenue from company and income tax. There are no subsidies given to the sector so that there is a positive contribution to the public finances. Vanilla's contribution is much greater at the provincial and district level, particularly in those provinces where little income is generated from mining and gas and oil extraction. The contribution of participants in the value chain to the finances of provincial and district governments may be rather more significant. Box 3-3 gives details of the economic benefits that have arisen in from vanilla trading.

A point of contention for the East Sepik government is the contribution of the export levy captured by Morobe province. The large exporter does not pay any taxes on its vanilla sent to Lae from East Sepik for conditioning, storage and onward export as this tax is paid when it is exported from Morobe province. Provincial governments are entitled to retain 40% of this amount for their budgets.

The large exporter, a private company, is said to employ around 100 people although this was not substantiated with the company (information was obtained from an electronic trade source) which would generate income tax. Freight forwarders, airlines and packaging companies also generate value added tax on their services and products. The amount of the export levy generated can vary considerably year on year due

to variations in the world price of vanilla. All exports of vanilla must be issued with a phytosanitary certificate issued by NAQIA. The amount charged for each export is small but with many export consignments the

Box 3-5 East Sepik province: Indicators of increasing economic activity due to vanilla

Indicators of increasing economic activity, on which Government Service Tax (VAT) of 10% would be due, include:

- An increase in flights in and out of Wewak, the capital of East Sepik.
  - There were 4 flights per week to Vanimo including Air Niugini in 2018 up from 2 or 3
- Air Niugini opened an agency in Maprik in September 2018 – much of the plane use is by vanilla traders based in and around Maprik.
- Air Sanga is providing flights direct to Vanimo from Hayfield airstrip in Maprik district
  - Infrastructure: NAQIA, customs, IRC, Westpac, ANZ, BSP will set up offices there.
- Wewak airport is being extended by 120 metres to allow larger planes to land (and transport vanilla).
- An increase in air cargo revenue, estimated at PGK 960/trader/week x 45 traders x 40 weeks = PGK 1.728.000 at Wewak airport. One day's cargo takings was PGK 13.000 on 6th September 2019.
- Banking: The Maprik BSP branch is reportedly the top sub-branch for deposits in PNG by a wide margin; it supplies cash to BSP branches in Wewak, Madang and Vanimo.
- Trading: Several hundred traders buy and sell vanilla in Maprik town on the four weekly trading days
- 3 containers of merchandise are transported to Maprik each week (increase in VAT generation); 15 containers of beer are shipped to Wewak each week from the brewery in Lae; there is more local trading, including river fish taken to Maprik for sale and a big food market in the town.
- In September 2018 the large exporter opened a PGK 23 million three-story building in Maprik comprising a department store, food bar, office and retail spaces and a vanilla buying centre (there are now 2 buying locations for the large exporter in Maprik to address the long ques) which the company says will provide more than 300 jobs and reduce the need for people to travel to Wewak on the Sepik highway, with its risk of armed holdups. Dr Malau, the East Sepik provincial administrator, remarked at the opening event that vanilla has enabled businesses to expand so the focus of the province will now be on the agricultural sector.
- District revenue generation: Maprik town benefits from vanilla selling licences (PGK 500/year compared to PGK 200 for selling other products): PGK 500/year x 300 traders = PGK 150.000.
- Wewak-based exporters register their exports with the NAQIA office there and the 10% export levy is collected; 40% of this is retained by the province.
- Household liquidity: A project in the vanilla growing area in Yangoru-Saussia district collected contribution for water tanks (PGK 500/household) in less than two weeks; it normally takes months to collect this amount from non-vanilla growing areas.
- Improved living conditions: "Style of living is high" - Dreikikir vanilla farmers have permanent houses, radios, music systems (boom boxes) solar panels, shower in house, water tanks and other household items.

contribution helps to defray the costs of its operation in each of PNG's air and seaports.

The vanilla value chain supports economic development, particularly in East Sepik province (Box 3-5).

3.2.5 CQ1.5 What is the contribution of the VC to the balance of trade?

The value of exports in the VC is PGK 236 million; the value of imports in the VC is PGK 4 million. So the VC balance of trade is very positive with an amount of PGK 232 million.

Nevertheless, the contribution of the vanilla sector to the national balance of trade is very small due to the significance of mineral, oil and gas exports as well as large quantities of other agricultural commodity exports, particularly palm oil and coffee. However, with the country strategy to increase the economic contribution of agriculture and manufacturing, the existence of the vanilla sector increases diversity and adds very high unit prices to its agricultural portfolio.

When vanilla prices are high, the vanilla value chain makes a very small but noticeable difference to the value of agricultural exports. Figure 3.4 shows the average contribution by value of PNG's main agricultural exports, between 2014 and 2016. The category 'Other crops', which includes vanilla, contributed 13%. Figure 3-5, based on BPNG provisional estimates for 2018, shows a considerable increase in the contribution of 'other crops', to 21% while the contribution from cocoa, coffee and tea declined.

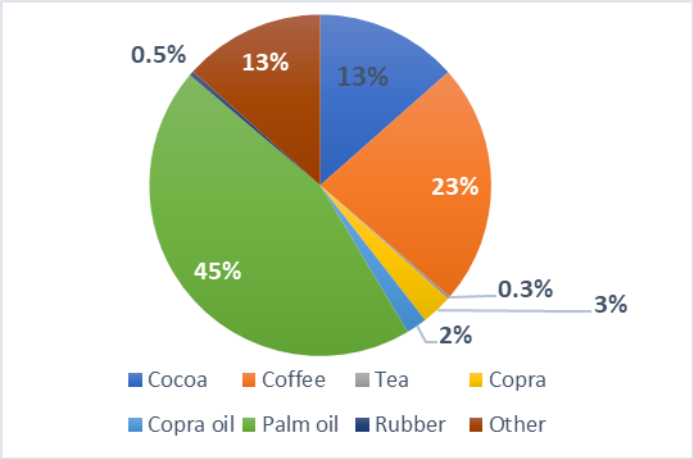


FIGURE 3.4 CONTRIBUTION BY VALUE OF PNG'S MAIN AGRICULTURAL EXPORTS 2014-2016
Source: Bank of PNG (2017) *Quarterly Economic Bulletin*. vol. XLV no. 4

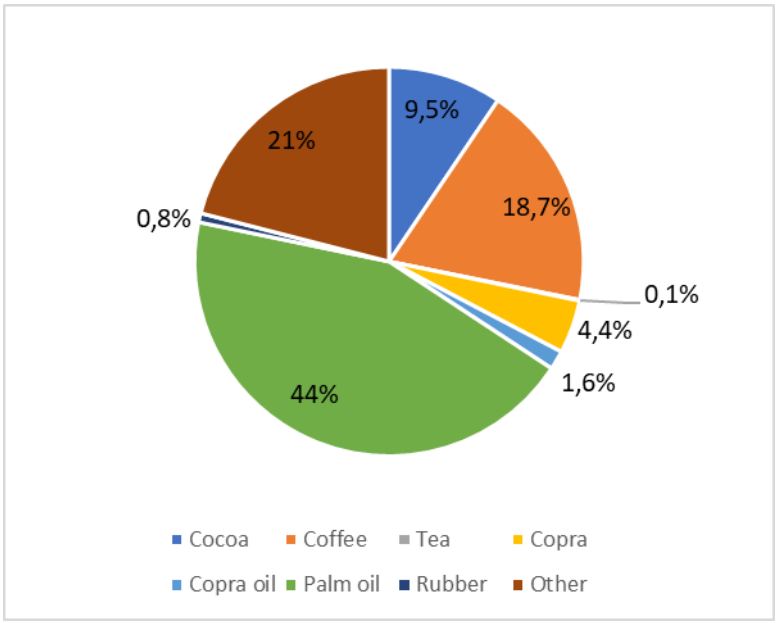


FIGURE 3.5 CONTRIBUTION BY VALUE OF PNG'S MAIN AGRICULTURAL EXPORTS (ESTIMATES FOR 2018)
Source: Bank of PNG Statistics

TABLE 3-13 AGRICULTURAL EXPORT VALUES, 2018 (PROVISIONAL, PGK MILLION FOB)

Cocoa	Coffee	Tea	Copra	Copra oil	Palm oil	Rubber	Other	Total
246,5	487,9	2	115,8	41,3	1.146.8	19,6	547,6	2.607,5

Source: Bank of PNG Quarterly Economic Bulletin

Table 3-13 shows the provisional value of PNG's main agricultural commodity exports in 2018. It is interesting to note that the estimated value of vanilla exports (PGK 236 million), included in the table as 'Other', is only a little less than the value of cocoa exports and is almost half that of the country's coffee exports.

Export statistics

The main export category (according to the Harmonized Commodity Description and Coding Systems (HS), the standard 8-digit code used to classify globally traded products) is 09051000: 'Vanilla, Neither crushed nor ground', *i.e.* whole vanilla beans.

Formally recorded vanilla exports amounted to just under PGK 75 million (€ 20 million) for 110 tonnes, calculated from data recorded by the National Statistics Office in 2017 (Table 3-12), based on records collected by NAQIA. The average price was PGK 675/kg; ranging from PGK 1 248/kg to PGK 26/kg, reflecting the different qualities and values of beans exported.

Indonesia was largest export destination by volume (quantity); 40 tonnes were formally exported there though at the average unit price of only PGK 316/kg. France was the largest export destination by value with an average unit price of PGK 1 248/kg for a total quantity of 10,8 tonnes. Although the average price for vanilla exports to Germany was slightly lower, at PGK 1 171/kg, the quantity exported was large (12.3 tonnes) which accounts for why it accounts for a higher proportion (19.2% of total exports) than France. HS category 09051000 refers to 'Crushed or ground' vanilla which is usually a lower-value product. In 2017 PNG exported 4.9 tonnes of this to Hong Kong and 0.5 tonnes to Canada at PGK 26/kg and PGK 1 009/kg respectively.

It seems that the NSO figures may under-record the amount and value of vanilla exports in 2017. Many observers were indicating that the exported quantity was around 250 tonnes (World Bank, 2019b).

Table 3-15 provides data from 2018, from the International Trade Centre database, of data on vanilla imports by importing countries. This indicates that both volumes and total value of vanilla exports are much greater than those recorded in PNG. The values are in US$ CIF for 2018. If these are adjusted by 20% to allow for shipping and insurance, and converted at the official rate, this gives an estimated value of PGK 121 112 000 for 235 tonnes. According to the ITC mirror data, exports by volume to Indonesia are even higher than the NSO data, comprising 56.6% by volume of total exports.

TABLE 3-14 PNG VANILLA EXPORTS 2017 (IN KG, PGK FOB AND PGK/KG)

HS 8-digit code	HS8 Description	Country	Quantity (kg)	FOB value (PGK)	Unit price (PGK/kg)	% Exports by quantity	% Exports by value
90510000	Neither crushed nor ground	Indonesia	40 199	12 694 892	316	36,30%	17,00%
90510000	Neither crushed nor ground	Australia	19 569	10 671 352	545	17,70%	14,30%
90510000	Neither crushed nor ground	USA	13 714	16 676 892	1 216	12,40%	22,30%
90510000	Neither crushed nor ground	Germany	123	14 402 474	1 171	11,10%	19,20%
90510000	Neither crushed nor ground	France	10 782	13 455 738	1 248	9,70%	18,00%
90520000	Crushed nor ground	Hong Kong	49	126 593	26	4,40%	0,20%
90510000	Neither crushed nor ground	UK	2 805	2 722 911	971	2,50%	3,60%
90510000	Neither crushed nor ground	Hong Kong	2 301	97 496	42	2,10%	0,10%
90510000	Neither crushed nor ground	Netherlands	1 342	1 501 232	1 119	1,20%	2,00%
90510000	Neither crushed nor ground	Italy	690	730 778	1 059	0,60%	1,00%
90520000	Crushed nor ground	Canada	519	523 419	1 009	0,50%	0,70%
90510000	Neither crushed nor ground	Canada	500	471 405	943	0,50%	0,60%
90510000	Neither crushed nor ground	New Zealand	447	397 278	888	0,40%	0,50%
90510000	Neither crushed nor ground	Japan	440	177 267	403	0,40%	0,20%
90510000	Neither crushed nor ground	Israel	150	29 418	196	0,10%	0,04%
90510000	Neither crushed nor ground	China (PR)	130	137 779	106	0,10%	0,20%
90510000	Neither crushed nor ground	Malaysia	45	45	1	0,04%	0,10%
90510000	Neither crushed nor ground	India	8	2 971	386	0,01%	0,00%
		TOTAL	**110 841**	**74 864 887**	**675**		

Source: Calculated from National Statistics Office data

TABLE 3-15 PNG VANILLA EXPORTS 2018 (IN TONNES, US$ CIF)

Importing country	Quantity (t)	Value (US$'000 cif)	Unit price (US$/t cif)
Indonesia	133	9 937	74,7
Australia	27	6 036	223,6
Germany	20	8 232	411,6
USA	20	8 071	403,6
France	13	5 685	437,3
Canada	7	2 018	288,3
UK	6	1 168	194,7
New Zealand	2	709	354,5
Switzerland	2	1 001	500,5
Iceland	1	3	3,0
Italy	1	392	392,0
Japan	1	102	102,0
Netherlands	1	337	337,0
Brazil	1	286	286,0
Total	**235**	**43 977**	**286,3**

Source: ITC Trade statistics (mirror data)

Apart from indicating the wide range of qualities exported, the average unit price also hides the variation in the vanilla FOB value (average export price) shown in Figures 3-1 to 3-3.

3.2.6 CQ1.6 Is the VC viable in the international economy?

PNG vanilla competes with the vanilla from the main producing countries, particularly Madagascar. Therefore, measuring the balance of the goods and services produced and consumed by the VC using relevant international prices (parity prices) gives an indication of the overall economic gain or loss for the national economy. It also gives an indication on the international competitiveness of the VC. Viability within the global environment is assessed with two simplified ratios.

There is some information available on vanilla prices from international food companies but the prices given are for Madagascar *V. planifolia*. PNG *V. tahitensis* tends to sell for a little, perhaps 10%, lower. In 2018 there was around a PGK 700 difference between local buying price and prices being quoted in the international market for Madagascar vanilla at source (see Table 3-16).

TABLE 3-16 CALCULATION OF THE NOMINAL PROTECTION COEFFICIENT (NPC)

1 kg Vanilla	Grade A International	Grade A Indonesia	Extract/Mix grade Indonesia
Market price (Price CIF Vanilla PNG)	PGK 1.200 = US$ 310	PGK 950 = US$ 246	PGK 850 PGK = US$ 220
International price	US$ 600 (Madagascar)	US$ 400 (Madagascar)	US$ 270 (Madagascar)
Nominal protection Coefficient (NPC) = Market price / International price	0,5	0,6	0,8

The vanilla from PNG is very competitive with an NPC between 0.5 and 0.6 for grade A and 0.8 for extract/mix grades. However, PNG vanilla is not as well-known as vanilla from Madagascar. It is less identified by its origin, particularly its lower-grade produce (which tends to be combined with Indonesian produce to meet international orders for ground vanilla). It is nonetheless a vanilla with an excellent quality/price ratio according to importers. Its pods age and store well; they dry out less quickly than other competitors' produce. With the rise of international vanilla prices, vanilla from PNG is again preferred by importers in place of vanilla from Madagascar. Nevertheless, it could gain its place in the world market and be no longer just a substitute product.

Based on the standard methodology for the study, the domestic resource cost (DRC) in the chain was computed as an indication of its viability within the global economy. The DRC is calculated by dividing the sum of domestic production factor costs by the total output of the value chain minus tradeable (imported) inputs at international prices.

> DRC = Non-tradeable domestic factors at market price (without transfers)
> (Production at international price – Tradeable goods and services at international prices)
> Non-tradeable domestic factors at market price (without transfers) = PGK 217 million – PGK 25 million = PGK 192 million.
> Production at international price = 240 t * US$ 300 (average international price for all grades) = US$ 120 million = PGK 463 million.
> Tradeable goods and services at international prices = PGK 18.2 million * 0.9[50] = PGK 16.4 million.
> DRC = PGK 192 million / (PGK 463 million – PGK 16.4 million) = 0.43.

Given the high current international price of vanilla in 2018, domestic resources are very efficiently invested in vanilla and creates gain for the national economy.

[50] According to the PNG Import & Exports customs tariff (2012 edition) the tariff is 10% on a large range of imports.

3.3 FQ2 Is this economic growth inclusive?

3.3.1 CQ2.1 How is income distributed across actors of the VC?

Figure 3-6 shows the breakdown of value added in the value chain. Value chain actors' net operating surplus, or profit, constitutes the largest proportion of value added, at 87%. Taxes account for 11.6% while hired labour accounts for 1.2% and financial charges and deprecation together represent just over 0.2%.

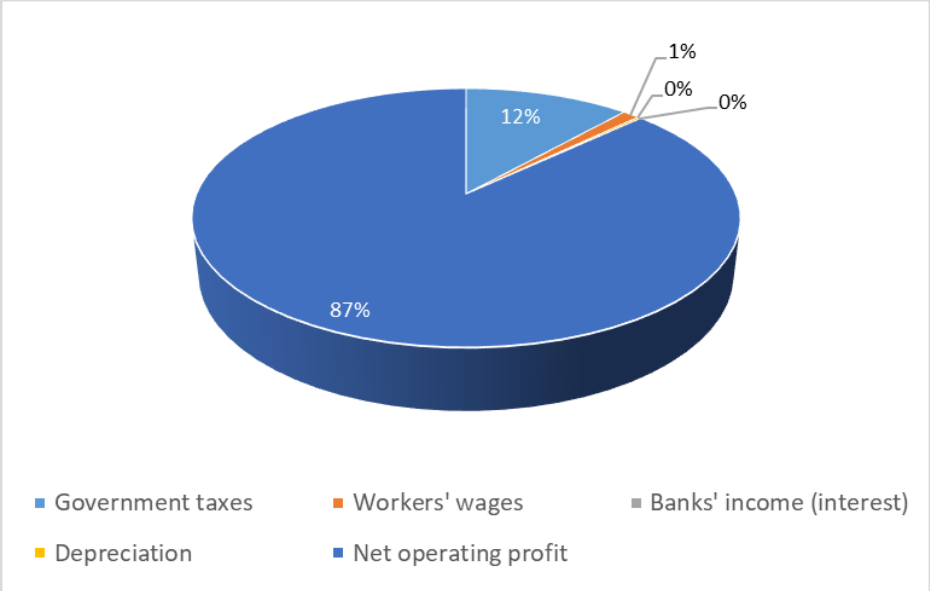


FIGURE 3.6 ALLOCATION OF VALUE ADDED IN THE VANILLA VALUE CHAIN (%)
Source: Table 3-9

The distribution of the net profit or player's income is skewed in favour of the large-scale vine-owning households and 83% of the net profit goes to the three farmer groups and the 17 000 households (Figure 3-7). The share received by the large exporter is 12% while the other two trader types receive just over 6%.

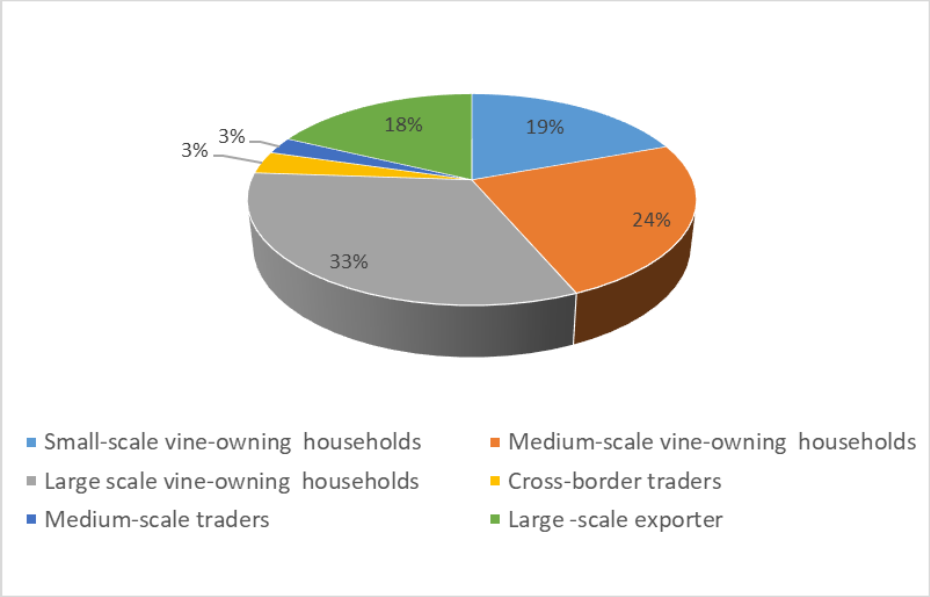


FIGURE 3.7 DISTRIBUTION OF NET PROFIT IN THE VANILLA VALUE CHAIN (%)
Source: Table 3-9

The vanilla producers are the main beneficiaries of the income/net profit generated by the vanilla sector. Table 3-17 and Figure 3-8 show that the largest share of income generated by the vanilla value chain accrues to the large-scale vine-owning households. Altogether, the 17 000 producing households benefit from the

86% share of income generated. The next largest shares goes to the large exporter (12%). In terms of the distribution of the value added in the vanilla value chain, the farmers' share is 67%, while that of the large-scale trader is 16% (Table 3-18).

TABLE 3-17 DISTRIBUTION OF INCOME AND COSTS AMONG THE VALUE CHAIN ACTORS (%)

	IC in VC	IC off VC	Total IC	Taxes	Wages	Financial costs	Capital depreciation	Net operating profits
Small-scale vine owners	0	10	1	0	0	0	0	22
Medium-scale vine owners	0	23	2	0	24	0	0	27
Large scale vine owners	0	28	3	0	30	0	0	37
Cross border traders	25	15	24	23	0	0	0	1
Medium-scale traders	15	9	15	15	1	0	49	1
Large-scale exporter	59	15	55	62	45	100	51	12
Total	100	100	100	100	100	100	100	100

TABLE 3-18 DISTRIBUTION OF VALUE ADDED IN THE VANILLA VC IN PNG (%)

Value chain actor	Share (%)	Amount (PGK)
Small-scale vine-owning households	17,2	42 080 192
Medium-scale vine-owning households	21,4	52 512 418
Large-scale vine owning households	28,8	70 582 299
Cross border traders	3,0	7 435 830
Medium-scale traders	2,3	5 626 000
Large-scale exporter	15,9	38 811 900
Workers' wages	1,0	2 566 010
Banks' income (interest)	0	15
Depreciation	0,02	50 395
Government taxes	10,3	25 204 201
Total	**100**	**244 869 260**

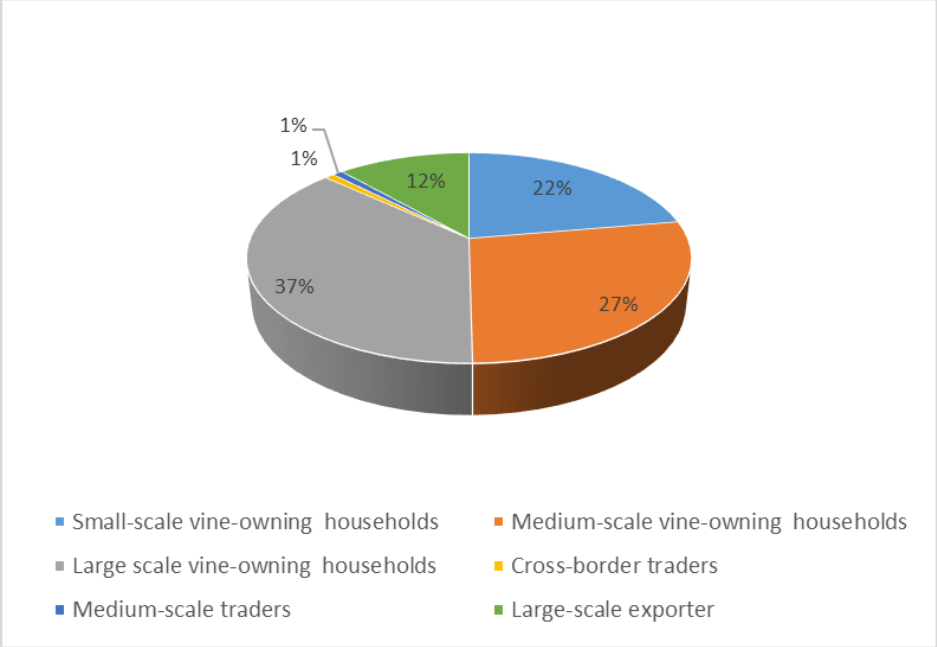


FIGURE 3.8 DISTRIBUTION OF NET OPERATING PROFIT (PLAYERS' INCOME) IN THE VANILLA VC IN PNG (%)
Source: Table 3-9

Figure 3.8 shows that the large-scale vine owning households, followed by the medium and small vine owning households, receive the highest share of income. followed by the large-scale exporter.

This suggests that vanilla production is an attractive financial proposition for farmers in PNG. However, there is wide variation in the prices obtained for the crop, due to range of qualities produced. The margins for traders are much tighter, particularly for the cross-border and medium-scale exporters.

Currently, Indonesia acts as a sponge for most of the low quality produce which means that the farmers can still opt for low quality production strategies and still do well financially (Table 3-19).

TABLE 3-19 FINAL PRICE AT FARM GATE (%)

Grade A
% final price (Indonesia market) at farm gate (via CBT) = 94 %
% final price (International market) at farm gate (via medium exporter) = 83 %
% final price (International market) at farm gate (via large exporter) = 79 %
Extract grade
% final price (Indonesia) at farm gate (via CBT and medium exporter) = 76 %
% final price (Indonesia) at farm gate (via large exporter) = 68 %

Generally, women reported that they have at least some control over the income from their own vanilla plots. However, they still allocate the bigger portion of the income to the household for budgeting on important family goals (see Social Analysis).

3.3.2 CQ2.2 What is the impact of the governance systems on income distribution?

The value chain is dominated by one large exporter, but other official exporters, as well as many informal traders, which provide alternative markets to rural producers. This major vanilla buying company price determines what growers receive for high quality vanilla. It is not easy to find out if this company is making excessive profits. During the time of the study (a boom period in PNG) this competition has probably been important in maintaining relatively high prices being offered to farmers. However, when the previous boom was over it was, according to some sources, it was the large exporter that still offered a market to farmers. The Spice Industry Board has not been active and to date has had little influence on governance in the value chain. Farmer organisations are generally not very strong and there is no apex organisation to represent vanilla farmer interests at national level. The current governance structure appears to work well in favour of farmers' income in times of boom (when global prices are high), but not when global prices fall.

There is more information now available about vanilla prices from international food companies but the prices given are for Madagascar *Vanilla planifolia*. PNG *V. tahitensis* tends to sell for a little, perhaps 10%, lower. In 2018 there was around a PGK 700 difference between local buying price and prices being quoted in the international market for Madagascar vanilla at source.

3.3.3 CQ2.3 How is employment distributed across the VC?

An estimated 17 000 households are involved in vanilla production as well as many traders in the informal sector and employees of companies which provide supporting services, such as transport. There is relatively little direct employment in the value chain, but the injection of money from vanilla trading into the local economy, particularly in East Sepik, is creating jobs.

Most production activities are carried out by household members without payment. Pollinating of vines is the most demaning task in vanilla production and some farmers get groups of youths to come and do this task in return for being given a meal and a small contribution.

Although the VC does not generate a lot of salaried work (and wages are low), it generates a lot of employment because production is so labour intensive.

3.4 Conclusions

Framing Question 1: What is the contribution of the VC to economic growth?		INDICATORS	RESULTS
CQ1.1	How profitable and sustainable are the VC activities for the entities involved?	Net income by type of actor	Small-scale vine owner: PGK 8 282 Medium-scale vine owner: PGK 7 594 Large-scale vine owner: PGK 13 741 CBT: PGK 115 932 Medium exporter: PGK 207 548 Large exporter: PGK 21 737 070
		Benchmark of farmers' net income with minimum wage and/or job opportunities	Minimum annual wage = PGK 7 322 At prices prevailing in 2018, VVC is highly profitable. If global prices fall and Indonesia does not buy PNG low-grade vanilla margins will tighten and some producers will leave value chain

Framing Question 1: What is the contribution of the VC to economic growth?		INDICATORS	RESULTS
CQ1.2	What is the contribution of the VC to the GDP?	Total VA and components	Total VA= PGK 227 million Wages: PGK 7 million Financial charges: PGK 15 000 Taxes: PGK 26 million Gross operating profit: PGK 189 million
		VA share of the GDP	GDP (2018) = PGK 76 billion Total VA in the VC= PGK 227 million Total VA / GDP (%) = 0.3%
		Rate of integration into the Economy (total VA/VC production)	Total VA= PGK 227 million VC Production= PGK 236 million Rate of integration = 96%
CQ1.3	What is the contribution of the VC to the agriculture sector GDP?	VA share of the Agriculture sector GDP	Agricultural sector GDP 2018 = PGK 22.6 billion Total VA= PGK 227 million VA/Agricultural sector GDP = 1%
CQ1.4	What is the contribution of the VC to the public finances?	Public Funds Balance	Value of total taxes in the VC = PGK 26 million There is no subsidy The balance is positive.
CQ1.5	What is the contribution of the VC to the balance of trade?	VC Balance of trade	Value of exports in the VC = PGK 236 million Value of imports in the VC = PGK 4 million Balance of trade is positive with an amount of PGK 232 million
		Total imports / VC production	
Framing Question 1: What is the contribution of the VC to economic growth?		INDICATORS	RESULTS
CQ1.6	Is the VC viable in the international economy?	Nominal Protection Coefficient (NPC)	The VC is competitive. 0.5 and 0.6 for grade A 0.8 for grade B
		Domestic Resource Cost Ratio (DRC)	DRC= 0.43 The VC creates gain for the national economy.

Framing Question 2: Is this economic growth inclusive? (To be completed with Social Analysis results)		INDICATORS	RESULTS
CQ2.1	How is income distributed across actors of the VC?	Total farm income	Small farmers ≈ PGK 42 million Medium Farmers≈ PGK 53 million Large farmers≈ PGK 71 million Total farm income ≈PGK 165 million
		% final price at farm gate	Grade A % final price (Indonesia market) at farm gate (via CBT) = 94%

			% final price (International market) at farm gate (via medium exporter) = 83% % final price (International market) at farm gate (via large exporter) = 79% Extract grade % final price (Indonesia) at farm gate (via CBT and medium exporter) = 76% % final price (Indonesia) at farm gate (via large exporter) = 68%
		Total wages and salaries	Wages at farm level = PGK 1.4 million Wages at trader level = PGK 1.2 million
CQ2.2	What is the impact of the governance systems on income distribution?	Income distribution	Income at farm level: PGK 165 million Income at trader level: PGK 52 million
CQ2.3	How is employment distributed across the VC?	Number of jobs and self-employment	No of jobs: Permanent: 82 (Large exporter) Casual: 1 280 days (Medium-scale exporters) Self-employment: 17 022 workers + family member inputs + employment created in service providers

Under current conditions, of very high global vanilla prices, vanilla appears highly profitable for smallholder producers if they access to sufficient household labour. The value chain is short and highly dependent on cross-border exports to Indonesia which provides an outlet for lower grade produce, and for one main vanilla exporter who exports large amounts of A grade and organic vanilla. Trading margins appear to be tight, as there is significant transport, particularly airfreight, costs, involved between the main purchasing centre of Maprik and the final exit airport but a number of small- and medium-scale traders are attracted to the value chain due to the prevailing high world market prices. There are a lot of risks in international trading that can seriously affect the margins.

The vanilla value chain's contribution to national GDP, balance of payments and public finances is very low, however vanilla is very important to the economy of East Sepik province which is dependent on low-value agricultural and marine commodities. Morobe Province benefits from the portion of vanilla, largely produced in East Sepik, that is registered for export in Lae. Sources of revenue generation include the 10% export levy, 60% of which is retained by the exporting province, and VAT and import duty on consumer and capital items purchased with vanilla incomes. There is a potential loss of revenues due to cross-border exports and duty-free purchases of cigarettes, consumer and electronic items purchased by vanilla traders for sale in PNG.
PNG gained the position of the third largest vanilla exporting country within a short space of time during the last boom at the start of the millennium and once again it has become a significant exporter, contributing around 10% of world vanilla production.

The domestic resources invested in vanilla production creates economic gain for the country, indicated by a domestic resource cost ratio (DRC) of 0.5. Similarly, the integration ratio, which compares total value added in the chain by the value of total production, at 0.96 indicates that the chain is reasonably well integrated and not dependent on imported inputs.

At current vanilla prices the vanilla value chain is providing an opportunity to thousands of smallholders, including women and youth, to benefit significantly from their efforts. Proceeds are being invested in more nutritious food, housing, education, including higher education, for purchasing vehicles used as PMV and for

freight, and in trading which all help to continue the benefits into the future. There is relatively little direct employment in the value chain, but the injection of money into the local economy is creating jobs.

4 THE SOCIAL ANALYSIS

4.1 Introduction

The social analysis contributes to answering two main overall questions:
i) Is the vanilla value chain in PNG socially sustainable?
ii) Is the economic growth associated with the vanilla chain in PNG inclusive?

The analysis aims at outlining the social context and assessing social impacts related to the activities of the vanilla value chain. The main framework used to guide the analysis is based on six basic domains: i) Working conditions; ii) Land & water rights; iii) Gender equality; iv) Food and nutrition security; v) Social capital and; vi) Living conditions.

The analysis is mainly based on existing literature, interviews with key informants, Focus Group Discussions and a household survey (see methods section 1.2 for more details). Nine Focus Group Discussions were held with women, with the number of participants ranging from 4-31 per focus group. The analysis attempts to set out the national context and then mainly focuses on East Sepik province where a high proportion of the vanilla in PNG is produced.

The results of the social analysis are set out mainly in this section, but also see the functional analysis and economic analysis.

4.2 Results: Social sustainability and inclusivity of the vanilla value chain

4.2.1 Working Conditions

4.2.1.1 Respect of labour rights

PNG has expressed its consent to the International Covenant on Economic, Social and Cultural Rights (ICESCR) and the International Covenant on Civil and Political Rights (ICCPR) and the treaties have entered into force since 21st Jul 2008[51]. The eight (out of 8) fundamental ILO international labour conventions are "in force" in PNG, but implementation is an issue (ILO, 2019). However, a lot of the vanilla value chain activities and benefits are in the informal sector where the law may not apply or there is little regulation or monitoring ((US Department of State, 2019).

The dominant company involved in vanilla, established in 2002, trades and processes vanilla and employs 100-200 people[52]. Its main office is in Lae, but we were only able to visit the Certified Organic buying component[53] of the company in their Maprik office. The Maprik office company key informant reported that they employed 25 people in their organic sector (8 full time; 2 female), 1 part-time agricultural officer and 16 inspectors (male farmers locally based near the certified growers) and 15 in their conventional sector (6 buyers; 6 female), 4 managers in the warehouse (1 female) and 5 helpers (4 female). Within the company, it was not possible to assess whether freedom of association is allowed and effective (collective bargaining), the extent to which workers benefit from enforceable and fair contracts in this company or to what extent any risks of discrimination in employment for specific categories of the population minimized.

Most of the vanilla value chain activities and benefits are in the informal sector and in rural communities. It is well documented in other agricultural sub-sectors, such as coffee and cocoa, that there is a considerable gap between the work done by women and the benefit they obtain because women do much of the work, but have much less access to, or control of, the resulting income (World Bank, 2014). With regard to vanilla, women in seven communities in East Sepik provided an estimate of the division of labour between men, women and children in their respective communities (Figure 4.1). The situation varied quite significantly between the communities, but in each case the results suggest that women to varying degrees contribute

[51] http://indicators.ohchr.org/
[52] http://www.sell147.com/company/Papua-New-Guinea/828999.htm
[53] Certified under Australia's Certified Organic Board

their labour to all pre and postharvest stages of vanilla activities. In terms of decision making around the use of income from sales of vanilla men are perceived to have the major influence (see also section 4.2.3).

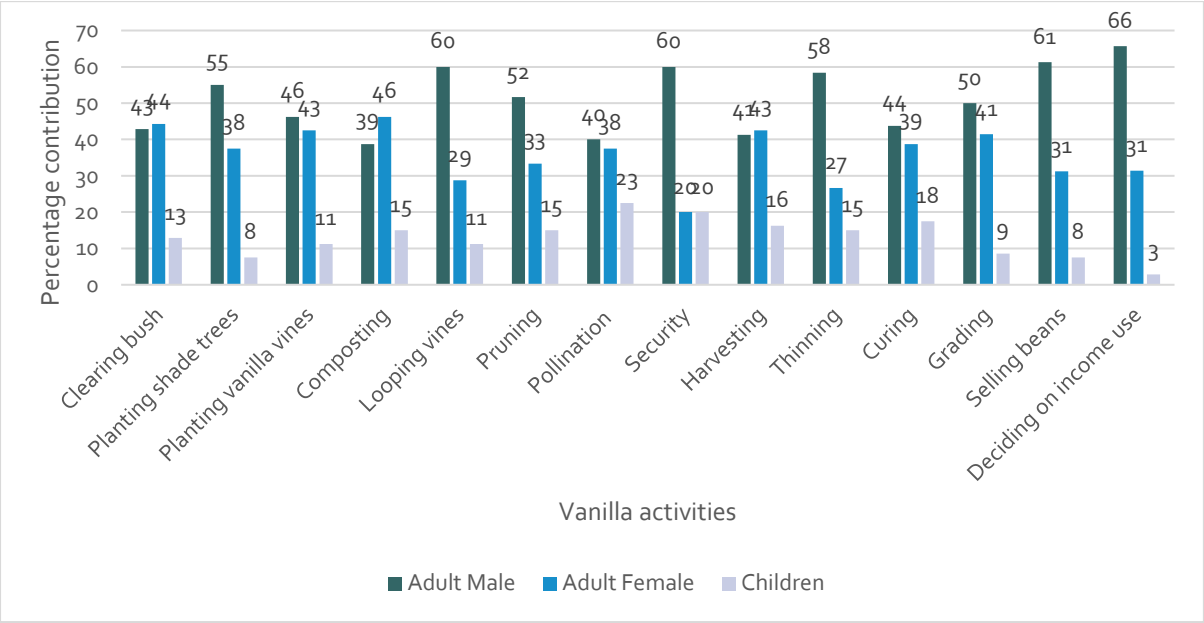


FIGURE 4.1 WOMEN'S PERCEPTIONS OF DIVISION OF LABOUR IN VANILLA ACTIVITIES AND DECISION ON USE OF INCOME (PERCENTAGE CONTRIBUTION)

Source: Focus Group Discussions with women in 7 communities in East Sepik (the number of women in each focus group ranged from 4 to 31 in each group).

4.2.1.2 Child Labour

In 2017, PNG adopted the National Action Plan to Eliminate Child Labour, which the United States Department of Labor Bureau of International Labor Affairs described as "a minimal advancement in efforts to eliminate the worst forms of child labour". Children in PNG engage in the worst forms of child labour, including in commercial sexual exploitation and mining. Laws do not specifically define the hazardous occupations and activities prohibited for children. The Labour Inspectorate's capacity to enforce child labour laws is limited due to lack of resources. Education is neither universal nor compulsory in PNG, and that the law does not specify a legal age for entering school or an age at which children are permitted to leave school. The Education Department has developed a ten-year National Education Plan for 2005–15 (NEP) to enable more children to be in school, however the ILO Committee observed that the NEP seemed intended to make only three years of basic education compulsory up to the age of 9. Moreover, the Committee noted that according to the International Trade Union Confederation (ITUC), the gross primary enrolment rate was 55.2%, and only 68% of these children remain at school up to the age of 10, while less than 20% of the country's children attend secondary school (ILO, 2019 p.345). The lack of a compulsory age for education and some children facing challenges accessing school increases the risk of children's involvement in the worst forms of child labour (US Department of Labor Bureau of International Labor Affairs).

Children are involved in the vanilla value chain (Figure 4.1), particularly contributing to pollination which is labour demanding and needs to be timely. Children are working in gardens where the main manager may be their father, their mother or the child. No specifically harmful jobs were reported or identified but protecting the vanilla gardens from theft could potentially involve a physical threat and higher risk of malaria if sleeping in the garden. In the communities visited it was reported that this was not preventing children going to primary school; their activities were either before school, at weekends or on holidays. Income from vanilla was also reported to be contributing to costs of education in some cases (see section 4.2.6).

4.2.1.3 Job safety

As explained above, most of the vanilla activities and benefits are in the informal sector and in rural areas. During the time of the study, vanilla prices were extremely high, vanilla beans were therefore very valuable and large amounts of money were changing hands. The most important risk is probably travel associated

with marketing of vanilla. One female trader showed us the PGK 93 000 (€ 25 000) she was carrying in her handbag and some months later we heard that she had been robbed when returning from sales at the border. A key informant cited an example of farmers in East Sepik being robbed on the road of PGK 300 000[54] (€ 79.000). Another risk is associated with the need for farmers to protect their gardens from theft, including reports of increasing malaria incidence where people are sleeping in their gardens to prevent such losses.

4.2.1.4 Attractiveness to youth

The returns to vanilla production were relatively high at the time of the study compared to alternatives (see economic analysis). Youths were attracted to both vanilla production and trading. In the household survey, 144 (53%) of the vanilla plots were managed by a person below the age of 40, 82 plots (30%) below the age of 30 and 14 plots (5%) below the age of 20 years.

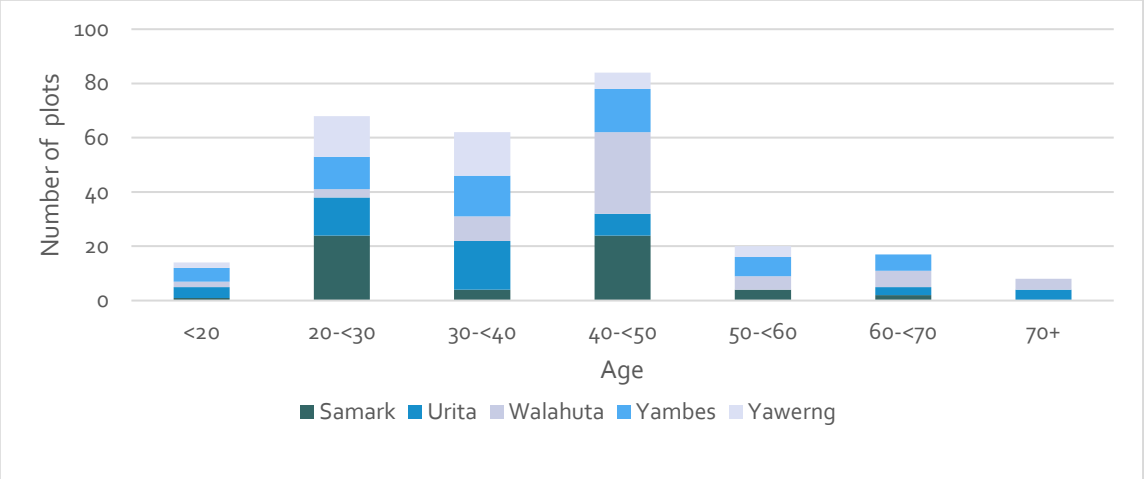


FIGURE 4.2 AGE DISTRIBUTION OF MAIN MANAGER OF VANILLA PLOT
Source: Vanilla Household survey

4.2.2 Land & Water Rights

Customary land is a key livelihood asset in PNG. Arrangements vary across the country but under customary tenure rights to land are generally based on a mixture of descent, residence and participation in communal activities. Exclusive individual landownership and inheritance was limited because, in the largely horticultural societies of PNG, an individual's rights to land for the cultivation of food crops waned as the garden reverted to fallow (Koczberski *et al.*, 2017). The relative importance in land rights of descent, residency and participation in activities varied, so that no single criterion was sufficient to provide unconditional rights. This flexible system ensured that most villagers had sufficient land to meet their daily livelihood needs and allowed temporary land rights to be transferred to individuals and lineages without birth rights to the land (Koczberski *et al.*, 2017).

Although traditional principles of land tenure are still followed, governance of customary land by landowning groups is changing in response to new demands and pressures. The key drivers of these changes include a) Large-scale resource development, such as mining and plantations; b) Smallholder production of cash crops, particularly perennial crops such as coffee and cocoa, and large-scale food production for urban markets. In areas where perennial cash crops have been incorporated into village farming systems there is a trend for customary tenure to become more individualised and for land to be 'sold' to other clan members; c) Population and land pressure. Increasing demand for land in villages and the need for cash are leading to many internal adjustments to land tenure arrangements. In some cases, this is eroding the flexibility of customary land tenure practices, resulting in a tightening up of access rights and increasing individual/family control over land; d) Internal migration of large numbers of people, usually from remote and poorly serviced areas, to urban areas and rural resource frontier regions. These migrants are entering into informal agreements with landowners to gain access to customary land; e) Rapid urbanisation and the growth of informal settlements, most of which is occurring on customary land in peri-urban areas and is sustaining an

[54] The same respondent mentioned that in 2017 there was PGK 27 000 000 "floating" in East Sepik province.

active land market in informal land 'sales' and rental arrangements; and f) Individualism and changing aspirations are emerging as PNG undergoes social and economic change. Especially where engagement with the market economy is strong, social relations and values are becoming more market-orientated, leading some clan members to view land as a commodity that can be 'sold' to people outside the landholding group (Koczberski *et al.*, 2017).

Do the locally applied rules promote secure and equitable tenure rights or access to land and water? Under PNG's customary title laws, land is owned communally by a specific lineage, clan or tribal group and usage rights to specific areas of land are allocated within the group. These rights can be sold or leased to other landowning groups and individuals or to the landless, but sale of customary land to foreigners is prohibited under the PNG Constitution. Almost all landowners in PNG are indigenous landowners and 97% of all land remains under customary title.

Generally, the dependence of smallholders on the value of resources extracted from their own customary land can be expected to increase with the distance of their normal place of residence from an urban centre or a decent road that leads to one. The more remote a rural settlement, the larger the proportion of households with land-based livelihoods, the more likely that these will depend entirely on the exercise of customary rights (Filer *et al.*, 2017).

These rights are secure in that customary land tenure is recognised in PNG's Constitution. They may also be considered relatively equitable, with Anderson (2006) suggesting that "PNG has one of the most equal distributions of land and natural resources on earth". However, women do not have equal rights as men (see 4.2.3.2) and generally access land through male members of their families.

However, there are a number of major issues regarding the current rules, who is implementing them and how they are applied, which have implications for equitable tenure rights and access.

Alienation of land held under customary title through the granting of Special Agricultural Business Leases (SABLs). The United Nations Human Rights Commission (UNHRC) and others have expressed concern at the alienation of land held under customary title through the granting of Special Agricultural Business Leases (SABLs) and that in some cases the SABLs are used as a relatively easy way to open land for logging of rainforest (Colman, 2018). More than 5 million hectares of land has been awarded to PNG-based subsidiaries of foreign companies on SABLs, which represent over 10% of the country's total landmass and potentially impact more than 700.000 people (Human Rights Watch, 2019). An example from East Sepik is a SABL issued for an oil palm planation in Turubu which PNG's Supreme Court ruled in August 2016 was invalid, finding that any logging in the area was illegal. However, an environmental NGO Global Witness reported that the Malaysian logging company had continued clearing forest[55].

Struggle between indigenous smallholders and Indigenous large holders and investors. Colman (2018) argues that while it is important that customary land rights are protected, what is being overlooked is the struggle between the indigenous smallholders (producing crops for home consumption, local markets and exports) and Indigenous large holders and investors.

Power of customary group leadership. The idea that clans and lineages are corporate groups of landowners was established in the colonial legacy of PNG. As a result, postcolonial laws and policies that have aimed to protect or enhance the powers and rights of customary landowners have generally made these corporate groups take on the characteristics of a private company. Filer *et al.* (2017) suggest that "*Most of the people who notionally belong to such groups or hold such rights progressively lose control over the pieces of paper that represent their membership or ownership. Certificates of incorporation are not used to accomplish anything like a traditional economic transaction; they are more like a form of paper currency that can be used as evidence of* the *right of an individual office-holder to act on behalf of a group that may only exist on paper. When survey plans and title deeds are added to this currency, the process of alienation is taken to another stage, as individuals are then able to accomplish the transfer of legally recognised 'customary rights' to third parties that bear no resemblance to any sort of customary group, and in so doing, strip away their customary quality*". They go on to suggest that the formalisation of customary land rights is

[55] https://www.radionz.co.nz/international/pacific-news/351026/loggers-still-operating-on-png-lease-despite-court-ruling

not just a process in which governments award legal titles to some people in preference to other people, it can also be a process in which the possession of titles and offices is used by powerful men to exclude other members of the customary group from decisions about the use of customary land. This is one of the main reasons why the advocates of indigenous land rights in Melanesia have been opposed to the registration of customary land titles, even under laws that prohibit the outright sale of customary land (Filer *et al.*, 2017).

In some parts of PNG, Karigawa (2018) suggests that the existing weak land administration system and mechanisms have contributed immensely towards "*tearing apart the bond and connections between clan members and the dismantling of communal land ownership*". Customary land is held at the sub-clan, family and individual levels, while the major clans just bear "an ownership name-tag". The existing land legislation in PNG recognises that ownership of customary land is vested in the clans, however, the realities on the ground indicate otherwise.

Lack of government capacity. There is a lack of capacity on the part of relevant government agencies. This has contributed to creating more opportunities for people to engage in illegal land transactions and protracted legal disputes. Foreign aid agencies have tried to strengthen capacity by funding the development of new policies and laws that aim to limit such opportunities. However, these efforts to enhance the 'power of regulation' commonly fail because they are based on an assumption of 'national ownership' that proves to be false. That is one reason why the architects of the recent land reform process in PNG, which resulted in the legislation that now allows incorporated land groups to register titles to their own land, insisted on keeping foreign aid agencies and consultants at arm's length (Filer *et al.*, 2017).

The 'rule of law' seems to be seriously compromised because of widespread ignorance of what the law says, willful misinterpretation of the law by politicians and public servants engaged in a 'culture of complicity' and a basic lack of enforcement capacity on the part of the courts and the police. The powers to make, enforce, bend, break or contest a body of rules may all be applied quite differently (Filer *et al.*, 2017).

Land reform. There are very different views around discussions on land reform and the implications for land security, equity and access. Land reform debate in PNG has been dominated by the assertion that customary tenure is incapable of providing secure property rights necessary for facilitating investment and commercial use of land. With communal ownership and no formal title to land, customary tenure is viewed by some stakeholders as a major obstacle to economic development and therefore land reform should focus on securing individual property rights through land titling (Koczberski *et al.,* 2017). For others, land reform initiatives (such as the recent National Land Summit, 1-3 May 2019) are regarded as attempts by the government to further weaken the country's customary land system and give greater access to multinational companies and commercial banks, mostly for logging, mining and industrial agriculture leases (Fletcher and Mousseau, 2019).

Three major attempts at land reform in PNG since the 1960s have failed. One reason for their failure has been their incompatibility with people's concepts of the moral basis of land rights and the strongly held view that customary land is inalienable. There is now greater acknowledgment that landowners must feel a sense of ownership of the land reform agenda. The central goal of the reforms is to identify ways to facilitate access to customary land for economic development while providing tenure security for investors and ensuring land remains under customary ownership (individual user rights but ownership at the group level). This represents a significant shift from earlier land reform programmes that sought to replace customary tenure (Koczberski *et al.,* 2017).

Where expropriation is indispensable: is a system for ensuring fair and prompt compensation in place (in accordance with the national law and publicly acknowledged as being fair)?

Tagliarino (2017) examined whether national laws in 50 countries provide compensation procedures that comply with international standards on the valuation of compensation. The assessment was made against a set of indicators that are based on the VGGTs and other international standards on the valuation of compensation. PNG was ranked 35th out of 50 countries; only 3 out of 10 indicators were fully met, one partially met and six not met at all (Table 4-1).

TABLE 4-1 ASSESSMENT OF PNG LAW AGAINST A LIST OF COMPENSATION VALUATION INDICATORS

Compensation Valuation Indicators	Assessment
1. Does the law allow for assessors to follow an alternative approach (*e.g.*, "replacement cost" approach) instead of a "fair market value approach" to calculating compensation in cases where land markets are weak or non-existent?	**Yes**
2. Does the law provide compensation for unregistered customary tenure rights held by Indigenous Peoples and local communities?	**Yes**
3. Does the law establish special protections for women landholders regarding compensation entitlements?	**Yes**
4. Does the law require assessors to take into account the loss of business and other economic activities?	**Partial**
5. Does the law require assessors to take into account the improvements (*i.e.*, attached and unattached assets on the land (*e.g.*, crops, buildings) made on the land?	**No**
6. Does the law require assessors to take into account intangible land values (*e.g.*, cultural, social, historical land values)?	**No**
7. Does the law provide affected populations with the right to opt for alternative land instead of compensation in cash?	**No**
8. Does the law provide affected populations with the right to negotiate the amount of compensation?	**No**
9. Does the law require that compensation must be paid prior to the taking of possession of the land or within a specified timeframe thereafter?	**No**
10. Are affected populations granted the right to appeal decisions on the amount of compensation in court or before a tribunal?	**No**

Source: Tagliarino (2017)

A major concern is that the institution of legal procedures for the alienation of customary land rights has generally not been matched by any effective capacity to regulate the subsequent distribution of 'landowner benefits' between the people who purport to represent the original owners (Filer at al, 2017).

Are there provisions foreseen to address stakeholder complains and for arbitration of possible conflicts caused by value chain investments?

Allen and Monson (2014) suggest that conflicts over land and extractive resource developments are increasing in PNG. They examined PNG's legally-mandated land mediation system in theory and practice and identified a number of weaknesses.

The resolution of disputes about the use, ownership and boundaries of customary land is generally governed by the Land Dispute Settlement Act 1975. The LDS Act establishes a system of land mediation that is intended to be "close to the people" and to provide "an avenue for traditional dispute settlement processes to be utilized". It establishes a system of land mediation that is to be conducted by state-sanctioned Land Mediators, who are intended to have detailed local knowledge of customary land tenure systems, which vary widely from place to place.

The administration of the land mediation process is the responsibility of provincial governments. However, unlike the system of tied national government payments to the provinces for Village Courts, there are no specific funds allocated to provinces for land mediation. In the absence of such funding, land mediation services mandated under the LDS Act are not being provided in many places.

According to data maintained by the Village Courts and Land Mediation Secretariat (VCLMS), there may be around 1.200 "permanent" Land Mediators across PNG, but according to an authoritative source there is only one female Land Mediator.

In some provinces, land mediation has been partially privatised with parties paying up to PGK 1.000 each for mediation conducted by state-appointed Land Mediators performing their role outside the terms of the LDS Act,21 or by informal, non-gazetted land mediators. Parties are willing to pay for these services because the

stakes are very high in the context of compensation payments associated with extractive resource projects, and all parties are likely to benefit from a mediated outcome.

The authors acknowledge land mediation is a very contested public policy space in PNG which makes it especially important that policy debate and formation is informed by a solid evidence base, which is currently lacking.

In the case of vanilla, no large-scale acquisition of land for production was reported or identified. The high labour demands required for pollination means that even managing three to five hectares of vanilla is a major challenge.

In terms of inclusiveness, vanilla has a major advantage in that people with rights to land can plant even quite small areas and potentially make a relatively good income, if they have access to sufficient labour. However, people invited to use land to which they do not have rights are commonly prevented from planting trees, particularly export cash crop species like coffee or cocoa, but also food producing trees such as breadfruit, sago and coconut. Tree planting is usually interpreted as a public affirmation of right holding. Even though much land is cultivated under usufructuary arrangements, it can be difficult for women and unmarried men to gain access to land on which to plant tree crops or to develop cash-earning business enterprises (Bourke and Harewood, 2009). This is likely to be the case for vanilla.

4.2.3 Gender Equality

In 2017, Papua New Guinea ranked 159 out of 160 countries of the Gender Inequality Index, which makes it the second lowest ranking country for gender equality in the world (UNDP, 2018).
Sullivan *et al.* (2005) provided the following context in their report on the social impact of the previous vanilla boom and bust on the Abelam people of East Sepik Province.

> "*The general Maprik area, from Dreikikir in the West through to Wosera in the east is Abelam territory. These people share one non-Austronesian (Ndu) language in different dialects across the whole region. The Abelam are distinctly different from coastal people who speak an Austronesian language. The neighboring Ndu speaking Boiken and Kwanga people both came up from the Sepik River basin, and were followed by the Abelam, who settled between them, south and southwest of the Maprik town area*".
>
> "*The Abelam can be summarized as a recently pacified warring culture that focuses on the cultivation and exchange of yams to maintain peace within and between communities. They place a premium on botanical information and gardening skills, as well as the ability to appease the ancestors and avoid antagonism within the group. There is considerable out-migration, or at least there was until the vanilla boom, and at the same time population growth has caused a hardening of what were once flexible land tenure rules. Abelam men and women are considered as fundamentally different, but not necessarily unequal, members of their community".*
>
> "*Anthropologist Diane Losche describes the 'ideal' for relations between men and women as a form of "harmonious interdependence" (1990:400). Although both the yam cult and the spirit cult (which includes initiation) exclude women, they do not so much denigrate as they do separate them. Women are expected to cook for men and boys during all ceremonial events, and observe the same taboos against sexual intimacy. The ideology in both cults demands misogyny and the authority of older over younger men, but some, including Losche, have argued that this is an ideology honored in the breach (Ibid). Not only are older men more feared than respected for the sorcery they own, but women are not antagonists to men either. As Forge explains (1971:141-42) "women are treated as inferior by men, who nevertheless believe them to be basically superior." And even as early as 1940, a pioneer female anthropologist recorded that "in spite of the rigorous exclusion of the women from the yam and tambaran cults, the daily relationships between the sexes are characterized by ease and friendliness." (Kaberry 1940-41:252). Whatever the ritual messages that may be conveyed, it is apparent that in daily life the relations between men and women in the Abelam (and by extension Dreikikir and Maprik) area are based on an idea of complementarity and not male dominance*" (Sullivan *et al.*, 2005).

4.2.3.1 Economic activities

In general, women in PNG derive limited benefit from the formal economy and those engaging in business mainly operate small-scale informal enterprises. The challenges faced by women include: a male dominated culture, limited ability to control business income, exclusion from decision making, and violence directed against them. PNG's legal framework does not adequately protect women's interests, particularly in relation to property rights and employment. Customary law, which frequently discriminates against women, is commonly applied (Hedditch and Manuel, 2010).

In East Sepik and Morobe, women are involved in vanilla production and postharvest activities, including trading and in some cases export. Women are mainly involved as producers. However, very few (perhaps 2-5%) are currently working with the large exporter's organic certification scheme.

Women may manage vanilla plots by themselves or jointly with their husbands. In the household survey, 24% of households had at least one vanilla garden/plot which was primarily managed by a female and a further 12% of households had at least one vanilla garden/plot jointly managed by a female and male (Table 4-2). Overall, 14% of vanilla gardens/plots were primarily managed by a female and 9% jointly managed by a female and male (Figure 4.3).

TABLE 4-2 NUMBER OF HOUSEHOLDS WITH AT LEAST ONE FEMALE MAIN MANAGER PLOT, AT LEAST ONE MALE ONLY MAIN MANAGER PLOT AND AT LEAST ONE JOINTLY-MANAGED PLOT BY VILLAGE

			Main vanilla plot manager		
Village		Number of households	Female	Male	Joint
Samark		20	7	18	3
Urita		20	3	19	3
Walahuta		20	4	18	2
Yambes		20	7	18	3
Yawerng		20	3	19	1
Grand Total		100	24	92	12

Source: Vanilla Household survey. Note: A household often has more than one vanilla plot and hence the total of female, male and joint can exceed the number of households.

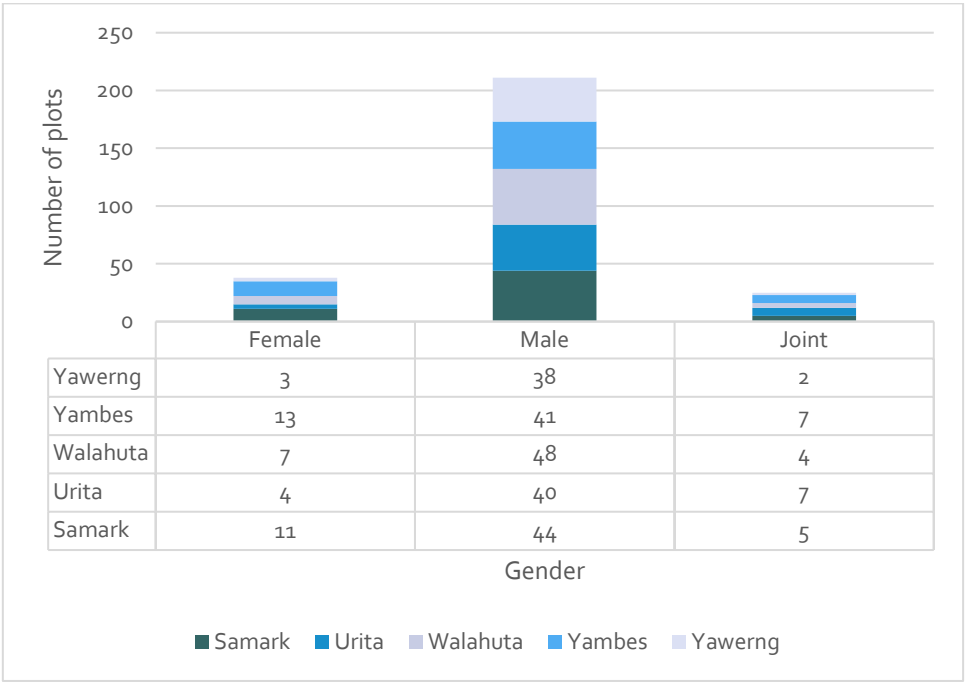


FIGURE 4.3 GENDER OF MAIN MANAGER OF VANILLA PLOT
Source: Vanilla Household survey

4.2.3.2 Access to resources and services

The majority of customary land in PNG is held on a patrilineal basis, passing from father to child (either son or daughter), with senior male clan or family leaders allocating the land. In the patrilineal system, men are seen as custodians of the land and therefore decision-making about the land lies with them. Women have limited rights over, and control of, the vast majority of land in PNG that is held under customary tenure (Hedditch and Manuel, 2010).

Customary land arrangements in East Sepik follow a patrilineal system, where women do not have equal land rights as men. In FGDs, women in seven communities explained their situation as follows. In the coastal community of Forok, women explained that 'men own the land'. In Jame village, (Maprik Wara LLG) near Maprik town, the women's FGD reported that women have equal rights to husband's land as long as they are married. Even if widowed they can still have rights as long as they don't re-marry. In the Ambunti-Dreikikir villages of Samark, Yambes, Yawerng and western Maprik communities of Urita and Walahuta women report that the clan owns the land and they have equal rights to cultivate the land. In Situm (Morobe) land tenure arrangements are even more complex (government land, block land and customary land), but women appear to have more control over land (*e.g.* if a woman from Situm marries a man from outside Situm then she controls the land).

Women have very limited access to credit, particularly in the formal sector. For example, the Bank of the South Pacific has an SME loan scheme where up to PGK 100 000 can be borrowed without collateral, but in the whole of the East Sepik only a handful of women (the manager estimated 5-10) had accessed the scheme. Sullivan *et al.* (2005) commented that the "*the typical grassroots is either distrustful of or intimidated by commercial banks, and although there are legitimate savings and loans societies in most major towns of PNG, they are few and far between. Non-literate and remote villagers without easy access to towns have few means with which to make their income 'grow'* ". However, some women in CBOs are accessing credit from the National Development Bank (*e.g.* women from Turubu had borrowed money for betel nut trading) but there were no reports of accessing credit for vanilla–related activities.

Women have less access to extension services than men, but access is very limited for both men and women (Bourke and Harwood, 2009[56]). The Department of Agriculture and Livestock (DAL) representative explained that extension officers report to governments at provincial and LLG levels, which appear to have very limited capacity (although there are very dedicated individuals). Commodity boards, such as cocoa and coffee, have their own extension arms where they employ extension staff, but this is not the case for vanilla. Women in Dreikikir villages of Samark, Yawerng and Yambes reported that their training in vanilla farming has been given by Alfred Jambram. The large exporter provides information on radio FM95.3 Central Sepik every day, promoting messages such as encouraging farmers to make sure that the vanilla bean is ready to harvest and how to correctly dry the vanilla (as reported by Jame and Bainyik Women's FGD, 2018).

There is a mobile network (Digicel) in all the communities visited in East Sepik. For those with access to mobile phones this makes it easier for them to get in touch with their family members living away from the village and most importantly to keep informed of the price of vanilla at the large exporter and on the street in Maprik. A number of women in the FGDs had mobile phones, but the extent of ownership by rural women is not clear.

The DAL representative explained that in the future a vanilla grower's association would be formed at provincial level and if the government was to provide support it would be through a lead agent such as the large exporter.

4.2.3.3 Decision making

Women have much greater control over decisions relating to food crop gardens and betel nut than cash crop gardens. In household vanilla plots in East Sepik, women reported that men generally have control over

[56] "Overall, agricultural extension and outreach is limited. With some exceptions, extension activity takes place near research stations, urban areas and main roads. Most rural villagers have little or no access to information about improved production and marketing of agricultural produce. A large unsatisfied demand for information exists on many aspects of food, cash crop and animal production and marketing, as well as for face-to-face contact with extension agents." (p453 Bourke, R.M. and Harwood, T. (eds) (2009).

vanilla income. However, many women (both married and heads of female headed households) reported having their own vanilla plots. Generally, women reported that they have at least some control over the income from their own vanilla plots. However, according to five of the FGDs even when women own and manage vanilla plots, they still allocate the bigger portion of the income to the household for budgeting on important family goals.

In the household survey only male heads of household were selected in the random selection. In 70% of these households, adult males were the sole main manager of the vanilla gardens (Table 4-3). Of these households, men only controlled the vanilla income in in 42 households and in 23 households it was jointly controlled. In 28% of the households there were male and female managers of vanilla gardens and in these cases 26 of the household heads reported that the vanilla income was jointly controlled. There is some indication that in households with more vanilla vines, women are more likely to have control over income from vanilla (Table 4-4).

TABLE 4-3 WHO CONTROLS THE INCOME FROM SALE OF VANILLA (BY MANAGER OF VANILLA GARDENS)?

		Manager of vanilla gardens in the household			
		AM only	AM, AF	AM, AF, CM	Total
Who controls the income?	AM only	42	2		44
	AM, AF	23	26	1	50
	AM, AF, CM			1	1
	No Harvest/ sales	5			5
	Grand Total	70	28	2	100

TABLE 4-4 WHO CONTROLS THE INCOME FROM SALE OF VANILLA (BY HOUSEHOLD CATEGORY-NUMBER OF VANILLA VINES)?

		Household category (based on number of vanilla vines)			
		G1 Small	G2 Medium	G3 Large	Total
Who controls the income?	AM only	14	18	12	44
	AM, AF	13	20	17	50
	AM, AF, CM		1		1
	No Harvest/ sales	4	1		5
	Grand Total	31	40	29	100

AM: adult males, AF: adult females, CM: child manager
Source: Vanilla Household survey

4.2.3.4 Leadership and empowerment

Women are more likely to participate in groups and Community Based Organizations (CBOs) than larger organizations such as cooperatives and associations. Women are much less likely to be in leadership positions than men. Where women are in leadership positions these are more likely to be in CBOs and church groups. In Yawerng there was a female magistrate. In FGDs, women reported that they can speak in public. In terms of power to influence services, territorial power and policy decision making women referred to the East Sepik Council of Women and being able to vote for the women's representative on the LLG. However, there are currently no female MPs in PNG (previously there were three). Strengthening women in leadership is a priority for the Ministry of Women.

4.2.3.5 Hardship and division of labour

In general, women's workload is disproportionally high compared to men. In other agricultural sub-sectors, such as coffee and cocoa, there is a considerable gap between the work done by women and the benefit they obtain because women do much (if not most) of the work (World Bank Group, 2014).

In East Sepik women reported that domestic work and childcare was overwhelmingly the responsibility of women and children. In terms of domestic work, women's FDGs estimated that women had 50-90% of the workload, children 10-30% and men 10-30%. In terms of childcare, women provide 50-90%, children 10-30% and men 10-30%.

In all women's FGDs there was 100% agreement that risks of women being subject to strenuous work are not being minimised.

4.2.4 Food and Nutrition Security

4.2.4.1 PNG Food and Nutrition security Context

DAL (2018) states that "*Food security remains a crucial yet poorly defined issue on PNG's development agenda*." Maternal and child undernutrition is pervasive in PNG. One in two children in the country have stunted growth due to chronic malnutrition and PNG has the fourth highest child stunting rate in the world (Hou, 2015, Save the Children, 2017).

A recent systematic review (McGlynn *et al.,* 2018) concluded that the prevalence of child undernutrition in PNG varied from 1% to 76% for wasting (median 11%), 5% to 92% for stunting (median 51%), and 14% to 59% for underweight (median 32%). Wide variations exist according to the index used for measurement, the population characteristics and the geographical region in which they live. The causes of child undernutrition in PNG are regionally variable due to a complex interplay of poverty, disease, food-security, lack of access to cash income, cultural, environmental and socio-political issues requiring a complex mix of solutions by governments, health systems and local communities.

The quality of nutrients in the diet is the major problem for nutrition in PNG, rather than the quantity of dietary intake. 80% of total dietary intake comes from root crops rich in fibre and moisture, but low in energy, so bulkiness can prevent ingestion of sufficient volume for energy, protein or other nutrients. Increased stunting prevalence in males was considered to be due to low protein and zinc intake. Reduced weight gain was associated with children eating traditional staples such as sago and taro (parts of the Momase region's diet) whilst eating yams was associated with increased stunting (East and West Sepik Provinces) possibly due to seasonal shortages, as they are harvested only once a year. Children consuming high protein and energy dense foods were more likely to have good growth in length (parts of Papua and Islands), whilst those consuming legumes and tinned fish were heavier and those eating coconut (lowland and coastal regions) were taller and heavier (McGlynn *et al.,* 2018).

Poor child nutritional outcomes were associated with low parental socioeconomic status, or when the age of the primary carer was either older or younger than parental norms, if parents used tobacco or alcohol or if the child was adopted. Better child nutritional outcomes were associated with better educated mothers or parents and the father's employment This may be related to improved cash availability or greater health awareness leading to better hygiene, improved health seeking behaviour during illness, or more effective disposal of stools. The nutrient quality of diets is related to the ability to purchase foods, disposable income, education level, housing conditions, use of health services and risk of illness, all of which can affect child growth. All improvements in socioeconomic status increased growth outcomes, except commercial palm oil production (McGlynn *et al.,* 2018).

Nutritional status and infection have a reciprocal relationship, but it is not always clear if undernutrition is a cause or an effect of infection. Child undernutrition was associated with incomplete vaccination and poor water and sanitation. Child undernutrition, falciparum malaria and parvovirus infection were all associated with an increase in anaemia (McGlynn *et al.,* 2018).

Children living in higher constant rainfall areas were more stunted, but higher seasonal variation of rainfall was associated with wasting. Variations in undernutrition by altitude and rainfall are likely attributable to differences in diet, especially low fat and protein, which can cause stunting. Children living in areas of steep terrain were more commonly stunted, maybe due to increased energy expenditure, unsuitable for vegetable production, reduced access to cash crops and health services. Children in rural areas were more susceptible to seasonal variation, stunting and underweight and the prevalence of undernutrition among them increased with the distance from the health centre. Overcrowded living conditions, especially in traditional houses, was associated with a greater prevalence of helminth infection and poor nutritional outcomes. Living in a household with running water or a tin roof were both protective of undernutrition, regardless of location (McGlynn *et al.,* 2018).

Acute undernutrition or wasting prevalence was very high in studies from Momase region, especially among children aged 6-36 months, and was more common in the wet season and at lower altitudes, with some variability. The clear trend was for wasting to be higher in children from 6 months of age, at a time when growth faltering begins, and coincides with the addition of complementary food and water to breastfeeding. It is also when worm infestation is highest, suggesting that gastrointestinal infection, and water, sanitation and hygiene (WASH) practices are contributing factors to acute undernutrition during the important transition in child feeding. Gibson concluded that stunting in a group of Sepik children was related to chronic deficits in energy and protein as a result of a diet of mainly tubers and was exacerbated in older male children by suboptimal zinc intake (McGlynn *et al.,* 2018).

4.2.4.2 Suggested interventions

Multiple cross-sectional measures would add valuable growth trend data to identify children and populations at risk and provide opportunity for timely interventions.

Firstly, nutrition-specific interventions will address the immediate causes of child undernutrition. In areas reporting high wasting, interventions will likely involve improved child access to adequate foods, effective feeding, care-giving and parenting practices and the prevention and treatment of infectious diseases. Where stunting prevalence is high but wasting is low, interventions to improve long-term food security, dietary quality including greater energy and protein and socioeconomic inequality are important.

Secondly, nutrition-sensitive interventions to address the underlying causes of child undernutrition will require adequate food security, access to effective health services and a safe, hygienic environment.

Thirdly, to address the basic societal causes of child undernutrition, interventions may involve strategies to decrease poverty, improve governance, enhance government policy and improve community illiteracy around nutrition, especially for women (McGlynn *et al.,* 2018).

Access to nutritious food is essential to good health, but national food security policy must also recognize the distinction between food insecurity and malnutrition. While food insecurity is one of the underlying causes of malnutrition other factors, such as diseases, poor health and childcare, lack of safe water and improved sanitation, hygiene and housing, are also critical causal factors. Infrastructure is particularly lacking: only 40% of population have access to an improved drinking water source and 19% are using an improved sanitation facility. Furthermore, a large part of the country's rural roads network is in a poor condition impacting adversely on access to health centres and schools and rural communities to access markets in towns and urban centres. The food and nutrition security situation is also compounded by a general lack of knowledge at household level on good nutrition and feeding practices which is complicated also by cultural beliefs and taboos (DAL, 2018).

PNG women are at the nexus of agriculture, nutrition, and health. As smallholder farmers and caretakers of children they make daily food production and consumption decisions for their families. Women are also much more likely than men to spend additional income on food and healthcare, so increasing women's income is likely to have a proportionally greater impact on children's health and nutrition than comparable increases in men's income. Given the significant time constraints on women, interventions that affect women's time allocation can help improve their own nutrition as well as that of their children. To enhance the contribution of women in food production and supply and to ensure food security at the household level, the empowerment constraints facing women in agriculture need to be addressed (DAL, 2018).

4.2.4.3 Availability of food

The consensus amongst women in the FGDs across all the communities was that food was available and local production of food was not affected by vanilla activities. Similarly, in almost all communities, women reported that vanilla activities did not affect food supplies on local markets. Interestingly in the five communities of Western Maprik and Dreikikir, a very high percentage of the vanilla gardens were also planted with food crops (Figure 4.4). For the smaller vanilla producers, all their vanilla gardens were intercropped with food crops, for the medium scale vanilla producers over 60% of vanilla gardens were intercropped with food crops and over 30% mixed food and cash and for the larger vanilla producer over 50% of vanilla gardens were intercropped with food crops and almost 40% with mixed food and cash crops such as betel nut and cocoa.

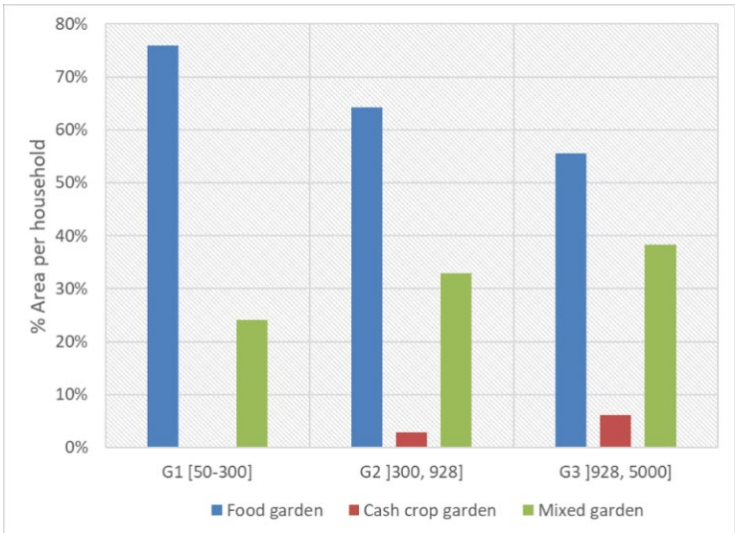


FIGURE 4.4 PERCENTAGE AREA OF VANILLA GARDENS PLANTED WITH FOOD, CASH AND MIXED CROPS
Source: Vanilla Household survey

4.2.4.4 Accessibility of food

Do people have more income to allocate to food as a result of vanilla activities? In all seven communities in East Sepik (and one community in Morobe) the main source of food was people's gardens. However, the women FG members reported that they also purchased food. In Turubu and Bainyik, participants were asked to say what they had eaten in their last meal[57]. The most common food items purchased appeared to be fish (tinned, dried, smoked). In Samark, Yawerng, Yambes, and Walahuta women in FGDs reported that people have more income to allocate to food as a result of vanilla activities. This was also the case in Urita, but households in this community are also generating income from cocoa and food crops. This village is located on the roadside and has access to daily transport to Maprik and local community markets. In the household survey, at least 87% of the households in each of the three vanilla household categories reported that they had used income from sales of vanilla in 2018 to purchase food (Figure 4.5). The most common items purchased were rice and tinned fish (Figure 4.6).

In all five of the West Maprik, Dreikikir villages women in FGDs reported that consumers food prices were increasing as a result of vanilla activities, particularly in stores.

[57] Turubu – i) Rice, smoked fish, coconut milk; ii) Sago, smoked fish, green vegetables, coconut milk; iii) Dried fish, green vegetable, sago; iv) Tinned fish; v) Dried fish
Bainyik – i) Sago, dried fish (from market), Green vegetables, coconut milk; ii) Sago, tinned fish, green vegetables, coconut milk; iii) Yam, sweet potato, banana, snake beans, green vegetables.

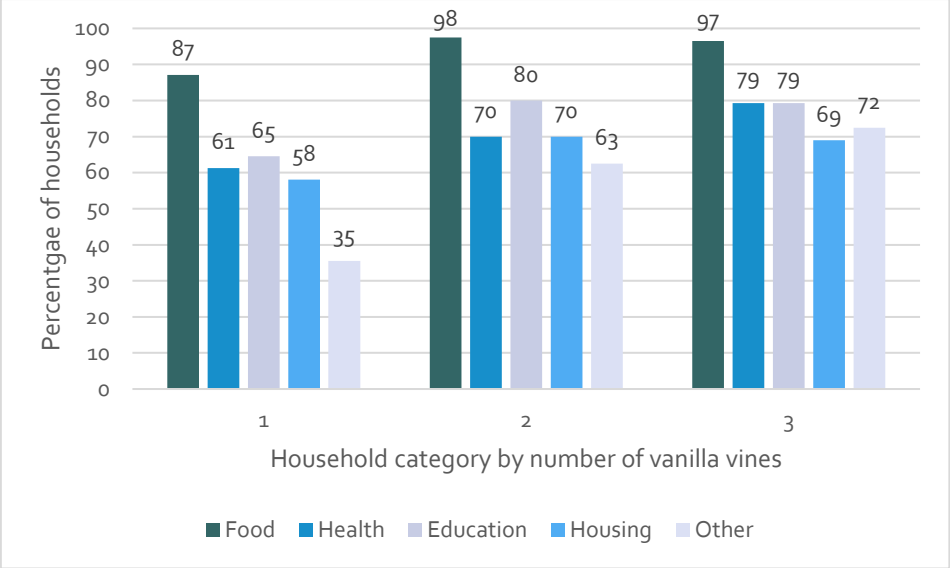


FIGURE 4.5 USE OF HOUSEHOLD VANILLA INCOME (BY HOUSEHOLD CATEGORY-NUMBER OF VANILLA VINES)
Source: Vanilla Household survey

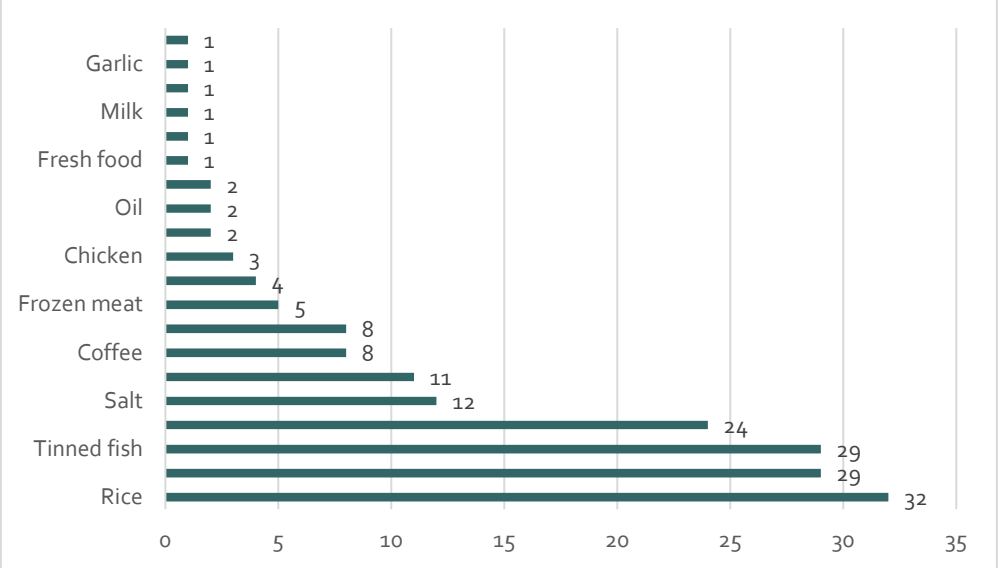


FIGURE 4.6 FOOD ITEMS PURCHASED FROM LAST SALE OF VANILLA (NUMBER OF HOUSEHOLDS REPORTING)
Source: Vanilla Household survey

4.2.4.5 Utilisation and nutritional adequacy

In all five communities, women reported that the nutritional quality of available food was improving, nutritional practices were being improved and dietary diversity had increased.

4.2.4.6 Stability of food supply and price

The consensus from women in these five communities was that income from vanilla had reduced the risk of periodic household food shortages. However, the price of food in stores had increased. It should be noted, however, that this study was done during a vanilla boom. If a bust is to follow then this could have detrimental effect on the stability of purchased food supply.

4.2.5 Social Capital

4.2.5.1 Strength of producer organisations

Cooperatives have a long and dynamic history in PNG and since 2000 they have been promoted by the government as a vehicle for economic and social development. Cooperatives in PNG conform to a four-tier system that includes primary (local), secondary (provincial), tertiary (comprising primary and secondary) cooperatives and the National Federation of Cooperatives at the highest level. Almost all cooperatives are still primary cooperatives. Previous studies found that PNG cooperatives faced challenges in their development such as incompetency in management, misappropriation of funds, abuse of processes and competition with Investor Owned Firms. One of the major challenges identified in PNG is poor institutional structure and governance (Garnevska *et al.,* 2014). According to the Department of Commerce and Industry there are currently about 6 000 cooperatives in PNG.

There are over 400 cooperatives in East Sepik registered as being involved in vanilla (Source: Ministry of Trade and Commerce PPAP Coordination Unit). However, only a fraction of these appear to be active. In four of the five villages in the household survey there were farmer organizations which were involved in vanilla activities (Table 4-5). According to the household survey all respondents reported that they had sold their vanilla on a personal basis, mainly to the large exporter or Maprik street traders. Yamark Cooperative Society reported two sales at the *Batas*, but only two individuals mentioned selling to *Batas*. Jacob Jambram reported that his association had completed two official export orders. Two other farmer organizations consulted, Yaya Cooperative Society (registered in 2016) and Afaum Business Group (registered in 2018) had not made any sales yet.

TABLE 4-5 FARMER ORGANIZATIONS WHICH ARE RELEVANT TO VANILLA IN FIVE VILLAGES

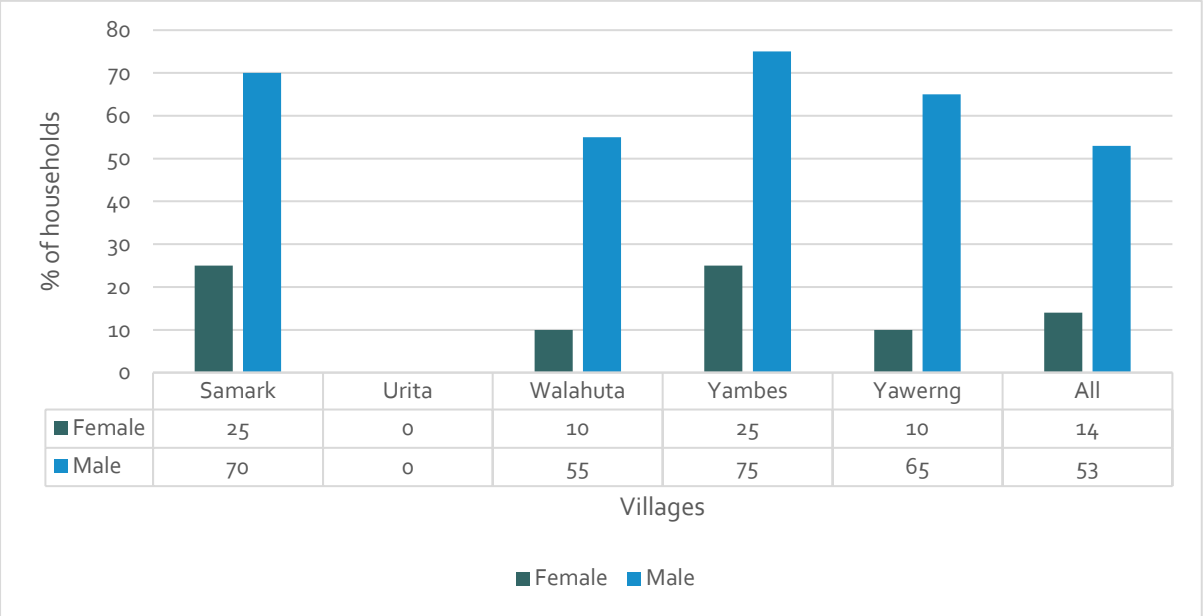
District/ Village	Organization	Number of members	No. of female members	Membership fee
Maprik district				
Walahuta	Afaum Business Group	31	5	100
	Awani Business Group	30	1	100
	Banahel Vanilla Association	24	1	100
Urita	None reported			
Ambunti-Dreikikir				
Samark -	Wasusimbil Association	150	60	300
	Yamark Cooperative Society	150	60	300
Yambes	Wambilel Cooperative Society	600+	Not reported	50
	Wasusimbil Association	150		
Yawerng	Yaya Cooperative Society	150	60	50

Source: Vanilla Household survey

In the household survey, 53% of households had at least one male member belonging to a farmer organization which was relevant to vanilla, while only 14% of households had a female member belong to a farmer organization relevant to vanilla (Figure 4.7).

In Samark, Yambes and Walahuta women FGDs reported their organizations were “good”, while in Yawerng participation by women was considered moderate. Similarly, in Samark, Yambes and Walahuta women agreed that their leadership was representative and accountable, but there was no agreement on this in Yawerng. In all four communities, women reported that their organizations are able to negotiate prices of vanilla, but it was not clear to what extent this was happening.

FIGURE 4.7 PERCENTAGE OF HOUSEHOLDS WITH A) A FEMALE MEMBER AND B) A MALE MEMBER WHO BELONGS TO A FARMER ORGANIZATION RELEVANT TO VANILLA



Source: Vanilla Household survey

4.2.5.2 Information and confidence in other value chain actors

Various sources attribute the introduction of vanilla to different individuals and organisations (see Annex 3). According to Bourke and Harewood (2009), the foundations of today's vanilla industry were laid in 1993, when Allan Bird (Bangui Bio Products Ltd) planted vanilla on a large block near Maprik in East Sepik Province. He encouraged smallholders around him to also plant. This provided the critical mass upon which a substantial smallholder-based industry could quickly develop once the right price incentives existed. In the words of Alan Bird, "*the vanilla industry was built without government help*". Services still appear to be primarily provided or paid for by either farmers themselves or the private sector. For example, women in Samark, Yawerng and Yambes reported they had received training in vanilla practices from Alfred Jambram. The large exporter provides information on radio FM95.3 Central Sepik every day *e.g.* make sure the bean is ready to harvest and how to correctly dry the vanilla (as reported by Jame and Bainyik Women's FGD). Vanilla prices in Maprik are known through word of mouth. There was a mobile network (Digicel) in all the communities visited in East Sepik. For those with access to mobile phones they are able to keep informed of the price of vanilla at the large exporter and on the street in Maprik.

The main area where trust appears to be lowest in the value chain is between framers and the large exporter. Sullivan *et al.* (2005) explained the situation just after the previous vanilla boom and bust as follows:

> "*We are in no position to assay whether or not Papindo and other major buyers played the primary role or not in debasing the value of PNG vanilla on the world market. This report is not an eyewitness account of the boom but an after-boom assessment of its impacts, and one resounding impact must be the distrust and dissatisfaction villagers have come to feel with this major Indonesian-Papua New Guinea retailer. Papindo cops the blame in virtually all category of informants we spoke to: they made a decision to move from buying only cured beans to buying green beans as well, which caused a rush on the gardens and a degradation of curing standards. When this was first evident, Papindo did not chose to return to buying cured beans, they continued and thus sustained the general corruption of quality (for reason we do not know). There may have been other factors we are not aware of, but the villagers from Dreikikir to Maprik and Wosera are firm believers that Papindo was largely responsible for turning the boom into a terrible, painful and overnight bust.*"

Interestingly Alan Bird, the East Sepik governor, came to the defence of the large exporter when he explained that after the previous vanilla boom the company stepped in when times were bad and kept buying and holding stocks of vanilla. The lack of trust from farmers in the large exporter was still very apparent. For

example, farmers do not trust the company on the grading of their vanilla beans. They consider that the company is rejecting their quality vanilla beans resulting in a low prices and income being received.

4.2.5.3 Social involvement

The general consensus from women in Samark, Yawerng, Yambes, Urita and Walahuta was that communities do participate in decisions that impact their livelihood. In Urita women referred to cocoa production and the PPAP project on new clone distribution, and the Healthy Island Concept (Box 4.1). In Walahuta women referred to the Healthy Island Concept and the Water Supply project provided by the South Seas Evangelical (SSE) church. In all five communities, women reported that there are actions to ensure respect of traditional knowledge and resources. In Samark an example was given of community meetings on anti-social behaviour by youths. In all five communities, women reported that there is participation in voluntary communal activities for benefit of the community. For example, in Samark Monday is community day where general and specific cleaning is done.

Box 4.1 Heathy Island Concept in East Sepik

The Healthy Island concept is based on the belief that people have the potential to make long-term differences in their health and in the health of others. The aim is to educate and empower "our" people to address root causes of the health and development issues that are affecting Healthy living lifestyle in the village or community.

Approach

- Every aspect of "health" in relation to individuals, families, clans, communities, and the nation is covered.
- Social, economic and spiritual well - being as well as aspects of health care are brought together.
- Many sectors and disciplines are involved

Impact of the programme since 2002

- Reduced number of patients reported at outpatient per health facility
- Disease pattern per village has dropped
- Increased supervised deliveries
- Improved village settings with proper housing
- Improved Toilets
- Improved Hygiene Behaviors
- Have access to safe drinking water
- Shared Responsibilities among men and women
- Reduced Strong Bad Customs and belief
- Community taking ownership of their own Health
- 100% Defecation free in the Villages

Source: Anon (2018) Presentation is better than cure: Experiences of healthy island approach with faith-based organisation. 2nd WASH coordination Workshop. Wewak, East Sepik Province. 30th August 2018. Venue: DDA Chamber

4.2.6 Living Conditions

4.2.6.1 Health services

PNG's healthcare system is primarily funded by the Government and international donations. Current spending on healthcare is 4.5% of GDP, and 20% of funding comes from donors. PNG has a high infant mortality rate, where an estimated 1 in 13 children die before they reach the age of 5. Only 53% of childbirth deliveries in the country are tended by a skilled professional. PNG has a high number of noncommunicable and communicable diseases including malaria[58], polio, tuberculosis, cholera, respiratory disease and an epidemic of HIV. As a result of challenges in transportation and overall access to health services, PNG has

[58] According to a recent survey 8.8% of the population of E. Sepik was infected with malaria parasites. (Hetzel *et al.*, 2018).

one of the highest rates of death of cancer globally. According to the World Health Organization, there are about 0.5 physicians and 5.3 nurses per 10 000 citizens (CFE-DM, 2019).

According to women in the seven communities visited in East Sepik, access to health facilities varied significantly with location (Table 4-6). However, it is not clear what services were available at these clinics. In an Oxfam scoping study for Angoram district hospital, hospital staff indicated that patients die due to the lack of basic facilities and the insanitary conditions (Oxfam, 2016[59]). A Key Informant from Save the Children explained that nationally the majority of people are not getting access to primary health care services; centres are closing and drugs are not available. Payment may be needed for the consultation and transport to reach the health facility. For example, in Forok the consultation fee was PGK 1.20/child and PGK 2/adult.

TABLE 4-6 DO HOUSEHOLDS HAVE ACCESS TO HEALTH FACILITIES?

Community	Women's FGD assessment
Samark	No. Seek health services at Yambes village or Dreikikir station health centre
Yawerng	No
Yambes	There is a clinic in the village that is being looked after by a local Aid Post Order (APO). The clinic serves the people of Samark also.
Urita	No. Clinic is located around a 1hour walk from the village. Run by South Seas Evangelical church
Walahuta	Yes. Located in the nearby village around 1-hour 's walk
Forok	Clinic in Brandi High school, 1 hour's walk away
Jame	Heath clinic is close by in the community
Bainyik	Health services are now in Maprik town. Before they had a community health worker, but due to funding it is closed. Started in 2004 and closed in 2017. Gloria worked for 11 years as a volunteer. Could check for malaria (and give medication) and test for TB

In Samark, Yawerng, Yambes, Urita and Walahuta all the women's FGDs agreed that vanilla did have an influence on people's health. This appears to be mainly in terms of improving their ability to pay, in that 70% of households reported that some of their income from vanilla sales in 2018 was spent on health services. However, reports from the Healthy Island initiative suggest that gains in health indicators (malaria, pneumonia, diarrhoea and skin diseases) were moving in reverse since 2014 (Figure 4.8).

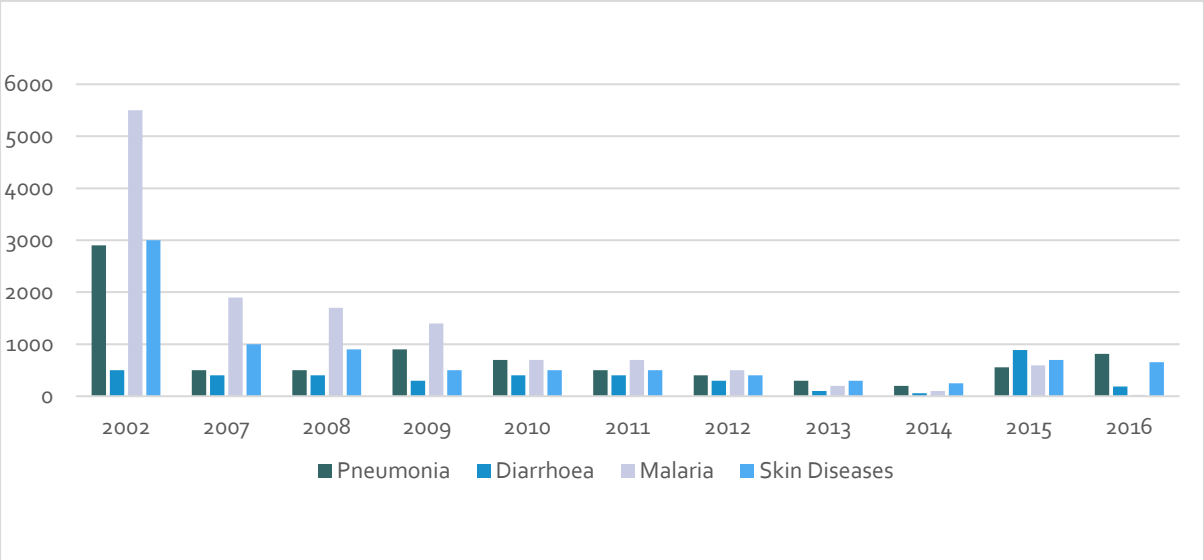


FIGURE 4.8 REPORTED CASES OF PREVENTABLE DISEASES FROM 2002 TO OCTOBER 2016 IN HEATHY ISLAND IMPLEMENTATION AREA OF EAST SEPIK
Source: Experiences of healthy island approach with a faith-based organisation (2018)

[59] Programme Development Scoping Report - Angoram, East Sepik, PNG.

4.2.6.2 Housing

Traditionally rural houses are built of natural materials, especially wood and grasses. Roofs are usually thatched, and walls are often constructed using a tiling technique, which creates attractive patterns and overlapping shapes. In lowland areas houses are often built on stilts, reducing the risk of them being flooded. Important houses may be protected by prominent spirit images, which allow spirits or ancestors to be present as protective forces, guarding over the house and its occupants. Increasingly houses are being built with iron sheets roofing and walls with non-natural materials. These are referred to as semi-permanent and permanent houses (Table 4-7). In all five communities of western Maprik and Dreikikir women reported that there were increasing numbers of semi-permanent and permanent houses and this was at least partially attributed to vanilla income. In the household survey, 66% of households reported that they had bought housing materials with income from vanilla sales.

TABLE 4-7 DO HOUSEHOLDS HAVE ACCESS TO GOOD QUALITY HOUSING?

Community	Women's FGD assessment
Samark	Yes. Most semi-permanent. These houses have roofing irons for rainwater harvesting compared to before. Only 2 permanent houses in the village
Yawerng	Yes. Semi-permanent house compared to before. X4 water tanks/others use water well
Yambes	Yes. There is a lot of permanent houses and water tanks in Yambes compare to all other 4 villages
Urita	Yes. 20 percent with permanent housing
Walahuta	Yes. 2 permanent houses. All semi-permanent/bush material, 50/50
Forok	12 fully permanent houses in the community
Jame	3 permanent houses in the community
Bainyik	3 permanent houses in the community. Not linked to vanilla income.

Water and sanitation are a significant issue in PNG, with 61% of the population not having access to safe water. In addition, 55% does not have access to improved sanitation. This increases the risk of the population suffering from diarrhoea, malnutrition, and stunting. In the Pacific region, PNG has the lowest national water coverage. PNG's area of piped coverage is lower that the world's average and it is the lowest in the Pacific (CFE-DM, 2019). There was less evidence of income from vanilla improving access to good quality water and sanitation facilities. In the household survey, four households reported that they had bought water tanks. A key informant from Oxfam reported that one community had approached them to provide advice on how they could as a community use vanilla income to invest in improved water supply to their village.

4.2.6.3 Education and training

In general, education in PNG is characterised by low levels of educational attainment and literacy, poor school attendance and retention rates, and high levels of gender inequality (Ryan *et al.,* 2017). PNG's national literacy rates are well below the regional averages with just 62.4% of adults being literate compared with 94.4% for the region, and 70.8% of youths compared with the regional average of 98.8% (UNDP, 2014). In 2009/10 school enrolment rates were also low with a national gross enrolment at primary school level of 74.4% (Momase region 62.4%) and a secondary rate of 44.4% (Momase region 25.9%) (UNDP, 2014). In 2012, PNG implemented the tuition-fee free education policy, which covered the cost of tuition for students in state schools from primary school to grade 10. This has contributed to increased enrolment in schools, especially in primary education, with almost two million children enrolled in 2014 compared with about one million a decade before. However, there are significant regional disparities and almost half a million children are still out of school. The country's net enrolment rate is the lowest in the Asia and Pacific region (63%) (CFE-DM, 2019).

The situation regarding access to schools and the contribution of vanilla income as reported by women in FGDs is shown in Table 4-8 below. In the household survey, 75% of respondents reported that they had used income from their 2018 vanilla sales on education.

TABLE 4-8 EDUCATION AND TRAINING

	Women's FGD assessment		
Community	**Is primary education accessible to households?**	**Are secondary and/or vocational education accessible to households?**	**Has vanilla has had any influence on people's education?**
Samark	No. Children attend school in Yambes village or in Dreikikir station	Yes. In Dreikikir station (2-3 hours' walk from the village to the secondary school in Dreikikir station and another 2 hours' walk back	Not really Accessibility to school is a major problem
Yawerng	No, primary school (grades 1-6 is located in the nearby village of Namaha which is 30 minutes' walk one way	Yes. Yamatung vocational school/ 2 hours' walk	No. No one in the village has got a tertiary college education
Yambes	Yes. There is a primary school that caters for grades 1 and 6.	Yes. Located in Dreikikir	Yes
Urita	Yes. There is a primary school that caters for grades 1 and 6	Yes. Buugam secondary school is 1-hour walk	Yes. 11 people to tertiary institutions. 1 currently at University
Walahuta	Yes	Yes	Yes

4.2.6.4 Other use of income by vanilla households

A range of other uses were made of income from vanilla sales in 2018 (Figure 4.9). The most frequently reported items were various types of solar equipment ranging from solar panel, solar battery and inverter to solar lights. Cooking/ kitchen utensils, cloth/ clothes and bedding were also reported by a number of households.

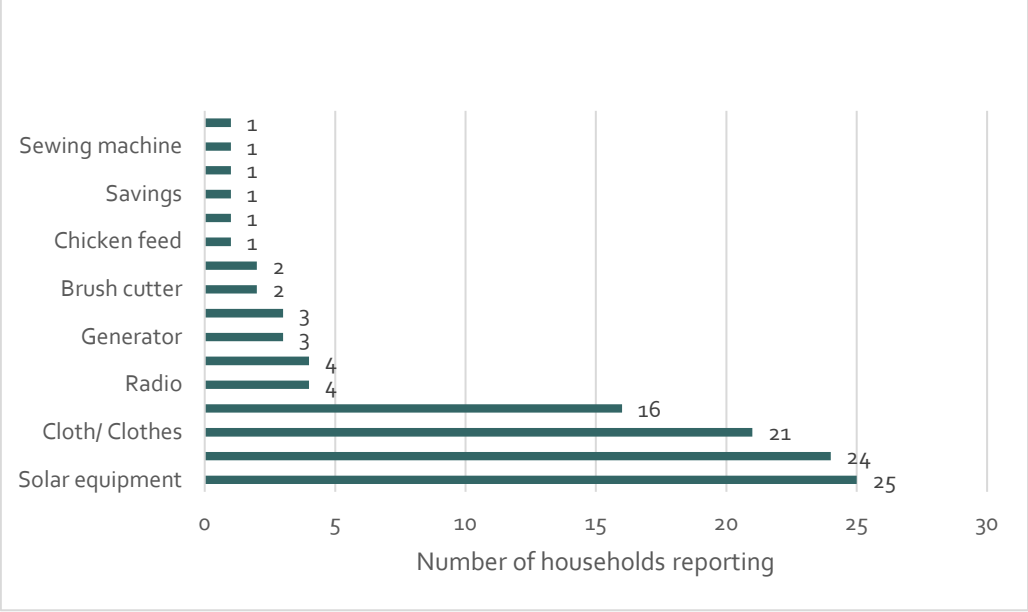


FIGURE 4.9 "OTHER" USE OF INCOME FROM SALE OF VANILLA IN 2018
Source: Vanilla Household survey

4.2.6.5 Perceptions of change resulting from engaging in the vanilla value chain

In the previous PNG vanilla boom, Sullivan *et al.* (2005) reported major negative social impacts including: Supermarkets and major retail stores raising their prices; prostitution, adultery, domestic violence; theft of green beans; land disputes; food insecurity.

In the household survey, 80 of the respondents (all male heads of households) reported that the changes resulting from engagement in the vanilla value chain were either completely (35%) or mainly (45%) positive. A further 9% regarded the changes as equally positive and negative (Table 4-9, Figures 4.10 and 4.11). The overall impression is that the negative aspects in the previous boom and bust have not occurred to the same extent this time. However, the major negative elements which were reported were abuse of alcohol and domestic violence (Figures 4.12 and 4.13).

TABLE 4-9 MALE HEADS OF HOUSEHOLDS' PERCEPTIONS OF CHANGE RESULTING FROM ENGAGING IN VALUE CHAIN

	AM	AM, AF	AM, AF, CM	Total
Completely positive	25	9	1	35
Mainly positive, but some negatives	31	14		45
Equally positive and negative	6	3		9
Mainly negative, but some positives				0
Completely negative				0
Not harvested or No response	8	2	1	11
Grand Total	70	28	2	100

AM: adult males, AF: adult females, CM: child manager. Source: Vanilla Household survey

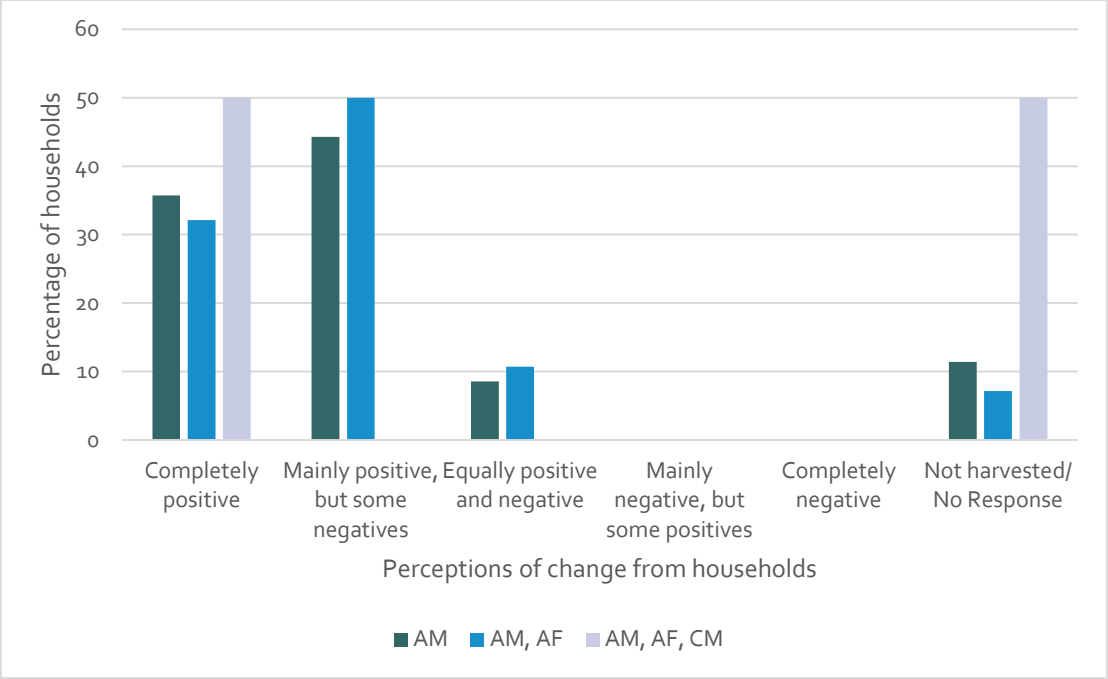
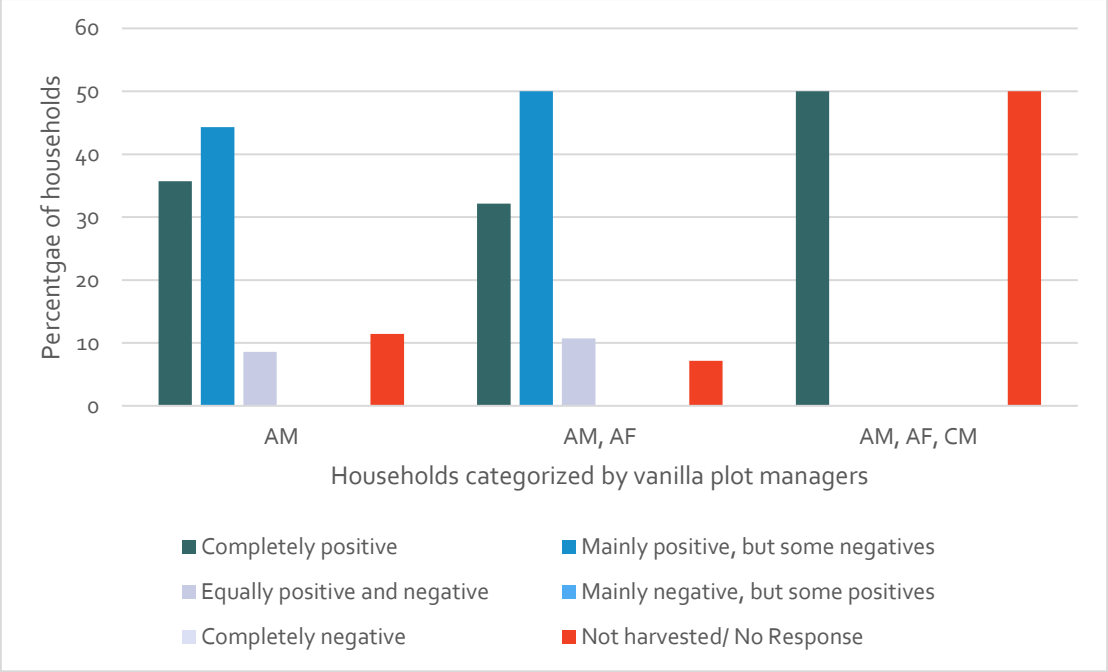


FIGURE 4.10 PERSPECTIVE OF HEAD OF HOUSEHOLD OF CHANGES IN HOUSEHOLD RESULTING FROM ENGAGEMENT IN VANILLA VALUE CHAIN



AM: adult males, AF: adult females, CM: child manager. Source: Vanilla Household survey

FIGURE 4.11 PERSPECTIVE OF HEAD OF HOUSEHOLD OF CHANGES IN HOUSEHOLD RESULTING FROM ENGAGEMENT IN VANILLA VALUE CHAIN BY HOUSEHOLDS WITH DIFFERENT VANILLA PLOT MANAGERS

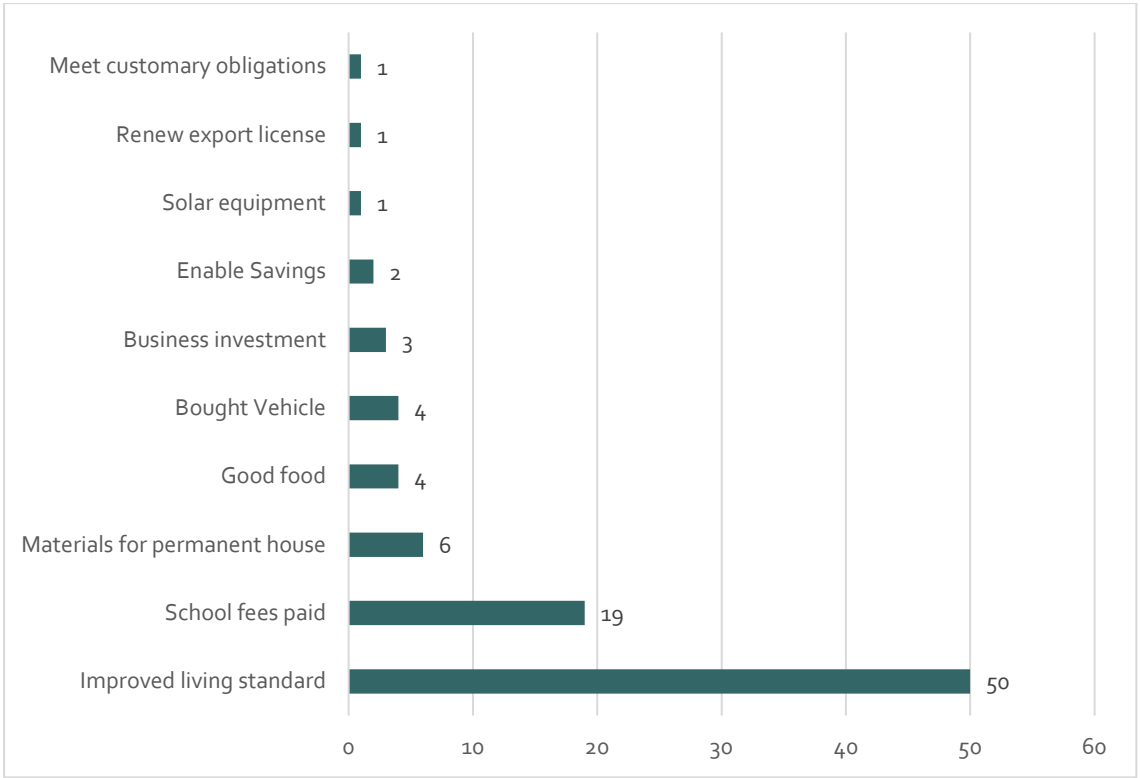


FIGURE 4.12 MALE PERSPECTIVES ON POSITIVE CHANGES FROM ENGAGEMENT IN VANILLA VALUE CHAIN

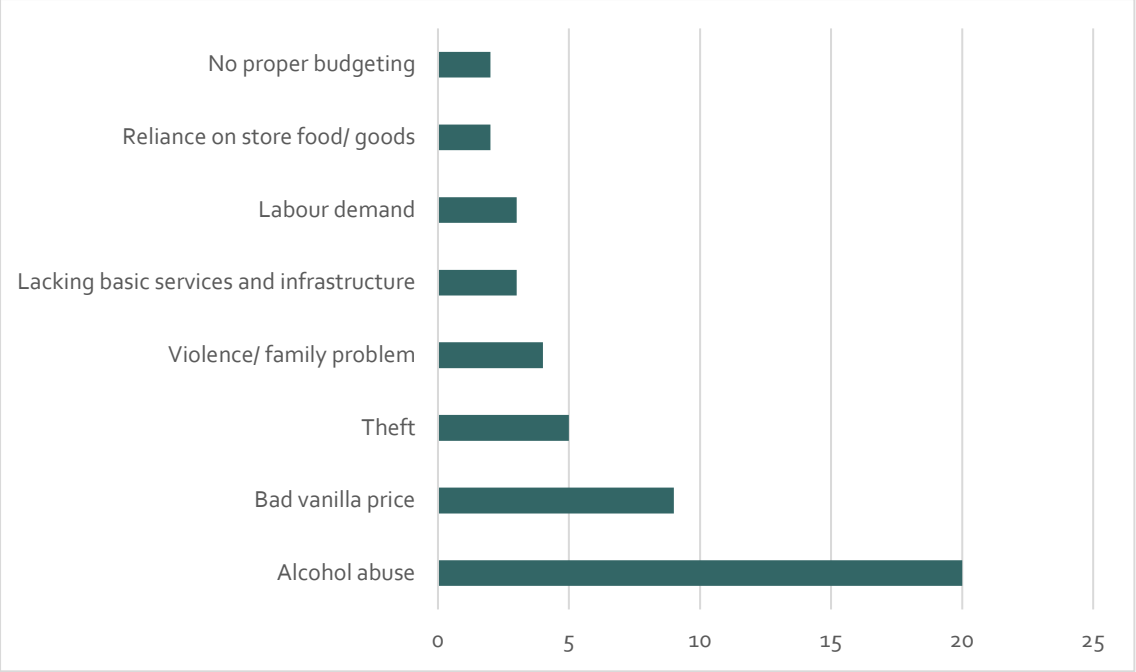


FIGURE 4.13 MALE PERSPECTIVE ON NEGATIVE CHANGES RESULTING FROM ENGAGEMENT WITH VANILLA VALUE CHAIN
Source: Vanilla Household survey

4.3 What can be done to enhance positives and minimize negatives?

The main suggestion to address minimize the negatives and enhance the positives was to change social behaviour (Figure 4.14). Suggestions including enforcing law and order, working through churches and village leaders using their influence.

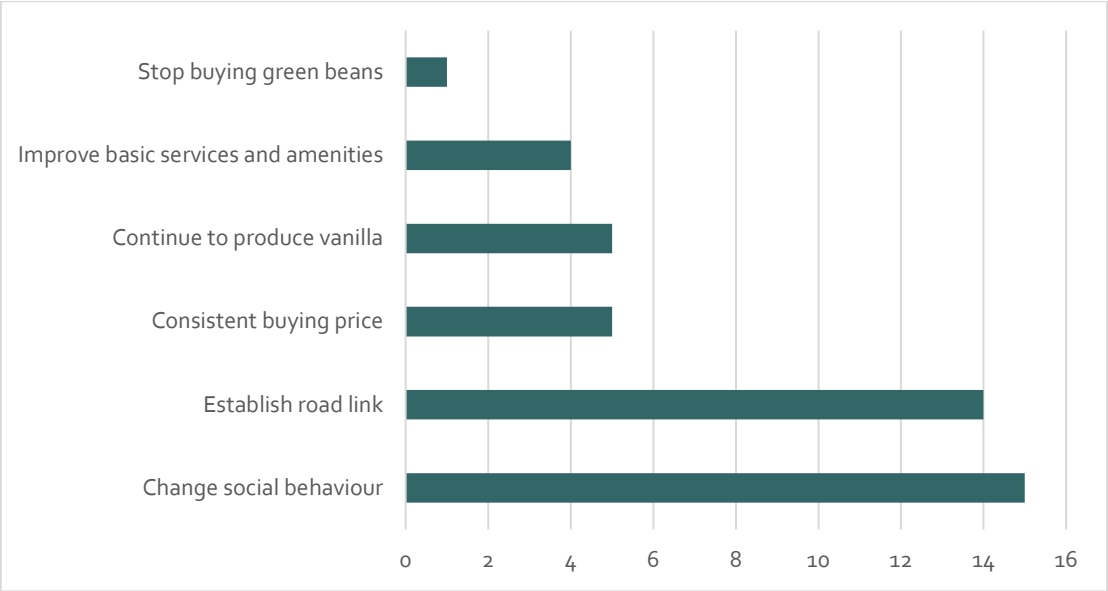


FIGURE 4.14 MALE PERSPECTIVES ON WHAT CAN BE DONE TO ENHANCE POSITIVES AND MINIMIZE NEGATIVE EFFECTS OF ENGAGING IN VANILLA VALUE CHAINS
Source: Vanilla Household survey

4.4 Main findings from the six domains of social enquiry

The general findings on the social sustainability of the vanilla value chain are summarised in the radar diagram (Figure 4.15) and elaborated further in the appended social profile spreadsheet tool in Annex 5. While working conditions and land rights are of concern in PNG, they are not major issues in the vanilla value

chain. Within the major challenges of gender inequality in PNG, women are participating in and benefiting from the vanilla value chain. While prices are good, vanilla income appears to be contributing to improving household nutrition security and living conditions. However, there are concerns regarding health and negative social outcomes, such as alcohol abuse and domestic violence. Social capital is generally weak in the value chain.

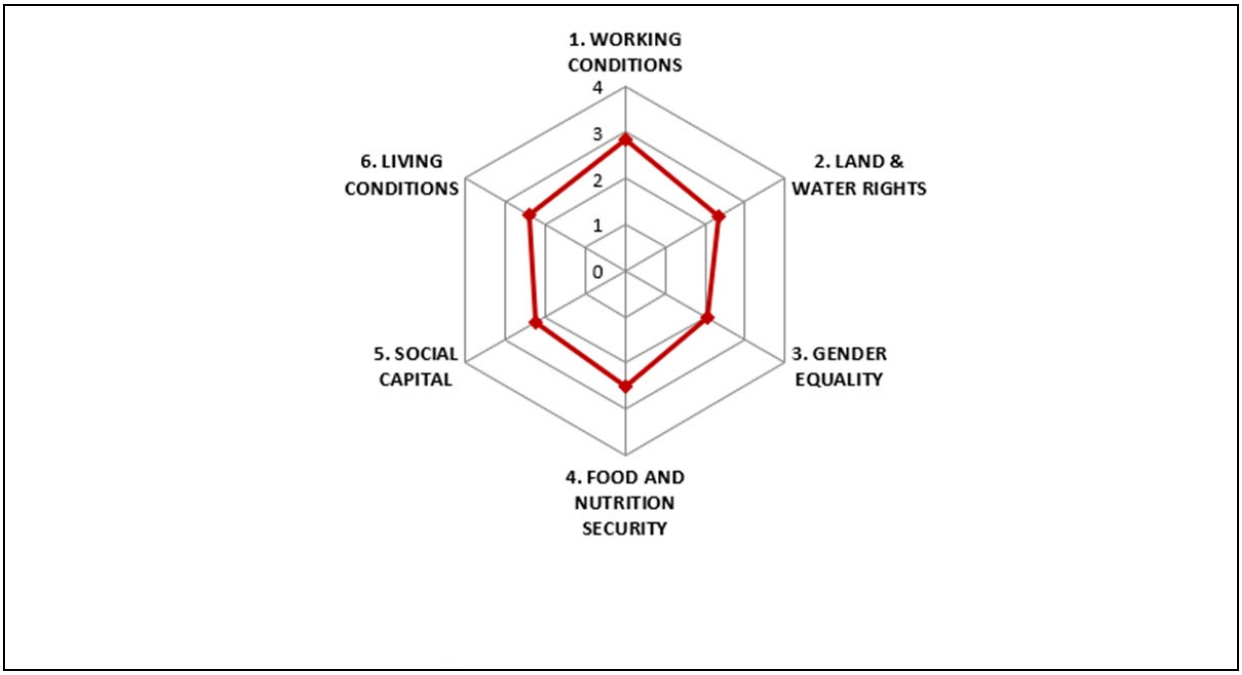


FIGURE 4.15 PNG VANILLA VALUE CHAIN SOCIAL ANALYSIS RADAR CHART

4.5 Conclusions

In terms of inclusiveness, vanilla has a major advantage in that men, women and youth with rights to land, in the right agro-ecological zones, can plant even quite small areas and potentially make a relatively good income, if they have access to sufficient labour and as long as the price of vanilla is relatively good.

People living in East Sepik appeared to be favoured by a number of factors favouring vanilla as an enterprise including favourable agro-ecological conditions, a rich horticultural knowledge (particularly in some areas) and proximity to the border with Indonesia.

The income in the value chain appears to be distributed reasonably well for rural producers (see economic analysis), although there are significant demands on labour, which is mainly met by family members.

The value chain appears to be dominated by the large exporter but there were a number of other official exporters, as well as informal traders, which provide alternative markets to rural producers. During the time of the study (a boom period in PNG) this competition has probably been important in maintaining relatively high prices being offered to farmers. However, when the previous boom was over it was reportedly the large exporter that still offered a market to farmers, albeit at very low prices. The Spice Industry Board has not been active and to date has had little influence on governance in the value chain. Farmer organisations are generally not very strong. The current governance structure appears to work well in favour of farmers' income in times of boom (when global prices are high), but not when global prices fall.

There is relatively little direct employment in the value chain, but the injection of money into the local economy is creating jobs.

Most of the activities and benefits in the value chain are in rural areas, where regulation on working conditions is not necessarily applied and certainly not monitored. Women, youth and children are working in the vanilla value chain. The extent to which they will benefit from the income will vary with household, but

women generally assessed the situation positively. In some cases, women and youth manage their own vanilla gardens and can control the income earned.

The food and nutrition situation in PNG is complex, and there is a serious problem with malnutrition, particularly of rural children. Based on feedback from women in this study, vanilla does not appear to be competing with food crops but the literature stresses that current subsistence food systems are not providing all nutritional needs, such as protein. This may be achieved through changing the farming system, trading (as has been the case traditionally) or selling cash crops and purchasing food. Part of the solution to this problem appears to lie with improving the socioeconomic situation of rural households and vanilla can contribute to achieving this. However, as recognized by DAL (2018) and others, other causal factors include diseases, poor health and childcare, lack of safe water and improved sanitation, hygiene and housing, the rural roads network adversely affecting access to health centres and schools. Others have also reported that there is a general lack of knowledge at household level on good nutrition and feeding practices, which is complicated also by cultural beliefs and taboos. In the FGDs in this study, women often appeared to be knowledgeable about food and nutrition, but again as noted by DAL (2018) there are significant time constraints on women, so interventions that affect women's time allocation can help improve their own nutrition as well as that of their children. To enhance the contribution of women in food and nutrition security at the household level, the empowerment constraints facing women in agriculture need to be addressed.

Farmer capacity at individual and organizational level varies considerably. In many ways farmers that we met in this study were already very knowledgeable, and in some cases innovative, with regard to vanilla. One of the challenges is that there is currently limited public sector capacity in terms of service provision to farmers and where there is, it tends to be commodity focused (*e.g.* cocoa). This can make a more holistic approach to improving farming and livelihoods systems more challenging. Planting vanilla as part of a diverse (food and cash crop) farming system can contribute to reducing the shock of volatile fluctuations in the global price of vanilla.

A key risk for smallholders engaging in this value chain is volatility of prices. Vanilla can be established without the use of external inputs, but it takes about three years after planting before vanilla vines start producing substantially. DAL recommends that farmers grow vanilla alongside other crops and trees in their gardens and many farmers appear to be doing this. In the main vanilla producing area of East Sepik, infrastructure is poor which makes marketing of produce more challenging. The high value to weight ratio for vanilla is a significant advantage to farmers here. Farmers appear to have a range of livelihood strategies in this area and if prices drop significantly farmers are likely to switch out of vanilla again as they did after the previous boom and bust. Given the agro-ecological suitability of vanilla to the East Sepik, a more stable price which could enable to farmers to plan around a more regular longer-term income could bring important benefits.

The vanilla boom that was occurring while this study was undertaken appears to have resulted in positive outcomes, but also some negative results. Both the positive and negative outcomes must be seen in the wider social, cultural and economic context of PNG. Injecting large amounts of money into system can amplify the existing issues such as alcohol abuse and gender-based violence. It is important for future value chain interventions to take this into account. In line with DAL (2018), to address malnutrition and other social goals in PNG agricultural policies, projects and investments need to be designed and implemented to achieve clear wider social goals. Organisations such as Oxfam, East Sepik Women's Association, Family for Change have a lot of experience in addressing some of the key social issues and could provide valuable partnerships.

5 THE ENVIRONMENTAL ANALYSIS

5.1 Introduction

The environmental analysis contributes to answering one overall framing question:
Is the vanilla value chain in PNG environmentally sustainable?
The analysis aims at outlining the environmental context and assessing environmental impacts related to the activities of the vanilla value chain, specifically:

CQ4.1 What is the potential impact of the vanilla value chain on resources depletion?
CQ4.2 What is the potential impact of the vanilla value chain on ecosystem quality?
CQ4.3 What is the potential impact of the vanilla value chain on human health?

The analysis is mainly based on existing literature, measurements, photographs and data relating to environmental aspects of production; interviews with key informants, Focus Group Discussions and a household survey (see methods section for more details). The analysis attempts to set out the national context and then mainly focuses on East Sepik province where a high proportion of the vanilla in PNG is produced.

The results of the environmental analysis are set out in this section, but functional analysis (*cf.* section 2) should also be consulted.

5.2 Introduction to Life Cycle Analysis

Agriculture and food systems are major contributors to both local and global environmental change. Sustainability is increasingly important as societal goal. Eco-efficiency and materials footprint are becoming mainstream elements in successful businesses, including commercial agricultural enterprises. Design and management for sustainability are becoming core components of social responsibility and market position vis-à-vis consumer expectations.

Life cycle thinking refers to a sustainability management approach that requires integration of all relevant supply chain activities associated with a product/service. This approach facilitates the identification of opportunities to improve resource efficiencies and reduce emissions whilst being aware of potential trade-offs, which may occur between different types of impacts or different supply chain steps as a result of management decisions. The leading standard for assessing environmental performance is life cycle assessment (LCA). LCA evaluates the relative potential environmental and human health impacts of products and services throughout their life cycle, beginning with raw material extraction and including all aspects of transportation, manufacturing, use and end-of-life treatment. LCA methodology is defined by the International Organization for Standardization (ISO) 14040-14044 standards (ISO 2006a, ISO 2006b[60]). ISO standardized framework provides prescriptive guidance for characterizing material and energy inputs and emissions along product supply chains. LCA addresses how these flows relate to a range of resource use, human health and environmental impact potentials.

LCA was traditionally applied to analyse industrial production systems, but in recent decades has been adapted to assess the environmental performance in agriculture and food production processes. However, agriculture does not consume resources in a linear sense and is not a pure "cradle-to-grave" process: many agricultural systems are interlinked and therefore changes to one system will have trade-offs.

A main strength of LCA is its comprehensiveness in terms of its life cycle perspective and coverage of environmental issues. However, the comprehensiveness is also a limitation, as it requires simplifications and generalisations in modelling of the product system and the environmental impacts. Considering the uncertainties in mapping of resources uses and emissions and in modelling their impacts and the fact that calculated impacts are aggregated over time and space, it is more correct to say that LCA calculates impacts potentials. Another limitation is that, while LCA can be used to indicate which product is better for the

[60]ISO (2006a) 14040: Environmental management. Life cycle assessment–principles and framework. Geneva.
ISO (2006b) 14044: Environmental management. Life cycle assessment–requirements and guidelines. Geneva.

environment, it cannot provide an answer if "better" is "good enough", *i.e.* if a product is environmentally sustainable in absolute terms (Bjorn *et al.*, 2018).

Papua New Guinea tropical forest is the major ecosystem affected by the plantation of vanilla gardens. These forests provide crucial ecosystem services and are known for their high richness in species, many of them endemic. Considering the present study, one of the LCA limitations in terms of impact categories relates to the incomplete consideration of land use impacts, particularly those on biodiversity and habitat fragmentation, which are highly dependent on local characteristics (connected with the spatial dimension problem). The other LCA limitation is the lack of local/regional specific data on emission factors needed for output calculations in life cycle inventory as well as characterization factors need for environmental impact evaluation; processes such as GHG emissions that depend on soil and climate conditions, have yet to be quantified for PNG forests and agricultural systems.

Even so, aiming at measuring and reporting sustainability, LCA is still a key tool for a comprehensive asset management, supporting decision-making while improving transparency and stakeholders' knowledge within the agri-food sector.

5.3 Goal definition

The overall objective of the environmental assessment component is to develop the LCA of the vanilla value chain in Papua New Guinea. Among its specific objectives are the identification and evaluation of the resources used and the substances emitted during the successive stages of the all value chain, considering the respective environmental impacts in several compartments, in human health, the quality of ecosystems and the depletion of natural resources. Consideration of the potential of mitigation measures is also part of the objectives of the present study, to be implemented by specific recommendations to improve the efficiency of resource use and / or reduction of emissions. In this context, the target audience for this LCA study is, first and foremost, the European Commission's Directorate-General for International Cooperation and Development (DG DEVCO) and those responsible for representing the European Union to Papua New Guinea. In a second line, all stakeholders and stakeholders in the governance of the vanilla value chain are potential recipients of this work. It is hoped that the conclusions and recommendations of the present study may be useful for environmental improvement of public policies and private initiatives associated with vanilla production in Papua New Guinea.

5.4 Functional unit and reference flows

Vanilla, in terms of function, is a cash crop in Papua New Guinea, having no significance in the local diet, but presenting a high economic importance in household income. In this sense, and as previously mentioned, the present work seeks to assess the potential environmental impacts of the entire vanilla value chain, from the cultivation and incorporation of the factors of production to the point of export.
The life cycle assessment requires the definition of the functional unit (FU), understood as the quantification of the function identified for the production system in question: in the present case it is a vanilla bean, cured. The reference year is 2018 as it is considered to be an average year for vanilla production and is also the most recent year in terms of the information collected. The FU considered in the present study is:

- 1 kg of vanilla beans, cured, packaged at export point (AEP): Port Moresby (Airport), Wutung (border with Indonesia), 2018.

In the terminology applied in LCA, the reference flow (RF) is the quantity and type of materials required to produce a FU. The RF used in this study includes direct input upstream processes and characteristic emissions from vanilla agricultural production, curing process, packaging and storage and transport to the point of export. The main RFs for vanilla value chain are therefore as follows:

- 1 kg vanilla beans, cured, packaged at export point (AEP): Port Moresby (Airport), Wutung (border with Indonesia), based on a net productivity of 280,8 kg of fresh vanilla beans per hectare[61].
- 5 kg mature vanilla pods, fresh
- auxiliary materials
- emissions to water, soil and air

[61] Yield for vanilla plantations aged 3 to 7 years old (Source: Household survey, April 2019).

5.5 System boundaries

5.5.1 General system description

As a rule, LCA of agricultural products covers six steps: farm inputs, agricultural stage, production, distribution, use/consumption and waste management. In the present case, the system boundaries for this analysis encompass the relevant material and energy inputs and emissions attributable to processes in the cradle-to-export gate supply chain of vanilla production in PNG. The vanilla value chain has been grouped into the following principal processes and products from vanilla cultivation and harvesting at farm state (vanilla farming), to vanilla processing (curing), to packaging and transportation to export point-gate, as depicted in Figure 5.1.

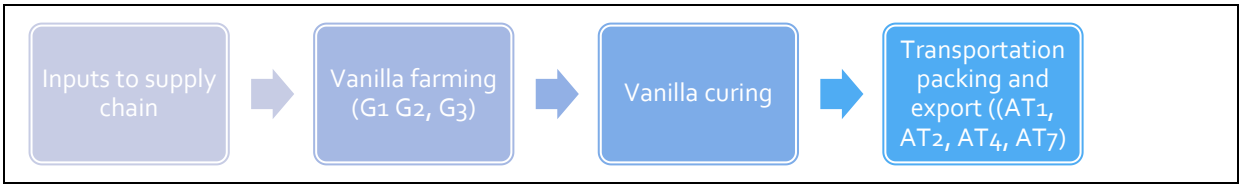


FIGURE 5.1 SYNOPSIS OF THE EAST SEPIK/PNG VANILLA SUPPLY CHAIN MODEL

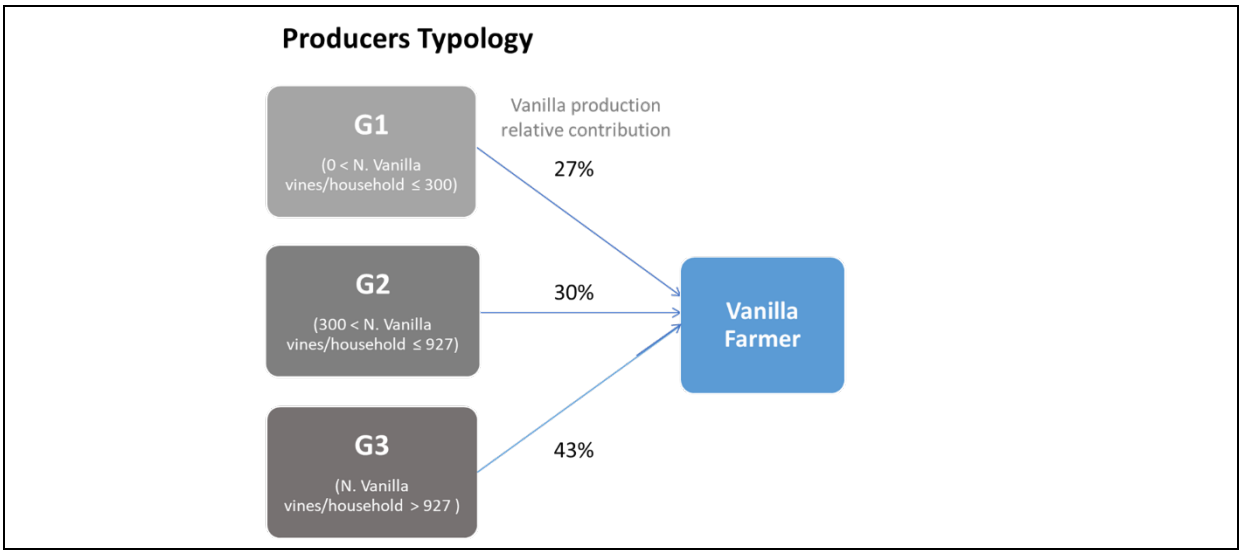
LCA considers all identifiable direct and upstream inputs and emissions to provide as comprehensive a view as is practical of the product system within each of the above processes. This analysis addresses cradle-to-export gate impacts of vanilla value chain. In this way, the production chains of inputs are traced back to natural resources. Capital goods, such as production infrastructures and buildings, were not considered in this study.

PNG vanilla value chain key actors have been identified and described in the functional analysis (section 2.7). It includes three types of producers:

- G1 - Small-scale vine owning households: [1-300] vines/household
- G2 - Medium-scale vine owning households:]300-927] vines/household
- G3 - Large-scale vine owning households:]927-5.000] vines/household

These three archetypes are identical in terms of vanilla cultivation and curing processes they used, but differ in average size of the vanilla garden, number of vanilla vines per hectare and average yield obtained (*cf.* section 2.7).

A "vanilla farmer" composite was created based on the relative contribution of producers G1, G2 and G3 to the total vanilla production (Figure 5.2). This “vanilla farmer” generically represents the part of the vanilla chain that corresponds to the sub-system “from cradle to farm gate” connecting to the sub-system “from farm to export gate”.



Different combinations of actors relate to different export routes. Four of these configurations, deemed more important, are depicted in Figure 5.3 and correspont to the sub-system "from farm to export gate" (see section 5.6.4 Transport and Packing for detailed exlanation).

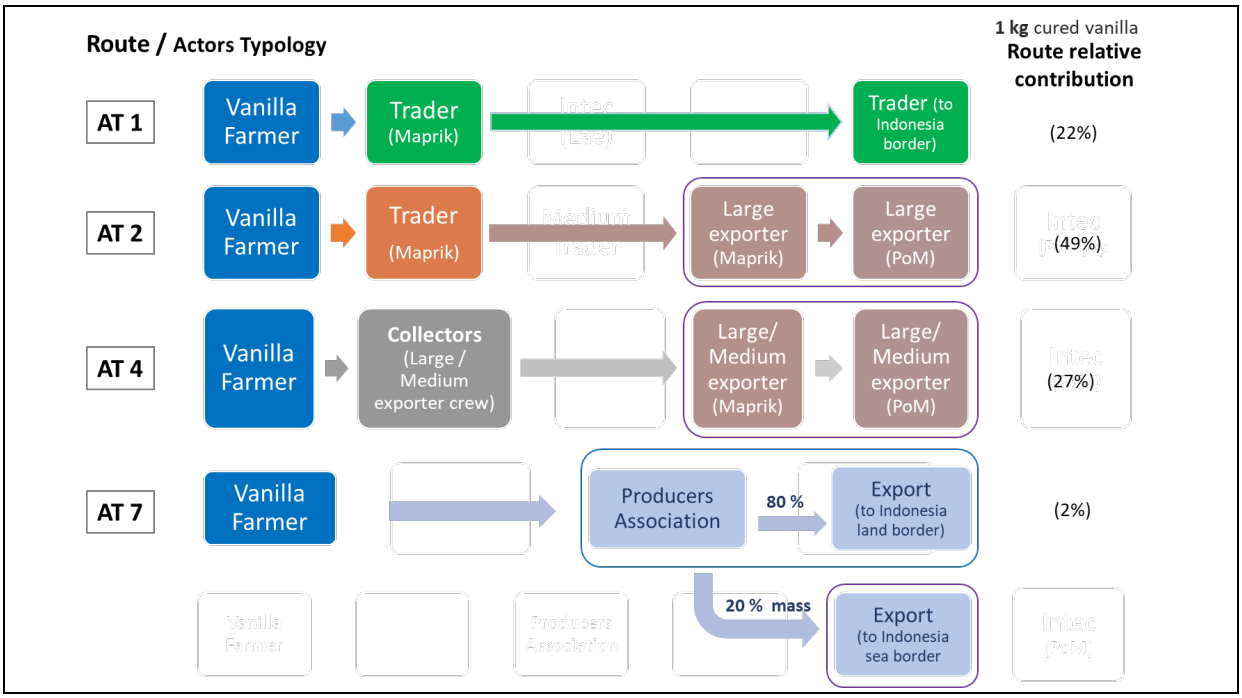


FIGURE 5.2 ROUTES ASSOCIATED TO ACTOR TYPOLOGY CONFIGURATIONS AND RELATIVE CONTRIBUTION TO TRANSPORTATION OF 1 KG VANILLA CURED BEANS, FROM FARM GATE TO EXPORT-POINT

A schematic view of the product flow for the vanilla value chain in Papua New Guinea is presented in Annex 6.

5.5.2 Temporal and geographic boundaries

This assessment is intended to be representative of vanilla production conditions in East Sepik/PNG at the time the study is conducted. Data and assumptions are intended to reflect current processes and market conditions. Data has been collected to best match these geographic and temporal conditions, fieldwork conducted in September 2018 complemented with a field survey in April 2019, provided most of the information used.

It should be noted that some processes within the system boundaries might in fact take place anywhere in the world and over a much wider range of time than the current year. For example, the processes associated with producing plastics in PNG take place both in the PNG as well as in a wide variety of other countries. The information to represent plastic production in this assessment has been selected with a preference for data representing RoW (Rest of the World). To the extent that such data is not available in all cases, it is hoped that the use of data from Europe, when needed, balances in part the actual sourcing of products from both within and outside PNG.

Regarding the temporal boundaries, certain processes may generate emissions over a longer period of time than the reference year. Regardless of such considerations, all data has been selected to as closely represent conditions in 2018 as is practical.

5.5.3 Inputs

In PNG, vanilla farmers rely on diesel powered equipment as access to electricity is very limited[62]. Practically all farmers use fuelwood for 'water killing' of *V. planifolia* pods, a process which is part of the vanilla curing stage and sunlight for curing *V. tahitensis* pods. Water availability is not a problem in vanilla production. Fertilization of the vines is done using mulch: the materials composing this substrate of culture are a mixture of fast-degrading constituents (*e.g.* dry grass, dry leaves) and slow decomposable elements (*e.g.* coconut husks, branches, bark). The use of biocides was never mentioned in the many interviews conducted, so if it occurs it will be localized and sporadic. When considering the vanilla processing and storing stages, the main inputs are plastic – clear plastic bags and vacuum bags, respectively – and cardboard boxes for export packaging.

5.6 Inventory and impact evaluation

5.6.1 Data collection, variability and uncertainty

Foreground data were collected in two occasions: from vanilla producers and traders/exporters during the team field mission in September 2018; from 100 vanilla growing households and 11 traders/trading organisations in an household survey carried out by the national expert and her team in the two main vanilla producing districts in East Sepik in April 2019.

Regarding secondary data, there are very few scientific or technical publications on vanilla although there are several training guides on vanilla production and curing. Ecoinvent database provides the only known information on the environmental impacts of vanilla growing using data from Madagascar.

Technology coverage, representativeness, reliability and uncertainty of the information were foreseen as prescribed in ISO 14044.

Representativeness for East Sepik/PNG vanilla extensive systems is reasonably assumed: all vanilla here produced is organic, rain fed, with mulch as the only input. However, the characteristics of the vanilla production PNG are quite diverse, as the field work and the analysis of the data collected in the surveys made clear. The typology of producers – *i.e.*, the definition of small G1, medium G2 and large G3 vine owning households – seems to be area/district dependent (see Annex 7). Also, the relative proportion of these class of producers was observed to vary considerably within the same district. Although this heterogeneity, local specificity and high dynamism created a challenge to model the overall system, it potentially contributes to create an LCA model that is more robust and general for East Sepik/PNG vanilla. However, it also indicates the importance of extending the survey to other relevant areas of vanila production in East Sepik.

LCA data quality was addressed considering the methodology proposed by the European Commission in the ILCD Handbook, 2010. This considers the following indicators: i) Technological representativeness (TeR), Geographical representativeness (GR), Time-related representativeness (TiR), Completeness (C), Precision / uncertainty (P) and Methodological appropriateness and consistency (M). Overall LCI Data Quality Rating (DQR) and Data Quality Level (DQL) assessment is prescribed; other methodological information can be obtained in the aforementioned document. The values of the different data quality indicators, as well as the score obtained (DQR) and the overall quality (QR), corresponding to the data sets integrated in the LCI, are presented in Annex 8.

5.6.2 Allocation

A critical point in the LCA methodology is that the value chain can induce, at some point, co-products. ISO 14044: 2006 identifies the methodologies associated with the application of the allocation process to solve the multifunctional issue. ISO 14044 provide definitions of products and wastes, where wastes are defined

[62] In PNG the percentage of rural population with access to electricity was reported at 15.47% in 2016, according to the World Bank collection of development indicators (https://tradingeconomics.com/papua-new-guinea/access-to-electricity-percent-of-rural-population-wb-data.html [accessed on 10 Jan 2019]; information gathered indicates that only rural communities adjacent to urban centres have electricity.

as materials that the process owner is required to, or intends to, dispose of. All co-products are allocated, whereas wastes are not. Databases provide various allocation functions that are required to build inventory data, either by function or by process. The present LCA study used an allocation method supported in the property "mass". No major points of multifunctionality have been identified in the studied value chain as most vanilla gardens are grown in monoculture system.

5.6.3 Cut-off criteria

All known processes and components related to the production and export of vanilla were integrated into the work whenever the necessary information was available, whether it was from PNG's own sources (official or private), international specialized literature or available from the internet from sources believed to be reliable, regardless of the size of the contribution. Thus, no specific process / cut-off process was applied to the calculations presented.

5.6.4 Life cycle inventory

Life cycle inventory (LCI) involves the compilation and quantification of inputs and outputs for a product throughout its life cycle. It is a quantitative model in which, all unit processes being studied must be accounted for by specifying the sizes of the inflows and outflows, per unit process. The four components of the LCI model for the vanilla value chain will be described below.

Land conversion and Carbon balance

Land transformation, from natural forest – primary or secondary – to vanilla cultivation results in a reduction of the carbon stock and consequent CO_2 emissions.

An Excel based tool was used to calculate these emissions for vanilla in PNG and attribute them to the cultivated crop. This instrument was the Direct Land Use Change Assessment Tool Version 2014.1 (published January 2014), developed by Blonk Consultants, Gouda, the Netherlands. It provides a predefined way of calculating greenhouse gas emissions from land use change and it is based on the PAS2050 and specifically the PAS2050-1 frameworks which describes how to derive the attribution of land transformation to a given crop/country combination.

The tool provides three basic functionalities, based on three different approaches related to data availability: (1) "*Country known & land use unknown*": this estimate is based on a number of reference scenarios for previous land use, combined with data from relative crop land expansions based on FAOSTAT data; (2) "*Country & land use unknown*": a weighted average is determined based on FAO statistics, using the same methodology as in 'country know & land use unknown' for calculating the GHG emissions for each relevant country; (3) "*Country & land use known*": these approaches are described in the PAS 2050-1 published by BSI and are made operational in the program using various IPCC data sources.

The carbon stock calculations are based on IPCC rules, and assumptions, as detailed in the tool basic documentation. The basic approach is to first calculate the carbon stocks in the soil and vegetation of the old situation and then subtract these from those of the new situation, to arrive at the total carbon stock change[63]. The assumptions for carbon stocks are dependent upon country, climate and soil type.

Vanilla related CO_2 emissions were calculated using the PAS 2050-1 protocol and the option "*Country & land use known*", with the following parameter values:

[63] An example of such a calculation can be found in the European Commission Biofuel. site[http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm].

Country of crop cultivation:	Papua New Guinea
Crop:	Vanilla
Type of crop	Perennial cropland[64]
Type of climate[65]:	Tropical, wet
Soil type[66]:	HAC[67] soils (80%); LAC[68] soils (20%)
Cultivation tillage intensity[69]:	No-till
Cultivation input level[70]:	Low
Previous vegetation type[71]: Expansion rate (20 years):	Primary tropical rain forest (60%) Secondary tropical forest (25%) Annual cropland (15%) 98,9%[72]

The estimated value for *GHG emissions from land use change* was 32,8 tonne CO_2eq/ha.year[73]

Vanilla cultivation

Vanilla planting has been described as part of a land use change process that normally involves clearing of forest (primary or secondary) areas to establish food gardens. After a period of 1 to 3 years, these gardens are then planted with cash crops like cacao, coffee or vanilla. If a food garden is replaced for a perennial cash crop, the change is irreversible, although the type of crop might change along the time in response to market prices[74]. However, this traditional farming system seems to have given way to a new system where vanilla plots are created at the direct expense of natural dense forest, as observed in Morobe province (visited in September 2018) and in Maprik and Ambunti-Dreikikir districts[75] (Vanilla Household survey, April 2019).

In PNG, vanilla is planted as a monoculture, in a semi-intensive regime. Shading is provided by the tutor tree – usually *Gliricidia sepium*. Densities recorded range from 1.5 X 2 m (3.333 tutors/ha) to 3 x 3 m (1.111 tutors/ha), with one vanilla plant per tutor. Vanilla can also be planted as part of an agroforestry system, such as found in Turubu and in the Maprik and Ambunti-Dreikikir districts (East Sepik Province); in addition to vanilla, this system includes several other economically important species - *Aquilaria acuminata* (agarwood), *Areca catechu* (betel nut) and *Jatropha curcas* (jatropha oil). The diversity of possible sources of income makes the farmer resilient to price fluctuations in the vanilla market. In Maprik and Ambunti-Dreikikir, vanilla cultivation seems to be part of a mixed system that includes several types of food crops (*cf.* Figure 4.4, section 4.2.4.3). The most common food crop is banana - banana trees are known to be planted to provide shade to the vines while tutoring trees are young, and then cut down. Although it was not possible to obtain information on the relative area occupied by food/commercial crops in vanilla plots, it was found that many of these areas were bordering the vanilla area[76].

Vanilla cultivation in PNG is low input system as there are no inputs of fertilizers, pesticides or herbicides; the vanilla vines are rainfed and the use of mulch protects the orchid's roots at the same time that provides

[64] Vanilla cultivation involves the plantation of tutor trees and the vines produce vanilla for 8-12 years before they need to be replaced.

[65] The climate types are named based on IPCC terminology. The JRC provides a world map on climate types (http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy.

[66] The soil types are named based on IPCC terminology; the JRC provides a world map on soil types (http://eusoils.jrc.ec.europa.eu/projects/RenewableEnergy).

[67] HAC - High activity clay.

[68] LAC – Low activity clay.

[69] The tillage intensity is described in Table 5.5 of IPCC 2006, Volume 4. See the section 5.2.3 for more details.

[70] The input level is described in Table 5.5 of IPCC 2006, Volume 4 (and supported by Figure 5.1). See the section 5.2.3 for more data.

[71] In a period of 20 years.

[72] Value calculated based on the data obtained in the Vanilla Household survey(April 2019).

[73] Referred to as CTL_2 and default value in section 5.7.1.

[74] Several farmers claimed to have replaced their vanilla plantations with cocoa plantations when vanilla prices fell in 2005; later, they replaced the cacao trees with tutor trees and vanilla plants, as cocoa prices were very low and vanilla prices were on the rise again.

[75] In these districts, over 92% of the vanilla plot area was planted in the same year as the natural forest was cleared and over 88% of the vanilla acreage was set less than 7 years ago.

[76] Probably due to vanilla intercropping limitations, as vanilla roots are known to be very susceptible to disturbance (*e.g.* the case of tuber crops, whose harvest creates a disturbance when planted close to the base of the support species).

mineral nutrients. The yield of fresh mature vanilla beans per hectare[77] for each class of vine-owning households is presented in the following table

Vanilla growing	Producers Typology		
	G1 (small holders)	G2 (medium holders)	G3 (large holders)
Average N.Vines / Household	191,5	599,2	172,5
Average N.Vines / ha	1840,3	1658,4	2668,8
Yield (kg green vanilla beans / ha)	614,9	134,5	143,6

(Source: Vanilla Household Survey, April 2019)

Vanilla nurseries are unknown in PNG but exist in other parts of the world (*e.g.* Madagascar). PNG vanilla farmers generate their own vanilla cuttings and propagate the vines through that process, although they might exchange / share the cuttings with family or friends.

For modelling purposes, a vanilla plantation is assumed to be a monoculture with a life period of 20 years[78]. Since vanilla is a high valuated commodity, the losses along the value chain are considered non-existent, as there is a market even for low grade / rejected vanilla.

Curing

In PNG the curing protocol consists of 5 stages: killing, starting, sweating, curing and conditioning. The objective of killing is to stop further vegetative development in the fresh pod and promote cell break-down while avoiding enzyme inactivation. In PNG, the most common vanilla bean killing protocols are heat treatment, either by uncontrolled temperature in the sun or by hot water treatment.

Only 2% of the vanilla is assumed to be water killed (D. Manukian, personal communication, 02 Sep 2018). Water killing involves heating water at 65 °C. Firewood is assumed to be the only fuel used.
The clear plastic bags used in the starting and in the 'sweating' phases are presumed to be made of polyethylene, with a density of 0,93 g/cm3 and a hold capacity of 1 kg.

Transport and Packaging

Transport

Transports are assumed to be weight-limited when the packed product has a density above 250 kg/m3 and volume-limited when the density is below 250 kg/m3[79]. Vanilla is different from other commodities, like cocoa or coffee, as the weight of traded / transported vanilla is comparatively very small. For this reason, it is assumed that the number of transports is not determined by the carrying capacity of the vehicles or aircraft but by the amount of vanilla the farmer or trader has in stock at a certain time.[80]

The transport model is based on four transport routes, each connected to a specific configuration of actors' typology (*cf.* Figure 5.3). The first two - AT1 and AT2 - assume that vanilla farmers travel individually from their villages to the point of trade (*e.g.* Maprik) to sell their produce; in the remaining two - AT4 and AT7 - the assumption is that exporters /associations travel to the farmers to buy their vanilla.

A brief characterization is provided for each route:

[77] Yield for vanilla plantations aged 3 to 7 years old.

[78] The modelling of alternative vanilla cultivation systems, either in agroforestry, in food intercropping, or both, requires specific data (*cf.* Goglio *et al.*, 2018), which not only do not exist in the literature as it would require special studies.; several vanilla plots were identified as been planted over 12 years ago, 19 years in one case (Source: Vanilla Household survey, April 2019).

[79] Weidema B P, Bauer C, Hischier R, Mutel C, Nemecek T, Reinhard J, Vadenbo C O, Wernet G (2013). Overview and methodology - Data quality guideline for the ecoinvent database version 3. ecoinvent report No. 1(v3).

[80] safety plays an important part in this as vanilla is a highly valuable product (trader, personal communication in Sep 2018).

AT1 – "Street traders"	– Vanilla producers travel by PMV[81] from their villages to Maprik to sell their vanilla; – Traders travel with their vanilla in 4WD vehicles, from Maprik to Wewak where they fly to Vanimo and then travel again in 4WD vehicles to Wutung (point of export)
AT2 – "Large exporter"	– Vanilla producers travel by PMV from their villages to Maprik to sell their vanilla to the large exporter – The large exporter sends the vanilla to Wewak where it is flown to Lae, and from there to Port Moresby (point of export)
AT4 – "Exporters"	– Exporter's agents[82] travel in 4WD vehicles from Maprik to villages to buy vanilla – Exporter sends the vanilla to Wewak where it is flown to Lae, and from there to Port Moresby (point of export)
AT7 – "Associations"	– Vanilla producer's association locally collects vanilla from farmer members – The Association travels with their vanilla in 4WD vehicles to Wewak where they fly from to Vanimo and then travel again in 4WD cars to Wutung (point of export) – The Association travels with their vanilla to Wewak and then by boat to Vanimo[83] (informal point of export)

The "equivalent" average distance matrix was calculated combining

- direct distances – obtained through GIS software from the coordinates provided
- road distances – as provided in special sites and/or measured in Google Map
- Flight distances (Air Niugini)
- Vanilla Household survey team experience – fuel consumption, travel times
- Information provided by stakeholders (September 2018)
- Vehicle sharing – people traveling together and dividing travel costs

The transport requirements associated with the vanilla value chain required to produce 1 FU are given in Table 5-1, including quantities and characteristics.

[81] PMV – public motor vehicle.

[82] Large exporter is also included in this group, since this company has agents who travel to the villages to buy vanilla.

[83] The vanilla then travels by boat from Vanimo to Jayapura.

TABLE 5-1 TRANSPORTATION MODEL FOR THE VANILLA VALUE CHAIN

Route	Mode	Equivalent Average Distance (km)	Vanilla (tkm)	Characteristic
AT1	Land	91,5	31,34	*Transport, freight, lorry 3.5-7.5 metric ton, EURO3 {RoW}| Alloc Def, U*
		74,3	-	*Transport, passenger car, large size, diesel, EURO 3 {RoW}| Alloc Def, U*
	Air	281	0,28	*Transport, freight, aircraft {RoW}| intracontinental | Alloc Def, U*
AT2	Land	91,5	31,34	*Transport, freight, lorry 3.5-7.5 metric ton, EURO3 {RoW}| Alloc Def, U*
		177,0	0,18	*Transport, freight, lorry 7.5-16 metric ton, EURO3 {RoW}| | Alloc Def, U*
	Air	831	0,51	*Transport, freight, aircraft {RoW}| intracontinental | Alloc Def, U*
AT4	Land	479,6	-	*Transport, passenger car, large size, diesel, EURO 3 {RoW}|, EURO 3 | Alloc Def, U*
		177,0	0,18	*Transport, freight, lorry 7.5-16 metric ton, EURO3 {RoW}| | Alloc Def, U*
	Air	831	0,51	*Transport, freight, aircraft {RoW}| intracontinental | Alloc Def, U*
AT7	Land	69,5	-	*Transport, passenger car, large size, diesel, EURO 3 {RoW}|, EURO 3 | Alloc Def, U*
	Air	281	0,28	*Transport, freight, aircraft {RoW}| intracontinental | Alloc Def, U*
	Sea*	351	45,55	Transport, freight, lorry 3.5-7.5 metric ton, EURO3 {RoW}| Alloc Def, U

*Fast speed boat

Packaging

Vanilla producers transport their vanilla in tied bundles of around 1 kg, normally in carrier bags or backpacks. It is assumed that only the large exporters in AT2 and AT4 routes package their vanilla prior to export. Vanilla is vacuum packed in special plastic bags that are then placed in cardboard boxes.[84] All the other traders use normal/dark plastic bags in carrier bags that are more easily accommodated in the vehicles used.

Vacuum bags were modelled as a PA/PE multilayer plastic (15/60 Polyamide (Nylon) 6/EU-27 | Polyethylene, LDPE; 75 µ); cardboard boxes were modelled as Corrugated board box {GLO}| market for corrugated board box | Alloc Def, U. (ecoinvent 3.5) (density: 0,13 kg/m2)

Emissions

The direct field emissions from vanilla cultivation are calculated based on Bengoa[85] *et al.* (2015) for dinitrogen monoxide (emission to air), and nitrate, phosphate and phosphorus (emissions to water).

[84] 5 kilograms per Vacuum bag; 25 kilograms per box (source: http://www.intecvanilla.com/).

[85] Bengoa X, Rossi, V, Humbert, S, Nemecek, T, Lansche, J, Mouron, P, Riedner, E (2015) World Food LCA Database Methodological Guidelines for the Life Cycle Inventory of Agricultural Products. Version 3.0. World Food LCA Database (WFLDB). Quantis and Agroscope, Lausanne and Zurich, Switzerland.

5.6.5 Secondary data and background processes

The ecoinvent 3.5 database was used with the "Allocation at point of substitution - unit" model. However, Industry Data 2.0 database was applied whenever considered more appropriate, (*e.g.* plastic vacuum packaging).

5.6.6 Impact assessment method and indicators

Impact assessment classifies and combines the flows of materials, energy, and emissions into and out of each product system by the type of impact their use or release has on the environment. The method used to evaluate environmental impact was the LCIA method ReCiPe89, version ReCiPe 2016 Endpoint (H). There are two mainstream ways to derive characterisation factors, *i.e.* at midpoint level and at endpoint level. ReCiPe calculates 18 midpoint indicators and 3 endpoint indicators. Midpoint indicators focus on single environmental problems and endpoint indicators show the environmental impact on three higher aggregation levels: 1) effect on human health, 2) ecosystems and 3) resource depletion or availability. Converting midpoints to endpoints simplifies the interpretation of the LCIA results but each aggregation step adds uncertainty. Figure 5.4 provides an overview of ReCiPe structure.

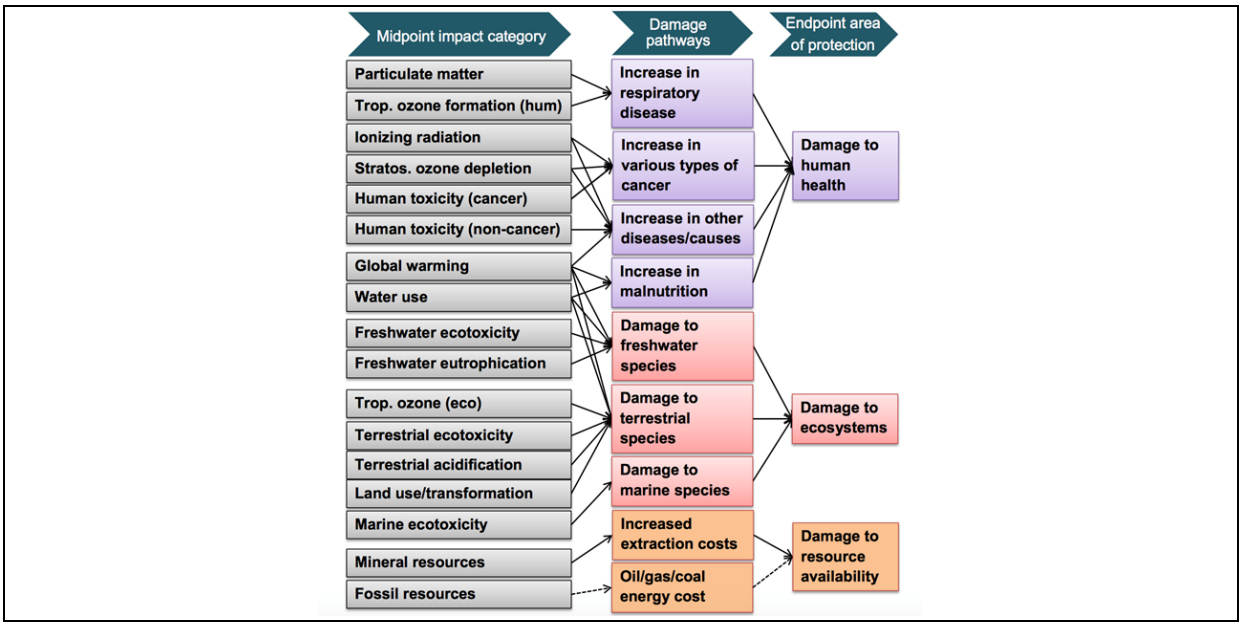


FIGURE 5.3 OVERVIEW OF RECIPE STRUCTURE

The endpoint indicators used in the current LCA are based on the following impact categories:

- Human health impact category: Impact that can be caused by the release of substances that affect humans through acute toxicity, cancer-based toxicity, respiratory effects, increases in UV radiation, and other causes. The evaluation of the overall impact of a system on human health follows the human health end-point in the ReCiPe methodology, in which substances are weighted based on their abilities to cause each of a variety of damages to human health.

- Ecosystem quality impact category: Impairment from the release of substances that cause acidification, eutrophication, toxicity to wildlife, land occupation, and a variety of other types of impact. The evaluation of the overall impact of a system on ecosystem quality follows the Ecosystem quality endpoint ReCiPe methodology, in which substances are weighted based on their ability to cause each of a variety of damages to wildlife species.

- Resources depletion impact category: Depletion caused when non-renewable resources are used or when renewable resources are used at a rate greater than they can be renewed; various materials can be

weighted more heavily based on their abundance and difficulty to obtain. The evaluation of the overall impact of a system on resource depletion follows the resources end-point in the ReCiPe methodology.

Finally, it should be noted that while LCA is the right tool to assess sustainability complexity it does not predict whether standards or safety margins are exceeded. The same precaution should be used in midpoints and endpoints analysis.

5.6.7 Calculation tool

SimaPro 9.0.0.35 software, developed by PRé Consultants was used to assist modelling, to link the reference flows with the LCI database and to compute the complete LCI of the systems in the present LCA study. LCI results were calculated combining foreground data (intermediate products and elementary flows) with generic datasets providing cradle-to-export gate background elementary flows to create an inventory of the two systems.

5.6.8 Contribution analysis

Contribution analysis aims to determine the extent to which each process modelled contributes to the overall environmental impact. In this study, the contribution analysis was simplified and was based on observation of the relative importance of the different processes to the overall potential impact. In this sense, the relative magnitude of the vanilla value chain was examined, considering human health, ecosystem quality and resource depletion (ReCiPe 2016 Endpoint) as indicators.

5.7 Results: Life Cycle Impact Assessment

Environmental impacts induced by the vanilla production system in East Sepik are presented in order to show the relative importance of characterization parameters to each of the 3 damage categories. After, the systemic perspective is unfolded to:

- Analyse the relative contribution of the three classes of typology of vanilla producers to the three classes of damage
- Understand the relative contribution to the environmental impacts of the main commercial routes to the point of export, involving different types of actors.

5.7.1 VC systemic perspective

The life cycle inventory to produce 1 kg of vanilla (*i.e.* 1 FU) of vanilla is given below:

- 63.3 vanilla plants
- 5 kg of vanilla mature green beans
- 288.3 m^2 in soil occupation
- 0.89 g of polyamide (packaging)
- 3.66 g of polyethylene, LDPE (curing, packaging)
- 8.59 g of corrugated board box (packaging)
- 13.75 kg of fuel (diesel)
- 0.31 kg of airplane fuel (kerosene)

The environmental impacts induced by the vanilla row in East Sepik (PNG), considering as end points Human Health, Ecosystem Quality and Resource Depletion, are presented in Table 5-2

TABLE 5-2 DAMAGE ASSESSMENT RESULTS OF VANILLA PRODUCTION (EAST SEPIK, PNG) [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / EXCLUDING INFRASTRUCTURE PROCESSES]

			Transportation and Packaging						Vanilla Farming		
Damage category	Unit	Total	AT7	AT4	AT2	AT1	Vanilla Farmers	Vanilla Curing	G3	G2	G1
Human health	DALY	9,56E-04	0,13%	5,36%	0,09%	0,70%	1,43%	0,00%	48,28%	37,10%	6,92%
Ecosystems	species.yr	9,45E-06	0,04%	1,63%	0,03%	0,21%	0,50%	0,00%	51,05%	39,23%	7,31%
Resources	USD2013	8,25E+00	1,61%	70,03%	1,29%	9,10%	17,96%	0,01%	0,00%	0,00%	0,00%

Absolute impacts are expressed per functional unit, 1 kg of cured vanilla, at export gate. Relative contribution to overall impacts is also provided (relative contribution is coloured in red if >50%, in rose if 20-50%, in yellow if 5-20% and green if lower than 5%.

The results obtained show the major weight of the descriptor "Vanilla farming" in the Quality of the Ecosystems and in the Human Health, specially the classes of large and of medium vine-owning households which have greater impact. Only the transportation and packaging of vanilla contributes to Resource Depletion; here we highlight route AT4 (exporters who travel to the villages to buy vanilla and then export it from Port Moresby) as the one with the highest relative weight. The impacts of vanilla curing are negligible.
Figure 5.5 presents additional characteristics related to the environmental impacts of the vanilla value chain in final points, showing the relative contribution of each impact category. It shows that Human Health is almost totally driven by Global Warming (97,5%). Ecosystems Quality indicator is defined by Land Use (69,4%) and Global Warming (29,8%), while Resources Depletion is totally defined by Fossil Resource Scarcity.

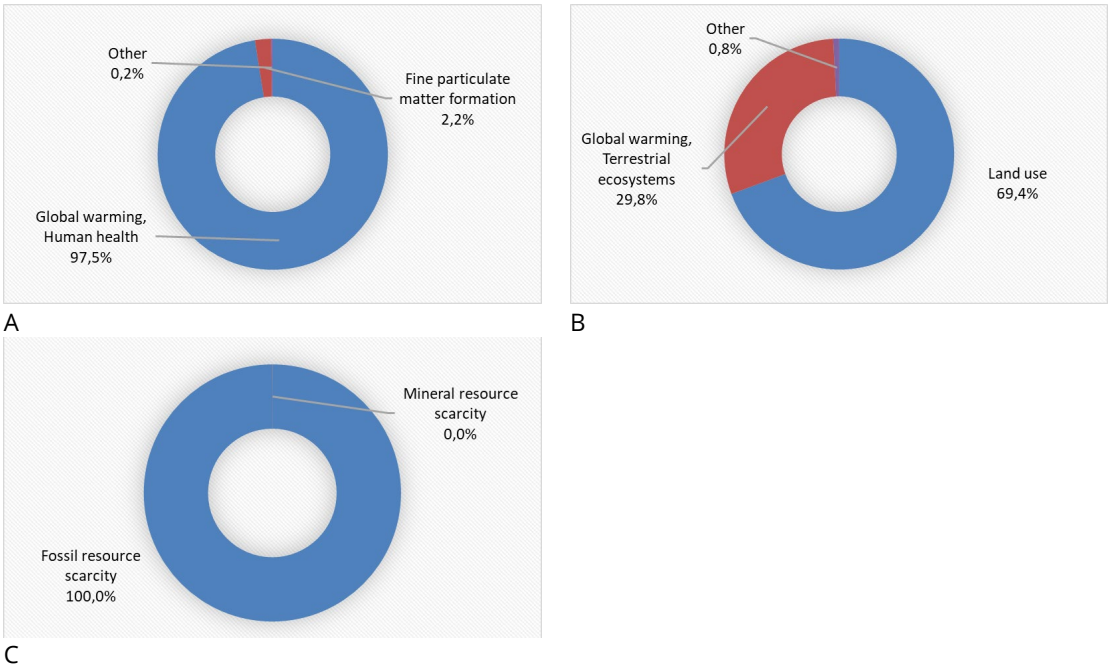


FIGURE 5.4 RELATIVE IMPORTANCE OF MIDPOINTS TO DAMAGE CATEGORIES OF VANILLA PRODUCTION (EAST SEPIK, PNG) - HUMAN HEALTH (A), ECOSYSTEMS QUALITY (B) AND RESOURCES DEPLETION (C) [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / EXCLUDING INFRASTRUCTURE PROCESSES]

Absolute impacts of each characterization category regarding vanilla production, as well as the relative contributions of different value chain activities to each category, are presented in Table 5-3. The results highlight the following aspects:

- Land use impact reflects the vanilla vine-owning groups different productive efficiency, with the less efficient (large vanilla vines owning households) needing a higher number of vines, and thus more land, to produce the same quantity of cured vanilla beans;

- Global warming impacts are the consequence of GHG emissions; in the present case the gas is mainly CO_2 that resulted from land transformation as almost all the land was forest prior to be cleared for vanilla plantation; again less efficient groups will have deforested more land to produce the same amount of vanilla;
- Freshwater eutrophication and ozone depletion are related to natural processes of organic matter decomposing and soil leaching (*cf.* Bengoa *et al.*, 2015); higher values are a consequence of lower vanilla yields, for the reasons already explained;
- Fossil resource scarcity and fine particulate matter, among other impact categories (*e.g.* ozone formation), are strongly related to vanilla transportation; the characteristics of each type of route, in terms of amount of vanilla transported, distances involved, number of travels, mode of transport and type of vehicle, determine the relative weight of each route typology[86] (*cf.* section 5.6.4);

TABLE 5-3 CHARACTERIZATION IMPACTS OF VVC (EAST SEPIK, PNG) - RECIPE 2016 ENDPOINT (H) [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / EXCLUDING INFRASTRUCTURE PROCESSES]

			Transportation and Packaging						Vanilla Farming		
Impact category	Unit	Total	AT7	AT4	AT2	AT1	Vanilla Farmers	Vanilla Curing	G3	G2	G1
Global warming, Human health	DALY	9,321E-04	0,09%	3,76%	0,07%	0,49%	0,97%	0,00%	49,50%	38,04%	7,09%
Global warming, Terrestrial ecosystems	species.yr	2,812E-06	0,09%	3,76%	0,07%	0,49%	0,97%	0,00%	49,50%	38,04%	7,09%
Global warming, Freshwater ecosystems	species.yr	7,683E-11	0,09%	3,76%	0,07%	0,49%	0,97%	0,00%	49,50%	38,04%	7,09%
Stratospheric ozone depletion	DALY	1,602E-07	0,10%	4,96%	0,09%	0,64%	1,00%	0,00%	48,75%	37,46%	6,99%
Ionizing radiation	DALY	5,268E-09	1,63%	69,80%	1,18%	9,05%	18,33%	0,03%	0,00%	0,00%	0,00%
Ozone formation, Human health	DALY	2,008E-07	1,90%	59,90%	1,39%	7,81%	29,00%	0,00%	0,00%	0,00%	0,00%
Fine particulate matter formation	DALY	2,145E-05	1,65%	69,20%	0,95%	8,96%	19,22%	0,01%	0,00%	0,00%	0,00%
Ozone formation, Terrestrial ecosystems	species.yr	2,897E-08	1,90%	60,03%	1,39%	7,82%	28,86%	0,00%	0,00%	0,00%	0,00%
Terrestrial acidification	species.yr	3,013E-08	1,77%	64,29%	1,42%	8,37%	24,13%	0,00%	0,00%	0,00%	0,00%
Freshwater eutrophication	species.yr	1,481E-08	0,07%	2,97%	0,04%	0,38%	0,82%	0,00%	50,07%	38,48%	7,17%
Terrestrial ecotoxicity	species.yr	3,623E-09	2,07%	55,76%	0,30%	7,18%	34,70%	0,00%	0,00%	0,00%	0,00%
Freshwater ecotoxicity	species.yr	6,266E-11	1,81%	64,24%	0,61%	8,28%	25,04%	0,02%	0,00%	0,00%	0,00%
Marine ecotoxicity	species.yr	2,508E-11	1,93%	60,35%	0,48%	7,78%	29,46%	0,01%	0,00%	0,00%	0,00%
Human carcinogenic toxicity	DALY	5,626E-07	1,67%	68,57%	1,01%	8,88%	19,86%	0,01%	0,00%	0,00%	0,00%
Human non-carcinogenic toxicity	DALY	1,054E-06	1,91%	60,80%	0,51%	7,83%	28,92%	0,02%	0,00%	0,00%	0,00%
Land use	species.yr	6,554E-06	0,00%	0,12%	0,00%	0,02%	0,04%	0,00%	52,22%	40,13%	7,48%
Mineral resource scarcity	USD2013	1,82E-03	1,70%	68,57%	0,35%	8,80%	20,57%	0,01%	0,00%	0,00%	0,00%
Fossil resource scarcity	USD2013	8,25E+00	1,61%	70,03%	1,29%	9,10%	17,96%	0,01%	0,00%	0,00%	0,00%
Water consumption, Human health	DALY	2,30E-07	1,62%	69,75%	1,37%	9,04%	18,13%	0,09%	0,00%	0,00%	0,00%
Water consumption, Terrestrial ecosystem	species.yr	1,40E-09	1,62%	69,75%	1,37%	9,04%	18,13%	0,09%	0,00%	0,00%	0,00%
Water consumption, Aquatic ecosystems	species.yr	6,25E-14	1,62%	69,75%	1,37%	9,04%	18,13%	0,09%	0,00%	0,00%	0,00%

Absolute impacts are expressed per functional unit, 1 kg of cured vanilla, at export gate. Relative contribution to overall impacts is also provided (relative contribution is coloured in red if >50%, in rose if 20-50%, in yellow if 5-20% and green if lower than 5%.

5.7.2 VC: focus on vanilla producers

Because vanilla farming was identified as the main activity regarding impact magnitude on vanilla value chain endpoint categories, a more detailed analysis was performed comparing the environmental impacts of the production of 1 kg of vanilla by each of the three classes of vanilla vine households. As all impact categories are affected in the same relative proportion, a single graph is presented, summarising the results (Figure 5.6). There is a marked difference in the environmental performance of the three groups, especially the small

[86] it is worth remembering that transportation by walking is quite significative among farmers and is not modelled in the LCA.

farmers' class as the one with the best environmental performance - the production of 1 kg of cured vanilla causes only 21% of the impact of the same amount of vanilla production by the medium vine owning households, the class with the worst environmental performance.

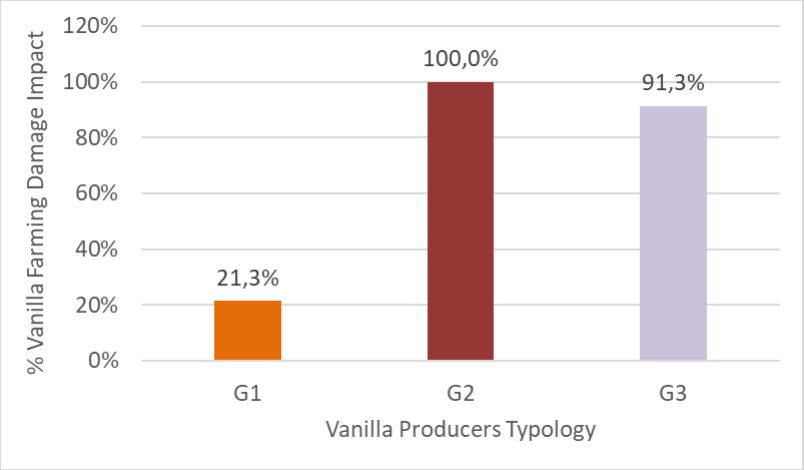


FIGURE 5.5 RELATIVE DAMAGE IMPACT ASSOCIATED TO THE PRODUCTION OF 1 KG OF VANILLA CURED BEANS BY EACH CLASS OF VINE-OWNING HOUSEHOLDS (G1-SMALL; G2-MEDIUM; G3-LARGE) [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / DAMAGE ASSESSMENT / EXCLUDING INFRASTRUCTURE PROCESSES]

5.7.3 VC: focus on transportation routes

The transport of 1 kg of vanilla along each of the four identified routes, from the place of production to the point of export, causes major or minor environmental impacts, depending on the characteristics of the route, the type of transport used, and the logistics involved. In order to assess the relative level of environmental damage associated with these routes, a comparative analysis was carried out, whose results are presented in Figure 5.7.

The route with the greatest impact is route A4, associated with the purchase of cured beans in the villages by teams from vanilla exporting companies. These journeys can be long (may last more than three days) and involve the use of individualized four-wheel drive vehicles (see section 5.6.4). The environmental consequences are particularly evident in depletion of fossil resources (higher fuel consumption). On the other hand, the route with the least environmental impact is A2, associated with the large exporter, whose main characteristic is the transport, by freight lorry, of vanilla from Maprik to Wewak, where it is then transported by air to Lae, and from there to Port Moresby (point of export). Overall, these results seem to indicate the existence of an "economy of scale" effect in environmental terms, an aspect that will be explored in section 5.8.1 (Sensitivity analysis).

Air transportation is not environmentally relevant as the very low kerosene consumption can attest (*cf.* section 5.6.8)

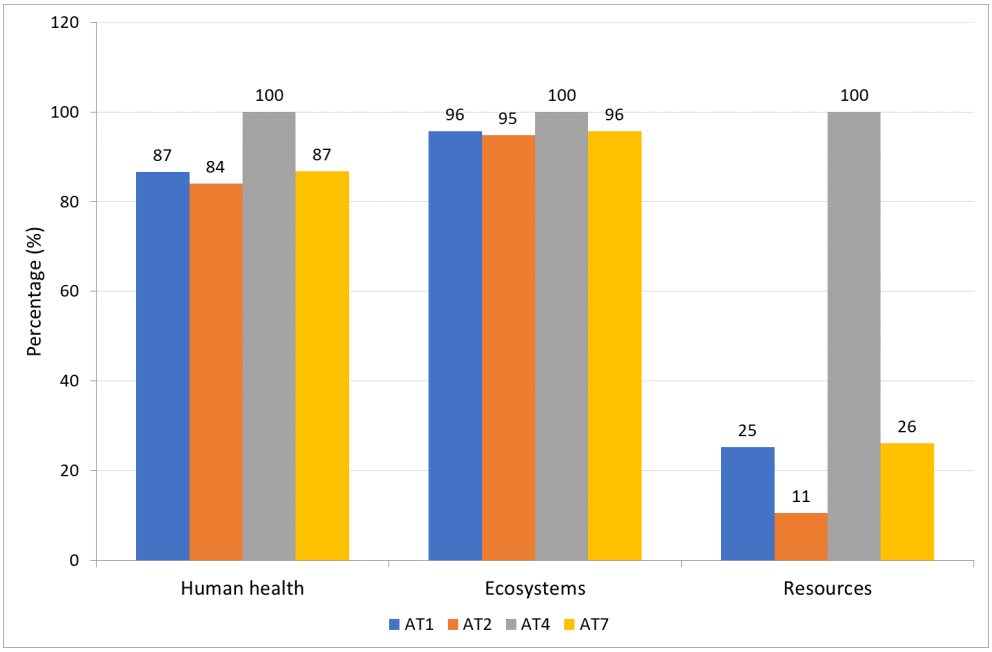


FIGURE 5.6 DAMAGE ASSESSMENT COMPARISON FOR TRANSPORTATION OF 1 KG THROUGH ROUTES AT1, AT2, AT4 AND AT7 IN EAST SEPIK/PNG [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / DAMAGE ASSESSMENT / EXCLUDING INFRASTRUCTURE PROCESSES]

5.8 Discussion

5.8.1 Sensitivity analysis

From the exploratory analysis and from the contribution analysis, three processes were identified as contributing the most to the different environmental impacts. The sensitivity of the three most influential factors was verified:

- Yield - as amount of vanilla (cured beans) produced per ha or as number of vanilla plants necessary to produce 1 kg of cured beans per year.
- The land conversion fraction (area converted from forest per ha of grown vanilla) which also reflects variation in the balance of carbon per area of land converted.
- Transportation: Road distances – namely from farmer's villages to the main centre (Maprik) and/or to the export gate, as it influences the average diesel consumption and the fossil resource depletion; Car sharing – from the villages to Maprik and to the export gate, car sharing is common among street traders and producers' associations and it affects average diesel consumption per individual seller, per trip.

Yield

The sensitivity of the three damage categories to this driver was tested by running the overall model with a +10% and +20% deviation and a -10% and – 20% deviation of the parameter "number of vines necessary to produce 1 kg of cured vanilla" for each typology of producer (G1, G2, G3).

The results, presented in Table 5-4, show a general linear effect, where an increase in yield leads to a proportional reduction of impacts, while a decrease in production leads to an increase in negative effects on the damage categories. Both Human health and Ecosystems benefit from an increase in yield in an almost exact proportion (slope ≈ 1).

TABLE 5-4 SENSITIVITY OF THE VVC MODEL, IN THE THREE DAMAGE CATEGORIES, TO DEVIATIONS OF + 20% TO -20% FROM THE AVERAGE NUMBER OF PLANTS REQUIRED TO PRODUCE 1 KG OF VANILLA (CURED BEANS)

			Yield			
Damage category	**Unit**	**Base Model**	**-20%**	**-10%**	**+10%**	**+20%**
Human health	DALY	9,557E-04	18,5%	9,2%	-9,2%	-18,5%
Ecosystems	species.yr	9,445E-06	19,5%	9,8%	-9,8%	-19,5%
Resources	USD2013	8,254E+00	0,0%	0,0%	0,0%	0,0%

The VVC model does not explicitly include the aspect of vanilla quality (*e.g.* Grade A, Grade B[87]), as the available information was found to be insufficient for this purpose. It is possible, however, to estimate[88] the potential increase in vanilla yield if all cured beans produced were Grade A. This scenario corresponds to a 21.3% increase in the number plants required to produce 1 kg of cured vanilla. The effects are a reduction in environmental impacts on human health and ecosystems by 20% and 21% respectively (Table 5-5).

TABLE 5-5 POTENTIAL ENVIRONMENTAL IMPACTS OF 100% GRADE A VANILLA PRODUCTION BY REFERENCE TO VVC BASE MODEL

Damage category	**Unit**	**Base Model**	**100% A Grade vanilla**	**Impact Effect (%)**
Human health	DALY	9,557E-04	7,682E-04	-19,62%
Ecosystems	species.yr	9,445E-06	7,486E-06	-20,75%
Resources	USD2013	8,254E+00	8,254E+00	0,00%

Land use change / Carbon balance

Land use transformation, expressed as expansion rate, was analysed considering -10%, -20%, -30% and -40% deviation from the base model value of 98,9% (*cf.* section 5.6.4.). The sensitivity analysis results for the three damage categories are presented in Table 5-6. Both Human health and Ecosystems benefit from a decrease in the rate of land transformation associated to vanilla expansion, but the positive aspects are more profound in the Human health area of protection (slope ≈ 1). This result reflects the direct impact of land transformation on carbon emissions that in the case of PNG vanilla is mainly due to deforestation.

TABLE 5-6 SENSITIVITY OF THE VVC MODEL, IN THE THREE DAMAGE CATEGORIES, TO DEVIATIONS OF – 10% TO -40% FROM THE OVERALL MODEL VANILLA EXPANSION RATE.

			Expansion rate (20 years)			
Damage category	**Unit**	**Base Model**	**-10%**	**-20%**	**-30%**	**-40%**
Human health	DALY	9,557E-04	-9,2%	-18,3%	-27,5%	-36,6%
Ecosystems	species.yr	9,445E-06	-2,8%	-5,6%	-8,4%	-11,2%
Resources	USD2013	8,254E+00	0,0%	0,0%	0,0%	0,0%

For the carbon emissions sensitivity analysis, six scenarios of land use change were evaluated: the first three correspond to conditions where CO_2 emissions are lower than the reference model (CTL_2); the other three represent circumstances where CO_2 emissions are higher than the base model. Direct Land Use Change Assessment Tool v. 2014.1 (Blonk, 2014) was the instrument used to estimate the GHG emissions from land transformation in PNG. The parameterization of each scenario is detailed in Annex 9, but a brief summary is given bellow:

[87] Grade A: 5 to 4 g per cured vanilla bean; Grade B: 4 to 3 g per cured vanilla bean).

[88] Computation based on the comparison, for each vanilla producer typology, between the average production value relative to households that only produce Grade A vanilla and the global average value, considering all vanilla producing households. The largest calculated difference was 21.3%, registered to typology G1.

- Emission model CTL_00 reflects the world vanilla situation, considering the world production areas in all countries for this crop; the normal average takes into account the differences in crop expansion at the expense of forest, grassland, annual/perennial crops); this scenario corresponds to the lowest value of CO_2eq emission;
- CTL_0 also reflects the world vanilla situation, considering the world production areas in all countries for this crop; the weighted average takes into account relative differences in crop expansion at the expense of forest, grassland, annual/perennial crops weighted by the amount of vanilla produced;
- CTL_1 assumes that land with tropical forest (primary and secondary), annual crop and perennial crops (as cocoa) is transformed into vanilla gardens - actually, this last situation occurred during the first boom of vanilla production in PNG, when several farmers substituted their cocoa plantations for vanilla gardens (D. Manukian, personal communication, 02 Sep 2018);
- CTL_3 replicates the fact that areas occupied by forests are being transformed directly into vanilla plantations without an intermediate period of annual crops; this scenario also considers the transformation of land with perennial crops into vanilla gardens;
- CTL_4 corresponds to a situation where the tropical forest is cleared for vanilla plantation, as found in the areas covered by the Household Survey (April 2019);
- CTL_5 only differs from the scenario CTL_4 in the fact that vanilla is now modelled as annual cropland (as predefined by the Direct Land Use Change Assessment Tool, in accordance with PAS2050-1 methodology); this scenario corresponds to the highest value of CO_2eq emission.

The six alternatives were compared with the CTL_2 land use change scenario used in LCA model. The relative deviations are shown in Table 5-7, where CLT_2 is used as reference and the values corresponding to the damage categories and the "Global warming" impact classes displayed[89]. The results show a linear effect (r^2=1), where a relative increase in CO_2 emission leads to a proportional increase of environmental damage / "Global warming" impacts, while a decrease in emissions leads to a decrease in negative effects on the damage / impacts categories.

[89] CO_2 emissions due to land use change affect only the three "global warming" impact categories by the same relative proportion; thus, for the sake of clarity, resulting deviations are displayed as a single line for each scenario.

TABLE 5-7 SENSITIVITY ANALYSIS OF THE VANILLA VALUE CHAIN LCA MODEL FOR DIFFERENT LAND USE CHANGE SCENARIOS (SEE TEXT FOR EXPLANATION)

CO2 emission Scenarios	Unit	CTL_2 (Base model)	CTL_00	CTL_0	CTL_1	CTL_3	CTL_4	CTL_5
CO2 emissions	t CO2 eq /ha	32,79	7,44	12,82	29,36	38,21	42,66	47,65

Damage category	Unit	CTL_2 (Base model)	CTL_00	CTL_0	CTL_1	CTL_3	CTL_4	CTL_5
Human health	DALY	9,56E-04	-70,8%	-55,8%	-9,6%	15,1%	27,5%	41,5%
Ecosystems	species.yr	9,45E-06	-21,6%	-17,0%	-2,9%	4,6%	8,4%	12,7%
Resources	USD2013	8,25E+00	0%	0%	0%	0%	0%	0%

Impact category	Unit	CTL_2 (Base model)	CTL_00	CTL_0	CTL_1	CTL_3	CTL_4	CTL_5
Global warming, Human health	DALY	9,32E-04						
Global warming, Terrestrial ecosystems	species.yr	2,81E-06	-72,6%	-57,2%	-9,8%	15,5%	28,2%	42,5%
Global warming, Freshwater ecosystems	species.yr	7,68E-11						

Although the model used does not incorporate vanilla cultivation under agroforestry or with food intercropping (*cf.* section 5.6.4) , it is expected that, under these circumstances, the carbon loss due to vanilla farming will be lower than for the base model due to maintenance of soil organic carbon and build-up of organic matter.

Transportation - Travel distances by road

To the exception of a few main roads - the highway between Maprik and Wewak or the road that connect Vanimo to Wutung – transportation distances are very difficult to calculate due to the complex topography of most of East Sepik. A "terrain factor" based on experience and notes from the research team was used to compensate for "crow flight" distances, knowing however that locals and people familiar with the area may know alternative (much) shorter routes. Having that in mind, the sensitivity of the damage categories to this driver was tested by running the overall model with a -20% to +20% deviation, with 10% intervals.

The results obtained, shown in Table 5-8, show an approximate linear relationship between distance travelled and environmental damage, with greater impact on resource depletion (slope ≈1).

TABLE 5-8 SENSITIVITY ANALYSIS OF THE VANILLA VALUE CHAIN LCA MODEL FOR TRAVEL DISTANCES

			Distance			
Damage category	Unit	Base Model	-20%	-10%	+10%	+20%
Human health	DALY	9,557E-04	-1,5%	-0,8%	0,8%	1,5%
Ecosystems	species.yr	9,445E-06	-0,5%	-0,2%	0,2%	0,5%
Resources	USD2013	8,254E+00	-19,6%	-9,8%	9,8%	19,6%

Transportation - Car sharing

Car sharing is common among street traders (typology A1) and producers' associations (typology A7) when carrying their vanilla to Wutung, in the border with Indonesia. By having more people using one vehicle, car sharing reduces each person's travel costs such as fuel costs and increases personal and cargo safety – this

being the main reason for travelling as a group. Car sharing is also considered a more environmentally friendly and sustainable way to travel as sharing journeys reduces carbon emissions and pollution.
To evaluate the sensitivity of the LCA model to the type of car sharing, two different car sharing modes were considered apart from the default sharing mode which corresponds to a group of 6 people sharing a 4WD vehicle:

Car sharing (half) – a group of 3 people share the same type of vehicle

Individual travelling – the trader travels by himself or with its own security people.

The results expressed as the relative increase in environmental burdens in relation to the default situation (car sharing: 6 people) are shown in Table 5.9. As expected, reducing the number of people sharing a car implies an increase in environmental parameters related to fuel consumption (*eg*, fuel resource scarcity, fine particulate matter). However, if the reduction in the number of participants in cars from 6 to 3 results in an increase of about 10% of the fuel consumption impact figures, individual travel more than quadruplicates this percentage.
From an environmental perspective, vanilla value chain strongly benefits from the actual situation where traders and/or association representatives opt to move in groups when travelling to the export point to sell their vanilla.

TABLE 5-9 PERCENTAGE OF VARIATION OF DAMAGE AND IMPACT CATEGORIES FOR THE VVC IN TWO CAR SHARING MODES USED BY TRADERS AND PRODUCER ASSOCIATIONS USING THE DEFAULT LCA MODEL AS REFERENCE (SEE TEXT FOR EXPLANATION)

Damage category	Unit	Car sharing (default)	Car sharing (half)	Individual travelling
Human health	DALY	9,557E-04	1%	4%
Ecosystems	species.yr	9,445E-06	0%	1%
Resources	USD2013	8,254E+00	10%	49%

Impact category	Unit	Car sharing (default)	Car sharing (half)	Individual travelling
Global warming, Human health	DALY	9,321E-04	1%	3%
Global warming, Terrestrial ecosystems	species.yr	2,812E-06	1%	3%
Global warming, Freshwater ecosystems	species.yr	7,683E-11	1%	3%
Stratospheric ozone depletion	DALY	1,602E-07	1%	3%
Ionizing radiation	DALY	5,268E-09	10%	49%
Ozone formation, Human health	DALY	2,008E-07	8%	42%
Fine particulate matter formation	DALY	2,145E-05	10%	49%
Ozone formation, Terrestrial ecosystems	species.yr	2,897E-08	8%	42%
Terrestrial acidification	species.yr	3,013E-08	9%	45%
Freshwater eutrophication	species.yr	1,481E-08	0%	2%
Terrestrial ecotoxicity	species.yr	3,623E-09	8%	39%
Freshwater ecotoxicity	species.yr	6,266E-11	9%	45%
Marine ecotoxicity	species.yr	2,508E-11	9%	43%
Human carcinogenic toxicity	DALY	5,626E-07	10%	48%
Human non-carcinogenic toxicity	DALY	1,054E-06	9%	43%
Land use	species.yr	6,554E-06	0%	0%
Mineral resource scarcity	USD2013	1,817E-03	10%	49%
Fossil resource scarcity	USD2013	8,252E+00	10%	49%
Water consumption, Human health	DALY	2,296E-07	10%	49%
Water consumption, Terrestrial ecosystem	species.yr	1,396E-09	10%	49%
Water consumption, Aquatic ecosystems	species.yr	6,246E-14	10%	49%

Absolute impacts are expressed per functional unit, 1 kg of cured vanilla, at export gate. Relative shift of each impact category is also provided (relative shift is coloured in red if over or equal to 50%, in orange if 20-50%, in blue if 5-20%, in black if lower than 5%)

5.8.2 Comparing cultivation of vanilla in East Sepik with Madagascar

To date, there are no public-domain publications with values of the environmental impacts associated with the production of vanilla (*cf.* Konstantas *et al.*, 2019). However, the Ecoinvent database includes the process[90] "Vanilla {MG} | vanilla production | Alloc Def, U ". Since the LCA model generated for vanilla production in East Sepik follows a basic architecture equivalent to that of the Ecoinvent process, it was decided to use the latter as a benchmarking of the East Sepik system - vanilla farming component.

Ecoinvent dataset was modelled within the project 'World Food LCA database (WFLDB); the production system regarded in the dataset aimed at representing vanilla produced in the Madagascar for the export

[90] https://v33.ecoquery.ecoinvent.org/Account/LogOn?ReturnUrl=%2fDetails%2fPDF%2fBEA320E7-49FC-41BB-9EC0-780D5029EF2F%2f06590A66-662A-4885-8494-AD0CF410F956

market; it characterises the production of 1 kg of vanilla, with an average yield from 750 kg/ha (referred to 2013). Included activities start with the nursery of vanilla plants and ends with the harvest of vanilla at farm gate. The dataset includes all activities of a year in the productive phase (8 years) and transport on farm. Activities in the establishment phase (3 years) include manual planting. Activities in the productive phase include harvest of vanilla plants. Further, direct field emissions and land use change are included. Heavy metal uptake by the crop is considered. The dataset doesn't include: (i) irrigation, fertilizers or pesticides, because they are not applied due to extensive production where cultivation is done mainly manually; (ii) materials for the planting, establishment and clearing phase, and; (iii) drying because vanilla is dried at ambient temperature. Direct field emissions in this production system are not caused by fertilizer or pesticide inputs from human activity but are related to deposition of nutrients, nutrient content of the soil and erosion. The results obtained are presented in Table 5-10 and in Figure 5.8

TABLE 5-10 COMPARISON OF THE IMPACTS GENERATED BY THE CULTIVATION OF 1 KG OF VANILLA IN MADAGASCAR [ECOINVENT 3.5, VANILLA {MG} | VANILLA PRODUCTION | ALLOC DEF, U "] WITH 1 KG VANILLA IN EAST SEPIK (PNG) [PROFILE "VANILLA FARMER"] - [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / DAMAGE ASSESSMENT / EXCLUDING INFRASTRUCTURE PROCESSES]

Damage category	Unit	Madagascar	East Sepik/PNG	Ratio [PNG]/[MG]
Human health	DALY	1,233E-06	8,821E-04	715,6
Ecosystems	species.yr	6,088E-07	9,218E-06	15,1
Resources	USD2013	4,989E-04	0,000E+00	0,0

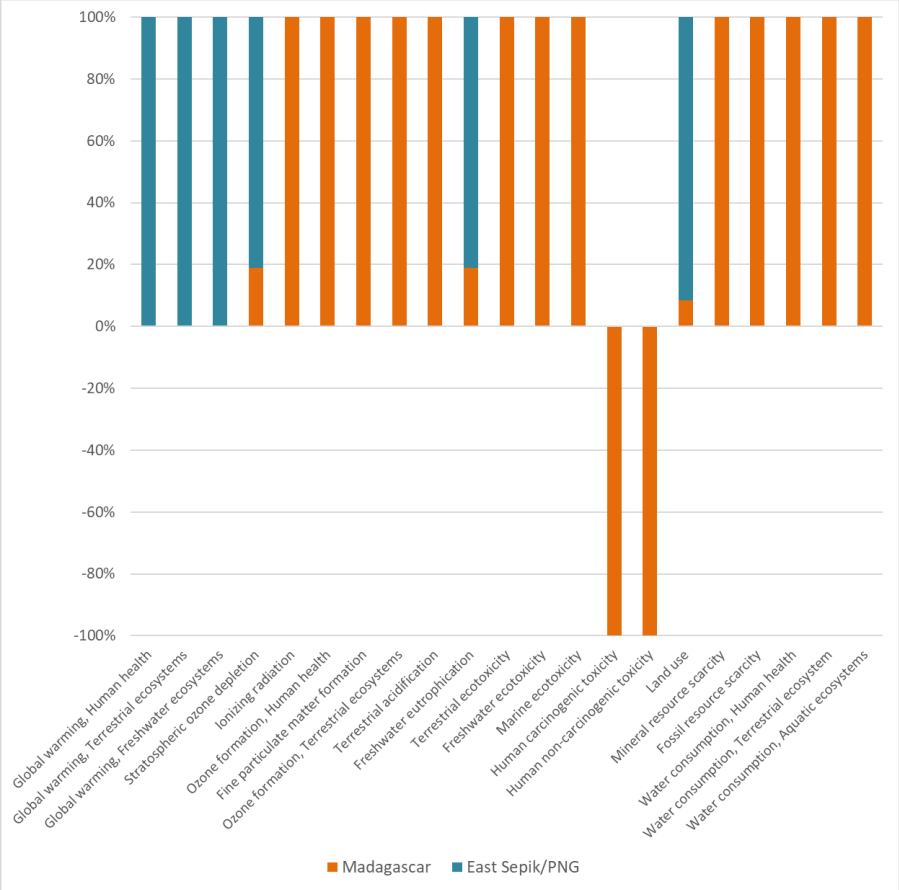


FIGURE 5.7 COMPARISON OF THE IMPACTS GENERATED BY THE CULTIVATION OF 1 KG OF VANILLA IN MADAGASCAR [ECOINVENT 3.5, VANILLA {MG} | VANILLA PRODUCTION | ALLOC DEF, U "] WITH 1 KG VANILLA IN EAST SEPIK (PNG) [PROFILE "VANILLA FARMER"] - [METHOD: RECIPE 2016 ENDPOINT (H) V1.00 / CHARACTERIZATION IMPACTS / EXCLUDING INFRASTRUCTURE PROCESSES]

Four aspects stand out:

- the impact in terms of climate change is much higher in PNG (more than 400 times higher), result of the alteration of the land use with the existing forest cut and the consequent decrease of carbon retained in biomass and soil, coupled with low yields;
- this latter factor is also involved in the value of "Land use" which is more than 10 times higher in PNG, even though in Madagascar the use of vanilla nurseries to produce seedlings signifies that more area is used to produce 1 kg of cured vanilla;
- regular use of tractors in activities associated with vanilla cultivation in Madagascar implies a set of impacts, mainly at the level of ecosystems, which do not exist in PNG.
- Human Health (DALY) is the damage category that is by far the most affected with production of 1 kg of cured vanilla in PNG vs. Madagascar (over 700 times higher)

5.8.3 Overview

Vanilla value chain environmental impacts in East Sepik/PNG are driven by three factors, as illustrated in Figure 5.9

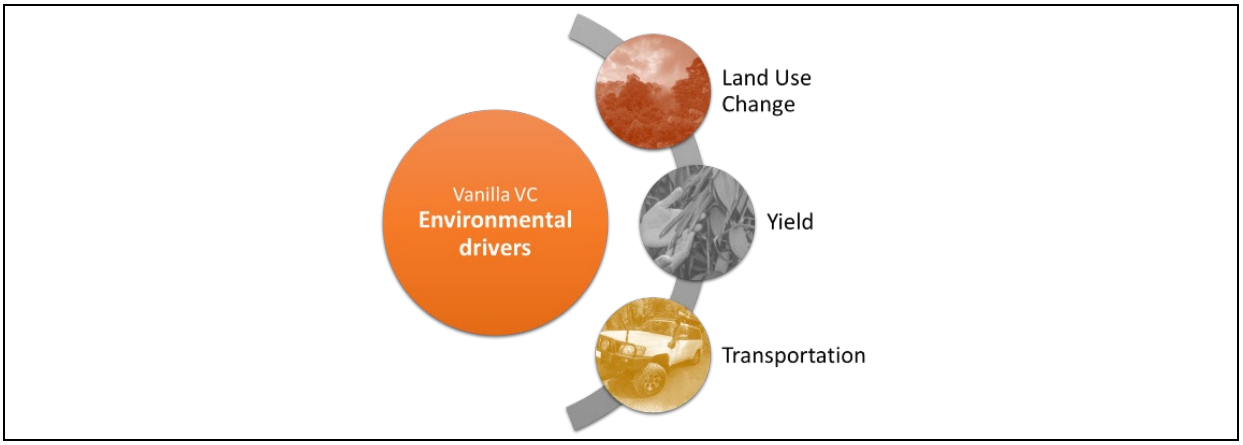


FIGURE 5.8 FACTORS DRIVING THE ENVIRONMENTAL IMPACTS OF VANILLA VALUE CHAIN IN EAST SEPIK/PNG

Land use change is a complex process. A direct relation between vanilla plantation and deforestation was observed in 2018 fieldwork and confirmed in the 2019 household survey, although it could not be asserted if vanilla farming is the primary cause for forest removal. Vanilla expansion seems to be very high (over 98%) and it is done mainly to the expense of primary/secondary forest. The traditional PNG agricultural rotation system - 3 years of food crops after forest clearance, before planting a perennial crop – seems to be replaced, in the case of vanilla, by a system where the perennial crop is planted immediately after clearing. This deforestation, implicit in the vanilla expansion rate, is the main cause of the high environmental impacts (Human Health and Ecosystem Quality) of the PNG vanilla cultivation system, a feature also in evidence when using Madagascar as comparison system.

Average **vanilla yield** is very low in East Sepik/PNG (estimated in little over 280 kg/ha.year for fresh vanilla beans) - an increase in yield will cause a reduction of the environmental impacts of vanilla farming through lower land use impact per FU and eventually through land sparing. Improving the quality of the vanilla produced by households (*e.g.* 100% Grade A) will contribute to a decrease in environmental damage as it is directly associated to an increase in yield.

Small vine-growers are by far the most eco-efficient type of producers in the sense that their production of 1 kg vanilla has the smallest environmental impact of the three classes of vanilla farmers. Medium vine-growers are the less efficient (their production of 1 kg of vanilla causes the highest environmental damage), closely followed by the large vanilla producers. The fact that the highest productivity is related to the group of small vine-owning farmers, in parallel to the fact that it is the same group that has the highest application rate of mulch per vanilla plant[91] (a proxy for a more careful management of the vanilla plantation), raises the question of the existence of time / labour constraints that limit the possibility of increased production of vanilla per hectare.

The vanilla value chain is a low input system (no fertilization, no irrigation, no chemical pest protection) and the depletion of resources is basically associated with the transportation of the vanilla to the point of export, through Wutung and Port Moresby.

The ground **transport of vanilla**, from the place of production to the point of export, is characterized by a system in which only one of the actors (the large exporter) moves quantities that justify the use of freight lorries, with the lowest environmental impact per kilogram transported. The other actors use collective means of transport (VWPs for vanilla farmers) or 4WD vehicles (in the case of traders and agents of producers' associations). Despite not being environmentally planned and practiced only for reasons of safety and cost reduction, car sharing on journeys to the border with Indonesia proved to be important and effective in reducing the environmental impacts of vanilla transport.

Main uncertainties

[91] 0,72 kg mulch/vanilla vine.year

There are considerable uncertainties regarding the value of GHG emissions related to land conversion as the LCA model is particularly sensitive to the land use change GHG scenarios calculated through the Direct Land Use Change Assessment Tool (Blonk, 2014), and the model used does not incorporate vanilla cultivation under agroforestry or in food intercropping. Although vanilla cultivation does not seem to follow the traditional farming system anymore, there are still uncertainties as to the percentage of land use expansion at expenses of natural forest; this is due to the fact that is not clear to what extent food crops are determinant in the conversion of land into vanilla plots.

There are also major uncertainties on physical distances between the locations included in the transportation model and the average fuel consumption of the modelled vehicles on PNG roads as traveling velocities vary substantially due to complex topography and pavement quality[92]. This has implications on the vanilla LCA model that is sensitive to travel distances.

Despite the uncertainty inherent to the methods and data, it is considered that the orders of magnitude of the impacts evaluated in this study and the key contributors identified are robust.

5.9 Conclusions

An approach to answer the question "Is the vanilla value chain in PNG environmentally sustainable?" is to compare obtained values with other references. Although there are no public studies on environmental impacts of vanilla production, the Ecoinvent 3.5 database provides information on the Madagascan "cradle-to-farm gate" vanilla production process. While comparing results from different studies is always challenging due to differences in goal and scope and methods used, this offers a relevant way to position the PNG VVC environmental sustainability.

Concerning **Human Health** damage, Global Warming is the main midpoint indicator for vanilla production in Madagascar, contributing 1,23E-06 DALY. In comparison to this, the 8,82E-04 DALY GHG emissions from PNG vanilla farming are very high. Consequently, it can be considered that PNG vanilla production has very high impacts on this area of protection.

Concerning damage on **Ecosystems**, the main contributor for vanilla production in Madagascar is Land Use, with 6,09E-07 species.yr. Considering this value, the 9,21E-06 species.yr Land Use impact from PNG vanilla farming is very high. As PNG vanilla farming is also the main contributor to damage on Ecosystems, it can be considered that PNG VVC has a high impact on this area of protection.

The damage category **Resources** is defined by Fossil Resource Scarcity, which is mainly determined by the transport of vanilla to the export gates of Port Moresby and Wutung. For this area of protection, there are no references that can be used for comparison.[93] However, there are asymmetries between the different transport routes in terms of resources depletion, with only one actor moving enough quantities that justify the use of freight lorries, with the lowest environmental impact per kilogram of vanilla transported.
In the PNG VVC, the major environmental impacts are Global Warming, affecting Human Health and Ecosystems, and Land Use, affecting Ecosystems - these environmental impacts occur during the cultivation/farming phase. The secondary environmental impacts are Fine Particulate Matter Formation affecting Human Health and Fossil Fuel Scarcity affecting Resources - these impacts occur during the transport and packaging stage. Impacts are summarized in Table 5-11.

[92] For an overview see:
Fontaras, G, Nikiforos-Georgios, Z, Biagio, C (2017). Fuel consumption and CO_2 emissions from passenger cars in Europe. Progress in Energy and Combustion Science, 60: 97-131.
Fontaras, G, Franco, V, Dilara, P, Martini, G, Manfredi, U (2014). Development and review of Euro 5 passenger car emission factors based on experimental results over various driving cycles. Science of the Total Environment, 468–469: 1034–104.2

[93] Nevertheless, it is worth noting that in another from cradle to export gate value chain study conducted in PNG - for cocoa production -, the endpoint Resources ranged from 19,5E-3 to 15,3E-3 USD2013, respectively 0,24% and 0,19% of the value obtained for vanilla [Source: Lescuyer, G., Helmes, R., Syndicus, I, Kerua, W. (2018). Value Chain Analysis of the cocoa industry in Papua New Guinea. (Version of 25th May 2018)].

The VVC is quite sensitive to land use change, an aspect intensified by the very low vanilla yields obtained. The unsustainability of PNG vanilla land use change can be discussed. The conversion of forest areas[94] to vanilla plantations affects biodiversity in terms of habitat availability and habitat quality; both aspects are reflected in Land Use midpoint indicator, as Endpoint ReCiPe 2016 method focuses on both land occupation and on land transformation[95]. Land transformation, from forest to perennial or annual crops, also results in greenhouse gases emission as there is a reduction of the total carbon stock per hectare; the LCA in Endpoint ReCiPe 2016 method totally reflects this change in the Global Warming midpoint indicators[96]. PNG vanilla low productivity has a direct effect on land occupation, as more land is needed to produce 1 FU compared to Madagascar; this in turn implies higher land use change impacts, as part of this land occupation is associated with land transformation.

The vanilla value chain is a low input system, and this is reflected in the relative weight of transport in the overall environmental impacts.

Vanilla, considered either as an annual crop or as a perennial crop, does not store more carbon than the PNG forests. Integrating vanilla into agroforestry systems, which includes several other economically important species[97], will benefit both the vanilla system - since the diversity of plant species will improve the ecological services provided by that system (including carbon storage) – and diversify the sources of income making the farmer more resilient to price fluctuations in the vanilla market.

Annual vanilla production, estimated at 240 tonnes, requires an area close to 6 920 ha[98]. In order to reduce environmental impacts of a scale-up in production, it is important to investigate the causal chain that is behind the generally low vanilla yields. This will help to define a set of policies to promote increasing production per hectare, combined with an increase in the quality of vanilla, in the already existing plantations. Given that current vanilla production practices involve little or no external inputs, environmental accreditation of the vanilla production areas should be encouraged. Such certification would also contribute to product differentiation and enhancement. It will be important to support small and medium-sized farmers in environmental certification, in particular by providing training and financing for accreditation.

From the point of view of transport (of goods), transport policy should be implemented to encourage the modernization of road fleets within a regulatory framework of periodic inspections. It is recommended that a regular programme of maintaining/improving the main existing roads is established.

[94] ReCife 2016 method uses a single conversion factor value for the transformation of forest - either primary or secondary - into cropland.

[95] For a discussion on the challenges of interpreting and combining the two aspects consult Mueller, C., de Baan, L., Koellner, T. (2014). Comparing direct land use impacts on biodiversity of conventional and organic milk—based on a Swedish case study. International Journal of Life Cycle Assessment, 19: 52–68.

[96] Global Warming, Human Health; Global Warming, Terrestrial Ecosystems; Global Warming, Freshwater Ecosystems.

[97] *eg*. *Aquilaria acuminata* (agarwood), *Areca catechu* (betel nut) and *Jatropha curcas* (Jatropha oil).

[98] *cf*. sections 3.2.2 and 5.7.1.

TABLE 5-11 QUALIFICATION OF ENVIRONMENTAL IMPACTS IN THE VALUE CHAIN AND SYNTHESIS OF RECOMMENDATIONS: VANILLA IN EAST SEPIK (PNG)

Impact (Characterization category)	Global Warming	Global Warming	Land Use	Fine Particulate Mater
Damage Category (endpoint)	Human Health	Ecosystem	Ecosystem	Human Health
Level of Impact	**Very High**	**Very High**	**Very High**	**High**
Value Chain Stage	Vanilla Farming (Agricultural production)	Vanilla Farming (Agricultural production)	Vanilla Farming (Agricultural production)	Transportation
Cause of Environmental Disfunction	Land use change	Land use change	Very low yields	Emissions from fuel consumption
Recommendation	Increase productivity /Agroforestry	Increase productivity / Agroforestry	Increase productivity / Agroforestry	Road improvement
	Land sparing	Land sparing	Land sparing	Vehicle inspection

6 Sustainability Overview, SWOT and Risk Analysis

6.1 Overview

Our study indicates that over the period of the study, from September 2018 – May 2019, the vanilla value chain was bringing considerable benefits from an economic and social perspective with some concerns about unconstrained expansion of vanilla areas on the environment. These findings would have been very different had the study been undertaken five years ago when vanilla prices were low. The volatility of the world price creates a high level of risk for smallholders and other investors. Global vanilla prices are currently very high and farming households are benefitting from them. Vanilla requires very little land relative to other cash crops or any other financial investments; the key inputs are knowledge and family labour. Particular parts of PNG have a highly suitable agro-ecology for growing vanilla. When world prices are high, as they were between 1999 and 2004 and since 2016, vanilla is a high-income endeavour. The impact of this income can be positive and negative. Unlike in the earlier boom of 1999-2004, the benefits of current high prices appear to outweigh the negative social costs although use of vanilla proceeds for alcohol consumption is highlighted as a concern. Market linkages is voiced as a challenge that producers want addressed. The lack of any published, verifiable data is a serious constraint for an in-depth economic analysis of the value chain.

Economic analysis
The economic analysis considers the contribution of the value chain to economic growth via four main questions: (1) Financial viability and value added; (2) Effects within the national economy; (3) Viability within the global economy and (4) Growth inclusiveness.

Financial viability and value added: Under current conditions, of very high global vanilla prices, vanilla appears highly profitable for smallholder producers as long as the large amount of labour needed is provided by family members. Purchased inputs are minimal. Five years' ago vanilla was hardly being cultivated as prices were low; growers who have cultivated it previously around the start of the millennium had ripped out their vines and replanted with cocoa or other cash crops. The value chain is short and highly dependent on informal cross-border exports to Indonesia which provides an outlet for lower grade produce, and for one main vanilla exporter who exports mainly A grade and organic vanilla. Trading margins appear to be tight, as there is significant transport, particularly airfreight, costs, involved between the main purchasing centre of Maprik and the final exit airport but a lot of small- and medium-scale traders are attracted to the value chain due to the high world market prices. There are a lot of risks in international trading that can seriously affect the margins.

Effects within the national economy: The vanilla value chain's contribution to national GDP, balance of payments and public finances is extremely low. The PNG economy is based on exports of minerals and oil and gas and large quantities of low-value agricultural commodities. However, vanilla is very important to the economy of East Sepik province which is dependent on low-value agricultural and marine commodities. Sources of revenue generation include the 10% export levy, 60% of which is retained by the exporting province, and VAT and import duty on consumer and capital items purchased with vanilla incomes. There is a potential loss of revenues due to cross-border exports and duty-free purchases of cigarettes, consumer and electronic items purchased by vanilla traders for sale in PNG.

Viability within the global economy: The vanilla from PNG is very competitive with a nominal protection coefficient of between 0.5 and 0.6 for Grade A and 0.8 for extract grades. The domestic resource cost is 0.4. At a time of high international prices domestic resources are efficiently invested in vanilla.

PNG gained the position of the third largest vanilla exporting country within a short space of time during the last boom at the start of the millennium and once again it has become a significant exporter. If producers know their efforts will still be rewarded, even when prices fall, PNG could sustain its place. Financial literacy is increasing and farmers are better able to appreciate the benefits to be gained from producing vanilla over a long period, even with lower prices. Much more could be done to improve the overall quality of vanilla produced. The main exporter has introduced an organic programme and over two hundred growers have been certified by an Australian certification organisation with a further 800 farmers in the process of accreditation. High grade produce is more likely to find a market at a reasonable price even price prices are

low. The main production cost is household labour for which there are often few other alternatives as remunerative for farmers in remote and mountainous locations. Vanilla has a high value to volume and can be easily transported. More attention will need to be paid to food safety and traceability.

The trading margins are slim and would not be attractive to an international commodity trading company. This means that Papua New Guineans need to be encouraged and facilitated to become long-term players rather than dipping in and out to the market when prices become attractive. This requires access to credit at reasonable rates and support for undertaking Due Diligence of buyers.

Food safety aspects were not mentioned by buyers and exporters. The crop is widely handled by farmers and traders and this could contribute to microbial contamination. In the previous boom a large consignment to the USA was rejected due to the presence of physical contaminants which severely damaged the country's reputation.

Relationships with major buyers, particularly those involved in the Sustainable Vanilla Initiative such as Barry Callebaut, Eurovanille, Firmenich, Silver Spoon, Symrise, Unilever, which purchase more than 70% of global vanilla beans, need to be approached to help grow and sustain supply and market for quality, sustainable vanilla and contribute to better livelihoods for vanilla farming households as they do in Madagascar.

The government needs to do more to support farmers' and business efforts. Sadly, PNG's external reputation for poor safety and very high production costs may also hinder efforts to build sustainability in the value chain. For PNG to be considered a serious, established player in the international economy these issues have to be addressed. Other countries are also vying for a share of the lucrative market, such as the Comoros, Cook Islands and Samoa and research is being undertaken in Florida to develop varieties that could be grown commercially there. A further threat is the production of natural vanillin.

Growth inclusiveness: at current vanilla prices the vanilla value chain is providing an opportunity to thousands of smallholders, including women and youth, to benefit significantly from their efforts. Proceeds are being invested in more nutritious food, housing, education, including higher education, for purchasing vehicles used as PMV and for freight, and in trading which all help to continue the benefits into the future. There is relatively little direct employment in the value chain, but the injection of money into the local economy is creating jobs.

Social analysis

The social analysis contributes to answering two main overall questions:

- Is the vanilla value chain in PNG socially sustainable?
- Is the economic growth associated with the vanilla chain in PNG inclusive?

Social sustainability

Working Conditions: The International Covenant on Economic, Social and Cultural Rights (ICESCR), the International Covenant on Civil and Political Rights (ICCPR) and the eight fundamental ILO international labour conventions are 'in force' in PNG. However, most of the activities and benefits in the value chain are in rural areas, where regulation on working conditions is not necessarily applied and certainly not monitored. Education is neither universal nor compulsory in PNG, which increases the risk of children's involvement in the worst forms of child labour. Children are involved in the vanilla value chain, particularly contributing to pollination, which is labour demanding and needs to be timely. However, no specifically harmful jobs were identified. The returns to vanilla production were relatively high at the time of the study compared to alternatives. Youths were attracted to both vanilla production and trading. The most important risk is probably travel associated with vanilla trading.

Land & Water Rights: Under PNG's customary title laws, land is owned communally by a specific lineage, clan or tribal group and usage rights are allocated within the group. Sale of customary land to foreigners is prohibited. Almost all landowners in PNG are indigenous landowners and 97% of all land remains under customary title. The United Nations Human Rights Commission (UNHRC) and others have expressed concern at the alienation of land held under customary title through the granting of Special Agricultural Business

Leases (SABLs) and that in some cases the SABLs are used as a relatively easy way to open land for logging of rainforest. What is being overlooked is the struggle between the indigenous smallholders and Indigenous large holders and investors. However, in the case of vanilla, no large-scale acquisition of land for production was identified. High labour demands required for pollination means that even managing five hectares of vanilla is a major challenge.

Gender Equality: PNG ranked 159 out of 160 countries of the Gender Inequality Index (2017), which makes it the second lowest ranking country for gender equality in the world. In general, women in PNG derive limited benefit from the formal economy and those engaging in business mainly operate small-scale informal enterprises. Women have limited rights over, and control of, the vast majority of land in PNG that is held under customary tenure. Women have very limited access to credit, particularly in the formal sector. Women have less access to extension services than men, but access is very limited for both men and women. In East Sepik and Morobe, women are involved in vanilla production and postharvest activities, including trading and in some cases export. Women are mainly involved as producers. Women may manage vanilla plots by themselves or jointly with their husbands. In the household survey, 24% of households had at least one vanilla garden which was primarily managed by a female and a further 12% of households had at least one vanilla garden jointly managed by a female and male. Overall, 14% of vanilla gardens were primarily managed by a female and 9% jointly managed by a female and male. Women have much greater control over decisions relating to food crop gardens and betel nut than cash crop gardens. In household vanilla plots in East Sepik, women reported that men generally have control over vanilla income. However, many women (both married and heads of female headed households) reported having their own vanilla plots. Generally, women reported that they have at least some control over the income from their own vanilla plots. However, according to five of the FGDs even when women own and manage vanilla plots, they still allocate the bigger portion of the income to the household for budgeting on important family goals. Women are more likely to participate in groups and CBOs than larger organizations such as cooperatives and associations. Women are much less likely to be in leadership positions than men, apart from in churches. In general, women's workload is disproportionally high compared to men and risks of women being subject to strenuous work are not being minimised.

Food and Nutrition Security: The food and nutrition situation in PNG is complex and serious. One in two children in the country have stunted growth due to chronic malnutrition and PNG has the fourth highest child stunting rate in the world. The causes of child undernutrition in PNG are regionally variable due to a complex interplay of poverty, disease, food-security, cultural, environmental and socio-political issues requiring a complex mix of solutions by governments, health systems and local communities. Based on feedback from women in this study, vanilla does not appear to be competing with food crops but the literature stresses that current subsistence food systems are not providing all nutritional needs, such as protein. This may be achieved through changing the farming system, trading (as has been the case traditionally) or selling cash crops and purchasing food. Part of the solution to this problem appears to lie with improving the socioeconomic situation of rural households and vanilla can contribute to achieving this. However, other causal factors include diseases, poor health and childcare, lack of safe water and improved sanitation, hygiene and housing, the rural roads network adversely affecting access to health centres and schools. In the FGDs in this study, women often appeared to be knowledgeable about food and nutrition, but there are significant time constraints on women, so interventions that affect women's time allocation can help improve their own nutrition as well as that of their children. To enhance the contribution of women in food and nutrition security at the household level, the empowerment constraints facing women in agriculture need to be addressed.

Social Capital: PNG cooperatives face challenges such as incompetency in management, misappropriation of funds, abuse of processes and competition with Investor Owned Firms. There are over 400 cooperatives in East Sepik registered as being involved in vanilla, however, only a fraction of these appear to be active. In the household survey, 53% of households had at least one male member belonging to a farmer organization which was relevant to vanilla, compared to only 14% of households which had a female member. Services still appear to be primarily provided or paid for by either farmers themselves or the private sector. The main area where trust appears to be lowest in the value chain is between farmers and the large exporter. Farmer capacity at individual and organizational level varies considerably. In many ways farmers that we met in this study were already very knowledgeable, and in some cases innovative, with regard to vanilla. One of the

challenges is that there is currently limited public sector capacity in terms of service provision to farmers and where there is, it tends to be commodity focused (*e.g.* cocoa). This can make a more holistic approach to improving farming and livelihoods systems more challenging. Planting vanilla as part of a diverse (food and cash crop) farming system can contribute to reducing the shock of volatile fluctuations in the global price of vanilla.

Living Conditions: Health facilities varied significantly with location. However, the majority of people are not getting access to primary health care services; centres are closing and drugs are not available. Women in FGDs agreed that vanilla did have an influence on people's health, but mainly in terms of improving their ability to pay; 70% of households reported that some of their income from vanilla sales in 2018 was spent on health services. However, reports from the Healthy Island initiative suggest that gains in health indicators (malaria, pneumonia, diarrhoea and skin diseases) were moving in reverse since 2014. In the household survey, 66% of households reported that they had bought housing materials with income from vanilla sales. Water and sanitation are a significant issue in PNG, with 61% of the population not having access to safe water and 55% without access to improved sanitation, increasing the risk of diarrhoea, malnutrition, and stunting. There was less evidence of income from vanilla improving access to good quality water and sanitation facilities. In general, education in PNG is characterised by low levels of educational attainment and literacy, poor school attendance and retention rates, and high levels of gender inequality. In the household survey, 75% of respondents reported that they had used income from their 2018 vanilla sales on education. A range of other uses were made of income from vanilla sales in 2018, particularly solar equipment ranging from solar panel, solar battery and inverter to solar lights.

In the previous PNG vanilla boom, Sullivan *et al.* (2005) reported major negative social impacts (retail stores raising their prices; prostitution, adultery, domestic violence; theft of green beans; land disputes; food insecurity). In the household survey, male heads of households reported that the changes resulting from engagement in the vanilla value chain were either completely (35%) or mainly (45%) positive. A further 9% regarded the changes as equally positive and negative. The overall impression is that the negative aspects in the previous boom and bust have not occurred to the same extent this time. However, the major negative elements which were reported were abuse of alcohol and domestic violence. The main suggestion to address minimize the negatives and enhance the positives was to change social behaviour. Suggestions including enforcing law and order, working through churches and village leaders using their influence.

The general findings on the social sustainability of the vanilla value chain are summarised in the radar diagram (*cf.* Figure 4.15).

Inclusiveness: Vanilla has a major advantage in that men, women and youth with rights to land, in the right agro-ecological zones, can plant very small areas and potentially make a relatively good income, if they have access to sufficient labour and as long as the price of vanilla is relatively good. The income in the value chain appears to be distributed reasonably well for rural producers, although there are significant demands on labour, which is mainly met by family members. Women, youth and children are working in the vanilla value chain. The extent to which they will benefit from the income will vary with household, but women generally assessed the situation positively. In some cases, women and youth manage their own vanilla gardens and can control the income earned.

The value chain appears to be dominated by one company (the large exporter), but there are a large number of other official exporters, as well as informal traders, which provide alternative markets to rural producers. During the time of the study this competition has probably been important in maintaining relatively high prices being offered to farmers. However, when the previous boom was over it was reportedly the large exporter that still offered a market to farmers, albeit at very low prices. The Spice Industry Board has not been active and to date has had little influence on governance in the value chain. Farmer organisations are generally not very strong. The current governance structure appears to work well in favour of farmers' income in times of boom (when global prices are high), but not when global prices fall.

Environmental analysis

The environmental analysis contributes to answering if the vanilla value chain in PNG environmentally sustainable via 3 core questions:

What is the potential impact of the vanilla value chain on resources depletion?
What is the potential impact of the vanilla value chain on ecosystem quality? and
What is the potential impact of the vanilla value chain on human health?

In the PNG VVC, the major environmental impacts are Global Warming, affecting Human Health and Ecosystems, and Land Use, affecting Ecosystems - these environmental impacts occur during the cultivation/farming phase. The secondary environmental impacts are Fine Particulate Matter Formation affecting Human Health and Fossil Fuel Scarcity affecting Resources - these impacts occur during the transport and packaging stage.

The vanilla value chain is a low input system (no fertilization, no irrigation, no chemical pest protection) and the depletion of resources is basically associated with the transportation of the vanilla to the point of export, through Wutung and Port Moresby.; this is reflected in the relative weight of transport in the overall environmental impacts.

The sustainability of VVC is highly sensitive to yield and to land use change. These two drivers are interconnected: an increase in yield will cause a reduction of the environmental impacts of vanilla farming through lower land use impact per FU and eventually through land sparing (reducing the land change from primary/secondary forest to vanilla plantation).

Vanilla, considered either as an annual crop or as a perennial crop, does not store more carbon than PNG's forests. Integrating vanilla into agroforestry systems, which includes several other economically important species[99], will benefit both the vanilla system - since the diversity of plant species will improve the ecological services provided by that system (including carbon storage) as it will also diversify the sources of income that make the farmer resilient to price fluctuations in the vanilla market.

[99] *e*.g. *Aquilaria acuminata* (agarwood), *Areca catechu* (betel nut) and *Jatropha curcas* (jatropha oil).

6.2 SWOT analysis

The SWOT (strengths, weaknesses, opportunities and threats) given in Table 6-1 highlights the internal (national) advantages that PNG has in vanilla production and exports along with challenges faced by stakeholders, as well as positive and negative considerations from an international perspective.

TABLE 6-1 SWOT ANALYSIS OF THE BROAD VIEW OF THE IMPORTANT FACTORS THAT ARE FAVOURABLE OR UNFAVORABLE TO THE VALUE CHAIN DEVELOPMENT AND ITS IMPACT

	Positive	Negative
Internal	STRENGTHS • Strong capability of numerous individuals along the VVC in producing, curing and marketing • Areas of PNG are agro-ecologically ideal for vanilla production • Growing reputation as a contender to Madagascar Bourbon vanilla • Very high value to weight ratio • High returns per hectare and per workday when prices high • Good mechanisms via social media for farmers to access domestic price information	WEAKNESSES • Individual access to finance for trading and access to global market information • Collective capacity generally low; particularly in marketing PNG vanilla as a brand • Low capacity of farmer organisations • Food safety may be an issue along medium-scale and informal VVC • Poor roads in main producing areas • Perceived unfair allocation of portion of export levy revenue attributed to province where packing occurs rather than production • Low productivity • Not easy to access global daily prices • No one (stop-shop) organisation representing the vanilla sector
External	OPPORTUNITIES • Global demand for natural vanilla and Tahitensis species growing • Specialised online retailers highlighting provenance and unique characteristics • Markets looking for socially and environmentally responsible production	THREATS • Global price volatility • Climate change could affect agro-ecology and increase disease risk • Food safety requirements in the USA and EU • Negative perception of PNG as dangerous, difficult and expensive place to do business • Natural vanillin substitutes • New/up and coming producers – Florida, Tanzania, Comoros, Cook Islands, Samoa

6.3 Risk analysis

The risk analysis matrix (Table 6-2) identifies and assesses how the findings from the four analyses could negatively affect the operation of the value chain, in terms of price trends, price volatility, logistics and infrastructures, policies, governance and institutions, social relations, food safety and phytosanitary situation, weather and climate change and natural environment.
It also addresses and attempts to answer the second cross-cutting question CQ4: Which risks may affect the performance of the vanilla value chain?

TABLE 6-2 RISK ANALYSIS: IDENTIFICATION AND ASSESSMENT OF HOW THE RISKS AFFECTING THE VANILLA VALUE CHAIN (ON FARMERS' PERFORMANCE, OVERALL FUNCTIONS OF THE VALUE CHAIN ETC.) COULD BE NEGATIVELY AFFECTED BY UNFAVOURABLE EVENTS

Risk Category	Comments	Relevant Indicators	Probability	Severity
Price trends	Increase in global prices since 2015 but peak prices considered to have been reached and likely to strongly decline (to @US$ 100/kg) in next 2-3 years	USA import prices EU import prices PNG export price	High	High: see information in chapter 2 on impact on production and exports of post 2004 bust
Price volatility	Most volatile of all agricultural products	Extent of changes in import and export prices over time	Very high	Very high
Logistics and infrastructure	Poor roads: prices offered to farmers can be lower to offset risks to vehicles and longer journey times; traders face higher procurement costs; both parties exposed to risk of theft in holdups partly due to poor road conditions; currently low use of electronic transfer payments Lack of roads: most vanilla has to be airfreighted to next domestic location prior to export	Road transport costs Air cargo rates Incidence of thefts	Low	Roads - low Theft - extremely high to those it happens to
Policies	Non-existence of specific vanilla policy (no relevant legislation since 1989 No recognition of the challenges and ways to address along VVC DAL is responsible but may not have capacity	Evidence-based stakeholder inclusive policy processes Revised legislation supporting inclusive, sustainable VVC	Low (as prices are currently high)	Appropriate policies are more important when prices are low
Governance and institutions	None of the current public sector organisations with responsibility for vanilla appear to be prioritising its development or collecting verifiable data.	Existence of entity representing different stakeholder interests Part of its role would be to make	Medium	Medium When prices fall, the need for this becomes more critical/high priority

Risk Category	Comments	Relevant Indicators	Probability	Severity
	The large exporter has positioned as lead agency but not transparent about its operations. Farmer organisations are generally weak; issues include low operational capacity Spice Industry Board lacks capacity to be effective body for vanilla Medium-scale vanilla traders have a lack of collaboration and no entity to represent their common interests PNG not represented in external platforms and networks	information accessible Membership of international flavour and aroma associations		
Social relations	Lack of trust in VVC; particularly between certain farmers and the large exporter; Farmer organisations generally not functioning well	Number of exports by farmer organisations	Medium	High when price drops
Gender and age	Not unique to VVC; PNG ranks second lowest in gender equality globally. Risk is that women's participation in VVC (provision of labour, plot management) does not result in equal access to income and benefits Low entry costs and high returns make it attractive to youth but proceeds may fuel excessive alcohol consumption; lack of access to land may lead to theft of beans	Level of income controlled by women	Medium	High particularly when vanilla price falls and less money is available
Food safety and (phyto)sanitary situation	Risks of physical and microbial contamination during handling and curing and possible contamination of organic beans with permethrin from treated bed nets	Consignment rejections	Medium	Limited to date but could increase or be detected; critical for high value gourmet beans

Risk Category	Comments	Relevant Indicators	Probability	Severity
	Traceability could become a market requirement			
Weather and climate change	Climate projections predict an increase of the average air temperature and in the annual and seasonal mean rainfall. Intensity and frequency of days of extreme rainfall are expected to increase. Incidence of drought will most likely decline although it is not possible to determine whether interannual variability in rainfall will change. Possible risk in shift of vanilla-growing areas (reduction/expansion); Humid conditions will favour spread of vanilla diseases; traditional vanilla sun curing process might be affected; Variable localized mud and/or landslides in vanilla gardens planted in steep slopes; inundations in flat areas; soil erosion.	Meteorological data (series)	Very High	Medium to high
Natural environment	Land use change Conversion of forest (primary/secondary) areas into vanilla gardens	Forest cover (%)	Very high	High climate change due to CO_2 emissions from deforestation and slash and burn practices Forest / habitat fragmentation

7 Conclusions and Recommendations

1. **The vanilla value chain is underperforming but current high prices are supporting viability particularly at the producer level**. All three categories of vanilla farmers are financially sustainable at current high prices, with rate of return on turnover ranging from 72 to 86%. The analyses do not include remuneration to the large amounts of labour necessary to produce vanilla but at current prices farmers with the two lowest numbers of vines would be able to pay for the quantity of labour required. For traders' side, margins are much tighter, with return on turnover ranging from 4 to 11%. One company dominates but smaller exporters help to improve the prices received by farmers. The overall poor quality of vanilla being produced has an impact on prices received. The study was conducted at the height of global prices which has produced windfalls for thousands of farmers. There is risk that these benefits will not sustain if prices fall to the same levels of the early 2000s.
Recommendation: Increase focus on product quality to build PNG's reputation; consider crop certification *e.g.* organic and geographical indication and branding and ensuring food safety.
2. **Vanilla is a high-risk and high cost business in PNG.** The risks include theft of beans, theft of trading capital, physical attacks trading fraud. This is a result of weak infrastructure and logistics, inadequate policing and a lack of due diligence. This has implications for the reputation of PNG in its ability to attract international buyers.
Recommendation: Support initiatives to improve infrastructure and logistics such as increased investment in roads and promotion and uptake of electronic payments by mobile phone companies. Strengthen capacity in due diligence arrangements.
3. **Vanilla is not sufficiently recognised by central government to be a valuable contributor to the national economy.** There is no up-to-date specific vanilla policy and there appears to be a limited common understanding within government of the challenges along the value chain and how they might be addressed.
Recommendation: Improve the collection of accurate statistics (production, financial, international trade, social, environmental) on the sector. Develop appropriate national, provincial and LLG policy processes. Provide an updated national vanilla policy.
4. **Vanilla makes a major contribution to the East Sepik economy.** 80% of PNG's vanilla is produced in East Sepik and the province should be receiving 60% of the export tax on vanilla. Under current arrangements, the province exporting a commodity receives 60% of the export tax revenue. Currently up to 75% of vanilla grown in East Sepik is taken to Lae in Morobe province for processing and packaging prior to export and hence East Sepik province does not receive a share of this income.
Recommendation: A system needs to be devised to capture the value of vanilla as it leaves East Sepik province so that it can receive its share of the tax revenue generated from vanilla production.
5. **There is weak governance of the sector and weak institutions that support farmers, traders and exporters.** Stakeholders consulted did not comment favourably on the role and operation of the Spice Industry Board (SIB). The SIB is responsible for supporting the sector, but they don't currently have the capacity to do this.
Recommendation: Improve trust and relationships through dialogue and action between actors (farmers, farmer organisations, traders, exporters) in the value chain. This needs to be facilitated by an honest broker, such as an international NGO or equivalent, in collaboration with provincial and LLG DAL officers.
An entity is needed to provide functions such oversight, guidelines, information, promotion, advice, market linkages. The PHAMA project staff could do a capacity assessment which should include detailed stakeholder consultations on how such an entity could be strengthened to support the vanilla sector.
6. **Gender and inter-generational inequality are major challenges, but not unique to the vanilla value chain.** PNG ranks second lowest in gender equality globally. There is a risk that women's participation in the VVC (provision of labour, plot management) does not result in equal access to income and benefits. Low entry costs and current high returns make the vanilla VC attractive to youth, but proceeds may fuel excessive alcohol consumption and lack of access to land may lead to theft of beans.
Recommendations: The role of women and youth in the vanilla VC needs to be recognised and appropriately supported. Interventions to strengthen the vanilla VC should partner with organisations with experience in supporting gender and inter-generational equality, such as international and national NGOs and CBOs working in vanilla-growing areas.
7. **Food safety and traceability are not currently an important issue for buyers but this is likely to become more important in the future, particularly for certified vanilla.** Food safety of exported beans may not be a significant issue for PNG as we understand that the main exporter treats its vanilla to minimise microbial and physical contamination. It was unclear whether any treatment is done by the medium-scale exporters. In 2008 a consignment exported to the USA was rejected due to the presence of physical contaminants. This harmed the image of PNG as a high-quality vanilla producer and has taken exporters a long time to mitigate the impact.

Recommendation: NAQIA to continue to be vigilant in its inspections as it is the key organisation in managing reputational risk of PNG vanilla. Vanilla stakeholders should consider means of improving traceability, including technology such as blockchain.

8. **Vanilla production is likely to be affected by climate change alongside other factors.** There are no research programmes and limited agricultural support services to the value chain to support stakeholders in this vulnerable value chain and strengthen its resilience, including adapting to climate change and protection from pest and diseases.

Recommendation: Vanilla growers are likely to need techniques adapted to wetter soil conditions as well as for diversified production systems *e.g.* agroforestry, food and cash crop intercropping.

NARI could investigate genetic selection for varieties more tolerant to wetter conditions. This could be through collaboration with other vanilla growing countries in the region. Cost-effective pest and diseases surveillance systems will be important.

There needs to be appropriate agricultural extension service support which takes account of the balance between current, limited, government extension capacity, farmer cooperatives and the motivation of the private sector with the type of information they could provide. Such interventions should consider partnerships involving public, private and civil society organisation to maximise synergy from their specific interests.

9. **There has been a major increase in the area of land planted to vanilla over last 20 years (over 98% in East Sepik) and it is done mainly at expense of primary/secondary forest.** The average vanilla yield is very low in East Sepik/PNG (estimated at little over 56 kg/ha.year for cured vanilla beans). The vanilla value chain is a low input system (no fertilization, no irrigation, no chemical pest protection).

Recommendation: Improve vanilla productivity and quality (land sparing) through low input management practices targeting organic vanilla markets. Encourage vanilla growing as part of a biodiverse socio-ecological system involving agroforestry and food/cash crop intercropping.

10. **This value chain study has provided an opportunity for a Papua New Guinean expert from a national university to gain considerable insight into the country's vanilla value chain from a multi-disciplinary perspective.** It would be beneficial to build on this to support the capacity of young researchers to contribute to the understanding of issues in the vanilla, and other, value chains from an economic, social, environmental and organisational perspective.

Recommendation: Donors and the government to consider ways in which they could provide funding to enable young researchers (MSc students) to undertake field studies of aspects of the vanilla value chain as part of their degree programmes.

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Vanilla handbooks and manuals

Several handbooks and manuals on producing vanilla were identified although not all are currently available.

A Field Handbook on Vanilla Production for Extension Officers and Farmers was apparently published by the Department of Agriculture and Livestock and PNG Spice Industry Board in Port Moresby, in 1999.

The National Agricultural Research Institute published several TokTok brochures, still available online[100], on vanilla growing, harvesting and curing, in 2003.

In 2005 Brian Robertson and Peter Donigi published Vanilla Farming: Making a Living Practical Guide available from PNG School Books.

In 2012 Piero Bianchessi published The Vanilla Handbook, available from CTA (Bianchessi, P. (2012) The vanilla handbook. Venui Vanilla, Vanuatu. ISBN 978 9 829 80681 9). This covers Pacific vanilla growing, based on his experience of growing vanilla in Vanuatu. The CTA's website indicated that the publication had been vised 12 times by people from PNG in the last six months.

The team met the LLG president in Yangoru-Saussia, who is also a trainer for AusAID on financial literacy and a vanilla farmer. He has produced a comprehensive guide to vanilla farming that he is looking to publish.

In Maprik, the large exporter broadcasts a radio programme together with a commercial about vanilla buying, called "Papindo Hour", in which tips on vanilla farming and curing are given. The company has also produced a vanilla handbook.

[100] www.nari.org.pg/sites/default/files/publications/toktoks/bubia/BUB004(P)_sapot_diwai_bilong_vanilla_buklet.pdf

Annex 1: Report on Vanilla Household survey and overview of vanilla-producing villages

Dr. Veronica Bue

Introduction

This report gives a summary of the fieldwork undertaken from 9th to 17th April 2019 in East Sepik by a team led by the National Expert. The purpose of the trip was to collect primary data to meet data gap addressing the four key questions in the Value Chain Analysis for Development (VCA4D). The report outlines the methods used in selecting the study sites and sample households for data collection. A summary is given on the livelihoods of the vanilla growing households from focus group discussions, informal interviews and participant observations.

Data Collection Methodology

Study Location

Five villages in the Maprik and Ambunti-Dreikikir districts were selected for the study (Table 1; Figure A1). These villages were purposely selected because they were highly involved in the cultivation, processing and selling of vanilla beans.

Table 1: Selected villages

No	Village	District
1	Samark	Ambunti-Dreikikir
2	Yawerng	Ambunti-Dreikikir
3	Yambes	Ambunti-Dreikikir
4	Urita	Maprik
5	Walahuta	Maprik

Study Population and Sample

The study population included all the households in all five villages. Systematic sampling was used to select the sample population for data collection. A sampling frame was done for each village before the interviews were conducted. Systematic sampling was used to select the sample. Intervals were calculated to select systematically 20 households in each village that made up the sample households (Table 2).

Table 2: Study population and sample

No	Village	Total households (HH)	Interval	Sample size
1	Samark	52	3	20
2	Yawerng	47	2	20
3	Yambes	88	4	20
4	Urita	65	3	20
5	Walahuta	62	3	20
Total sample population				100

Note: Calculation of interval

Total HH/desired sample size 52/20=2.6 (3)

Data Collection

The day before the actual data collection began the Team Leader went through the survey question with the three enumerations for clarity and understanding of the questions. Face-to-face interviews were conducted by the two enumerators and the Team Leader after households have been identified from the sampling frame. Focus group interviews were conducted by the Team Leader. Data were collected in all five villages from 1st to the 12th of April 2019.

Brief Overview of the Social, Economic and Environmental Situations of the Five Surveyed Villages

Samark village, Ambunti-Dreikikir district

Village Setting and Population

Samark was the first village selected for the fieldwork. It is situated on the Prince Alexander mountain range and is three hours walk from the nearest feeder road (the feeder road leads to the Sepik Highway) to reach the village. Currently road construction is underway to make the village accessible by vehicle. Samark is a small village made up of 52 households with an estimated population of 256 people including children.

There is no primary school in the village. School age children usually walk for 30 minutes following bush trails to attend school in Yambes village and walk back to Samark after school. There is also no clinic in the village. The nearest clinic is at

Yambes village. There is no tradestore but people sell basic store goods such as rice, tinned fish, sugar, salt, noodles, bar soap, etc. in their residence. There is a Pentecostal church located in the village.

Environment

The village has a vast land mass covered with primary forest. However, the topography is mostly hilly thus accessing land for vanilla production and gardening is a challenge. However, people are used to cultivating gardens on the hillside. Most of the vanilla and food crop gardens are located on the hillside. The gardens are quite a distance from the dwelling area when considering the mountains and hills that one must be climbed/descended to reach.

Social Status

Land is accessible to all households within the same clan and both men and women have the same rights to cultivate vanilla or food gardens on clan land. Women are respected in the community and they have the rights to voice their opinion during community meetings. Women are actively involved in church activities and taken up leadership role in the church (such as women's group leaders). One of the things observed in Samark was that there is a good leadership in the community and people, especially youths respect their leaders and elders.

There were only three permanent houses in the village and only 1 house has a water tank. Most of the houses were semi-permanent. These semi-permanent houses mostly had roofing irons and the rest of the materials were local (bush material). The roofing irons make it easier for the households to collect rainwater. For those households without tank, 44-gallon drums and large pots and containers are used to collect water for drinking. For other water needs it is sourced from dug-out wells and small creeks.

Life has changed for the people of Samark. Changes were observed in the clothes they wear, household items such as radio/CD player with large speakers or boom box, mattresses and beddings, kitchen utensils and solar lights. Solar and battery lights have replaced the kerosene lamps and are now essential items in all the households. Building materials are carried on shoulders from the feeder roads to the village. Villagers are hired to help bring materials over to the village. There is mobile network (Digicel) which makes it easier for them to get in touch with family members living away from the village and most importantly to keep informed of the price of vanilla at the large exporter and on the Street (Maprik).

Consumption of store food such as rice, noodles and tinned fish has also increased. When we slept over for a night, we were served rice and tinned fish for dinner and breakfast. During the focus group discussions, a woman indicated that after selling of vanilla beans they usually buy basic store foods like people living in towns who were earning fortnightly income. The basic foods are rice, tinned fish/meat, noodles, sugar, tea, coffee, salt, toiletries, detergents, etc. Because they are located inland, they made sure they bought enough to cater for 1 to 2 months before visiting the shops in Maprik again after selling the next lot of vanilla beans again.

The only training almost all the people attended was the training given to the community by Alfred Jambram on vanilla production and curing.

Income Earning Activities

Vanilla is the main and only source of income for all the households of Samark. Garden foods are cultivated only for home consumption. Even though income generated from sale of food crops would be important for women, women in Samark do not sell garden produce which is most likely due to not having easy access to roadside markets and markets in the District Centres.

Since all households have vanilla plots, labour sought for vanilla cultivation would only come from the immediate family living in the same household as everyone would be busy with their own plots. Those households that needed extra labour would have to seek labour from youths where their labour is paid through cooked food and/or cash. For example, a farmer in Yambes indicated paying K20 each to the youths (6 of them) with cooked food. This is the same situation across all five villages.

Yawerng village, Ambunti-Dreikikir district

Yawerng village is situated along a feeder road and is five minutes' drive from the main highway. Yawerng is the smallest village with 47 households. There is a primary school located in a nearby village of Namaha where it takes around 30 minutes by foot. The school is run by the South Sea Mission. A government-run vocational school is located at Yawatong some 2 hours by foot. There is no clinic at Yawerng or villages nearby; hence medical services are sought in Dreikikir station which is about 2 hours walk from Yawerng. Again, there is no trade store, but people sell basic store goods such as rice, tinned fish, sugar, salt, noodles, bar soap, etc… in their residence.

Environment

The village has enough land for vanilla and food crop cultivation. Again, the topography is mostly hilly thus; accessing land for vanilla production and gardening would also be a challenge. Most of the vanilla and food crop gardens are located on the hillside.

Social Status

Land is accessible to all households within the same clan and both men and women have the same rights to cultivate vanilla or food gardens on clan land. Women are respected in the community and they have the rights to voice their opinion during community meetings. Women are actively involved in church activities and taken up leadership role in the Catholic church (such as women's group leaders). There is a female village court Magistrate in the village. This woman is outspoken and is respected by the community.

Most of the houses are semi-permanent and only four houses have water tanks. Again, households without tanks use 44-gallon drums and large pots and containers to collect rainwater for drinking. For other water needs it is sourced from dug-out wells

Solar and battery lights have now replaced the kerosene lamps and are now essential items in all the households. There is mobile network (Digicel) which makes it easier for them to get in touch with their families living away from the village and most importantly to keep informed of the price of vanilla at the large exporter and on the Street. Consumption of store food such as rice, noodles and tinned fish has also increased.

Income Earning Activities

Vanilla is the main source of income for all the households of Yawerng. Households also grow betel nut and sell at roadside markets. Garden foods are cultivated both for home consumption and sale at the roadside market as well as at Maprik. Women are mostly involved in cultivating food crops for sale and marketing of the same. Thus, income generated from sale of food crops is kept by them.

Again, since all households have vanilla plots, labour sought for vanilla cultivation would only come from the immediate family living in the same household. The same situation for Samark is applicable here for those who need extra labour.

The only training almost all the people attended was the training given to the community by Alfred Jambram on vanilla production and curing.

Yambes village, Ambunti-Dreikikir district

Village Setting and Population

Yambes village is also situated on the Prince Alexander mountain ranges and is two hours walk from one of feeder roads that lead to the main highway. Like Samark village, Yambes is only accessible by foot. An attempt by the villagers to create a road that is accessible by vehicle years back was in vain because of the lack of support from the government to maintain it. Yambes is quite a large village compared to the other four villages. The village is made up of 88 households which are scattered over quite a large area because of the clan system where households belonging to the same clan live together and use the natural resources communally.

There is an elementary school that caters for grades 1 and 6. Grades 7 and 8 are done at Dreikikir High School located at the Station which takes about 2 hours to walk to school on bush trek and another 2 hours to return home. Fortunately, there is a clinic in the village that is being looked after by a local Aid Post Order (APO). The clinic serves the people of Samark also. Similarly, people sell basic store goods such as rice, tinned fish, sugar, salt, noodles, bar soap, etc. in their residence. There are three churches in the village, which are Catholic, Pentecostal and Seventh Day Adventist.

Environment

Like Samark village, Yambes has a vast land mass covered with primary forest. Again, the topography is mostly hilly thus; accessing land for vanilla production and gardening would be a challenge. Also, most of the vanilla and food crop gardens are located on the hillside. Most of these gardens are quite a distance from the dwelling area also considering the mountains and hills that must be climbed/descended to reach.

Social Status

Like all five sites, land is accessible to all households within the same clan and both men and women have the same rights to cultivate vanilla or food gardens on clan land. Women are respected in the community and they have the rights to voice their opinion during community meetings. Women are actively involved in church activities and taken up leadership role in the church (such as women's group leaders).

Life has changed for the people of Yambes as a result of having access to cash from vanilla. Changes can be seen in their lifestyle (clothes they wear, households' items such as radio/CD player with large speakers or boom box, mattresses and beddings, kitchen utensils and solar lights. Interestingly, Yambes is so different from other villages in terms of permanent houses with water tanks. Most of the houses in the village are permanent and are installed with water tanks. Only very few houses are semi-permanent. Another interesting thing we witnessed was the instalment of big solar panels and solar lights in all houses. The scenario looked so different in the night when all the houses were lighted up with lights installed both inside and outside (serve as security lights) making the village looked more like a small suburb in an urban centre.

One of the things observed in Yambes was the problem of anti-social behaviour by youths. We were told that there is a lot of antisocial behaviour amongst youths as a result of a lot of alcohol consumption and access to cash from vanilla. We witnessed these ourselves when we spent a night in Yambes village. Drunkard youths fought amongst themselves and created a lot of disturbances in the community. There is mobile network (Digicel) which makes it easier for communication.

Income Earning Activities

Vanilla is the main and only source of income for all the households of Yambes. Like Samark, garden foods are cultivated only for home consumption. Since all households have vanilla plots, labour sought for vanilla cultivation would only come from the immediate family living in the same household. Those households that needed extra labour would have to seek labour from the youth which are paid through cooked food and/or cash.

The only training almost all the people attended was the training given to the community by Alfred Jambram on vanilla production and curing.

Urita village, Maprik district

Village Setting and Population

Urita village is situated along a feeder road approximate 30 minutes' drive from the main Sepik Highway. There is a total of 65 households. Urita village is one of those villages being engaged in the Healthy Island Concept introduced by the South Sea Evangelical Church (SSEC). They are also involved in the World Bank funded cocoa project where they are currently into farming of the improved cocoa clones. There is a cocoa bud wood garden and nursery is in the village for free distribution to interested farmers.

There is a government primary school situated within the vicinity of Urita (5 minutes' walk from the village) The nearest clinic is run by the SSEC in Burugam village which is located around one hour walk from Urita. There are small trade stores as well as people selling basic store goods such as rice, tinned fish, sugar, salt, noodles, bar soap, etc at their residence.

Environment

The village has a large land mass for vanilla cultivation. The land is mostly flat with some hilly areas.

Social Status

Land is accessible to all households within the same clan and both men and women have the same rights to cultivate vanilla or food gardens on clan land. Women are respected in the community and they have the rights to voice their opinion during community meetings. Like the other villages, women are actively involved in church activities and taken up leadership role in the church (such as women's group leaders).

There were only two permanent houses in the village and only 1 house has a water tank. Most of the houses were semi-permanent and a few were made of bush material. Life has improved for the people of Urita but not as obviously as in Yambes village. There is mobile network (Digicel) in the village.

Income Earning Activities

Vanilla is the main source of income. Vanilla income is often supplemented by income earned from cocoa, betelnut and food crops. Because Urita has easy access to roadside and food market in Maprik, garden foods are cultivated both for home consumption and sale.

Since all households have vanilla plots, labour sought for vanilla cultivation would only come from the immediate family living in the same household. Those households that needed extra labour would have to seek from the youth who are paid through cooked food and/or cash.

Walahuta village, Maprik district

Village Setting and Population

Walahuta is also located in West Maprik and is made up of 62 households. The village is situated on a feeder road about 5 minutes' drive from the main highway. Walahuta is also engaged in the Healthy Island concept. With the assistance in kind from the SSEC, they have built a dam on the hills and supplied water by gravity to the village. The water supply had made it so much easier for the people of Walahuta. Until recently, silt has built up in the water hose and had blocked water from following. Households with the coordination from the Ward Councillor had made plans to clean the hose to restore the water supply.

A primary school is situated on the periphery of the village. There are trade stores as well as people selling basic store goods such as rice, tinned fish, sugar, salt, noodles, bar soap, etc at their residence.

Environment

The village has a large land mass for food and vanilla cultivation. Most of the land is flat with a few hills.

Social Status

Land is accessible to all households thus; both men and women have the same rights to cultivate vanilla or food gardens on clan land. Women are respected in the community and they have the rights to voice their opinion during community meetings. Women are actively involved in church activities and have taken up leadership roles in the church (such as women's group leaders).

There were only three permanent houses in the village and only 1 house has a water tank. Most of the houses were semi-permanent. These semi-permanent houses mostly had roofing irons and the rest of the materials were local (bush material). The roofing irons makes it easier for the households to collect rainwater. Again, for those households without a tank, 44-gallon drums and large pots and containers are used to collect water for drinking. For other water needs it is sourced from dug-out wells and small creeks.

Life has improved for the people of Walahuta as in the other four villages. There is a mobile network (Digicel) which makes it easier for them to get in touch with their families and to keep informed of the vanilla price.

Income Earning Activities

Vanilla is the main source of income for all the households of Walahuta. Cocoa is second to vanilla and supplements household incomes. There is a cocoa drier in the centre of the village for community use. Garden foods are cultivated for both home consumption and for sales at roadside markets and in Maprik's local food market.

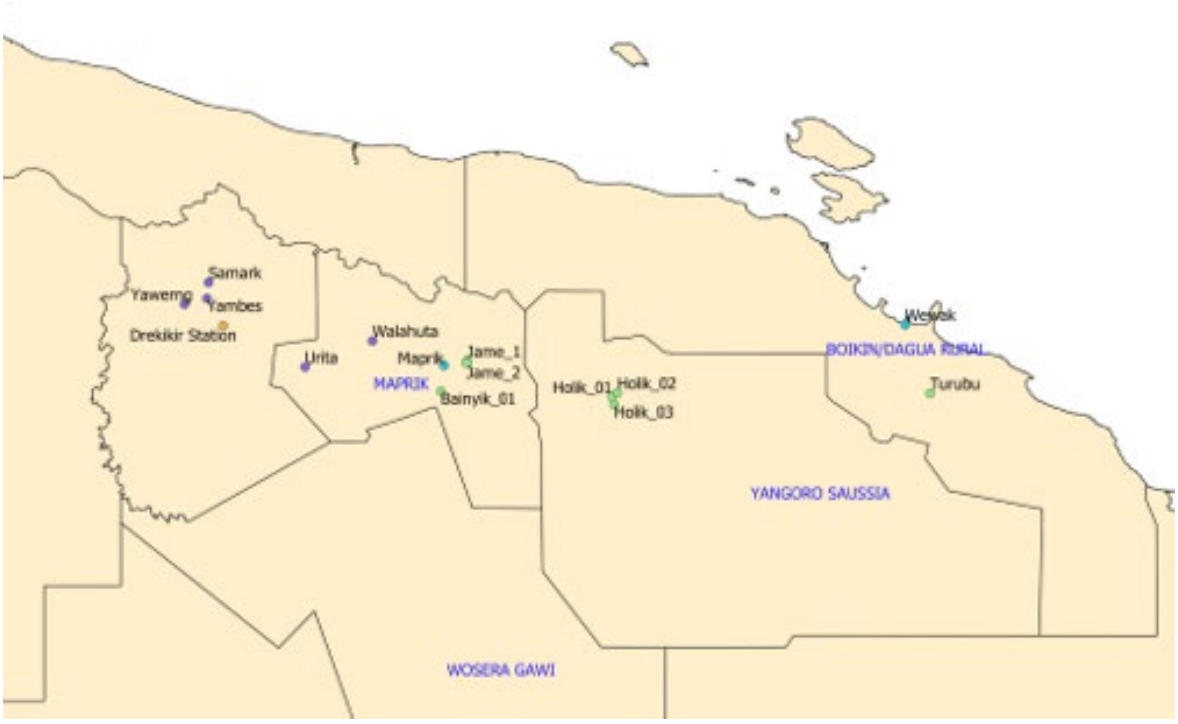
It is the same scenario in all five villages that since all households have vanilla plots, labour sought for vanilla cultivation would only come from the immediate family living in the same household.

Summary

Involvement of households in vanilla cultivation has really improved their living standards. Households have bought store goods and equipment to improve their lifestyles. For some households, collection of rainwater in tanks and other storage containers bought from the shop has reduced the drudgery of women having to source water long distances. Also important is that households have access to cash to purchase food during temporary food shortages or according to their preferences.

However, there are negative impacts as well amongst youths especially and young married couples, because of misuse of income on harmful substances and causing anti-social behaviour in the community. In some communities anti-social behaviour is controlled by village leaders while in others it is not.

Figure A1 Location of vanilla-producing villages visited during the study and mission



Vanilla Household questionnaire

Name of interviewer……Date of interview……..

1. Background to vanilla household

1.1 Name of head of household (and any other household members interviewed)

……

……

1.2 Location: Village: …… Ward: …… LLG: ……

District: …… GPS coordinates: LAT…… LONG……

1.3 a) Gender of head of household *Male / Female* b) Age of head of household (years) ……

c) Number of people in the household N. Adults (>16) …… N. Children (<= 16) ……

1.4 How many vanilla plots are owned or managed by members of this household? ……

Complete the table below by answering the following questions

	Plot 1	**Plot 2**	**Plot 3**	**Plot 4**	**Plot 5**
1.5 Who is the main manager/decision maker for this plot (Relationship to head of household: head, spouse, child, other)?					
1.6 What is their gender (M/ F)?					
1.7 What is their age?					
1.8 Are they member of an organization relevant to their vanilla enterprise (YES/ NO) (e.g. informal group, association, cooperative)					
1.9 If YES, Name of organization					
1.10 Number of members in organization					
1.11 Number of females in organization					
1.12 Is there an annual membership fee? If yes, how much (in Kina)					

2. Vanilla production

For each vanilla plot please provide the following information:

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
2.1 Main manager of plot (relationship to head)					
2.2 Topography of the plot (flat, sloping, mixture)					
2.3 Time to reach plot from house-walking time in minutes					
2.4 When were the vines planted/revived (year)?					
2.5 When was forest on this plot cleared (year)?					
2.6 Number of vines in plot					
2.7 Number of *V.planifolia* vines					
2.8 a Vanilla support: which tree species are used? **2.8 b** Which tree species are planted?					
2.9 Is vanilla intercropped and/or is there agroforestry Y/N					
2.10 If YES, list the main crops and trees					
2.11 Spacing (e.g. 2x2 m, 2.5x2.5 m, 3x3 m)					
2.12 Plot size (area in hectares or as X x Y meters)					
2.13 Was hired labour used? Y/ N, If Yes go to 2.14 &2.15; if No go to 2.16					
2.14 How many days hired labour employed in 2018? Establishment Maintenance Pollination Security Harvesting Curing Selling					
2.15 How much was one labourer paid per workday?					
2.16 What materials were used for mulching?					
2.17 How many times is this plot mulched per year?					
2.18 How much mulch is applied per year in local units (e.g. 40 kg bag, bucket, wheel barrow) ……					
Interviewer to record the number of kg per local unit					
2.19 Is fertiliser used on vines in this plot? Yes / No.					
2.20 a If yes, what type of fertilizer? **2.20 b** How much did you spend (Kina)?					
2.21 Are pesticides on your vines? YES/ NO					

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
2.22 a If YES, which pesticides are used? **2.22 b** How much did you spend (Kina)?					
2.23 Are herbicides used on this plot? YES/ NO					
2.24 a If YES, which herbicides are used? **2.24 b** How much did you spend (Kina)?					
2.25 What are total annual production costs (Kina)?					

2.26 Source of labour

The following tables should be completed depending on who are the main managers of the plots referred to above

Plot managers	L1	L2	L3
Adult male	o		
adult male and adult female	o	o	
adult male, adult female and child	o	o	o

(**Put a cross (X) in the box to indicate the source of labour)**

Table L1 Adult male manager plots

	Who provides the labour					
Task	**Family**	**Hired**	**Adult Male**	**Adult Female**	**Child* Male**	**Child* Female**
Establishment						
Maintenance						
Pollination						
Security						
Harvesting						
Curing						
Selling						

Table L2 Adult female manager plots

	Who provides the labour					
Task	**Family**	**Hired**	**Adult Male**	**Adult Female**	**Child* Male**	**Child* Female**
Establishment						
Maintenance						
Pollination						
Security						
Harvesting						
Curing						
Selling						

Table L3 Child manager plots

	Who provides the labour					
Task	**Family**	**Hired**	**Adult Male**	**Adult Female**	**Child* Male**	**Child* Female**
Establishment						
Maintenance						
Pollination						
Security						
Harvesting						
Curing						
Selling						

*Child is defined as 16 years of age and under**2.27** Vanilla local agricultural calendar: When do the main vanilla activities take place?

X= activity takes place ; XX = main period when this activity takes place

	Month											
Activity	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Establishment												
Maintenance												
Pollination												
Security												
Harvesting												
Curing												
Selling												

3. Processing and marketing of vanilla

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5	Total all plots
3.1 What is the average **number** of green beans produced per vine per year?						
3.2 What method do you use for killing for V. tahitensis? Water Killing / Sun killing / Both						
3.3 What method do you use for killing for V. planifolia? Water Killing / Sun killing / Both						
3.4 For how many weeks do you normally cure your vanilla?						
3.5 What costs do you incur in curing? Kina						
3.6 What was the total **weigh**t of cured beans produced from all the household plots in 2018?						
3.7 Do you sell green beans? Yes / No? If yes, how many [number] / much [kg]? How much did you earn (in Kina)?						
3.8 Were there any cured beans you could not sell or were wasted? Yes / No If yes, why weren't you able to sell them?						
3.9 If yes, how many [number] / much [kg]? How much did you earn (in Kina)?						

3.10 In 2018 how many times did you sell cured beans? …. For each transaction complete the following table:

Sale [Month of transaction]	Vanilla Species	Quantity sold (kg)	Grade	Price (Kina / kg)	Buyer name	Buyer type	Location of sale	Distance (km)	Transportation mode (list)	Type of vehicle	Average fuel consumption (l)
1 [ ]											

* street buyer (small/big e.g. Wingei traders); aggregator (e.g. Paradise Spices); farmers' organization; exporter (e.g. Ramoi); Papindo/Intec; direct to Batas
** Name of village or town

3.11 In 2017 how many times did you sell cured beans? …. For each transaction complete following table:

Sale [Month of transaction]	Vanilla Species	Quantity sold (kg)	Grade	Price (Kina/ kg)	Buyer Name	Buyer type*	Place of sale**
1 [ ]							

* street buyer (small/big e.g. Wingei traders); aggregator (e.g. Paradise Spices); farmers' organization; exporter (e.g. Ramoi); Papindo/Intec ; direct to Batas
** Name of village or town

<u>Buying beans</u>

3.12 In 2018 did anybody in this household buy green / cured beans from other farmers? Yes / No
3.13 IF YES, who (head, spouse, children)…… If no, skip to 4.
3.14 Was the vanilla green or cured? ……
3.15 How much was bought? ……..
3.16 How much was paid? Kina …… Where you paid in cash (Y/N) …… or deposit in bank account (Y/N) ……
3.17 Who were these beans sold to? (street buyer (small/big eg Wingei traders); aggregator (eg Paradise Spices); farmers' organization; exporter (eg Ramoi); Papindo/Intec) ; direct to Batas ……

4. Control, access and use of income from sale of beans

4.1 For each category of vanilla manager in this household,

a) Who had control of income from sale of beans in 2018?
b) Who had access to income from sale of beans in 2018?
c) How was the income used?

	a) Control	**b) Access**	**c) Use of income* from beans sold in 2018**					**d) What food did you purchase last time you went shopping?**
			food	health	education	Housing materials	Other (specify)	
Adult male manager								
Adult female manager								
Child manager								

4.2 From the perspective of the adult male in the household:

a) Were the changes in your household resulting from engagement in the vanilla value chain:
(put a cross (X)

I.	Completely positive	
II.	Mainly positive, but with some negatives	
III.	Equally positive and negative	
IV.	Mainly negative, but with some positives	
V.	Completely negative	

b) Explain your answer above

.....

c) What could be done to enhance the positive and minimize the negative effects?

.....

4.3 From the perspective of the adult female in the household

a) Were the changes in your household resulting from engagement in the vanilla value chain:
(put a cross (X)

I.	Completely positive	
II.	Mainly positive, but with some negatives	
III.	Equally positive and negative	

IV.	Mainly negative, but with some positives	
V.	Completely negative	

b) Explain your answer above

.....

c) What could be done to enhance the positive and minimize the negatives effects?

.....

Vanilla Traders Questionnaire

Interview at least 2 of each category i.e. Border traders (2), Formal exporters (2), Maprik small scale traders that don't export (2); Aggregators (people who act as brokers/don't use own money to purchase (2); if possible 1 boat trader

Name of interviewer..... Date of interview.....

5. Background to vanilla trader

5.1 Name of vanilla trader

.....

5.2 Location: Village: ..... Ward: ..... LLG: .....

District: ..... GPS coordinates: LAT ..... LONG .....

1.3 Age ..... 1.4 Gender M / F

1.4 Type of trader (street buyer (small/big e.g. Wingei traders); aggregator (e.g. for Paradise Spices); exporter (e.g. Ramoi); Papindo/Intec; direct to Bata)

.....

1.5 Number of years you have operated as a vanilla trader? .....

1.6 Do you have regular suppliers? (farmers, other traders) Y / N If yes, where from?

.....

1.7 Do you have regular purchases? If yes, who are they?

.....

1.8 How often do you trade in a year (How many weeks a year?) .....

6. Trading details

2.1 For 2018 please tell me about your vanilla sales? (Please complete table)

Sale [Month of transaction]	Vanilla Species	Quantity sold (kg)	Grade(s)	Price (Kina/ kg)	Buyer Name	Buyer type*	Place of sale**
1 [ ]							
2 [ ]							
3 [ ]							
Total							

2.2 What percentage were you unable to sell and what did you do with it?

.....

2.3 What was the maximum price you bought vanilla for? K.....

2.4 What was the most common price you paid for buying vanilla? K .....

2.5 What was the minimum price you bought vanilla for? K .....

2.6 What was the maximum price you sold vanilla for? K .....

2.7 What was the most common price you received for your vanilla? K .....

2.8 What was the minimum price you sold vanilla for? K .....

2.9 Do you buy and sell organic vanilla? .....

2.10 What costs did you incur in trading apart from PMV transport in 2018? (e.g. car hire, security, flights, taxis, accommodation and food, other payments – bank charges, export tax, packaging, phytosanitary certificate)

Please list amounts spent in Kina

Car hire	Security	Flights	Taxis	Accommodation & food	Bank charges	Packaging	Phytosanitary certificate	Export tax	Other

2.11 Tell me about the transportation of your vanilla beans (average per month)

	From:	To:	Amount of Vanilla (kg)	Distance (km)	Transportation mode	Type of vehicle	Average fuel consumption (l)/purchase (if purchased)

2.12 Do you export vanilla? Y / N If yes, where are your main markets?

.....

2.13 Have you ever been robbed? If yes, how much have you lost?

2.14 Do you sell vanilla online, e.g. via Facebook? Y / N If yes, is this effective?

.....

7. **Batas sales** For traders selling at the *Batas*:

7.1 Do you know your buyer in advance? Y / N If yes, how do you know them? .....

7.2 How often are you asked to show your export documents? (phytosanitary certificate, exporter licence, other documents)

.....

7.3 How often does NAQIA/Customs record your sales? .....

7.4 How often do you have to pay export tax at the Batas? (e.g. every visit; sometimes – specify how often) .....

Annex 2: List of stakeholders consulted

Organisation	People met
East Sepik Province government	Governor; Executive officer to Governor
EU delegation, Port Moresby	EU delegate Programme Officer
Min of Agriculture, Port Moresby	EO, Department of Planning
PNG Spice Industries Board, Port Moresby	Officer
Women in Agricultural Development Foundation	President
National Agriculture Quarantine and Inspection Authority (NAQIA), Port Moresby	Officer
Department of Customs, Port Moresby	Export Officer
Pacific Horticultural & Agricultural Market Access Program (PHAMA), Port Moresby	PNG Country Manager
FAO, Port Moresby	Representative; Gender Focal Point
Ministry of Trade and Commerce	Secretary
PPAP Coordination Unit, Port Moresby	Officer
Ministry of Women and Youth, Port Moresby	Officer
National Statistical Office, Port Moresby	Officer
National Research Institute, Port Moresby	Research Fellow
Department of Forestry, Port Moresby	CTA, EU/PNGFA National Forestry Inventory Project
Department of Environmental Conservation, Ministry of the Environment, Port Moresby	Principal Scientist,
Vanilla exporters, Port Moresby	MD, Global Village Exports; William Yanei Ltd
East Sepik Provincial Agricultural Office, Wewak	Provincial Agricultural Officer
Turubu LLG vanilla growers, Wewak district	Ward councillors, ~30 vanilla farmers
Bangui Bio vanilla exporter, Wewak	MD
Vanilla exporter, Wewak	MD
Waiyu Ltd, Maprik	Manager
Save the Children, Wewak	Senior Programme Coordinator
Water Aid, Wewak	Officers
NAQIA, Wewak	Officer
Yangoru-Saussia LLG president, East Sepik	LLG President & vanilla grower
Holik 2 village, Wosera	Vanilla growers
Women in Agricultural Development Foundation, Hayfield	Officer
Papindo, Maprik	Manager, Intec Organic Vanilla Programme
Maprik District HQ	Maprik District Administrator; Vimca Cooperative executive members
Jame village, Maprik	~40 male and female vanilla growers
Vanilla street traders, buyer and exporters, Maprik	
Bainyik village, Maprik	~20 Men and women vanilla growers
District Agricultural Office, Maprik	District Agricultural Officer
Dreikikir district vanilla grower/Dreikikir Vanilla Farmers	Representative
Ramoi Vanilla Ltd, Wewak	MD
Bank of the South Pacific, Wewak	Branch Manager
PNG Air freight, Wewak	Clerk
Family for Change, Wewak	Staff member
Water Aid, Wewak	Staff member
DAL, Situm, Morobe province	OIC, Situm; ~70 male, female and youth vanilla growers
Morobe Provincial HQ	Provincial Administrator
Department of Agriculture and Livestock	Acting Provincial Program Adviser Vanilla programme adviser

Finschhafen vanilla growers, Lae	Farmer group leader
Oxfam, Port Moresby	Director
Department of National Planning & Monitoring, Port Moresby	Technical adviser, M&E
	Programme director, European Development Fund

Annex 3: Vanilla origins in PNG

Vanilla was introduced to French Polynesia in 1848. Vanilla originated in PNG from several different sources. It was first recorded as being grown commercially, along with cocoa and nutmeg, on Matanatar plantation in East New Britain, near Kokopo, in 1908 by 'Queen' Emma Kolbe, a businesswoman and trader from Samoa[101]. Matanatar was later used as the experimental plantation for a large German company during the German administration in the 1920s. *Vanilla planifolia* was introduced at the Lowland Agricultural Experimental Station (LAES) at Kerevat, East New Britain from Madagascar in 1963; subsequent introductions included two varieties of *V. tahitensis* in 1968 and a variety of *V. pompona* in 1973. In 1969 it was introduced to East Sepik, probably at the Bainyik Agricultural Station near Maprik. In 1973 it was noted that vanilla appeared to do well in East New Britain but 'the long and tedious processing methods and doubtful markets make the crop unattractive to growers'[102].

Vanilla was promoted in 1991 as part of an ADB project on improving smallholder market access, implemented by the Department of Agriculture and Livestock in East Sepik province. Vanilla growing is very similar to cultivating yams (the staple food) where tubers are planted into ridges and staking is necessary. Several stories were recounted of Papuan New Guineans seeing the care that Europeans took of vanilla vines and, assuming they must be valuable, would take pieces to plant themselves.

The Department of Agriculture and Livestock's Rural Officer in Maprik District, James Hosea, says that vanilla was first introduced to Maprik in 1992 under the DAL's Minor Crop Diversification Programme. Villagers in all 4 Maprik LLGs were trained in cultivating and processing vanilla at that time (although the quality of that training is unknown). He confirmed that planting in the Maprik area really took off between 1993 and 1998, and the number of plants brought to harvest in 1998 was close to 60.000. The DPI in Maprik, however, told us that the cultivated form of vanilla was introduced in 1996-7 under the Smart Program.

At around the same time, in 1993, Alfred Jambram a field supervisor at Vudal Agricultural College in East New Britain, saw the vanilla trials at LAES and felt that the crop would do much better in his home area of Dreikikir in East Sepik. He left his job and took 18 vines to his home in Yambes village, East Sepik which he planted and where he gave training to a few local farmers who received free cuttings. He approached DAL about giving training to other farmers. The first course was given at Maprik where farmers paid K10 for training notes and received vine cuttings, both Planifolia and Tahitensis. Alfred later went to their plots to show them how to do pollination and then curing and sales. He persuaded the cocoa buying company, Agmark in Maprik and Wewak to buy vanilla. Much of the introduction and uptake was due to the enthusiasm of individuals who had seen the crop under trial in other parts of the country and thought it would do well in East Sepik and other provinces and were able to make links with overseas buyers. They were supported by agricultural officers working for the Department of Agriculture and Livestock, some of whom are still involved in the sector and the team were able to interview.

[101] Gash, N. and Whittaker, J. (1975) A pictorial history of New Guinea. The Jacaranda Press

[102] LAES Review, 1978:55

Annex 4: Consolidation of value chain accounts

TABLE A4-1 SYNTHESIS ACCOUNT OF THE SMALL-SCALE VINE OWNING HOUSEHOLDS (5.081 HH)

EXPENSES	Value	REVENUE	Value
Equipment purchase	924 742	Grade A to CBT	7 560 000
Return transport to market	182 916	Grade A to MT	1 400 000
Coop membership fee	762 150	Grade A to LT	3 990 000
		Grade B to CBT	19 500 000
Total	**1 869 808**	Grade Bto MT	3 250 000
		Grade B to LT	8 250 000
		Total	**43 950 000**
VA			
Casual labour/food purchase	0		
Gross profit	**42 080 192**		
Depreciation	**0**		
Net profit	42 080 192		
Net profit rate (%)	96		

TABLE A4-2 SYNTHESIS ACCOUNT OF THE MEDIUM-SCALE VINE OWNING HOUSEHOLDS (6.834 HH)

EXPENSES	Value	SALES	Value
Intermediate consumption			
Equipment purchase	2 938 620	Grade A to CBT	2 520 000
Return transport to market	293 862	Grade A to MT	4 000 000
Coop membership fee	1 025 100	Grade A to LT	31 540 000
		Grade B to CBT	1 495 000
Total	**4 257 582**	Grade Bto MT	2 145 000
		Grade B to LT	15 070 000
		Total	**56 770 000**
VA			
Casual labour/food purchase	615 060		
Gross profit	**51 897 358**		
Depreciation	**0**		
Net profit	51 897 358		
Net profit rate	91		

TABLE A4-3 SYNTHESIS ACCOUNT OF THE LARGE-SCALE VINE OWNING HOUSEHOLDS (5.081 HH), PGK

EXPENSES	Value	SALES	Value
Intermediate consumption		Grade A to CBT	8 100 000
Equipment purchase	3 348 379	Grade A to MT	9 000 000
Return transport to market	315 022	Grade A to LT	21 850 000
Coop membership fee	1 524 300	Grade B to CBT	8 840 000
		Grade Bto MT	8 840 000
Total	**5 187 701**	Grade B to LT	19 140 000
		Total	**75 770 000**
Gross profit	**70 582 299**		
VA			
Casual labour/food purchase	762 150		
Gross profit	69 820 149		
Depreciation	0		
Net profit	69 820 149		
Net profit rate	92		

TABLE A4-4 SYNTHESIS ACCOUNT OF THE STREET TRADERS/CROSS-BORDER TRADERS (17 TRADERS)

EXPENSES	Value	REVENUE	Value
Intermediate consumption		CB to Wutung A	6 650 000
Vanilla purchase from SSVOHH A	7 560 000	CB to Wutung B	39 015 000
Vanilla purchase from SSVOHH B	19 500 000	CB to Intec A	12 540 000
Vanilla purchase from MSVOHH A	2 520 000	**Total**	**58 205 000**
Vanilla purchase from MSVOHH B	1 495 000		
Vanilla purchase from LSVOHH A	8 100 000		
Vanilla purchase from LSVOHH B	8 840 000		
Total vanilla purchase	**48 015 000**		
Packaging	6 800		
Scales	3 400		
Return transport Wingei to Maprik	85 000		
Return transport to Wewak	272 000		
Return flight Wewak - Vanimo	810 560		
Vanilla cargo charge	731 850		
Taxi Vanimo - Wutung	408 000		
Wheelbarrow hire	13 600		
Accomodation Vanimo	272 000		
Phytosanitary certificate	144 840		
Airtime	6 120		
Subtotal	**2 754 170**		
Value added			
Export licence	42 500		
Trader licence Maprik	8 500		
Export levy (10%)	*5 820 501*		
Total	5 871 501		
Total costs	*56 640 671*		
Gross profit	**1 564 329**		
Depreciation	0		
Net profit	1 564 329		
Net profit rate	3		

TABLE A4-5 SYNTHESIS ACCOUNT OF THE MEDIUM-SCALE TRADERS (8 TRADERS)

EXPENSES	Value	REVENUE	Value
Intermediate consumption		Int market A	17 280 000
Vanilla purchase from SSVOHH A	1 400 000	Indonesia B	18 615 000
Vanilla purchase from SSVOHH B	3 250 000	**Total**	**35 895 000**
Vanilla purchase from MSVOHH A	4 000 000		
Vanilla purchase from MSVOHH B	2 145 000		
Vanilla purchase from LSVOHH A	9 000 000		
Vanilla purchase from LSVOHH B	8 840 000		
Total vanilla purchase	**28 635 000**		
Packaging	192 000		
Scales	4 800		
Packhouse rental (50%)	80 000		
Consumables	24 000		
Electricity	96 000		
Water	96 000		
Fuel, oil	120 000		
Aggregator fee	320 000		
Vanilla internal air cargo charge	576 000		
Phytosanitary certificates	96 000		
Internet access	29 200		
Subtotal	**1 634 000**		
Value Added			
Export licence	20 000		
Casual labour	28 800		
Export levy (10%)	*3 589 500*		
Goods and services tax (10%)	82 120		
Subtotal	3 720 420		
Gross profit	1 905 580		
Depreciation of equipment			
Pick-up (5 years)	224 000		
Computer and printer (3 yrs)	13 200		
Other equipment (5 years)	8 000		
Subtotal	245 200		
Net profit (earnings per producer)	1 660 380		
Net profit rate (return on turnover)	5		

TABLE A4-6 SYNTHESIS ACCOUNT OF THE LARGE EXPORTER (1 COMPANY)

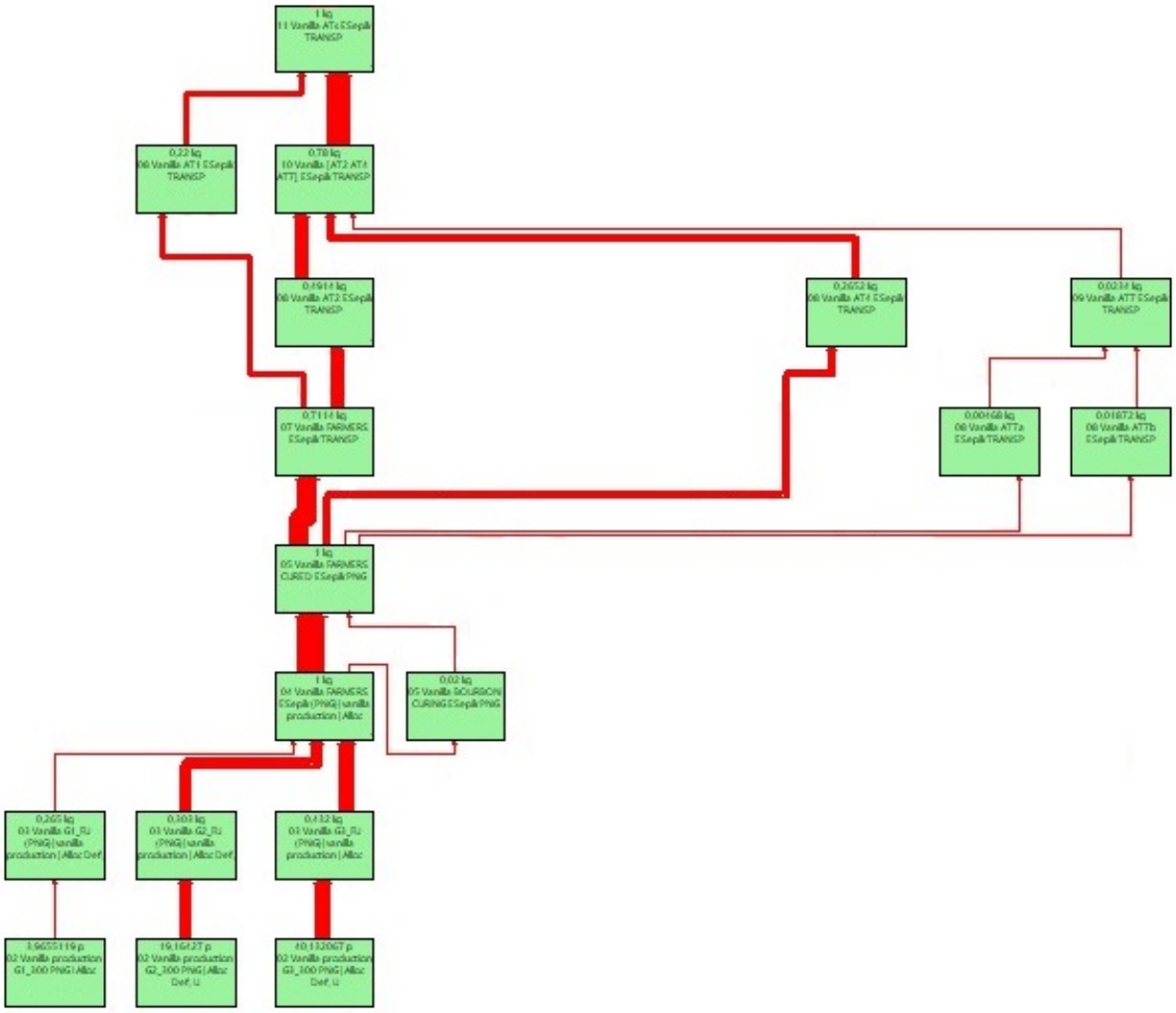
EXPENSES	Value	RESOURCES	Value
Intermediate consumption		Int export A	88 320 000
Vanilla purchase from SSVOHH A	3 990 000	Indo export B	65 620 000
Vanilla purchase from SSVOHH B	8 250 000	**Total**	**153 940 000**
Vanilla purchase from MSVOHH A	31 540 000		
Vanilla purchase from MSVOHH B	15 070 000		
Vanilla purchase from LSVOHH A	21 850 000		
Vanilla purchase from LSVOHH B	19 140 000		
Vanilla purchase from CB trader	12 540 000		
Total vanilla purchase	**112 380 000**		
Packaging	109 200		
Premises rental	33 000		
Consumables	10 000		
Electricity	25 000		
Water	10 000		
Fuel, oil	64 800		
Phytosanitary certificates	46 800		
Vanilla internal air cargo charge	2 412 800		
Internet access	36 500		
Sub-total	*2 748 100*		
Value added			
Management	180 000		
Permanent labour	980 000		
Financial charges	15 000		
Export levy (10%)	15 394 000		
Goods and services tax (10%)	244 580		
Export licence	2 500		
Subtotal	*16 816 080*		
Total cost			
Gross profit	21 995 820		
Depreciation of equipment			
Vans (5 years)	224 000		
Equipment (5 years)	10 000		
Computer and printer (3 yrs)	24 750		
Subtotal	*258 750*		
Net profit	**21 737 070**		
Net profit rate	14		

Annex 5: Social profile spreadsheet

SOCIAL PROFILE (V.2017-0)		Value chain:	*Vanilla*
		Country :	*Papua New Guinea*
Date last modif.	. . / . . / 20 . .		

Domain	Present profile		Trend	Previous profile ../../20..	
	Score level	Count		Score level	Count
1. WORKING CONDITIONS	Substantial	2,83	↑	Not at all	0,00
2. LAND & WATER RIGHTS	Moderate/Low	2,33	↑	Not at all	0,00
3. GENDER EQUALITY	Moderate/Low	2,05	↑	Not at all	0,00
4. FOOD AND NUTRITION SECURITY	Substantial	2,50	↑	Not at all	0,00
5. SOCIAL CAPITAL	Moderate/Low	2,22	↑	Not at all	0,00
6. LIVING CONDITIONS	Moderate/Low	2,39	↑	Not at all	0,00

Annex 6: Flow scheme for vanilla in Papua New Guinea



Annex 7: Typology of producers per location – Village and District

FIGURE A6.1 – DISTRIBUTION PATTERN BY VILLAGES OF EACH OF THE THREE TYPES OF PRODUCERS (G1, G2 AND G3) CONSIDERING THE TOTAL AREA OF VANILLA PLANTATION (SOURCE: VANILLA HOUSEHOLD SURVEY, 2019)

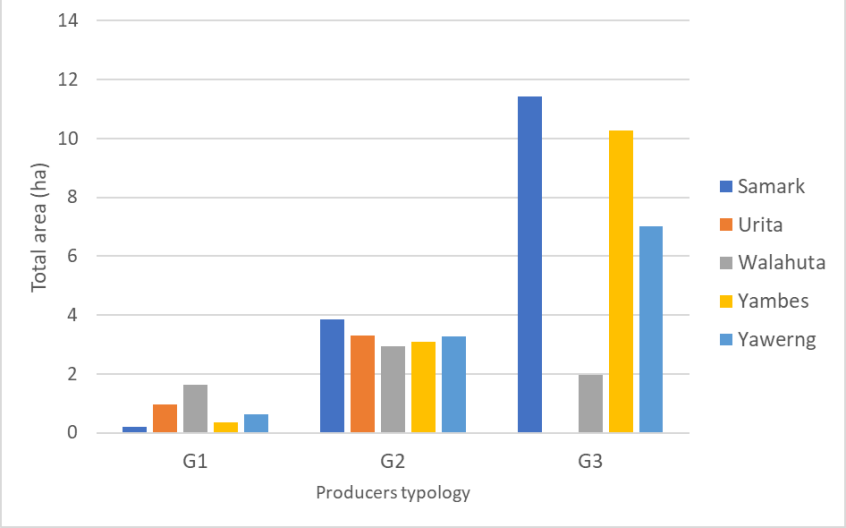


FIGURE A6.2 –RELATIVE PERCENTAGE OF THE THREE TYPES OF PRODUCERS (G1, G2 AND G3) PER VILLAGE FOR THE TOTAL AREA OF VANILLA PLANTATION (SOURCE: HOUSEHOLD SURVEY, 2019)

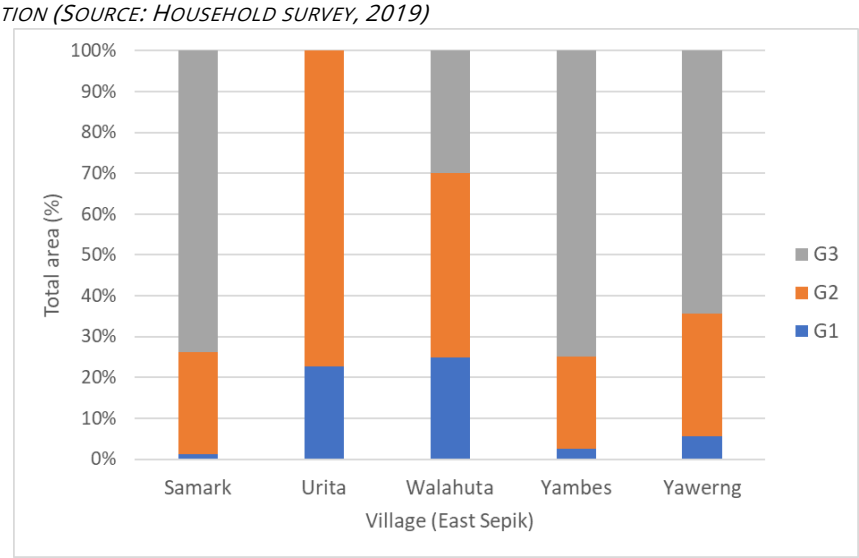


FIGURE A6.3 – DISTRIBUTION PATTERN BY DISTRICT (EAST SEPIK) OF EACH OF THE THREE TYPES OF PRODUCERS (G1, G2 AND G3) CONSIDERING THE TOTAL AREA OF VANILLA PLANTATION (SOURCE: HOUSEHOLD SURVEY, 2019)

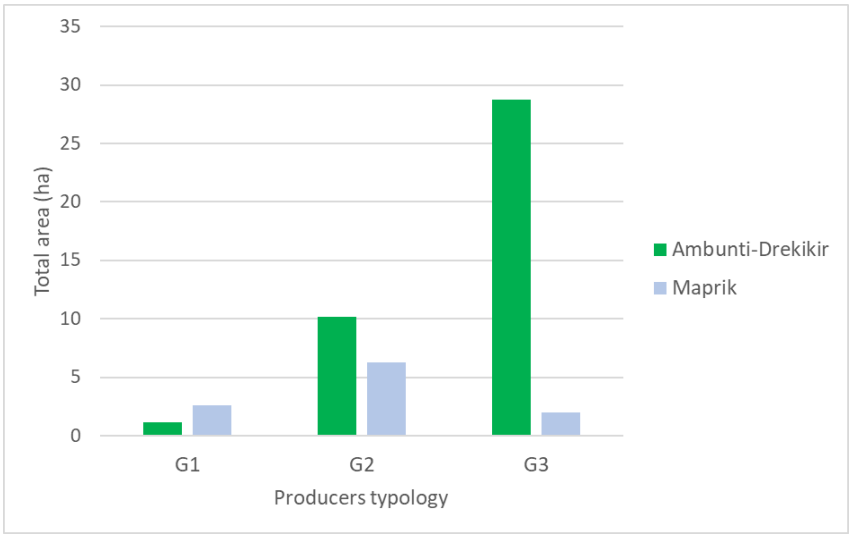
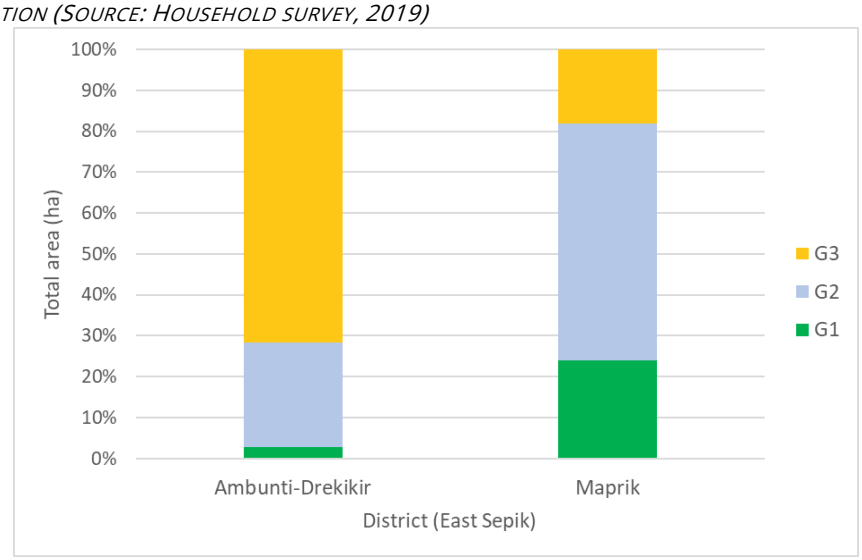


FIGURE A6.4 - RELATIVE PERCENTAGE OF THE THREE TYPES OF PRODUCERS (G1, G2 AND G3) PER DISTRICT FOR THE TOTAL AREA OF VANILLA PLANTATION (SOURCE: HOUSEHOLD SURVEY, 2019)



Annex 8: Quality, variability and uncertainty of the data used in the LCA model

TABLE A7.1 - QUALITATIVE ASSESSMENT OF THE VARIABILITY OF PRIMARY DATA USED IN LCA

Actors	Data used in the model	Evaluation
Producers	Vanilla plantation (type of land use transformation, expansion rate, plant density)	3
	Vanilla production and management practices (materials)	3
	Production of mature fresh vanilla beans: weight produced per plant	3
	Vanilla curing (processes, materials)	2
	Process of vanilla packaging and transport to place of sale; distances travelled; vehicle types	2
Traders	Process of vanilla buying, packaging and transport to storehouse; distances travelled; vehicle types	4
	Process of vanilla packaging and transport to the Indonesian border (place of export); distances travelled; vehicle types	2
	Process of vanilla packaging and transport to Lae (place of export); distances travelled; vehicle types	2

Qualitative classification: scale from 1 to 5 [1 - data of low variability, representative of the typical actor; 5 - data of great variability, actor type of difficult characterization]

TABLE A7.2 - VALUES OF DATA QUALITY, SCORING AND GENERAL QUALITY INDICATORS RECORDED FOR THE VARIOUS DATA CATEGORIES INTEGRATED IN THE PAPUA NEW GUINEA VANILLA LIFE CYCLE INVENTORY

Data category	TeR	GR	TiR	C	P	M	Data Quality Rating (DQR)	Global Quality (GQ)
1. Plantation stage								
Land transformation	1	3	1	2	2	1	1.8	Bq
Expansion rate	1	3	1	2	2	1	1,8	Bq
Plant density	1	1	1	2	3	2	1.7	Bq
2. Production stage								
Mulching	1	2	1	2	3	3	2.0	Bq
Yield per vine	1	2	1	2	3	1	1.7	Bq
4. Curing								
Killing	1	1	1	2	3	2	1.7	Bq
5. Trading								
Packaging	3	1	1	4	5	4	3.0	dE
Distances travelled	3	4	1	3	5	4	3.3	dE

Data Quality Rating (DQR)	Data Global Quality (GQ)
< 1.6	"High quality" (Eq)
>1.6 a >=3	"Basic quality" (Bq)
>3 a <= 4	"Data estimate" (dE)

Annex 9: CO_2 emissions resulting from different land use change scenarios

CO2 emission Scenarios	Tropical Rain Forest [Primary] (%)	Tropical Forest [Secondary] (%)	Perennial cropland (%)	Annual cropland (%)	Expansion (%)	GHG emissions from Land use change (tonne CO2eq/ha.year)
CLT 00	Land use change GHG emissions when country & land use is unknown (normal average)**				***	7,44
CLT 0	Land use change GHG emissions when country & land use is unknown (weighted case)**				***	12,82
CLT 1	40	40	5	15	98,9	29,36
CLT 2 (Base model)	60	25	0	15	98,9	32,79
CLT 3	70	25	5	0	98,9	38,21
CLT 4	80	20	0	0	98,9	42,66
CLT 5*	80	20	0	0	98,9	47,65

* - vanilla as annual crop

** - Direct Land Use Change Assessment Tool v. 2014.1 model (**Blonk Consultants**)

*** - already incorporated in the model