Australasian Agribusiness Review – Vol. 24 – 2016

Paper 2

ISSN: 1442-6951

Improving sweetpotato marketing in Papua New Guinea: Results from a value chain analysis[1]

Hui-Shung (Christie) Chang, John Spriggs, Jesse Anjen, Eleo Dowa, John Kewa and Donald Hehona

Hui-Shung (Christie) Chang, Associate Professor and Principal Research Fellow at the Institute for Rural Futures, University of New England, Armidale, NSW, Australia.
email: hchang@une.edu.au.
John Spriggs, Professor, Australian Institute for Sustainable Development, University of Canberra, Australia.
Jesse Anjen, National Agricultural Research Institute, PNG
Eleo Dowa, National Agricultural Research Institute, PNG
John Kewa, Fresh Produce Development Agency, PNG
Donald Hehona, Fresh Produce Development Agency, PNG

Abstract

Sweetpotato is the most important food crop in the Highlands of Papua New Guinea (PNG). In recent years, sweetpotato has become a cash crop for smallholder farmers driven by the need to generate income in a market economy. Marketing opportunities exist for Highland sweetpotato, especially in coastal markets, because of income growth and urbanisation. Despite this, long distance sweetpotato marketing has been problematic. The objective of this research was to identify socio-economic constraints to, and opportunities for, improving the marketing efficiency of the long distance sweetpotato value chain in PNG. The results from the value chain analysis suggested that although there was a demand for high quality Highland sweetpotato in coastal markets, the long distance sweetpotato value chain was underdeveloped. This was due to several constraints: lack of access to support services (credit, extension and market information); poor infrastructure (roads and the transport system and storage and market facilities); inadequate postharvest management; lack of business skills, financial literacy and marketing planning; unclear price signals; lack of trust among chain players, uncoordinated value chain activities; and declining demand. The main conclusion was that to transition from subsistence farming to semi-commercial/commercial farming, smallholder farmers need to become more market-oriented and better equipped with business skills. Furthermore, they need to be prepared to change their current marketing and postharvest practices in order to supply high quality products to the right markets at competitive prices. Government also has a key role to play in terms of providing an appropriate enabling environment, including a reliable transport system, business development services and a locally appropriate pricing and grading system. This environment is necessary to support the effort of farmers in adopting improved marketing and postharvest practices.

Key words: value chain analysis, sweetpotato, smallholder farmers, Papua New Guinea.

[1] This paper reports part of the project "Improving marketing efficiency, postharvest management and value addition of sweetpotato in PNG", funded by the Australian Centre for International Agricultural Research (ACIAR). We would like to thank ACIAR for its financial support, and all the collaborators for their contribution and input to this research. Insightful and constructive comments and suggestions from the anonymous reviewer and the editors have resulted in a substantially improved paper, and are greatly appreciated.

1. Introduction

Sweetpotato is the most important food crop in Papua New Guinea (PNG), accounting for 43% of all food energy (Bourke and Vlassek 2004). It is grown throughout PNG by subsistence farmers, although production is centred in the Highlands, where 75% of the crop is produced. Sweetpotato is becoming a cash crop for smallholder farmers, driven by the need to generate income in a modernising market economy. On the other hand, there is an increasing demand for higher quality Highland sweetpotato in coastal cities, especially Lae and Port Moresby, as a result of economic growth and urbanisation. However, potential marketing opportunities, and crop profitability, have been constrained by high product losses of 30-50%, in instances of substantial shipping delays in reaching the Port Moresby markets (Spriggs 2005). In this research, we sought to identify constraints to, and opportunities for, improving the marketing efficiency of the PNG sweetpotato value chain. A better performing sweetpotato value chain has significant implications for the livelihood, food security and income of smallholder farmers.

2. Methodology

In this study we adopted a value chain approach to understand and improve sweetpotato marketing in PNG. Both qualitative and quantitative methods were employed.

A value chain approach is different from a selling approach (Anon. n.d.). In a traditional selling system, farmers produce commodities that are "pushed" into the marketplace. Farmers are isolated from the end-users or consumers, and have little control over their input costs or the prices they receive for their products. In a value chain marketing system, farmers are linked to market through flows of information and products, and work closely with input suppliers, processors and marketers to deliver the specific products the market wants. An efficient value chain is supported by an enabling policy and institutional environment, basic infrastructure, availability of necessary inputs, credit and technical support, and a well-functioning market.

In this study, a value chain analysis[2] was conducted to identify the major constraints and opportunities faced by all the key players along the long distance sweetpotato value chain in PNG. This was completed via a review of literature, stakeholder consultations, informant interviews, focus group discussions, field observations, price analysis, volume assessment and a consumer survey. Personal interviews were conducted using semi-structured questionnaires. Focus group discussions were held separately with women's groups and with farmers and farmer-sellers, using several leading questions to facilitate open-ended discussion. The questions for farmers and value chain operators focused on their operations, relationships with their suppliers and/or buyers, the issues and problems they faced, and opportunities and possible solutions they envisaged. A consumer survey was conducted in Lae to better understand consumer demand for sweetpotato. Technical trials (e.g. consignment trials and disease surveys) were also conducted to track the movement of sweetpotato from farm to market, to observe how sweetpotato was handled, to identify where product damage was occurring and to assess product losses. [3]

Key issues from the value chain analysis were summarised in a 2x2 SWOT (strengths (S), weaknesses (W), opportunities (O) and threats (T)) matrix, following the analytical framework described in Johnson et al. (2005).

[2] The term "value chain analysis" was first used by Porter (1985) to identify the competitive advantage a firm has by breaking down the firm's entire operation (i.e., the value chain) into primary and support activities. Porter (1985) also used "value system" to refer to the system of firms (value chains) that are linked together vertically to deliver value to the final consumer. As the value chain concept becomes popularised, the term "value system" has been superseded by value chain that is now more commonly referred to the wide range of activities and key players that links the steps a product takes from the farmer to the consumer. Similarly, "supply chain" has been superseded by value chain, which has a market-driven and market linkages connotation to it, as opposed to supply chain that could appear to be supply-driven. In the literature, value chain and supply chain may at times be used interchangeably, or at least closely related (Anon. n.d.). This is also true for the use of terminology such as "marketing system" or "market chain" commonly used in the agricultural marketing literature.

[3] In this paper, we focus on the socio-economic aspects of the value chain. Results from the technical trials can be found in Chang and Irving (2013).

The research methods used for the value chain analysis included:

Personal interviews with sweetpotato marketers. Eight individuals in Goroka and Mt Hagen who regularly marketed sweetpotato to Lae and Port Moresby were interviewed. These individuals were either farmer-sellers (farmers marketing their own sweetpotato), semi-wholesalers (farmers marketing their own sweetpotato, as well as sweetpotato purchased from other farmers, primarily for on-sale in bulk to retailers), or wholesalers (operators specialised in buying and selling mixed vegetables and sweetpotato in bulk).
Focus groups of smallholder farmers. Two farmer focus groups were conducted in Goroka (ten participants) and Mt Hagen (six participants). These farmers sold their produce to one or more of the sweetpotato marketers mentioned above.
Focus groups of women group leaders. Two focus groups of women leaders were conducted in Goroka (eight participants), and Mt Hagen (13 participants). All participants had been involved in both local and long distance sweetpotato marketing for many years. They represented their districts in either the Eastern Highlands Province (EHP) or the Western Highlands Province (WHP). Group discussions focused on three areas: division of labour in the sweetpotato value chain; distribution of income within the household; and marketing and other issues.
Personal interviews with road transporters and shipping companies. Eight truck operators were interviewed at the Lae market while sweetpotato bags were being off-loaded. Managers of two shipping companies (Consort and Bismark), as well as eight trucking company representatives were interviewed at their offices.
Personal interviews with institutional buyers. Representatives of eight institutional buyers in Lae were interviewed, including the National Catering Services at Unitech, Lae Technical College Massing Facility, and six *kai bars* (fast food outlets in PNG).
Consumer survey. Some 92 women from seven church/community groups in Lae were interviewed. Non-probability sampling was used due to lack of a well-defined sampling frame (no phone book or official record of residency was available). Interviews were pre-arranged and conducted at a church or community centre. Previous consumer surveys have shown that it can be very challenging to conduct a survey in a public place in PNG, because it tends to attract large crowds which interrupted the survey and potentially threaten the safety of interviewers. The survey questionnaire was mostly structured, but included several open-ended questions. The focus was on understanding consumer preference for sweetpotato against other food staples, preferences for sweetpotato varieties, and the physical characteristics and eating quality associated with each variety.
Volume assessment. Three volume assessments were conducted at the Lae main market. The objectives were to find out how much sweetpotato was sold at Lae (as compared to Port Moresby), and to explain, if data permitted, price differentials and linkages between the two markets. Each assessment involved: (1) counting the number of sweetpotato bags that came through the Lae market gate between 7:00 am and 10:00 am over the weekly trading period (Monday to Saturday); (2) recording the variety and location of production; (3) recording a 'beginning inventory' on early Monday morning before the market was open; and (4) recording an 'ending inventory' on late Saturday afternoon after the market was closed. Weekly disappearance was then arrived at by adding the beginning inventory to new arrivals and taking away the ending inventory.
Price analysis. Statistical analysis was conducted using time series data from 1992-2009 to better understand factors contributing to significant variability in prices, both from year to year and from month to month. The goal was to identify seasonality in production or consumption, if it existed, as well as to understand marketing margins and price linkages between the four main markets (Hagen, Goroka, Lae and Port Moresby).
Marketing cost analysis. The marketing costs of a farmer-seller who sold 20 bags of sweetpotato in the Kasena village and to Goroka, Lae and Port Moresby were analysed to identify major cost items and strategies by which marketing costs could be reduced and financial returns to smallholder farmer-sellers increased. Costs of marketing that were considered included: packaging, loading/unloading, market entry fees, transport costs for both sweetpotato and the marketer (including return airfares from Hagen/Goroka to Lae/Port Moresby), communications, living expenses when away from home, product losses, as well as the opportunity costs associated with being away from the farm for 3-5 days (to the Lae market) and 7-10 days (to the Port Moresby market).

In addition to the value chain approach, this project was also guided by the principles of participatory action research (PAR) (Huizer 1997, McTaggart 1989). The approach required the researchers to work closely and collaboratively with local stakeholders, to identify their needs and address issues that were important to them, rather than focusing mainly on topics that were primarily of interest to researchers. One avenue through which stakeholder viewpoints were taken into account was the stakeholder workshop, whereby priority issues were identified, and action plans to address those issues were developed.

In this paper, we focus on the results of the value chain analysis and stakeholder workshop. The results and lessons learned from implementation of the action plans can be found in Chang and Irving (2013).

3. Fresh produce marketing in PNG

Benediktsson (2002) divided the PNG fresh produce market into three segments: the formal market, the informal market and direct bulk selling. At the formal market, producers sell to wholesalers, who, in turn, supply both retail establishments in the urban centres, and catering services operating at the many mining and logging enclaves scattered throughout the country. The informal market refers to open-air markets (equivalent to wet markets in Asia) found in every city, town and village and along major roads, with a mixture of farmer-sellers and resellers. In the case of direct bulk selling, producers sell directly to supermarkets, restaurants, small institutions and resellers at the open-air market. The market share of fresh produce in the formal sector is relatively small country-wide at about 10-15%, compared with the informal sector at about 85-90% (Chang and Griffith 2011). The percentage of sweetpotato that is sold through the formal sector is likely to be less than one percent.

The majority of temperate vegetables sold in the major city centres in PNG, especially Lae and Port Moresby, come from the Western Highlands and Eastern Highlands provinces (Chang and Griffith 2011). For the Port Moresby market, vegetables that are considered hardier, such as onion, carrot, potato, sweetpotato, English cabbage and avocado, are first delivered by road via the Highlands Highway from the Highlands to Lae, either in 20-foot (dry) containers or 3-6 tonne open-back trucks, or in public motor vehicles (PMVs), often also carrying passengers, and then shipped to Port Moresby by sea. The road journey from Hagen to Lae (443km) takes about 10-12 hours (often completed overnight), and the sea journey from Lae to Port Moresby takes about 3-5 days if there is no major delay. Figure 1 shows the fresh produce transport route from the PNG Highlands to Port Moresby.

More perishable and higher-value vegetables, such as tomato, broccoli, cauliflower, capsicum, spring onion, French bean and lettuce, are transported mainly by air directly from the Highlands to Port Moresby and to the mining towns. Most flights take about an hour. Some of these vegetables are also shipped in chiller containers by wholesalers from the Highlands to Port Moresby. However, for small traders and farmer-sellers, fresh produce is put in a chiller container only from Lae to Port Moresby. The break in the cold chain makes quality control and assurance very difficult – this has been an area of contention for compensation where the farmer and the shipping company blame each other for product spoilage.

Supply disruptions were commonplace. This was due to: poor road conditions/landslides/bad weather; law and order issues (road blocks by rascals and disgruntled landowners along the Highlands Highway); port congestions in Lae to Port Moresby; and lack of cargo space on passenger flights. Fresh produce suppliers were most vulnerable to these transport and logistics problems because of the perishability of their goods. Poor transport infrastructure, and hence long delays, have been identified as the most significant contributor to quality deterioration and inconsistency in supply in the fresh produce marketing in PNG (Wilson 2008, Global Development Solutions 2008, Martin and Jagadish 2006, McGregor et al. 2003, Peter 2001, Epstein 2000, Burdon 1998, Daysh 1995).

Many of the issues facing the fresh produce sector were applicable to sweetpotato. However, because of its low value–to-weight ratio, the long distance marketing of

sweetpotato has its own additional challenges. These are discussed in the following section.

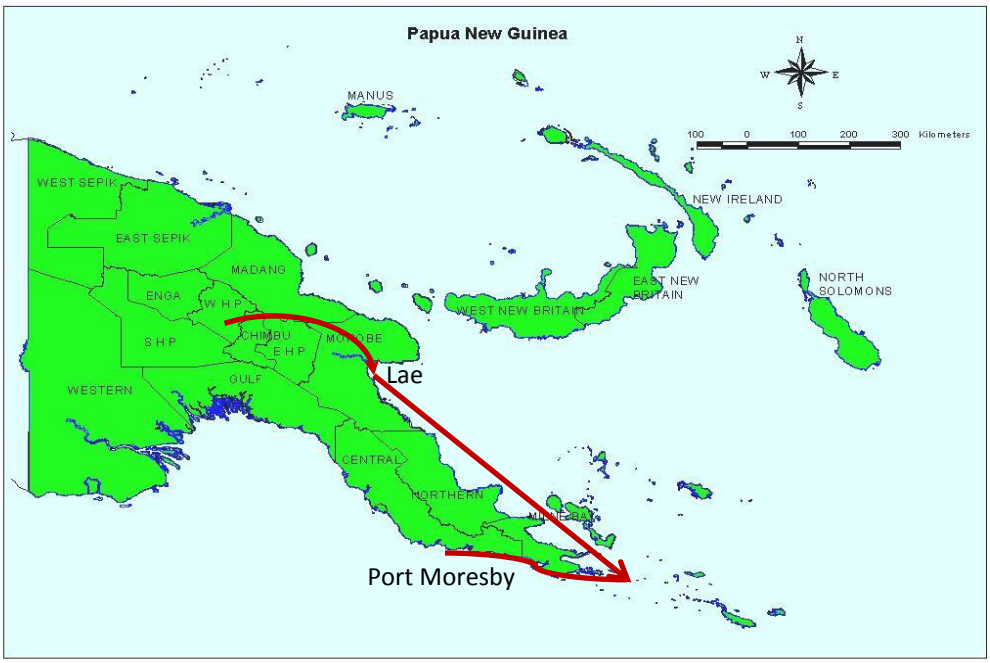


Figure 1. Fresh produce transport route from the PNG Highlands to Port Moresby

4. The sweetpotato value chain in PNG

Key aspects of sweetpotato production, consumption and marketing are summarised in this section, based on a review of previous research.

4.1. Sweetpotato Production

Total production of sweetpotato in PNG has been estimated at around 3 million tonnes (Bourke and Vlassek 2004), of which approximately 75% was produced in the Highlands. Approximately 60-75% of Highland sweetpotato was used for human consumption, with the remainder used as pig feed. Table 1 shows the top ten sweetpotato producing provinces in PNG. The number one producer, the Southern Highlands Province, produced 620,000 tonnes of sweetpotato in 2000. Given the provincial population of 523,613 at the time (Bourke and Harwood 2009), average per capita production per annum was therefore around 1.20 tonnes. Assuming one third of this was fed to pigs, apparent human consumption of sweetpotato could be as high as 2.00kg/person/day in the Southern Highlands.

Table 1. Annual production of sweetpotato in PNG (in '000 tonnes), 2000.

Province	Production
Southern Highlands	620
Eastern Highlands	470
Western Highlands	426
Enga	341
Simbu	295
Morobe	195
Bougainville	93
Madang	78
Oro	53
Central	49

**Source: Bourke and Vlassek 2004.*

According to Bourke et al. (2004), the supply of sweetpotato was continuous, non-seasonal and regular to irregular in most parts of PNG, but there was a tendency for it to be available in larger quantities at certain periods of the year. These periods varied between locations and between years. For example, in the Eastern Highlands supply tended be at its highest in March-July, and at its lowest in October-January. Bourke et al. (2004) concluded that the supply of sweetpotato did not vary in a regular annual cycle, and as such demonstrated no apparent seasonality in production. This stability has been essential for providing food security in the past. However, there is a concern that production may have become more variable and unpredictable because of climate change (Bourke and Harwood 2009). In the price analysis to be discussed later, the hypothesis of whether seasonality existed in sweetpotato production in PNG was tested.

In PNG, women play a significant role in sweetpotato production. As a staple food crop, sweetpotato is considered a "feminine crop", and therefore sweetpotato cultivation from planting to harvesting is traditionally a "women's job" (Benediktsson 2002), while the "men's job" is limited to land preparation at the beginning of the production cycle (for example clearing away vegetation, making garden beds, and building drainage and fences).

Bourke and Vlassek (2004) have estimated sweetpotato yields to be 15 tonnes/ha in the PNG Highlands, and 13 tonnes/ha in the Lowlands. Given that sweetpotato yields could be as high as 30-35 tonnes/ha, as reported in Australia, Israel, and Egypt (CIP n.d.), there appears considerable room for yield improvement in PNG. Several ACIAR-funded projects sought to explore these issues concurrently with this project.

4.2. Sweetpotato Consumption

Gibson (2001a) estimated national average annual per capita sweetpotato consumption in PNG to be 260kg (Table 2). Substantial differences were found in the diets of rural and urban households, with consumption being 299kg in rural areas and 42kg in coastal cities. By contrast, annual per capita consumption of rice in rural areas was 24kg, just over one third of that in urban areas (66kg). There was also a regional difference in staple food consumption. While sweetpotato was the main staple food for Highlanders, banana, taro, sago, sweetpotato and rice constituted a much more diverse diet for people living in coastal cities. Gibson (2001a) attributed these differing consumption patterns to availability of locally produced foods, and a lack of market penetration by imported foodstuffs, especially rice, into rural areas and by locally produced foods being relatively more expensive in urban areas due mainly to high transport costs.

Table 2. Per capita food consumption (in kg) in 1996*

	Rural	Urban	PNG
Sweetpotato	299	42	260
Banana (cooking and sweet)	90	47	83
Taro	68	23	62
Greens, vegetables, nuts, etc.*	68	20	61
Coconut	42	51	44
Sugarcane	40	10	35
Rice	24	66	31
Yam	31	9	28
Cassava	27	9	25
Sago	21	33	23
Potato	--	--	3
Other	96	186	109
Total	806	496	764

Source: Gibson 2001a.

Other explanations for differing consumption patterns include urbanisation and income growth (Scott et al. 2000, Rosegrant et al. 2001). It has been argued that with higher incomes, which often occurred in the cities first, there is a general tendency for staple

food consumption to move away from starchy roots and tubers (such as sweetpotato, cassava, yam and sago) and towards more nutritious, versatile, convenient and better tasting choices, such as rice, wheat and potato. As income rises further, this is expected to be followed by a move towards a more diverse and balanced diet that may consist of cereals, animal protein and fruit and vegetables. These changes in consumption patterns are evident in countries such as Japan, Taiwan and China, where sweetpotato (dubbed as a "poor man's food") was once a major staple food for the poor (Bourke n.d.). This means that, despite its reported health benefits, sweetpotato consumption in PNG will decline as consumers gain access to a more diverse and nutritious diet. The differing consumption patterns of sweetpotato and rice between PNG rural and urban areas, shown in Gibson (2001a), is a good illustration of these inevitable changes in a growing and urbanising economy.

4.3. Sweetpotato Marketing

Sweetpotato is a bulky, perishable commodity with a high weight-to-value ratio. Long distance marketing for sweetpotato is challenging, especially for farmer-sellers (Chang et al. 2008). Typically, sweetpotato is harvested in the Highlands and packed into white poly bags, which are then picked up from the village by trucks or PMVs, dropped off alongside the Highlands Highway, and reloaded onto semi-trailers going down to Lae. In Lae, sweetpotato bags are unloaded and re-loaded again onto shipping containers at the wharf, and transported to Port Moresby by sea. Upon their arrival in Port Moresby, the sweetpotato bags are collected by farmers or their representatives at the wharf, and transported to warehouses near the Gordons market. This long journey from the PNG Highlands to Port Moresby takes approximately 5-7 days.

Sweetpotato is packed in 50 kg stock feed bags by specialist packers. All sweetpotatoes, big and small, good or damaged, are packed together, with small tubers packed between larger tubers to minimize movement during transit. To minimise transport costs, the 50 kg bag can be extended with additional pieces of cloth, and so tightly packed that it can weigh up to 80-100kg. One reason that farmers often tried to pack as much in as possible is to minimise transaction costs. This occurs because most transactions (including transport, entry to the market and buying and selling) are charged by the bag (and adjusted only marginally by the size of the bag). It is well-known that sweetpotato bags from the EHP (80-100kg/bag) are much tightly packed and heavier than that of the WHP (60-80kg/bag).

Preliminary results from the consignment trials conducted in this research showed that such packing practices often led to severe skinning and breakages, which allowed diseases to develop during the 5-7 day journey to Port Moresby. Oversized bags, rough handling, no curing, poor product ventilation, and delays in transit all contribute to the large product losses (30 to 50%) that occur from farm to market due to rotting and physical damage (Spriggs 2005). As was the case with fresh produce marketing, access and availability to transport was identified as a major issue in sweetpotato marketing. This issue could be more significant for sweetpotato farmers because of the extra space required to take on extremely heavy and over-sized bags.

Most sweetpotato in PNG is marketed by farmer-sellers who either sell in the open-air market themselves, or to resellers or institutional buyers (supermarkets, hotels, restaurants, schools, hospitals, catering services, etc.). One of the main reasons why farmers choose to market sweetpotato (and other vegetables) themselves is a lack of trust in people outside of their kinship networks (Spriggs 2005). The other reason is that there is no reliable wholesaling system for sweetpotato. During our research farmers often complained about being 'ripped off' by middlemen and wholesalers, who paid low prices, did not pay on time, or did not pay at all. These complaints could be a result of distrust, misconception of the role of a middleman and misunderstanding of retail and wholesale prices. In most cases, sweetpotato bags were transported to Lae by semi-trailers returning to Lae. Backloading of this kind was completed unofficially without the knowledge or approval of the trucking company involved. Therefore, the shipment was not insured. Another drawback with backloading was associated with uncertainty about transport availability and timing.

Women dominate local marketing at open-air markets, while men dominate long distance marketing and the wholesale markets. As explained by Benediktsson (2002), this is because selling the marketable surpluses in the local market is a natural extension of women's involvement in food crop production. Men find it menial and embarrassing to sit and sell at the market for long hours, with typically little returns. On the other hand, men generally conduct long distance marketing because it is more profitable and prestigious, and is viewed as running a big business (Spriggs 2005). With very few exceptions, open-air markets are overcrowded, unsanitary, weakly policed, and without shelter, shade, water or toilet facilities (Brearley 2005). The very poor conditions of the open-air markets reflect a disregard for the struggle and hardship that women face, and reflect of women in PNG society (Chang and Be'Soer 2011).

5. Key findings

5.1. Interviews of value chain operators

An analysis of the long distance sweetpotato value chain indicated that value chain operators faced significant challenges in delivering a bulky and perishable product over long distances. However, the concerns of different operators were not necessarily the same.

For smallholder farmers, the major constraint to improving sweetpotato marketing centred on access to credit, availability and cost of transport, and lack of storage facilities.

For wholesalers, institutional buyers, trucking companies and shipping companies, the main issue was with farmers being unprofessional in their business dealings – that is, not delivering on time, not delivering the quality/volume that had been agreed upon, and delivering poor quality goods due to inappropriate packaging and handling practices. However, these issues were not considered important to their overall operation, because sweetpotato constituted only a small proportion of their total business (in most cases, less than 10% in value terms).

The value chain analysis also showed that the sweetpotato value chain was fragmented and uncoordinated, with little or no relationship, communication, or marketing arrangements between farmers and service providers, or between suppliers and buyers – not even with so-called "regular suppliers" or "regular buyers". The majority of transactions were conducted on the spot, without any planning on the part of farmers, and without any consideration of future transactions. This short-term mentality could explain why opportunistic behaviours and cheating were widespread along the value chain.

The key message from formal market operators and credit and transport service providers was that doing business with smallholder farmers was a high cost because they were considered disorganised, had poor business skills, and were unprofessional. It is a common sentiment of the companies working with smallholder farmers that fresh produce constitutes not only a very small proportion of their total business, but also often an unprofitable one.

Therefore, the onus is on smallholder farmers to show that they are worthy business partners if they want to do business with these companies. For transport providers, this means smallholder farmers organising themselves and consolidating their sweetpotato bags into full container loads, so they can be picked up from one central location and from one responsible party who represents a group of smallholder farmers. For credit providers, it means smallholder famers need to become financially literate, learning how to manage money and changing their attitude towards loans – that is, understanding that loans are not grants, and they must be repaid according to set schedules.

These results are summarised in Appendices 1-3.

5.2. Focus group discussion on marketing issues facing women

Several issues were identified from the focus group discussions with female farmer leaders. They included:

- Personal safety and harassment;
- Poor market facilities;

- Variable gate fees and bus fares;
- Insufficient time for doing both gardening and marketing;
- Bags are too big and heavy;
- Transport is expensive and not reliable;
- Prices are not known, low or fluctuating;
- Profits/losses unknown because of no record keeping;
- Sweetpotato marketing is laborious; and
- Lack of support from husband and sons.

These results were consistent with what was found by Brearley (2005): that personal safety, harassment, heavy workloads (that is, little or no help from men or children), poor market facilities, and low price and oversupply at the local market were the key issues facing female farmers.

Women often encounter low prices and oversupply at the local markets, for a number of reasons. First, the majority of women in the Highlands sell at local markets near where they live (as opposed to men, who sell at distant markets in Lae or Port Moresby). Second, women tend to go to the market together (they see each other as companions rather than as competitors). Third, women go to market when they need cash, especially for school fees or social obligations, as do others in their villages or neighbourhood. And finally and most importantly, women tend to consistently grow the same produce, because they are easy to grow and often they require no or little purchased inputs, or simply because they are what is available from the local nurseries. Carrots, cabbage and sweetpotato are the most common crops grown and sold by subsistence and semi-commercial farmers. To avoid low price and oversupply in the Highlands, women need to have the business skills to decide what to produce, and the technical skills to produce new crops that potentially yield better financial returns. They should also be able to participate in long distance marketing to the coastal markets without concerns regarding their personal safety, and without fear of harassment and robbery on the long journey.

There were also issues in the distribution of income and division of labour within the household. Some women claimed that they had little say on how income was spent, even though they have done most of the hard work. The most upsetting issue for women appeared to be the lack of support from the males, given the time-consuming and laborious nature of sweetpotato production and marketing. Gender training that raises awareness of gender inequality in PNG society was suggested as a starting point to address the gender issue.

Women also indicated that they needed training in the following areas:

- Crop production;
- Marketing skills;
- Bookkeeping;
- Gross margins analysis;
- Sweetpotato processing and preservation (value addition); and
- Recipes for using sweetpotato.

Clearly, women knew what they needed to improve their participation in the market. More detailed discussion on the results of the focus group discussions can be found in Chang et al. (2010).

5.3. Consumer survey

The main findings from the consumer survey in Lae were:

- The majority of sweetpotato was bought from open-air markets;
- Most respondents had a strong preference for particular sweetpotato varieties, but they found it hard to find the varieties they wanted. One reason was that many varieties looked alike and it was difficult for both sellers and consumers to distinguish one from the other. The other reason was because Highland sweetpotato was unwashed, and the layers of soil left on intentionally to protect the sweetpotato from skinning and rots might have disguised the true identity of the variety;

- *Kerot* and *Wahgi Besta* were the most preferred varieties, and *Rachael* the least preferred variety;
- A small price premium appeared to exist for *Kerot*, and a small price discount for *Rachael*;
- The preferred physical characteristics of sweetpotato were: dry/firm/powdery, yellow flesh, red skin, medium size, elongated shape, smooth skin, mature, and sweet;
- Some respondents expressed a strong preference for rice on convenience and novelty grounds; and
- Households with children and young adults also tended to prefer rice over sweetpotato.

These latter results are consistent with Gibson (2001a, 2001b).

Trying to understand the relationship between prices and varieties can be difficult, because sweetpotato sold at the open-air market are priced by bags for wholesaling sales, or in heaps for retailing sales. In most cases, the heap would contain sweetpotato of variable sizes and mixed qualities. This pricing scheme does not provide a clear price signal, making it difficult for farmers and buyers to assess and respond to changes in demand and supply conditions.

For more detailed discussion of the consumer survey, see Omot et al. (2010).

5.4. Price analysis

The aims of this price analysis were to understand changes in price and marketing margins over time, to test for seasonality in sweetpotato production or consumption, and to draw marketing implications for farmer-sellers. The analysis was based on the retail prices collected weekly by the Fresh Produce Development Agency from its Urban Market Survey at four major open-air markets in PNG (Mt Hagen, Goroka, Lae, and Port Moresby). Because many data points were missing, the weekly data were aggregated into annual data and then analysed.

Annual prices[4]. Sweetpotato prices did fluctuate quite significantly during the data period 1992 – 2009. Summary statistics of the four price series are presented in Table 3. Average prices for the four markets over 18 years (second row) were: K0.44/kg in Hagen, K0.43/kg in Goroka, K0.58/kg in Lae, and K1.10/kg in Port Moresby. Prices appeared to be similar for Hagen and Goroka where sweetpotato was produced, whereas at the main markets, the price in Port Moresby was much higher than the price in Lae. Price differentials (or margins) between Lae and Hagen and Goroka were K0.14-K0.15/kg, and margins between Lae and Port Moresby were K0.52/kg. Margins between the Highlands and Port Moresby were K0.66/kg-K0.67/kg. Marketing margins are important, on the one hand they must more than offset the cost of marketing for a long distance marketing endeavour to be profitable. On the other hand, too high a marketing margin relative to the cost of marketing may reflect some inefficiency in the marketing system that allows for extra profits to be extracted often by the parties who possess market power.

Table 3. Descriptive statistics for annual prices (in K/kg), 1992-2009

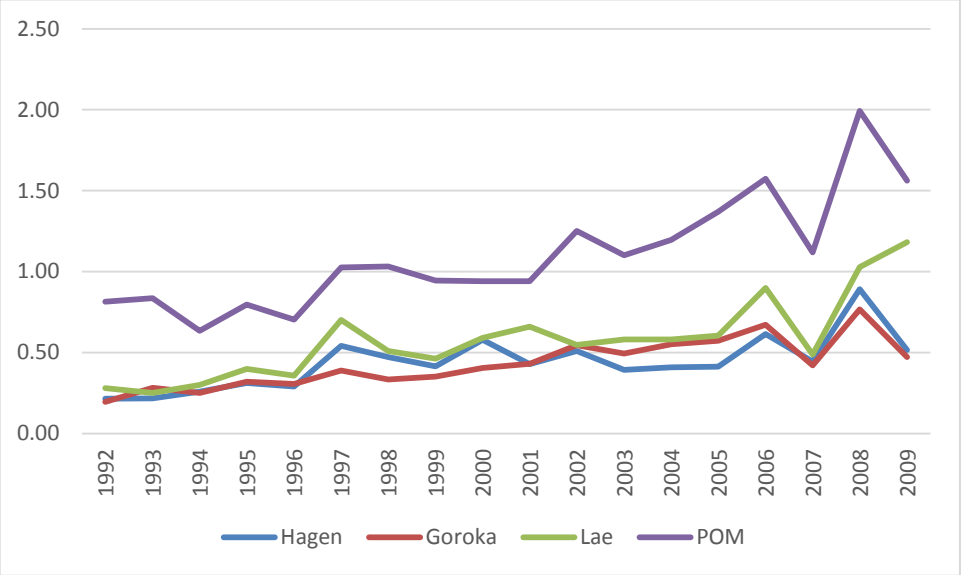
	Hagen	Goroka	Lae	Port Moresby
Mean	0.44	0.43	0.58	1.10
Median	0.42	0.41	0.56	1.03
Standard Deviation	0.16	0.15	0.25	0.35
Minimum	0.22	0.20	0.25	0.64
Maximum	0.89	0.77	1.18	1.99
CoV	37%	35%	43%	31%

[4] One PNG Kina was worth A$0.45 in 2008.

Variability of prices in these four markets has been assessed based on coefficients of variation (CoV), which were arrived at by dividing the standard deviation by the mean value and multiplied by 100%. As shown (bottom of Table 3), CoVs were 37%, 35%, 43%, and 31% in Hagen, Goroka, Lae, and Port Moresby, respectively. This means that the prices in Lae were more variable than the prices in Port Moresby, while the price in Hagen is slightly more variable than in Goroka. Because of the high level of aggregation, one can expect price variability to be much higher on a daily, weekly, or monthly basis. Since these differences in variability have not been tested for statistical significance, they can only be used as a guide.

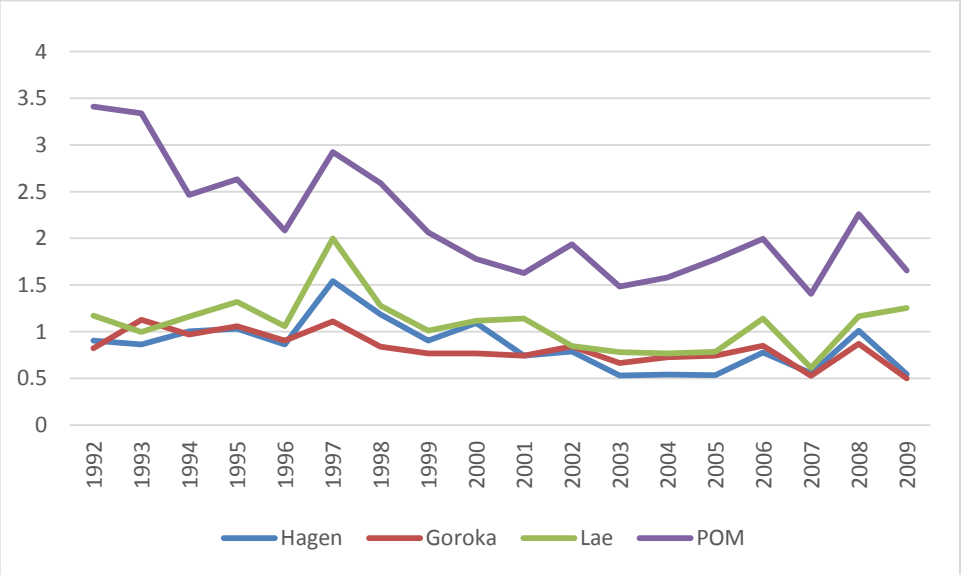
Changes in prices and marketing margins over 1992-2009 are shown in Figure 2. It is clear that sweetpotato has become more expensive over time in nominal terms (i.e., before being adjusted for inflation) as prices seemed to be trending upwards since 1992, despite a significant fall in 2007.

Figure 2. Nominal annual prices, 1992-2009



However, when nominal prices were adjusted by the Consumer Price Index (CPI), there was a clear downward trend in all markets, although to varying degrees. The declining trend was most distinct in Port Moresby.

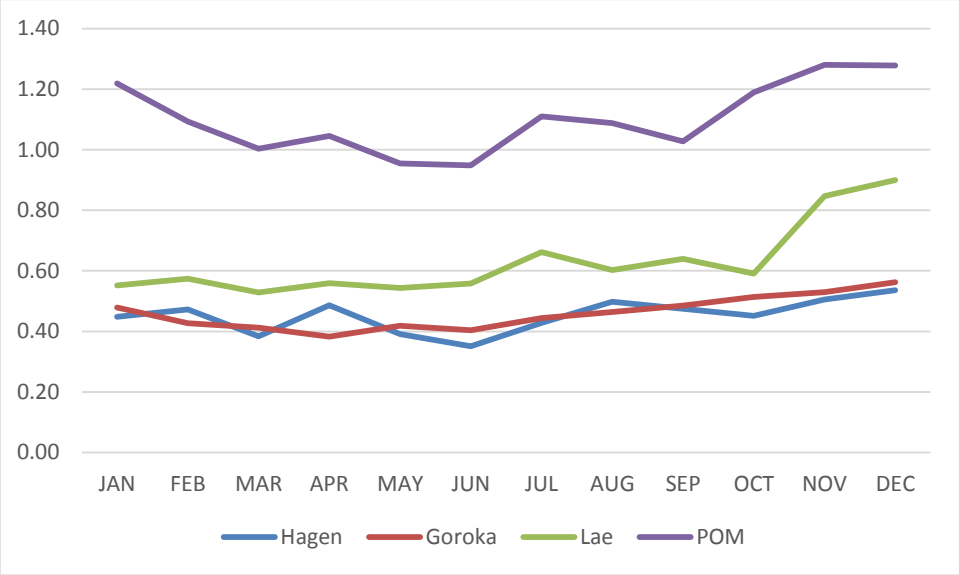
Figure 3. Real annual prices, 1992-2009



Average monthly prices. Prices of many agricultural products often exhibit clear seasonal patterns, with predictable highs and lows within a calendar year that reflect the biological processes of production, and the production and marketing practices of farmers (Bickel 1975). Understanding seasonality is important because marketing strategies can be employed to take advantage of high prices and to avoid low prices. Seasonality is especially obvious for agricultural products that can be produced once or twice a year due to agro-climatic conditions, such as rice, wheat, corn and calves. Seasonality in sweetpotato production also exists in Australia, the United States, Africa and Asia, where sweetpotato is harvested once a year. In our discussion with farmers, it was always stated that "we can grow sweetpotato all year round and there is no seasonality". However, there were also complaints about variable prices.

To see whether a seasonal pattern existed in sweetpotato, the average price (in nominal term) of each month over 1992-2009 was calculated, as shown in Figure 4.[5]

Figure 4. Average monthly prices, 1992-2009

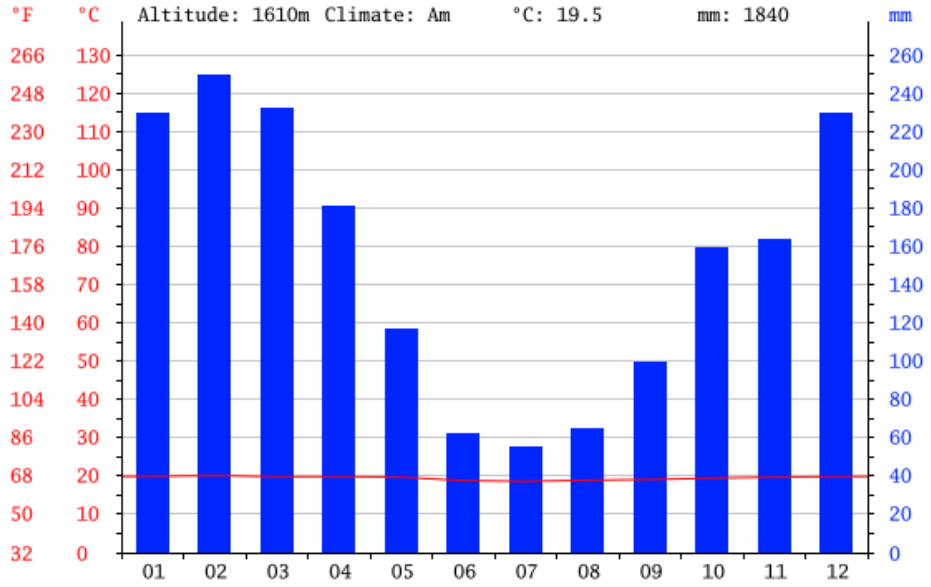


Several observations can be made. First, sweetpotato prices in Port Moresby fluctuated quite a lot, and were higher in October-January and lower in May-June, whereas prices in Lae were more stable, with the exception of hikes in November and December. Contrary to the claim of no clear seasonal pattern by Bourke et al. (2004), the few highs and lows consistently being observed in Port Moresby and Lae did suggest that there were regular and predictable changes recurring every year in sweetpotato prices.

But what causes the highs and lows in prices? Goroka and EHP are discussed here as examples. As shown in Figure 5, monthly rainfall in EHP follows a seasonal pattern, with a wet season from December to March, where mean monthly rainfalls of about 230 mm to 250 mm are experienced. This is followed by a dry season from June to September, where monthly rainfalls in the range of 60 mm to 120 mm are experienced. The months of April–May and October–November tend to be transitional (Climate-Data.Org. n.d.).

[5] There are econometric techniques that can potentially be used to test for seasonality, as suggested in Bickel (1975). However, the quality of the data has prevented the use of a more sophisticated and reliable quantitative approach than is presented here.

Figure 5. Rainfalls and temperatures in Goroka, EHP.



Source: Climate-Data.Org. n.d.

Farmers tend to plant sweetpotato at the start of the wet season (October) when the ground is soft. Since most sweeetpotato varieties can be harvested in 4-5 months after planting, there will be a large supply in about 4-5 months' time, i.e. starting in February-March in the following year, and coinciding with a potential fall in prices. New planting is limited during the drier months of June-September, when the ground may be too hard to break. The dry period also coincides with the height of the coffee season (June-August) when demand for labour is at its highest. The rainfall pattern and coffee season seemed to lend support to statements made by Bourke et al. (2004) that in EHP, sweetpotato supply "tends be at its highest in March-July and at its lowest in October-January". In addition, we found that prices were higher in December and January, also due to higher demand as Papua New Guineans celebrated Christmas and New Year, with long holidays during this period. In WHP, the rainfall pattern is similar to that of EHP, but the level of rainfall is generally higher. For example, during the dry period of June-August, average monthly rainfall is between 120 and 130 mm.

The higher prices observed in October-January in the Lae and Port Moresby market would suggest that opportunities exist for some farmers, especially those who are located in areas with favourable rainfall patterns, to change their production and marketing practices so that planting and harvesting can coincide with high market prices. Farmers who have easy access to water sources may also consider irrigation[6].

5.5. Volume assessment

Three volume assessments were conducted at the Lae main market in 2008. The aim was to gauge the volume of sweetpotato traded Lae and Port Moresby, because no such data existed. Results on weekly volume counts and weekly disappearance, and differences between the Lae and Port Moresby markets, are summarised below.

Weekly volume counts. Table 4 shows the breakup of sweetpotato delivered to the Lae main market from various districts in EHP and WHP. A total of 912, 974, and 1200 bags, respectively, arrived at the Lae main market in the three weeks surveyed (bottom of Table

[6] There is no irrigation system in PNG, and irrigation is not widely practiced.

4). These volumes did not include those destined for Port Moresby or other open-air markets within the Lae city.

Table 4. Sweetpotato arrivals at the Lae Main Market during the week of assessment, by district and by province

Province	Districts	Assessment 1	Assessment 2	Assessment 3
		31.3 to 5.4 2008	8-16.8.2008	17-22.11.2008
EHP	Kainantu	15	6	5
	Okapa	43	6	6
	Bena	12	0	0
	Goroka	106	145	105
	Asaro	134	134	150
	Unknown district	NA	24	89
Sub-total		310	314	355
WHP*	Anglimp/S. Wahgi	238	127	209
	North Wahgi	12	0	0
	Mul/Baiyer	168	0	100
	Hagen Central	96	119	325
	Tambul/Nebilya	3	0	10
	Unknown district	57	32	130
Sub-total		574	278	774
Unknown Province**		29	382***	71
New arrivals		912	974	1200

*WHP was split into WHP and Jiwaka provinces in 2012. Anglimp/S. Wahgi and North Wahgi are now part of Jiwaka provinve.

**The origins of these bags were not known because they could not be recorded in time.

***Based on the observations from Assessments 1 and 3, the majority of these were more likely to have come from WHP.

Several observations could be made. First, WHP farmers supplied almost twice as many bags as EHP (around 33% vs 65%). Second, the majority of sweetpotato came from the Goroka and Asaro districts in EHP, and from the Anglimp/South Wahgi, Mul/Baiyer and Central Hagen districts in WHP. Third, although not presented here in detail, varieties supplied appeared to be quite location-specific. As recorded, *Wahgi Besta* was the main variety from Anglimp/South Wahgi, *Korowest* and *wanmun* from Hagen Central, and *Gimane* from Asaro and Goroka.

Weekly disappearance. The beginning inventory was taken on early Monday morning and the ending inventory on late Saturday afternoon. The beginning and ending inventories did not take into account bags that were already opened, or sweetpotato heaps that were on display, which could amount to 5-10 bags. The levels of inventories are listed below in Table 5.

Table 5. Weekly disappearance of sweetpotatoes at the Lae main market

	Assessment 1	Assessment 2	Assessment 3
Beginning inventory	96	168	261
New arrivals	912	974	1200
Ending inventory	149	211	238
Bags sold in Lae	859	931	1223
Bags shipped to POM	800-1000	800-1000	800-1000

The Lae market absorbed (or consumed) 859, 931, and 1223 bags of sweetpotato, respectively, in the three weeks surveyed. With an urban population of about 150,000, this was quite a substantial market for the Highland sweetpotato. The other observation was that the number of sweetpotato bags left in the market at the end of the week (i.e., the ending inventory) amounted to 150-250 bags. Give that there was no storage facility or shelter at the Lae market, some of these bags might be exposed to the sun and the rain for 3-5 days before being disposed of. The negative impact on quality could be expected to be large. Lack of storage facilities in the Lae market was identified as a major concern for smallholder farmers during supply chain mapping. Given the large number of sweetpotatoes passing through the market, the concern is well-justified and should be addressed if the quality of sweetpotato and the fortune of farmer-sellers are to be improved.

Comparing supply to Lae and Port Moresby markets. Consort and Bismark were two carriers delivering sweetpotato from Lae to Port Moresby. Among the two, Bismark was the main carrier when the survey was taken, because its rates were cheaper. According to Consort's shipping data, they handled only a small volume of sweetpotato during the three weeks surveyed (704kg/90kg/bag [7] =78 bags, 178kg/90kg/bag=2bags, and 898kg/90kg/bag=10 bags). To obtain a good estimate of the total shipment, data from Bismark was required, however this was not forthcoming and so data had to be inferred. Personal communication with an informant revealed that, on average, there were 4-5 full container loads (800-1000 bags) per week of sweetpotatoes heading for Port Moresby. This means that the market for Highland sweetpotato was almost the same for Lae and Port Moresby. The important difference between the two markets was that the urban population in Port Moresby was around 500,000 in 2008, more than three times that of Lae (at 150,000). This comparison could imply a possible supply shortage of Highland sweetpotato in Port Moresby, and hence the much higher prices observed. In the analysis of the cost of marketing, we will shed light on the relative profitability in marketing to Lae and Port Moresby.

5.6. Cost of marketing

Breakeven prices per bag that are required to cover the total cost of production and marketing for selling at different markets are presented in Table 6. The breakeven prices per bag were: Port Moresby, K120; Lae, K55; Goroka, K35; and Kasena, K25 (second last row of Table 6), and the cost of marketing accounted approximately for 83%, 64%, 43%, and 20% of the total costs, respectively. When the breakeven prices were compared with the prices prevailing at the four markets (bottom row of Table 6), we found that the gross margins for selling to Lae and Port Moresby could be either small or negative. This was also true when the cost of marketing was compared with the marketing margin averaged over 1992-2009, from Goroka to Lae (K20/bag vs K13/bag), and from Lae to Port Moresby (K65/bag vs K60/bag). Unfortunately, these price-cost-return relationships were rarely thought of or understood by farmer-sellers before they embarked on their journey.

Detailed breakdown of marketing costs is presented in Appendix 4.

[7] 90kg/bag was assumed in converting kilogram to number of bags. We noticed that sweetpotato bags were bigger and more tightly packed in EHP (90-100kg/bag) than in WHP (60-80kg/bag). In addition, the weight of each sweetpotato bag seemed to have increased from an average of 70-75kg/bag a few years ago to the current 90-100kg/bag. Also, previously it had been assumed that a full container load carried 350 bags, but now it is around 200 bags. This trend is worrying because of the damage caused by the ever bigger and more tightly packed sweetpotato bags.

Table 6. Marketing costs and breakeven prices for selling at Kasena Village, Goroka, Lae and Port Moresby, in Kina.

Cost items	Port Moresby	Lae	Goroka	Kasena
Total costs of production	400	400	400	400
Total cost of packing SP bags	100	100	100	100
Total costs of marketing	1900	600	200	0
Total Costs	2400	1100	700	500
Cost of production/bag	20	20	20	20
Costs of marketing/bag	100	35	15	5
Break-even price/bag	120	55	35	25
Selling price/bag	80-150	60-80	20-40	20-40

In the case study below, we show that the breakeven price in Port Moresby could be reduced to K90/bag by selling in container loads and by undertaking sound supply chain coordination.

5.7 A case study of Joe Kold's value chain

Joe Kold was a sweetpotato wholesaler based in Kelowa Village, Mt. Hagen Central District, WHP. Over the course of the project, it became evident that Joe's supply chain was one that can be considered as a "best-fit" practice in the PNG context.

Based on our interviews with transporting companies, the key requirements for them to consider in working with sweetpotato farmers included:

- A minimum number of 200 bags to fill up a 20-foot container;
- One collection point at a central location for pickup;
- Good road access to the pickup point; and
- One contact person between the farmers and the trucking company.

The requirements from institutional buyers were associated with quality and consistency in supply. Joe appeared to be able to meet these requirements.

The factors that set Joe apart from other farmer-sellers of sweetpotato included:

- Entrepreneurship. When we first met Joe in 2009, he was the only wholesaler we found in WHP, although there were a couple in EHP. Joe was generous with his time and forthcoming with information. Unlike other farmers, he saw no issues that he could not solve himself, and he therefore never asked for assistance of any kind. Another personal asset Joe had was social capital, stemming from his close relationships with the community and the local church. Significantly, Joshua, the Pastor of the church and the leader of the community, was his brother and business partner.
- Professionalism and commitment. Joe delivered regularly (initially once every two weeks and later once a week) to ensure continuing supplies to his customers (mainly resellers in Port Moresby) regardless of how prices fluctuated or whether he made a profit or not from the previous shipment. Most farmer-sellers stopped marketing after encountering a loss.
- Consolidation. Joe sent one to one-and-a-half full container loads to Port Moresby, which enabled him to not only deal formally with trucking companies, but also helped to reduce transport delays and multiple rough handling often experienced by other farmer-sellers who marketed small numbers of bags and relied on open-back trucks or backhauling semi-trailers.
- Supply chain coordination. Joe planned and arranged for: (1) harvest with his farmer suppliers to supply a full container load; (2) transport with trucking companies to coincide with once-a-week shipping schedules; and (3) regular delivery to his customers in Port Moresby.

- Location. Another marketing advantage for Joe was good road access, with his location being about 10 km from Hagen town, and linked to the Highlands Highway by sealed road. In addition, he was able to use the Kelowa church ground as a depot for consolidation. Good road access and a central collection point make it possible for him to have a formal arrangement with the trucking companies to bring container trucks into his village for loading.
- Quality products. Joe selected the varieties that were hardy (*Wanmun* and *Korowest*) and could withstand the long journey to Port Moresby. He insisted on buying only mature roots (6-7 months old) that had been grown in mounds (so the roots were stronger, larger and more uniform in size), and he conducted quality checks at the garden and during packing. He also tried to sell as quickly as possible by offering discounts to reduce spoilage.
- Good relationships with farmer-suppliers and reseller-customers. Joe paid good prices and provided reliable supply, good quality product and credit to his buyers, and rewards to his buyers for bringing him new customers.
- Market watch. Joe monitored supply and demand circumstances before arranging for harvesting. Because of this, he was able to buy and sell at the right prices, and hence, made reasonable returns to sustain his business.

Joe was apparently doing extremely well, compared to other farmer-sellers. It was also clear that it required a lot of effort and business skills on his part, as well as having a locational advantage, to achieve what he has achieved. However, there were areas that improvements could be made:

- Diversifying into higher-value market segments (e.g., hotels, restaurants and supermarkets), with grading and improved packaging.
- Improving business skills to deal with buyers in the formal market sector.
- Building a shed at the depot to protect sweetpotatoes from the elements and from unnecessary damage.
- Synchronising production among his suppliers to ensure consistency in supply all year round.
- Establishing new supply networks beyond his own communities to expand his business.

6. Overall assessment -- SWOT Analysis

As shown in Table 7, the *strengths* of the sweetpotato value chain in PNG include entrepreneurship (willingness to take risks), excellent farming skills, excellent products, and the natural environment (fertile soils and temperate climate which allow year-round production of high quality sweetpotato). The main *weakness* is associated with the social and cultural norms and beliefs that inhibit collaboration and better coordination of the value chain, which are crucial for improving marketing efficiency and quality. Another key *weakness* is lack of information (or misinformation) on the workings of the market and on quality issues. The main *opportunity* is a projected increase in demand for fresh produce in general arising from the PNG Liquefied Natural Gas (LNG) project, other development projects, and associated economic growth over the next several years (ACIL Tasman 2009). However, there is a serious *threat* associated with socioeconomic and demographic changes that may result in reduced consumption of sweetpotato in favour of rice and other non-traditional staple foods.

Table 7. A SWOT analysis of the sweetpotato value chain in PNG

Strengths	Weaknesses
Fertile soils and temperate climate, allowing year round production of high quality sweetpotato; Many varieties to meet consumer preferences; Highlanders were enterprising people with excellent farming skills (being the first farmers in the world).	Sweetpotato was low value-to-weight and perishable; Markets were distant; Poor packaging and postharvest practices; Lack of communication and value chain coordination; Low-input, low-yield production; Farmer-sellers lacked of market orientation, business skills and financial literacy; Farmers-seller operations were high costs due to diseconomies of scale. Sweetpotato was sold by bags or in heaps that masked price signals; No quality standards and no price premium resulted in no economic incentive to improve quality; Opportunism and cheating along the value chain.
Opportunities	Threats
Consumers preferred Highland sweetpotato (over coastal varieties); Increasing demand for higher quality sweetpotato in coastal cities as a result of urbanisation and economic growth; Increasing availability of microfinance; Emerging local buyers and wholesalers; Health benefits of sweetpotato better recognised (especially orange-fleshed).	Climate change affecting production stability and yields; Socioeconomic changes resulted in dietary changes that were against sweetpotato; Labour shortage and cost increases due to the mining boom; Conditions of feeder roads and the Highlands Highway deteriorated further; Law and order and poor facilities at the Lae and Port Moresby open-air markets.

7. The stakeholder workshop

A one-and-a-half day stakeholder workshop was held in Goroka in the beginning of the second year of the project, soon after completion of the value chain analysis. The workshop started with presentations of results from the value chain analysis, followed by discussions of the results and the identification of priority issues. Around 40 participants attended the workshop. These included researchers and value chain players whom the research team had interviewed during the value chain analysis.

Priority issues were identified after two rounds of voting. In the first round, workshop participants were divided into three groups based on the research themes of marketing efficiency, postharvest management and value addition, as reflected in the title of the project. Each participant under the research theme was asked to nominate three issues that were important to him or her. As an illustration, this paper focuses on the results of the marketing efficiency theme. Results from the other two themes can be found in Chang and Irving (2013). After voting, seven priority issues (out of nearly 50) were identified under the research theme of marketing efficiency:

- Lack of credit facilities;
- Cost and availability of transport;
- Cost of labour;
- Market information on consumer/buyer preferences for sweetpotato, including information sharing;
- Laborious nature of sweetpotato marketing;
- Training on marketing strategies; and
- Personal safety and harassment.

Participants were asked again to nominate three issues that were important to them. After the second round of voting and at the end of the workshop, three priority issues were arrived at for the marketing efficiency theme:

- Lack of credit facilities;
- Poor transport system; and

- Lack of marketing information on consumer/buyer preferences for sweetpotato.
- Action plans were then developed, and were to be implemented in the second year of the project.

Several observations from the stakeholder workshop included:

- The participatory action research approach and consensus decision making were effective tools in prioritising issues that were considered important to, and agreed on by, stakeholders;
- Although three issues of special relevance to women were selected in the first round, they were voted out in the second round in this particular prioritising process; and
- Several policy and institutional issues, such as declining demand, the pricing scheme and lack of quality standards, were not recognised and therefore missed being selected as priority issues at the stakeholder workshop. Perhaps these were not as pressing or as obvious as access to credit or transport that farmer-sellers faced on a daily basis. However, some of those policy and institutional issues are strategic in nature, and could have a major impact on the long-term development of the sweetpotato value chain.

Given the diversity of stakeholders, it seems natural that stakeholders will prioritise value chain issues according to their level of participation, and the links within the chain that they are most commonly associated with, as outlined in Appendices 1-3. However, it appears there is a need to modify the method of prioritising to ensure all key issues, both practical and strategic, and gender-and level-specific, are properly identified. One possibility is having an equal representation of stakeholder from each level of the value chain, as well as an equal representation of men and women, at the workshop so there is less bias. Another possibility is that workshops are held at different levels of the value chain, and 1-2 of the top priorities from each level are included in a final 'whole of value chain' priority issues list.

8. Strategic Issues and policy implications

Based on the SWOT analysis, several strategic issues were identified.

8.1. Consumer demand

A review of literature on consumer demand suggested that as an economy develops and income increases, changes in consumption patterns will take place. First, a decrease in demand for starchy foods will occur, as well as an increase in demand for animal protein and fruit and vegetables. Second, demand for higher quality and more convenient products will increase. Third, more shopping will be carried out in supermarkets, as opposed to shopping in traditional open-air or wet markets. These changes have already occurred in the urban areas of PNG (Gibson 2001a, 2001b). Therefore, the demand for sweetpotato can be expected to decline further as these changes spread further afield. This means that in order to compete with other products and reduce the pace of such changes, the sweetpotato value chain must improve its overall competitiveness by growing varieties that the consumer prefers, increasing crop yields, improving quality outturn, and reducing marketing costs in the short to medium term. In the longer term, sweetpotato farmers must be prepared for inevitable declines in demand for sweetpotato, and consequently in profitability, by diversifying their income sources.

The PNG government and development agencies such as NZAid and ACIAR have funded a number of sweetpotato and vegetable projects in PNG. However these projects, as well as associated extension programs, tended to focus primarily on improving on-farm production (e.g., variety evaluation, soil management, pests and diseases and pathogen-tested planting materials). Only a few have focussed on value chain, marketing and postharvest management (e.g., Spriggs 2005 and 2008). More research on marketing is therefore necessary to support production research, because improving on-farm production alone may only lead to small enhancements in rural household incomes given that demand for sweetpotato, as a starchy staple food, is insensitive to price and income changes. The outcome could well be negative for non-adopters of new production technology, because potentially large increases in output supply can result in price falls if they are not matched by market demand (Spriggs 2005).

Equally important is the balance between investment in research and investment in development and extension to ensure that research outputs are translated into development outcomes and impacts.

8.2. Marketing infrastructure

A major source of competitiveness in agricultural value chains is an enabling environment for private sector involvement, including access to appropriate physical infrastructure (such as roads, market facilities, storage facilities), and marketing support services (for example grades and standards, credit, insurance and market information). For the majority of PNG sweetpotato value chain operators, these basic services were found to be lacking. Consequently, there are opportunities for government and the private sector to work together to improve physical infrastructure, and to provide improved support services. First, communication needs to be improved within the value chain, as well as between value chain operators and government, to identify areas where support and services are most in need of improvement. Second, research is needed to identify areas and opportunities for public-private partnerships.

8.3. Market information system

Adequate and reliable market information is essential for government to develop appropriate policies, and for the private sector to develop effective production and marketing strategies to improve business performance. Current agricultural information systems maintained by government agencies in PNG (such as the Fresh Produce Development Agency, National Statistics Office, and Customs Office) and by shipping companies are inadequate and unreliable. More resources are needed to improve the existing data collection, analysis and dissemination processes. There is also a need to develop locally-appropriate quality standards and grading schemes to facilitate trade, and to encourage high-quality production. As Leamon (1989) stated, "an effective QA system in horticulture begins with the definition of quality specification for the product". Pricing mechanisms that are weight- and quality-based are also necessary, to provide accurate price signals to consumers and producers alike, as well as to provide incentives to value chain players to improve product quality.

8.4. Gender issues

Women are the main producers (and marketers) of sweetpotato. However, they face significant obstacles both inside and outside their homes. Gender training of household members and value chain operators needs to be put in place to change attitudes towards women. Moreover, any research, development or extension effort to improve on-farm productivity and marketing efficiency must involve women. Improving market facilities should also be a priority to improve the working conditions of women, and to encourage their participation in marketing. More research is also needed to find labour-saving technology that helps reduce workloads and minimises the drudgery associated with sweetpotato production and marketing.

8.5. Business development support services

The value chain analysis suggested that the sweetpotato value chain was fragmented and under-developed. This may be a reflection of the current stage of economic development in which PNG finds itself. The gross margin analysis clearly showed that it was very costly for individual farmers to consider long distance marketing on their own, and that there was little profit in doing so. On the other hand, the case study also showed that value chain performance could be improved by marketing through a wholesaler, with the necessary resources and business skills to manage marketing activities efficiently. It therefore seems that a functioning wholesale sector has the potential to overcome several issues currently faced by smallholder farmer-sellers, including access to credit, transport and market information as identified in the stakeholder workshop. Wholesalers, being the link and intermediaries between farmers and customers, appear well-suited to take the role of chain leaders who can play a key role in consolidating produce, and in exerting influence on grading, quality control, and appropriate postharvest management. However, not all entrepreneurs are equipped with those skills, and therefore education and training, and business development support services are required to ensure that

entrepreneurs have the necessary skills and business ethics to deal professionally and sustainably with information-poor smallholder farmers.

9. Conclusions

In this paper we presented the key results from a detailed mapping of the PNG sweetpotato value chain, using both qualitative and quantitative methods. A range of issues were identified. They included practical issues faced by farmers on a daily basis regarding access to credit, transport infrastructure and market information, as well as strategic issues related to future demand, the pricing scheme, quality standards, market institutions, and gender issues. These farmer-level and strategic issues have implications for the long-term development of the sweetpotato value chain in PNG. To transition from subsistence farming to semi-commercial/commercial farming, smallholder farmers need to become more market-oriented and better equipped with business skills. Furthermore, to compete more effectively with other staple foods, especially rice, they need to be prepared to change their current marketing and postharvest practices in order to supply high quality products to the right markets at competitive prices. Government also has a key role to play in terms of providing an appropriate enabling environment, including a reliable transport system, business development services and a locally appropriate pricing and grading system. This environment is necessary to support the effort of farmers in adopting improved marketing and postharvest practices.

References

Anon. n.d. The value chain approach to economic development and poverty reduction. http://www.researchintouse.com/nrk/RIUinfo/valuechain/Value-Chain-Approach.pdf

ACIL Tasman, 2009. PNG LNG Economic Impact Study: An assessment of the direct and indirect impacts of the proposed PNG LNG Project on the economy of Papua New Guinea.

Benediktsson, K., 2002. *Harvesting Development: The Construction of Fresh Food Markets in Papua New Guinea*. Nordic Institute of Asian Studies, Singapore.

Bickel, B. 1975. Seasonality of agricultural prices. Monthly Review, Federal Reserve Bank of Kansa City.

Bourke, R., Camarotto, C., D'Souza, E.J., Nema, K., Tarepe, T.N. and Woodhouse, S. 2004. Production patterns of 180 economic crops in Papua New Guinea. Coombs Academic Publishing, Research School of Pacific and Asian Studies, The Australian National University, Canberra.

Bourke, M. n.d. Potato, Sweet. Berkshire Encyclopedia of World History.

Bourke, R.M. and Vlassak, V. 2004. Estimates of food crop production in Papua New Guinea. Land Management Group, Australian National University, Canberra.

Bourke, M and Harwood, T. (eds), 2009. *Food and Agriculture in Papua New Guinea*. ANU Press, Canberra.

Brearley, T. 2005. Increasing the autonomy of women as a means to improving community well-being and facilitating development: An exploratory study in Papua New Guinea*"*. Report for ACIAR Project ASEM/2001/037 entitled *Improving the Marketing System for Fresh Produce from the Highlands of PNG*.

Burdon, J.N. 1998. Improvements in the storage and transportation of fresh produce from the Highlands of Papua New Guinea to Port Moresby. A report prepared for the Fresh Produce Development Company (unpublished).

Chang, C., Spriggs, J. and Newman, S. 2008. Improving sweetpotato marketing in PNG Highlands, Acta Horticulturae 794.

Chang, H.S., Be'Soer, L., Anjen, J. and Ramita, I. 2010. Marketing issues facing woman sweetpotato farmers in Papua New Guinea. Conference paper presented to AARES Annual Conference in Adelaide, February 2010.

Chang, H.S. and Griffith, G. 2011. Assessing buyers' requirements for fresh produce in the formal market sector in Papua New Guinea. *Australasian Agribusiness Review*, 19, Paper No. 5, pp.64-75.

Chang, H.S and Be'Soer, L. 2011. Sweetpotato marketing in Papua New Guinea: A gender perspective. Stewart Postharvest Review, 3:12.

Chang, H.S. and Irving, D. 2013. Improving marketing efficiency, postharvest management and value addition of sweetpotato in Papua New Guinea. Final Report to ACIAR.

CIP (International Potato Centre). n.d. Sweetpotato production estimates in global sweetpotato cultivation - World Sweetpotato Atlas.

Climate-Data.Org. n.d. Climate: Goroka. http://en.climate-data.org/location/50976/.

Daysh, M., 1995. Review of production and marketing of horticulture crops in Papua New Guinea. A report prepared for the World Bank (unpublished).

Epstein, S. 2000. A review of Stabex Project 4.17/Fresh Produce Development Company. A report prepared for the Fresh Produce Development Agency (unpublished).

Gibson, J. 2001a. Food demand in the rural and urban sectors of PNG. In R.M. Bourke, M.G. Allen and J.G. Salisbury (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference. ACIAR Proceedings No. 99.* Australian Centre for International Agricultural Research, Canberra. pp.45-53.

Gibson, J. 2001b. Migration and dietary change: Highlanders and the demand for staples in urban PNG. In R.M. Bourke, M.G. Allen and J.G. Salisbury (eds). *Food Security for Papua New Guinea. Proceedings of the Papua New Guinea Food and Nutrition 2000 Conference. ACIAR Proceedings No. 99.* Australian Centre for International Agricultural Research, Canberra, pp.88-110.

Global Development Solutions, 2008. An integrated value chain analysis of the fresh produce sector in Papua New Guinea. A report prepared for the World Bank (unpublished).

Huizer, G. 1997. Participatory action research and people's participation: Introduction and case studies. Sustainable Development Department, Food and Agriculture Organisation of the United Nations. http://www.fao.org/sd/PPdirect/PPre0030.htm.

Johnson, G., Scholes, K. and Whittington, R. 2005. *Exploring Corporate Strategy*. Prentice Hall: London.

Leamon K.C. Introducing quality assurance into Victorian horticulture. In: Beattie, B.B. (ed), Proceedings of the Australian Conference on Postharvest Horticulture, Gosford, NSW Agriculture and Fisheries. The Australian Institute of Agricultural Science, 1989, pp.335-338.

Martin, S. and Jagadish, A. 2006. Marketing of smallholder produce from the Highlands of PNG: An analysis and recommendations. Paper presented at the Seminar on the Orderly and Sustainable Development of the Markets for Smallholder Produced Fresh Produce, Goroka, PNG, 26 June 2006.

McGregor A, Lutulele R and Wapi B. 2003. Papua New Guinea horticulture industry sector study. Unpublished consultancy report.

McTaggart. R. 1989. 16 Tenets of participatory action research. http://www.caledonia.org.uk/par.htm.

Omot, N., Spriggs, J. and Chang, C., 2010. Consumer preferences and supplier responsiveness. Conference paper presented to AARES Annual Conference in Adelaide, February 2010.

Peter, R. 2001. A survey to establish causes of inconsistent supply of fresh produce to the wholesale and retail market sectors. Report prepared for FPDA.

Porter, M. 1985. *Competitive Advantage: Creating and Sustaining Superior Performance*. The Free Press, New York.

Rosegrant, M.W., Paisner, M.S., Meijer, S. and Witcover, J. 2001. Global food projections to 2020: Emerging trends and alternative futures. International Food Policy Research Institute.

Scott, G.J., Rosegrant, M.W. and Ringler, C. 2000. Roots and tubers for the 21st Century: Trends, projections and policy options. International Food Policy Research Institute, Washington, D.C.

Spriggs, J., 2005. Towards a research agenda for improving consumer demand and marketing of sweetpotato in PNG. A Report to the Australian Centre for International Agricultural Research.

Spriggs, J. 2008. FR2007-16 -- Improving the marketing system for fresh produce of the Highlands of PNG. Final report to ACIAR for ASEM/2001/037.

Wilson, T. 2008. Report on the 2008 FPDA socioeconomic survey. A report prepared for the Institutional Strengthening Project for the Fresh Produce Development Agency (unpublished).

Appendices

Appendix 1. Results from farmer interviews

	Main issues	Possible solutions/comments
Farmers/ farmer-sellers	Lack of credit facilities; Upfront cash payments; Labour cost too high; Transport cost too high and limited availability; Poor roads; No storage facilities; Lack of local buyers; Lack of information on price and consumer preference.	Developing local processing facilities; Other ways of utilising sweetpotato; Training in book keeping, postharvest handling, and processing; Building storage facilities; Improving feeder roads; Establishing microfinance in the district; Increasing numbers of local buyers.
Female farmers	Same issues as farmers and farmer-sellers. PLUS Gender-specific issues, including: Personal safety; No safe accommodation in Lae; Can't open bank account; Heavy workload (no help from men and children); Harassment en route to market and at the market; Poor market facilities; Low price and oversupply in local markets; Lack of business skills.	Selling to local buyers; Group marketing; Gender training for the family; Government building new markets and improving existing facilities; Training on marketing and business skills; New ways of cooking and processing sweetpotato.

Appendix 2. Results from buyer interviews

	Main issues	Possible solutions/comments
Wholesalers	Damage to vehicles due to over-filled bags and overloading; Selling prices fixed for years; High fuel costs.	No major suggestions as most wholesalers have their own storage sheds and trucks, access to credit from commercial banks, regular suppliers and customers, and secured contracts.
Institutional buyers	Supply shortage and cost increase due to landslides and roadblocks; Breakdown of cooking machines; Delayed payment from government; Limited budget; Student complaints (no variety, small servings, bad food, etc).	Use several regular suppliers to manage potential supply interruptions; Price is more of a concern than quality due to a set budget.
Kai bars	Source mainly from the open-air market.	The volume of sweetpotato purchased is small compared with potato.

Appendix 3. Results from service provider interviews

	Main issues	Possible solutions/comments
Shipping companies	Unreasonable compensation claims; Harassment from farmers when spoilage occurred; Ship birthing problems (Consort in Lae, Bismark in Port Moresby); High costs of fuel and parts.	Statutory declarations; Sorting/better packaging /separate produce; Government improves port facilities.
Truck drivers	Poor feeder roads (can't go into the villages); Farmers not organised/no concept of time; Landslides/potholes; Police checkpoints and harassment; Holdups and roadblocks; Vehicle breakdowns; Tribal fights.	A central pickup point/ a consolidation depot; Government improves road conditions; Farmers better organised.
Transport companies	Farmers are not organised and do not keep to schedule; High costs of repair and maintenance due to bad roads; Big problem if there are shipping delays and can't unload; Compensation claims from farmers; Some containers carry chemicals and can't be used to carry fresh produce; Dealing with small farmers is time consuming and costly; Looting/hijacking of containers.	Delivering to company's depot; Deal with one big supplier; One pickup point and one drop off point (with proper storage facilities); Curing and proper packaging to reduce losses and complaints; Use open-cut or chiller containers; Statutory declaration of no claims (to avoid liabilities).
Credit providers	Costly and risky in dealing with small, individual farmers (no stable income, no collaterals); Don't know how to manage money; Handout mentality.	Financial literacy training; Group-based or community-based lending approach.

Appendix 4.

Marketing costs and breakeven prices for four selling options, in Kina

Cost items	POM	Lae	Goroka	Kasena
Cost of bags (K3/bag)	60	60	60	60
Packing (K2/bag)	40	40	40	40
Loading/unloading of sweetpotato bags: Carriers - Goroka (K1/bag)	20	20	20	0
Carriers - Lae (K2/bag)	40	40	0	0
Carriers - Port Moresby (K2/bag)	40	0	0	0
Transport of sweetpotato bags: Village to Goroka (truck) (K5/bag)	100	100	100	0
Goroka to Lae (K8/bag)	160	160	0	0
Lae to Port Moresby (Bismark, K17.50/bag + K15 for bill of lading+ tax)	435	0	0	0
Port Moresby wharf to warehouse (K5/bag)	100	0	0	0
Order deliveries (K5/bag)	20	0	0	0
Transport of farmer: Village to Goroka (K3/one way)	6	6	24	0
Goroka to Lae (K25 one way)	25	50	0	0
Lae to Lae airport	4	0	0	0
Lae to Port Moresby (by plane)	268	0	0	0
Airport to Port Moresby home (K10 one way)	20	0	0	0
Home to wharf (K5 one way)	10	0	0	0
Port Moresby to Goroka (by plane)	268	0	0	0
Living expenses:				
Food	100	50	0	0
Accommodation in Lae	10	15	0	0
Accommodation in Port Moresby	50	0	0	0
Phone calls	50	50	0	0
Market gate fees (K2-3/bag)	30	60	40	0
Storage in Port Moresby (K2/bag)	40	0	0	0
Miscellaneous	100	50	20	0

Total costs of marketing	1996	701	304	100
Total costs of production (K20/bag)	400	400	400	400
Total costs	2396	1101	704	500
Cost of production/bag	20	20	20	20
Costs of marketing/bag	100	35	15	5
Break-even price/bag	120	55	35	25

The following assumptions were made:

Cost of production: K20/bag. This could vary from K10 to K25, depending whether family labour or hired labour was used.

Selling: in Lae and POM, 50% is sold in bags to re-sellers, and 50% in heaps by the farmer; in Goroka, all are sold in heaps; in Kasena, all are sold in bags to a village buyer.

Normally 3-5 bags can be sold in a day, either in bags or in heaps.

Accommodation: Lae (K5/night, 2 nights); POM (K10/night, 5 nights).

Food: K20/day when out of town in Lae or POM.

Gate fees: POM, K3; Lae, K2; and Goroka, K2.