PAPUA NEW GUINEA PROJECT NOTE #12 DECEMBER 2023

Potential Impacts of an El Niño Related Drought on Sweet Potato Consumption and Prices in Papua New Guinea

Josiah Joseph, Glen Hayoge, Helmtrude Sikas-Iha, Paul Dorosh, Emily Schmidt and Mekamu Jemal Kedir

Introduction

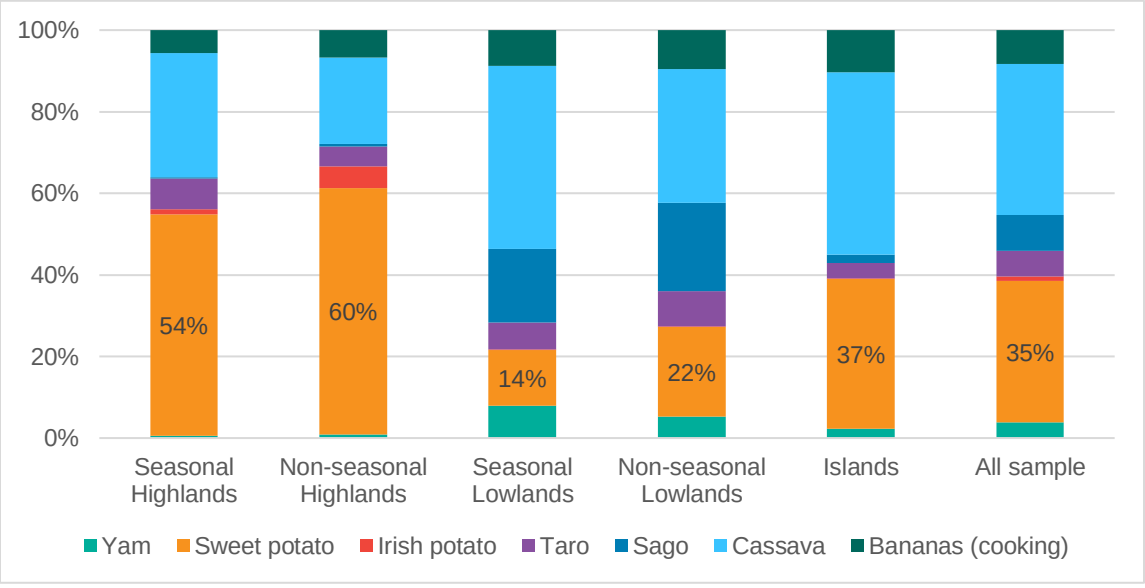
Sweet potato plays an important role in the food system of Papua New Guinea (PNG), accounting for over 12 percent of total calories consumed in the country (IFPRI,2023). Three-quarters of sweet potato production takes place in the highlands where it is harvested throughout the year (Chang et al., 2013). However, the production and consumption of sweet potatoes in PNG faces several challenges, including climate change, pests and diseases, and market access constraints. In particular, a significant decline in sweet potato production due to an El Niño-related drought in early 2024 is a realistic possibility.

This memo describes analysis using a partial equilibrium model to estimate the potential effects of a shortfall in sweet potato production on market prices and consumption, including consumption levels for various types of households in the highlands and other parts of PNG. We also discuss policy options for mitigating negative effects on household welfare.

Consumption patterns

Sweet potatoes are a major staple food in Papua New Guinea (PNG). A recent rural household survey conducted by the International Food Policy Research Institute (IFPRI) in 2023 found that average annual sweet potato consumption amounted to 125 kgs per person and accounted for about one third of total calories from starchy staples, equivalent to 12 percent of total calories consumed per person per day (Figure 1). There are substantial regional variations in sweet potato consumption, however. Sweet potatoes are the major staple in much of the highlands, which account for 75 percent of national production and where sweet potato contributes up to 57 percent of calorie intake from starchy foods and about 20 percent of total calorie intake.

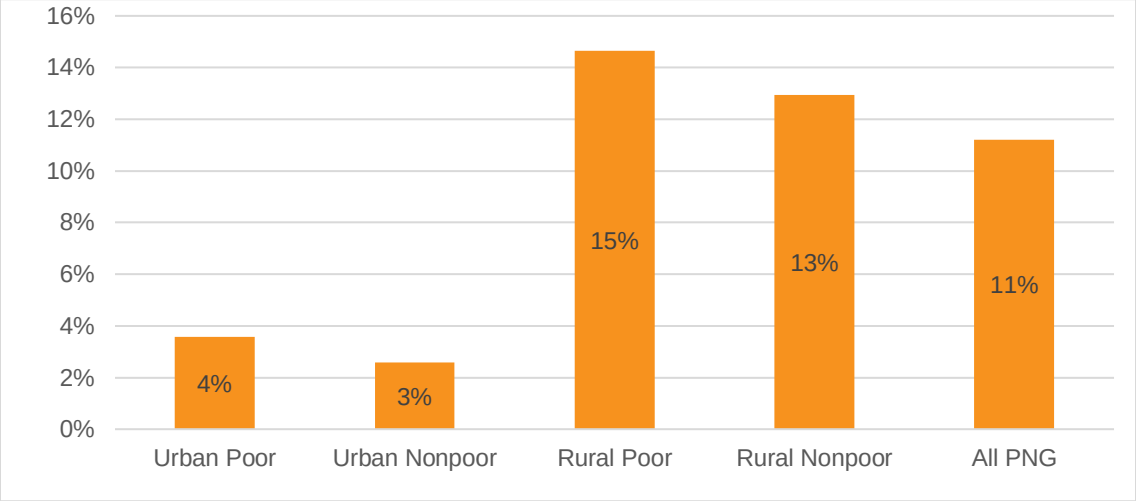
Figure 1: PNG Share of Calories from Starchy Staples



Source: PNG Rural Household Survey sample (IFPRI, 2023)

The household average value of sweet potato consumption accounts for 11 percent of total expenditure.[1] However, the share of household budget dedicated to sweet potato is considerably higher for rural households, comprising 15 and 13 percent for poor and nonpoor households, respectively (Figure 2). Urban households depend less on sweet potato, dedicating approximately 4 and 3 percent of their household budget for poor and nonpoor households, respectively.

Figure 2. PNG Consumption Expenditure Shares of Sweet Potato by Household Group

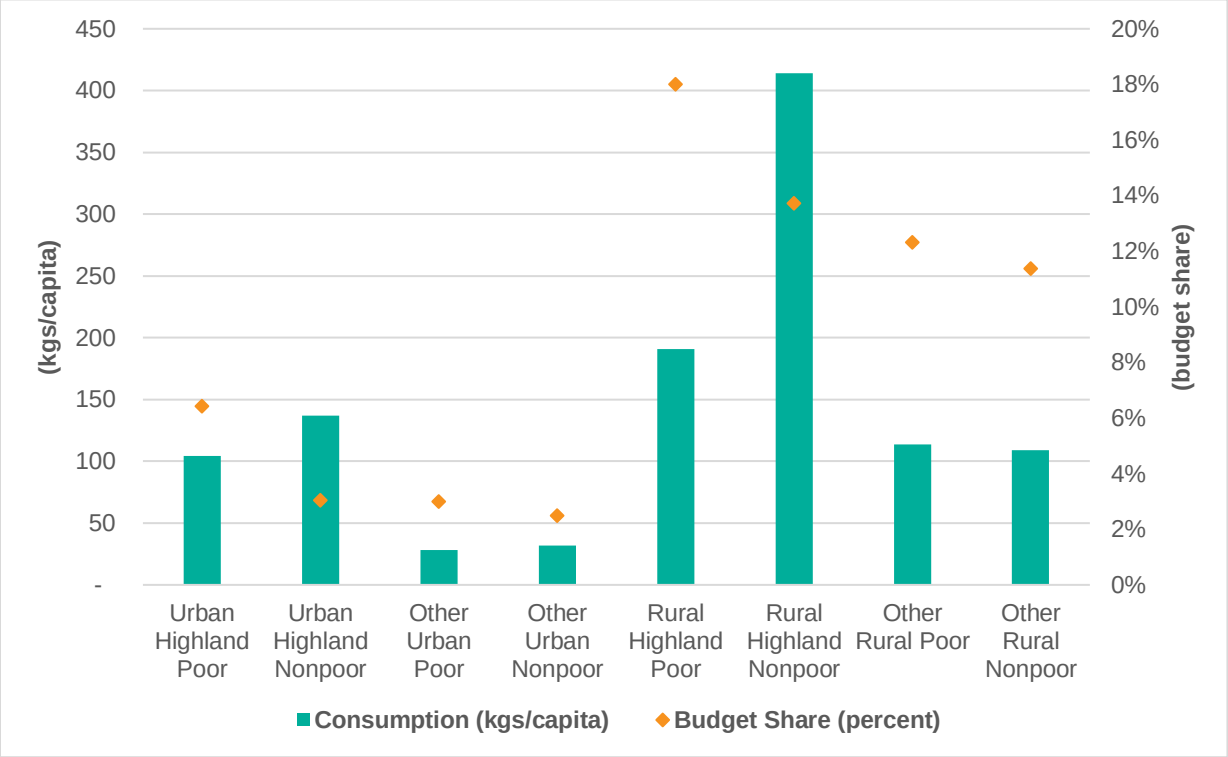


Source: Authors calculation from HIES 2009/10.

These differences in consumption and expenditure patterns between urban and rural households are even more pronounced across regions. Within the highlands, rural poor households consume 1.1 times more kilograms of sweet potatoes per capita than the national average, allocating 18 percent of their household budget to sweet potato. Highland non-poor households consume 2.2 times more kilograms of sweet potatoes compared to the highland rural poor households, however dedicate less share of their household budget (14 percent) to sweet potatoes given that they have a higher overall household budget (Figure 3).

[1] Expenditure share includes the market value of own-produced sweet potato that is consumed by the household.

Figure 3. PNG Sweet Potato Consumption, 2009-10

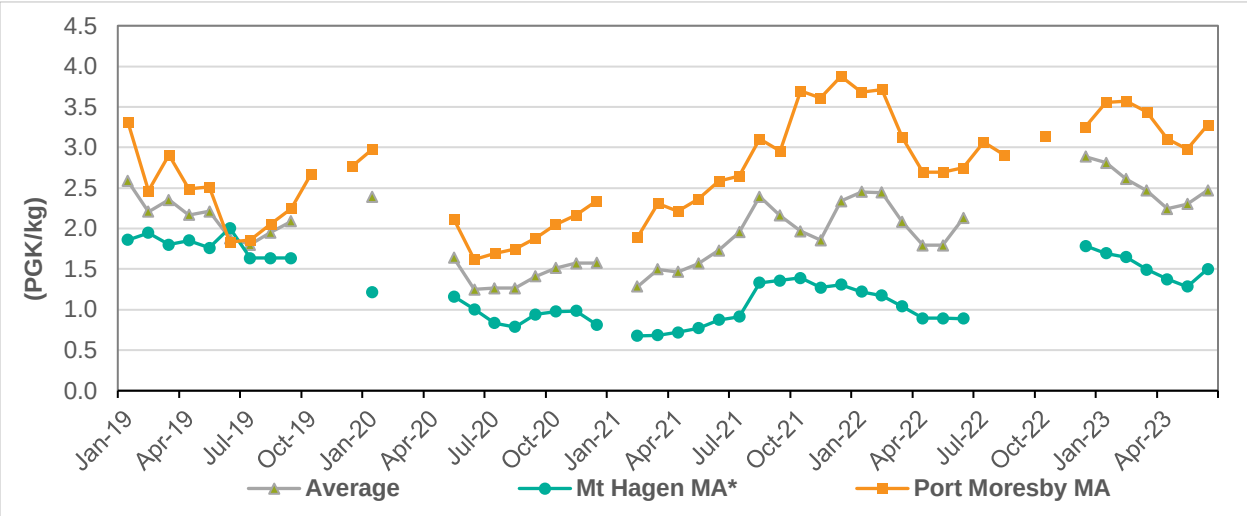


Source: Authors calculation from HIES 2009/10.

Marketing

Sweet potato is cultivated year-round in the highlands, with harvests about five months after planting. This steady supply contributes to ongoing price stability throughout the year. However, regional price variations of sweet potato are significant. In the highlands, in Mt. Hagen for example, sweet potato prices averaged about 1.17 PGK/kg from February 2021 to June 2023. In contrast, in the lowlands, where local production falls short of meeting local demand, the sweet potato price is substantially higher. Prices are also higher in major cities along the coast. For example, in Port Moresby during the same period, the price of sweet potato was 2.6 times higher than in the highlands, amounting to 3.04 PGK/kg. This price difference reflects the additional cost associated with storage and transportation from the highlands to the lowlands (Figure 4).

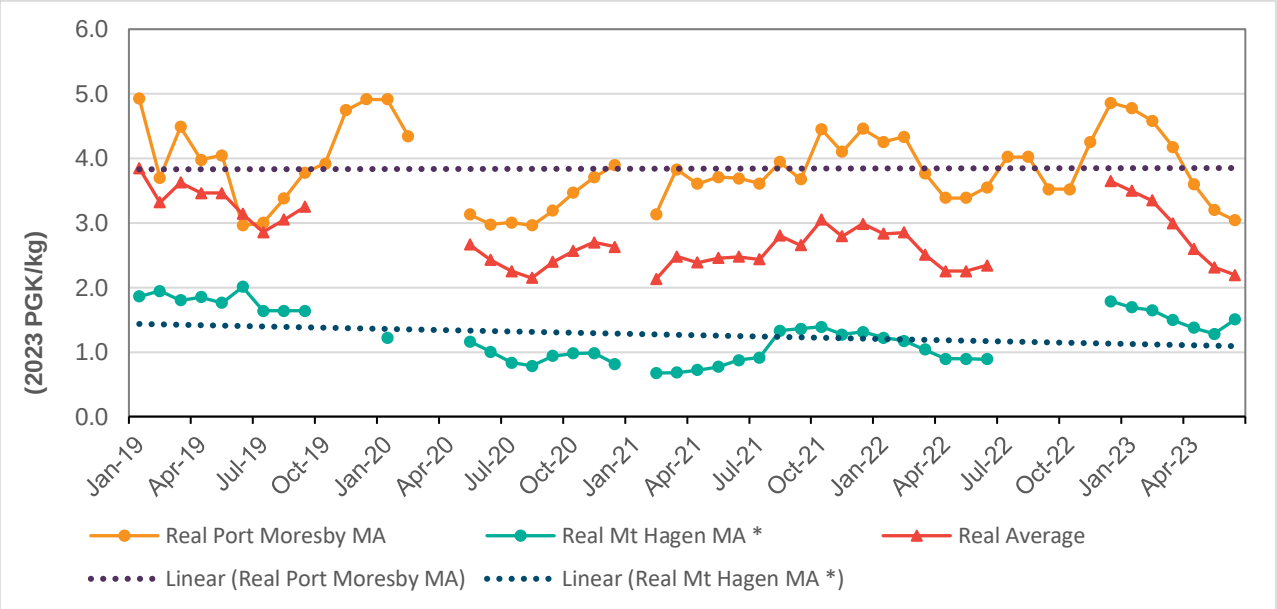
Figure 4. Market Price of Sweet Potato in Port Moresby and Mt. Hagen (PGK/kg), 2019-23



Source: Fresh Produce Development Agency data. Note: * *Moving* average the price data point represent a 3-month moving average based on the current, previous, and next month

Adjusting for inflation using an index based on the PNG Consumer Price Index (CPI), the real price of sweet potatoes in Mt. Hagen has a slight downward trend, in contrast to real prices in Port Moresby where there is no significant upward or downward trend (Figure 5).

Figure 5. Market Price of Sweet Potato in Port Moresby and Mt. Hagen (Real 2023 PGK/kg), 2019-23



Source: Fresh Produce Development Agency data. *Note: Moving average: the price data point represent a 3-month moving average based on the current, previous, and next month

Weather-Related Shocks to Sweet Potato Production

While sweet potatoes are adaptable to various climate conditions, they remain susceptible to extreme weather events such as droughts and floods. According to estimates from the 2015/16 El Niño event, sweet potato yields in the highlands of PNG declined by up to 50 percent. Likewise, an El Niño-related drought in 2023 and early 2024 could have a similar negative effect on sweet potato production in PNG.

Model simulations: Potential Impacts of a Sweet Potato Production Shortfall

To estimate the potential effects of a major sweet potato production shortfall, we use a simple partial equilibrium model of supply and demand of sweet potatoes in PNG. The model, based on estimates for production, exports and consumption from the FAO Food Balance Sheets for 2021 (FAO, 2023), calculates production, consumption and price changes given model parameters (e.g. price responsiveness of supply and demand) and changes in productivity.

Estimates of sweet potato consumption and demand parameters for various household groups are based on data from the 2009/10 Household Income and Expenditure Survey (HIES) and Diao et al. (2021). The simulations below are designed to show the potential impacts of an El Niño – related drought that reduces sweet potato crop productivity by 50 percent in the highlands.[2] We analyze both short- and medium-run effects, as well as the effects of a drought accompanied by a 10 percent reduction in household incomes.

In Simulation 1, we model a 50 percent decline in productivity of sweet potatoes in the highlands (equivalent to a 37.5 percent reduction in national productivity since highlands production is 75 percent of national production). Production in this scenario falls by only 21.9 percent, given the resultant market price increase of 74.5 percent, which spurs farmers to produce more sweet potato, albeit this production output takes time to realize (Table 1 and Figure 6).

Table 1: Potential Effects of Drought on the PNG Sweet Potato Sector (Model Simulations)

		Sim 1 2023	**Sim 2** 2023	**Sim 3** 2024	**Sim 4** 2024
	Base	Short-run	Short-run	Medium-run	Medium-run
Production ('000 tons)	699.0	545.9	530.1	600.6	575.9
(% change)	---	-21.9%	-24.2%	-14.1%	-17.6%
Market Price	---	74.5%	62.2%	42.4%	35.9%
Consumption ('000 tons)	602.0	470.1	456.5	517.2	496.0
(% change)		-21.9%	-24.2%	-14.1%	-17.6%

Source: Model simulations.

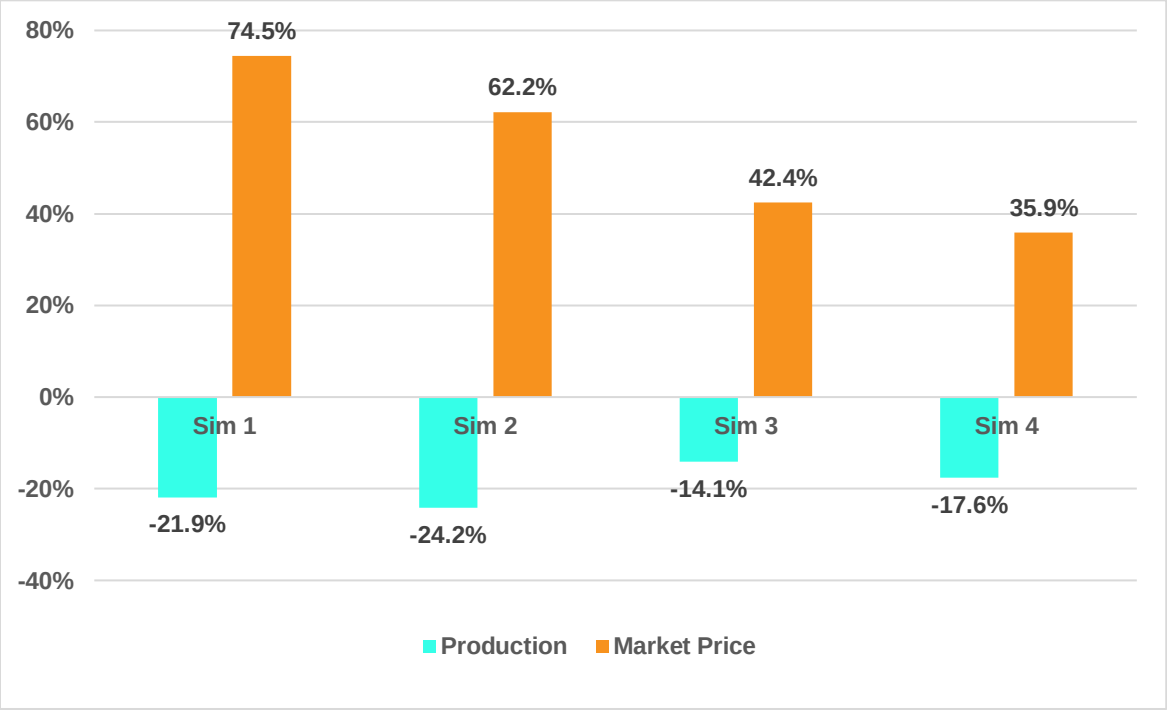
[2] Model parameters such as sweet potato productivity loss can be set at any reduction level, however we use 50% to illustrate this simulation, following reported production losses due to the 2015/16 El Niño event.

In addition to the negative 50 percent productivity shock, simulation 2 assumes that household incomes throughout PNG also decline by 10 percent due to reduced overall economy activity linked to the drought. Because of lower household incomes, demand for sweet potatoes is less than in Simulation 1; consumption declines by 24.2 percent (as compared to 21.9 percent in Simulation 1) and prices rise by only 62.2 percent (compared to 74.5 percent in simulation 1).

In the medium-run simulations (simulation 3 and 4), farmers and consumers have more time to adjust production and consumption in response to the drought-induced price increase. As a result, the price increase required to raise supply and lower demand to bring about a balance in the market is only 42.4 percent (compared to 74.5% in simulation 1). Ultimately, the percentage declines in production and consumption are also less – only 14.1 percent, as compared to 21.9 percent in Simulation 1.

Assuming a 10 percent decline in household incomes over the medium term, the 50 percent decline in sweet potato productivity leads to a drop of 17.6 percent in production and a 35.9 percent increase in prices (Simulation 4), compared to a 24.2 percent fall in production and a 62.2 percent increase in price in the short run (Simulation 2).

Figure 6: Effects of a 50 Percent Decline in Sweet Potato Productivity



Source: Model simulations.

***Note:** *Sim 1 (0%Y) S-Run- Short run simulation of a 50 percent decline in productivity with no income change.*

Sim 2 (-10%Y) S-Run: Short run simulation of a 50 percent decline in productivity and a 10 percent income decline.

Sim 3 (0%Y) M-Run- Medium run simulation of a 50 percent decline in productivity with no income change.

Sim 4 (-10%Y) M-Run: Medium run simulation of a 50 percent decline in productivity and a 10 percent income decline.

Impact of sweet potato production decline on highland households

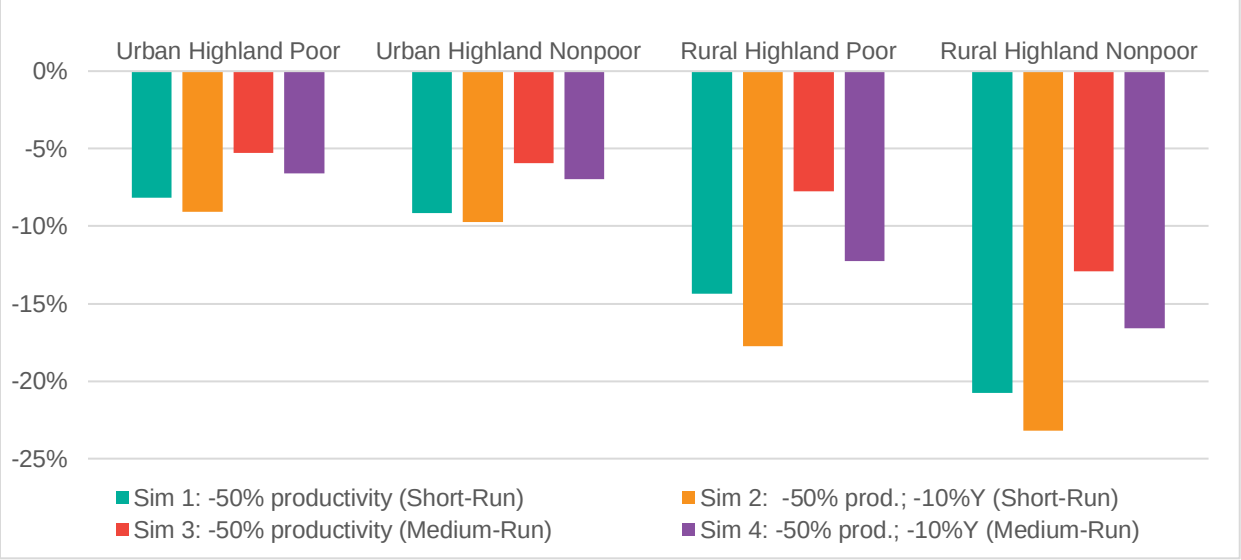
Table 2 and Figure 7 show the simulated short and medium run effects of the sweet potato productivity declines on household sweet potato consumption. In Simulation 1, the 50 percent decline in sweet potato productivity in the highlands results in a sharp drop in household consumption for both the rural poor (-14.3 percent) and rural non-poor households (-20.8 percent) in the highlands. These declines in consumption are even greater if household incomes fall 10 percent (Simulation 2), with consumption falling an additional 2 to 3 percentage points. Urban households, with their lower dependence on sweet potatoes and better access to alternative food sources, experience a smaller decline.

Table 2: Effects of a 50 Percent Decline in Productivity on Household Sweet Potato Consumption

	Sweet Potato	**Sim 1**	**Sim 2**	**Sim 3**	**Sim 4**
	Consumption ('000 tons)	2023 Short-run	2023 Short-run	2024 Medium-run	2024 Medium-run
Urban Highlands Poor	3.3	-8.2%	-9.1%	-5.3%	-6.6%
Urban Highlands Non Poor	3.7	-9.2%	-9.7%	-5.9%	-6.9%
Rural Highlands Poor	109.7	-14.3%	-17.8%	-7.7%	-12.3%
Rural Highlands Non Poor	267.5	-20.8%	-23.2%	-12.9%	-16.6%

Source: Model simulations.

Figure 7: Effects of a 50 percent decline in productivity on household sweet potato consumption



Source: Model simulations.

The medium-run simulation results (Simulation 3 and 4) show similar patterns, but with lower percentage declines in consumption than in Simulations 1 and 2, as consumers and producers have more time to adjust their consumption patterns and production inputs to the productivity shock. The largest losses are suffered by the rural poor and rural non-poor households in the highlands. Sweet potato consumption of the rural poor and non-poor in the medium term declines by 7.7 and 12.9 percent, respectively, compared to their short run reductions of 14.3 and 20.8 percent. Including the effects of a 10 percent decline in household income (simulation 4), sweet potato consumption in the medium-run declines by -12.3 and -16.6 percent for poor and non-poor rural households in the highlands, respectively.

Responding to and Preparing for an El Niño-Related Drought in the Highlands: Lessons Learned and Future Planning

The 2016 El Niño Related Drought: Government Response

In mid-2015, areas of the highlands suffered from a drought and periodic frost that led to losses in agricultural productivity. An estimated 1.47 million people faced food insecurity, of which 180 thousand were classified as severely food insecure. In response, WFP collaborated with the Government of PNG to distribute fortified rice to 4,930 households (24,650 people), representing 13.7 percent of the severely food insecure population. Each household was to receive a 70 kilogram ration of rice, expected to last six weeks (totaling 345.1 tons of rice at a cost of USD 37.6 million).[3]

Planning for a potential El Niño Related Drought in 2024

A major production shortfall in sweet potato like that of 2015-16 could have significant adverse effects on household incomes and consumption in Papua New Guinea. Model simulations indicate that an El Niño - related drought in the highlands could result in a 22 percent decrease in production (and consumption) of sweet potato in the short-run, and a 14 percent decrease in consumption of sweet potatoes the medium-run.

In principle, it would be possible to replace these 83 to 129 billion kcals[4] (equivalent weight of kcals under the 14-22 percent decrease in consumption simulated above) of sweet potato that would normally be consumed under average conditions with an alternative food source. For example, substituting an equivalent number of calories from sweet potato would require 23 to 35 thousand tons of rice costing 8 to 12 million USD (at a CIF import price of USD 350/ton).

In addition to the financial cost of providing food aid to affected populations, it is crucial that logistical planning for mobilizing a delivery mechanism (perhaps utilizing private sector trade and transport services) is in place as early as possible to avert delays in food aid delivery and accounting. The costs and challenge of reaching remote populations will require substantial planning to ensure a timely response if the anticipated production shortfall does indeed occur.

[3] Only 23% of the ration was received by 18 April 2016. WFP (Relief Web, 2016).

[4] *Assuming 980 kcal/kg and 3650 kcal/kg for sweet potatoes and rice, respectively.*

Summary and Conclusions

Sweet potatoes are a major food crop in Papua New Guinea, particularly in the highlands, where they account for about 20 percent of total calorie intake from all foods (IFPRI, 2023). There is essentially no external trade (imports or exports) of sweet potatoes, so domestic prices are determined by domestic production (supply) and consumption (demand).

The modeling analysis presented in this note suggests that a major production shortfall in the highlands, as occurred in 2015-16, could result in sharp increases in the price of sweet potatoes and corresponding declines in consumption. For example, a 50 percent decline in productivity of sweet potatoes in the highlands (corresponding to a 38 percent decline in national productivity), could result in a 75 percent increase in sweet potato prices and a 22 percent decline in sweet potato consumption in the short run.

In the short-term, one option to offset this loss of supply of calories would be targeted transfers of rice (as was done through a World Food Programme relief effort in 2016). Other options to reduce food insecurity of poor households in the highlands include other in-kind food transfers, cash transfers, subsidized sales of rice or other food, and emergency school feeding programs.

In the medium term, investments in local water capture and storage for supplemental irrigation in drought years, as well as research and extension on drought tolerant sweet potatoes and other crops could help increase and stabilize production. More research on production, marketing and other aspects of the sweet potato value chain is also warranted.

References

Chang, Hui-Shung Christie, and Kewa, John. "Sweet potato Value Chain Analysis in Papua New Guinea." Conference paper presented at the 8th ASAE Conference, Savar, Bangladesh, 15-17 October 2014.

Chang, Hui-Shung Christie, Irving, Donald, Lutulele, Robert, Komolong, Birte, Be'Soer, Lilly. (May 2013). "Improving Marketing Efficiency, Postharvest Management and Value Addition of Sweet potato in Papua New Guinea." Final Report Number: FR2013-02. Project Number: ASEM/2006/035. Canberra: ACIAR. ISBN: 978-1-922137-34-0.

Diao, Xinshen; Dorosh, Paul A.; Fang, Peixun; and Schmidt, Emily. 2021. Effects of COVID-19 and other shocks on Papua New Guinea's food economy: A multi-market simulation analysis. IFPRI Discussion Paper 2004. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/p15738coll2.134293

Food and Agriculture Organization of the United Nations (FAO). 2023. FAOSTAT. In: Food and Agriculture Organization of the United Nations [online]. Rome. [accessed October 2023]. https://www.fao.org/faostat/en/#data/QCL

National Disaster Centre, Papua New Guinea. "Papua New Guinea Climate and Special Services: August 2023 Drought Update." ReliefWeb, Aug. 2023, https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-climate-and-special-services-august-2023-drought-update.

Relief Web. 2016. "Papua New Guinea Drought: WFP Food Distributions Wind Up Amid Signs of Recovery", https://reliefweb.int/report/papua-new-guinea/papua-new-guinea-drought-wfp-food-distributions-wind-amid-signs-recovery.

ABOUT THE AUTHORS

Josiah Joseph (josiahjosephnsomapping@gmail.com) is a National Statistician of the National Statistical Office (NSO), Papua New Guinea.

Glen Hayoge (glenhayoge@gmail.com) is a Manager of the Fresh Produce Development Agency (FPDA), Papua New Guinea.

Helmtrude Sikas-Iha (trudie.iha@gmail.com) is a Consultant of the International Food Policy Research Institute.

Paul Dorosh (p.dorosh@cgiar.org) is a Director in the Development Strategies and Governance Unit of the International Food Policy Research Institute, Washington, DC.

Emily Schmidt (e.schmidt@cgiar.org) is a Senior Research Fellow in the Development Strategies and Governance Unit of the International Food Policy Research Institute.

Mekamu Jemal (M.KedirJemal@cgiar.org) is a Senior Research Analyst in the Development Strategies and Governance Unit of the International Food Policy Research Institute, Washington, DC.

ACKNOWLEDGMENTS

Funding for this work output was provided by the Australia Department of Foreign Affairs and Trade (DFAT) through the Australia High Commission (AHC) in Port Moresby.

This publication has been prepared as an output of the Papua New Guinea country program and has not been independently peer reviewed. Any opinions expressed here belong to the author(s) and are not necessarily representative of or endorsed by IFPRI.

INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

A world free of hunger and malnutrition

IFPRI is a CGIAR Research Center

1201 Eye Street, NW, Washington, DC 20005 USA | T. +1-202-862-5600 | F. +1-202-862-5606 | Email: ifpri@cgiar.org | www.ifpri.org | www.ifpri.info

© 2024, copyright remains with the author(s). All rights reserved.