**Sweetpotato value chain analysis in Papua New Guinea***

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Conference paper presented to the 8th ASAE Conference, Savar, Bangladesh, 15-17 October 2014.

**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 Highlands sweetpotato, especially in coastal markets, because of income growth and urbanisation. However, long distance sweetpotato marketing has been problematic, as a result of high risk and high cost. 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.

A value chain analysis was conducted using both qualitative and quantitative methods, including personal interviews of key value chain operators (microfinance institutions, transporters, wholesalers, local market traders, and institutional buyers), farmer focus groups, a consumer survey, and an economic analysis of volume, price and cost. The results suggested that there were serious issues regarding access to credit, transport infrastructure (high costs, poor roads, and no specialised transport system), postharvest management (no sorting or grading, poor packaging, rough and multiple handling, and no proper storage facilities), chain coordination (no collaboration or communication between value chain operators), and support services (insufficient market information and no training and extension to build business skills). For female farmers, there were gender-specific issues related to personal safety, poor market facilities, and inequality in the division of labour and the distribution of income within the household.

To meet growing demand for high quality products at competitive prices, smallholder farmers must be better organised into groups and be prepared to work collaboratively. Coupled with building their business skills, this approach should make it possible to improve their access to markets, and improve farmer income.

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

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*This paper is part of the project “Improving marketing efficiency, postharvest management and value addition of sweet potato 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.
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## Introduction

Sweetpotato is the most important food crop in Papua New Guinea, accounting for 43% of all food energy. Sweetpotato is grown throughout PNG, although production is centred in the Highlands, where 75% of the crop is produced. The national average consumption of sweetpotato is 260 kg/person/year. Sweetpotato is becoming a cash crop for smallholder farmers driven by the need to generate income in a modernising market economy. The proportion of production sold has been estimated at approximately 60,000 tonnes a year (or 2% of total production of around 3 million tonnes) (Spriggs 2005).

The market potential for sweetpotato in PNG has improved significantly in recent years due to the mining boom and urbanisation. Demand for sweetpotato from coastal cities, especially Lae and Port Moresby, has increased as a result of these factors. Recent data suggest that the quantity of sweetpotato shipped from Lae to Port Moresby has more than doubled since late 2010 (Chang and Irving 2013). However, expanded marketing opportunities, and potential crop profitability, have been constrained by the high costs of marketing, as well as by product losses. Marketing costs can account for up to 75% of total costs, while postharvest losses can be as high as 30-50% when the product arrives in Port Moresby, especially if there have been substantial shipping delays (Irving et al. 2011). 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 positive implications for food security and smallholder farmers' income.

## Overview of the sweetpotato market in PNG

Key aspects of sweetpotato production, consumption and marketing are reviewed briefly in this section.

**Sweetpotato production.** Total production of sweetpotato in PNG has been estimated at around 3 million tonnes (Bourke and Vlassek 2004), of which approximately 75% is produced in the Highlands. Approximately 60-75% of Highland sweetpotato is used for human consumption, and the remainder as pig feed. Table 1 shows the top ten sweetpotato producing provinces in PNG. The number one producer, the Southern Highlands Province, produces 620,000 tonnes of sweetpotato a year. Given the provincial population of 523,613 (Bourke and Harwood 2009), average per capita production per annum is 1.18 tonnes. Assuming one third of this is fed to pigs, apparent human consumption of sweetpotato may be estimated at 2.14kg/person/day in the Southern Highlands.

The supply of sweetpotato is continuous, non-seasonal and regular to irregular in most parts of PNG (Bourke et al. 2004). However, there is a tendency for sweetpotato to be available in larger quantities at certain periods of the year. These periods vary between locations and between years. For example, in the Eastern Highlands supply tends be at its highest in March-July and at its lowest in October-January, while the corresponding periods in the Southern Highlands are several months earlier. This means that the supply of sweetpotato does not vary in a regular annual cycle across PNG as a whole, and as such demonstrates no apparent seasonality in production. This stability has been essential in the past for providing food security. However, there is concern that production may have become more variable and unpredictable because of climate change (Bourke and Harwood 2009).
In the PNG Highlands, women play a significant role in sweetpotato production. As a staple food crop, sweetpotato is considered a "feminine crop" and therefore sweetpotato cultivation is mainly a "women's job" from planting to harvesting. The "men's job" is limited to land preparation (clearing the bush, making garden beds and building drainage and fences) at the beginning of the production cycle.

Bourke and Vlassek (2004) estimated sweetpotato yields to be at 15 tonnes/ha in the PNG Highlands and 13 tonnes/ha in the Lowlands. However, these figures are substantially higher than FAO's estimate and our own research, which suggest that the sweetpotato yield is approximately 5 tonnes/ha overall. In either case, given that sweetpotato yields can be as high as 30-35 tonnes/ha, as in Australia, Israel, and Egypt (CIP n.d.), there is considerable room for yield improvement in PNG.

**Sweetpotato consumption.** Gibson (2001a) estimated that national average annual per capita sweetpotato consumption in PNG to be 260kg (Table 2). Substantial differences existed in the diet 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).

These differing consumption patterns occur due to lack of market penetration by imported foodstuffs, especially rice, into rural areas. Similarly, it can be difficult to market locally produced foods into urban areas due to high transport costs. Transport and logistical problems have been identified as the number one issue for fresh produce marketing in PNG (Chang and Griffith. 2011; Wilson 2008; Global Development Solutions 2008; Peter 2001; Epstein 2000; Burdon 1998; Daysh 1995). There is also a regional difference in staple food consumption. That is, while sweetpotato is the main staple food for highlanders, banana, taro, sago, sweetpotato and rice constitute a much more diverse diet for people living in coastal cities. It has also been found that those who consumed sweetpotato in Port Moresby and Lae were mainly migrants from the Highlands (Benediktsson 2002; Gibson 2001b). The availability of other staple foods in the growing coastal cities is a potential threat to future sweetpotato marketing. Another potential threat facing sweetpotato, as well as other starchy foods, is a change in food consumption patterns away from traditional staple crops, and towards fresh fruit and vegetables and animal protein (Rosegrant et al. 2001). This means while it is important to improve crop yields and to reduce the marketing cost of sweetpotato, policymakers and industry should also be aware of changes in consumer demand, and in the relative price and availability of competing products.

**Sweetpotato marketing.** Sweetpotato is a bulky, perishable commodity with a high weight-to-value ratio. Long distance marketing for sweetpotato is challenging, and demands a lot of resources and chain coordination (Chang et al. 2008). Typically, sweetpotato is harvested in the Highlands and packed tightly into white poly bags (weighing 80-100kg each), which are then picked up from the village by trucks or public motor vehicles, dropped off alongside the Highlands Highway, reloaded onto semi-trailers going down to Lae, unloaded and re-loaded again onto shipping containers at the wharf, and transported Port Moresby by boat. Upon 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 between seven and ten days.

The long distance sweetpotato value chain is complex and fragmented, and many things can go wrong. Long delays in transport are frequent because of unavailability of PMVs or trucks, bad roads, landslides, roadblocks, shipping delays, and other factors. These transport problems, and poor chain coordination, result in high risks and high transaction costs. Total marketing costs can account for more than 50% of total costs when sweetpotato is transported from a highland village to Port Moresby (Chang 2009). A significant portion of these costs could be reduced if farmers could work together and consolidate their bags, rather than going to the coastal markets by themselves with only a small number of bags. Good vertical and horizontal coordination is critical. However, it is generally lacking and difficult to achieve, given PNG's unique cultures and social institutions where family ties are paramount and outsiders are distrusted. Figure 1 shows the transport route that sweetpotato passes through.

## Methodology

A value chain approach was taken to identify the constraints to, and opportunities for, improving long distance sweetpotato marketing from the PNG Highlands to the coastal markets of Lae and Port Moresby. Both qualitative and quantitative methods were employed. Value chain mapping, a largely qualitative approach, was conducted through a series of personal interviews and focus groups involving key value chain operators, including marketers, truck/bus drivers, trucking companies, shipping companies, microfinance institutions, and institutional buyers. These 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, while an analysis of marketing costs for different marketing options was also completed.

The research methods used for value chain mapping are summarised below:

- *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 (specialising in buying and selling in bulk, mixed vegetables and sweetpotato).
- *Focus groups of smallholder farmers*. Two focus groups of farmers were conducted in Goroka (ten participants) and Mt Hagen (six participants). These farmers sold their produce to one or more 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 were experienced sweetpotato producers and marketers. Most of them had been involved in both local and long distance sweetpotato marketing. They represented their districts in either the Eastern Highlands or Western Highlands Province. Discussion focused on three areas: division of labour in sweetpotato production and marketing, distribution of income within the household, and marketing issues faced.
- *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*. Eight institutional buyers in Lae were interviewed, including representatives of National Catering Services (at Unitech), Lae Technical College Massing Facility, and six kai bars (fast food outlets).
- *Consumer survey*. Ninety two women from 7 church/community groups in Lae were interviewed. Non-probability sampling was used because of a lack of a well-defined sampling frame (no phone book or official record of residency was available). Interviews were conducted at a church or a community centre because of security concerns. Previous consumer surveys have shown that it can be very challenging to conduct 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 largely structured, but included several open-ended questions. The focus was on understanding consumer preference for sweetpotato against other food staples, preference for sweetpotato varieties, and physical characteristics and eating quality associated with each variety.
- *Marketing cost analysis*. The costs of marketing from Kasena village to three potential markets (Goroka, Lae, and Port Moresby) were itemised and compared to identify

strategies by which marketing costs could be reduced and returns to farmers increased. Costs of marketing include: packaging materials, packing, loading/unloading, market entry fees, transport for both sweetpotato and the marketer, communications, living expenses when away from home, product losses, and the opportunity costs of being away from the farm for 3-5 days.

The results from the value chain analysis were summarised in a 4 x 4 matrix, following the analytical framework of a SWOT (strengths (S), weaknesses (W), opportunities (O) and threats (T)) as suggested in Johnson et al. (2005).

**Key Findings**

In this section, we summarise the results from stakeholder interviews, the consumer survey, and marketing cost analysis, as well as a SWOT matrix which synthesises key findings from the value chain analysis, and strategic issues facing the sweetpotato value chain in PNG.

**Interviews of value chain operators.** Mapping 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, the availability and cost of transport, and a lack of storage facilities. These issues were more severe for farmer-sellers than semi-wholesalers. Key gender-specific issues faced by female farmers included 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. This finding is consistent with Brearley (2005).

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 poor quality 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). These results are summarised in Tables 3-6.

The value chain mapping also showed that the sweetpotato value chain was fragmented and uncoordinated with little or no relationship, communication, or marketing arrangement between farmers and service providers, or between suppliers and buyers – not even with “regular suppliers”. The majority of transactions were conducted on the spot without any planning on the part of farmers, and without any consideration of future transactions.

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 big 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 the smallholder farmers to show that they are worthy business partners if they want to do business with big companies. For transport providers, this means smallholder farmers organising themselves and consolidating their sweetpotatoes 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, loans are not grants and they must be repaid according to set schedules.

**Consumer survey**. The main findings from the consumer survey were:

- The majority of consumers bought sweetpotato from open markets;
- Consumers had a strong preference for particular sweetpotato varieties, with *Kerot* and *Wahgi Besta* topping the list;
- The most preferred physical characteristics of sweetpotato were: yellow flesh, red skin, medium size, elongated shape, smooth skin, mature, sweet, and dry/firm/powdery.
- A small price premium appeared to exist for *Kerot,* the most preferred variety, and a price discount for *Rachael*, the least preferred variety. The relationship between price and other varieties were not as clear cut.

Price comparisons were difficult to make because sweetpotato sold at the open market was priced either by bags or in heaps of varying sizes and 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. The majority of consumers interviewed preferred certain varieties of Highlands sweetpotato. However, they found it hard to get what they wanted because of lack of product information.

Some consumers expressed a strong preference for rice on convenience and novelty grounds. Households with children and young adults also tended to prefer rice over sweetpotato. These latter results are consistent with Gibson (2001a, 2001b). Improving product information through product labelling and pricing by weight and quality may help reduce search costs, and make it easy for consumers to find what they like. More detailed discussion on the results of the consumer survey can be found in Omot et al. (2010).

**Cost of marketing.** It became clear from the value chain mapping that the majority of farmers and marketers did not understand costs, market prices, and profits, except that sweetpotato price was highly variable and costs were high. Many farmers and marketers went to the market without any market knowledge, including whether they could expect to make a profit or a loss. Attempts were made to collect price and volume data, but with limited success due to lack of resources. However, information on the cost of marketing was provided by a farmer-seller from the Kasena village in the Asaro Valley, located 10 km from Goroka. The example provided below (Table 4) was based on selling 20 bags of sweetpotato each to four different markets (Kasena, Goroka, Lae and Port Moresby (POM)). The objectives of the exercise were to identify major cost items and to suggest how marketing costs could be reduced and returns to farmers increased.

The costs of marketing considered include: sweetpotato bag costs, packaging, loading and unloading, market entry fees, transport for both sweetpotato and the wholesaler (including return airfares from Goroka/Lae to POM), communications, living expenses when away from home, and product losses (Table 7). The following assumptions were made:

- Cost of production: 20 kina per bag.
- 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 a heap.
- Accommodation: Lae (5 kina/night, 2 nights); POM (10 kina/night, 5 nights).
- Food: 20 kina/day when out of town in Lae or POM.
- Gate fees: POM 3 kina; Lae 2 kina; and Goroka 2 kina.
- Product losses: marginal losses in Goroka or Lae; 10% in POM.

The breakeven prices per bag were: To POM, K133; to Lae, K57; to Goroka, K35; and in Kasena, K25 (last row of Table 4). These figures are not favourable compared with

prevailing wholesale prices of K90-150/bag for POM, K60-80/bag for Lae, and K30-40/bag for Goroka. The corresponding costs of marketing per bag were: K110, K37, K15, and K5, respectively. Marketing costs, in percentage terms, were 83%, 65%, 43%, and 20% of total costs, respectively, for the four marketing options. It is clear that the cost of marketing per bag could be reduced as the distance to market reduces and as the number of bags increases. Another case study of a wholesaler operating from Central Hagen in Western Highlands provice has shown that with a full container load (about 200 bags), the breakeven price in POM can be as low as K80-90/bag (Chang and Irving 2013).

Our suggestions to smallholder farmers to improve marketing include the following:

- farmers monitor the market closely and avoid making the journey to market unless they have a sufficient number of bags and the expected market price is sufficiently higher than the breakeven price;
- farmers try to reduce their costs by hiring an agent in Lae or POM, rather than going to the markets themselves;
- farmers consolidate their bags with other farmers to take advantage of economies of scale in marketing;
- farmers sell in bulk to re-sellers in Lae to avoid spending more time away from home than is necessary; or
- farmers sell to local buyers and avoid all the costs and risks associated with going to the market themselves.

In the case study below, we show that the breakeven price was reduced to K90/bag by selling in container loads, and that sound value chain coordination could reduce marketing costs and product losses further.

**SWOT analysis.** As shown in Table 8, 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 the projected increase in demand 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 economic and demographic changes that may result in reduced consumption of sweetpotato in favour of rice and other non-traditional staple foods.

**Strategic issues**. Based on the SWOT analysis, strategic issues that need addressing include:

- Marketing infrastructure. A major source of competitiveness in agricultural value chains is access to appropriate physical infrastructure (such as roads, market facilities, storage facilities) and marketing support services (for example grades and standards, access to credit and insurance, and market information). For the majority of PNG sweetpotato value chain operators, these basic services were lacking. Consequently, there are opportunities for government and the private sector to work together to improve physical infrastructure and provide 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 is in most need of improvement. Second, research is needed to identify the areas and opportunities for public-private partnerships, to provide policymakers with sufficient information to develop appropriate policies and strategies that are favourable to smallholder farmers.

- Market information. Adequate and reliable market information is essential to develop appropriate policies, as well as production and marketing strategies to benefit smallholder farmers and other value chain operators. Current agricultural information systems maintained by government agencies (such as Fresh Produce Development Agency, National Statistics Office and Customs Office) and shipping companies are inadequate and unreliable. Improving the market information system will require improvements to data collection processes, and developing locally appropriate quality standards and grading schemes. Furtherrmore, pricing mechanisms that are weight- and quality-based need to be put into place, to provide accurate price signals and market information to policymakers and value chain operators, as well as to consumers.
- Value chain coordination. The sweetpotato value chain is currently fragmented and uncoordinated. Chain coordination and the flow of market information must be improved to lower costs and improve marketing efficiency. The marketing cost analysis clearly showed that it was very costly for individual farmers to take on long distance marketing on their own, to the extent that their profit was minimal. One viable alternative is to sell to local buyers, while another is to market as a group. However, social dynamics and cultural diversity in PNG present significant obstacles to collective action, and to building trusting and sustainable business partnerships. More research is required to investigate whether and how alternative business models can work in the PNG sweetpotato value chain context.
- Female farmers. 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 should 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 facilities in the local market for women should also be a priority to encourage female participation at the market.
- Capacity building. The value chain mapping suggested that, given the current stages of economic development in PNG, the sweetpotato marketing system was undeveloped and smallholder farmers, as well as other supply chain operators, lacked the necessary resources and skills to tackle some of the problems that they themselves have identified. More resources are needed to support extension and development activities to build and strengthen their technical and business skills. Education of farmers and value chain operators on consumer preference and postharvest issues is an important first step towards a more market-oriented production and marketing system.

## Conclusions

This paper presented a detailed mapping of the PNG sweetpotato value chain. The results indicated that there were serious issues facing the sweetpotato value chain operators regarding access to credit, transport infrastructure, and support services, as well as issues related to postharvest handling, market institutions, and chain coordination. To take advantage of the growing demand for high quality sweetpotato, smallholder farmers must organise themselves into groups in order to improve their access to the market, to credit, training, and extension services, and to work collaboratively in the area of marketing to meet demand for a high quality product at competitive prices. There is also a role for government in creating an enabling environment, particularly by improving physical infrastructure and support services.

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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.

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.

Table 3. Results from farmer interviews

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

Table 4. Results from buyer interviews

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

Table 5. Results from service provider interviews

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

Table 6. Results from the consumer survey

| | Main issues | Possible solutions |
|---|---|---|
| Consumer survey | Highland sweetpotato is preferred over coastal varieties;<br>Consumers have strong preference for variety;<br>No information on varieties, where it is grown, and when it is harvested;<br>Price variability. | Improving quality;<br>Lower price;<br>Product labelling;<br>Establishing grade standards;<br>Improving communication between farmers and consumers. |

Table 7. Marketing costs and breakeven prices for four selling options

| **Cost items** | **POM** | **Lae** | **Goroka** | **Kasena** |
|---|---|---|---|---|
| Cost of bags (3 kina/bag) | 60 | 60 | 60 | 60 |
| Packing (2 kina/bag) | 40 | 40 | 40 | 40 |
| Loading/unloading of sweetpotato bags: Carriers - Goroka (1 kina/bag) | 20 | 20 | 20 | 0 |
| Carriers - Lae (2 kina/bag) | 40 | 40 | 0 | 0 |
| Carriers - POM (2 kina/bag) | 40 | 0 | 0 | 0 |
| Transport of sweetpotato bags: Village to Goroka (truck) (5 kina/bag) | 100 | 100 | 100 | 0 |
| Goroka to Lae (8 kina/bag) | 160 | 160 | 0 | 0 |
| Lae to POM (Bismark, 17.50 kina/bag + tax +15 kina for bill of lading) | 435 | 0 | 0 | 0 |
| POM wharf to warehouse (5 kina/bag) | 100 | 0 | 0 | 0 |
| Order deliveries (5 kina/bag) | 20 | 0 | 0 | 0 |
| Transport of farmer: Village to Goroka (3 kina/one way) | 6 | 6 | 24 | 0 |
| Goroka to Lae (25 kina one way) | 25 | 50 | 0 | 0 |
| Lae to Lae airport | 4 | 0 | 0 | 0 |
| Lae to POM (by plane) | 268 | 0 | 0 | 0 |
| Airport to POM home (10 kina one way) | 20 | 0 | 0 | 0 |
| Home to wharf (5 kina one way) | 10 | 0 | 0 | 0 |
| POM to Goroka (by plane) | 268 | 0 | 0 | 0 |
| Living expenses: | | | | |
| Food | 100 | 80 | 0 | 0 |
| Accommodation in Lae | 10 | 15 | 0 | 0 |
| Accommodation in POM | 50 | 0 | 0 | 0 |
| Phone calls | 50 | 50 | 0 | 0 |
| Market gate fees (per bag) | 30 | 60 | 40 | 0 |
| Storage in POM (2 kina/bag) | 40 | 0 | 0 | 0 |
| Miscellaneous | 100 | 50 | 20 | 0 |
| Product losses in POM (10%) | 2 bags | 0 | 0 | 0 |
| Total costs of marketing | 1996 | 731 | 304 | 100 |
| Total costs of production (20 kina/bag) | 400 | 400 | 400 | 400 |
| Total costs | 2396 | 1131 | 704 | 500 |
| Costs of marketing/bag | 110** | 37 | 15 | 5 |
| Break-even price/bag | 133** | 57 | 35 | 25 |

Table 8. SWOT analysis of sweetpotato value chain in PNG

| **Strengths** | **Weaknesses** |
|---|---|
| Fertile soils and temperate climate produce high quality sweetpotato all year round;<br>No apparent production seasonality;<br>Sweetpotato can be produced year round;<br>Many varieties to cater for consumer preference;<br>Entrepreneurship;<br>Excellent farming skills (being the first sweetpotato farmers in the world). | Sweetpotato is low value (per kg) and perishable; Markets are distant;<br>Poor packaging and postharvest handling causing skinning and product losses;<br>Sweetpotato is priced by bags or in heaps (an arbitrary yardstick, does not provide clear price signal);<br>No quality standards; no price premium, no incentive to improve quality<br>Lack of business skills: not market-oriented, no planning, cannot manage money;<br>Irregular supply: grow to meet the need for cash;<br>Lack of information and myths prevail: sweetpotato is strong; product loss is minimal; everything is marketable; middlemen rip farmers off<br>Social and cultural constraints: tribalism and distrust of outsiders;<br>DIY: high costs due to diseconomies of scale. |
| **Opportunities** | **Threats** |
| Increased demand as a result of urbanisation and economic growth;<br>Consumers prefer highland sweetpotato (over coastal varieties);<br>More local buyers/wholesalers are emerging;<br>Prevalence of mobile phones (market information; communication with buyers/suppliers);<br>Microcredit is more readily available in rural areas (National Development Bank, Nationwide, S&L Societies, PNG Microfinance);<br>Consumers prefer highland sweetpotato (over coastal varieties);<br>Product differentiation/labelling for highland sweetpotato;<br>Health benefits of sweetpotato (esp. orange-fleshed);<br>Providing food security amidst climate change. | Climate change (too wet or too dry for too long) affecting yields and production;<br>Economic and demographical changes resulted in dietary/lifestyle changes against traditional staple food such as sweetpotato;<br>Transport services becoming more scarce and expensive due to demand from the mining sector;<br>Feeder roads deteriorate further;<br>Labour shortage and general inflation due to mining boom;<br>Law and order;<br>Poor facilities at the open markets (except Hagen). |

Figure1. The journey from the PNG Highlands to Port Moresby