

Effects of Covid-19 on Papua New Guinea's Food Economy: A Multi-Market Simulation Analysis

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Developments in the agricultural economy of Papua New Guinea have major impacts on household food consumption decisions. A household's ability to produce and sell food is affected by climate and associated agricultural potential, market opportunities (domestic, import and export) and unexpected shocks. Each of these factors affects the overall food system, thereby influencing production and consumption of all food products and the markets in which they are traded.

The COVID-19 pandemic has presented a challenge far more complex than an agricultural production shock such as El Niño or a pest-specific shock. Rather than directly affecting agricultural output and rural household welfare, the COVID-19 pandemic has affected economies across the globe via trade disruptions (logistics and international trade barriers), social distancing policies (domestic food market and non-essential business closures) and transportation restrictions (both road closures and air travel cancellations and restrictions). The measures aimed to curb the spread of COVID-19 have affected household incomes via urban job loss, less market interaction, and dramatic changes in world food prices. While rice prices have increased, luxury food prices, such as chocolate (i.e. cocoa), have decreased.

PNG's unique and highly varied biophysical landscape has shaped agricultural production patterns, outcomes, and livelihoods for centuries. Understanding how the PNG agri-food economy and resulting household consumption is affected by COVID-19 (shocks) therefore requires attention to

Key Policy Messages

- Urban households, especially the urban poor, are particularly vulnerable to shocks related to the Covid-19 pandemic.
- Lower economic activity in urban areas, increases in marketing costs due to domestic trade disruptions, and 30 percent higher imported rice prices combine to lower urban incomes by almost 15 percent.
- Rural household incomes, affected mainly by reduced urban demand and market disruptions, fall by only about four percent. Nonetheless, calorie consumption for the rural poor and non-poor falls by 5.5 and 4.2 percent, respectively.

linkages and substitution effects across various products and the markets in which they are traded.

Multi-market model

The multi-market model built for this analysis can be used to simulate a variety of shocks on an economy, and likewise a portfolio of investments (e.g. improvements or maintenance of transport infrastructure) and policies (e.g. agricultural investments). This research note focuses on the effects of COVID-19 policies and related economic effects.

The flow chart in Figure 1 maps the major linkages between production, incomes, prices and consumption that are modeled in the multi-market model. The dark green boxes show the areas where COVID-19 has the greatest effect on the PNG food economy.

Following the flow chart, agricultural (crop and livestock) production may be affected by a variety of shocks including adverse weather, pests and diseases.¹

Marketing costs, including the cost of transporting goods to domestic markets (and the cost of receiving agricultural inputs from a market), help determine domestic market prices and incentives for agricultural production.

Household demand for each specific food good depends on household income (agriculture and non-agriculture) and the current prices of various other food and non-food items. Domestic market prices are also influenced by the prices on the world market, as well as trade policies (e.g. import tariffs).

Finally import and export volumes are determined by the difference between domestic production and domestic demand. For import goods, such as rice, demand by households far exceeds domestic production, so imports account for nearly all of supply.

Figure 1: Multi-market model



Data

The multi-market model considers the different production and consumption patterns within PNG by region and by rural/urban and poor/non-poor households. For Southern and Momase Regions, urban households are further disaggregated by metro vs. other urban, following the survey sample design employed by the PNG Household Income Expenditure Survey (HIES) 2009/10 (NSO, 2009/10). The PNG multi-market model captures the detailed structure of 26 agricultural sectors (defined by crop or livestock type) and two broad nonagricultural sectors: 1) tradable non-agriculture -- dominated by manufacturing and 2) non-tradable non-agriculture -- dominated by services.²

Estimates of Calorie Consumption

The model includes estimates of calories consumed per person per day based on calorie conversion factors for individual food items estimated by the FAO for PNG. With per capita gross national income (GNI) at more than \$2,000 USD at current exchange rates and prices, PNG is classified by the World Bank as a low-middle-income country. However, most PNG households can be categorized as poor or low-income. In contrast, in 2009/10, the richest top 10 percent of the population accounted for almost one-third of total national income, and the top 20 percent accounted for almost 50 percent. (World Bank, 2020).³

While PNG enjoyed relatively rapid growth in export agriculture in recent years (Schmidt and Fang, 2020), growth in total agricultural output was just 2.5 percent per year between 2009-2017, only slightly higher than the population growth rate of 2.1 percent in the same period. With slow growth in agriculture, we expect that most rural households, and

¹ Weather and pest shocks (e.g. El Niño, African swine fever, fall armyworm) are monitored within PNG by a variety of task forces.

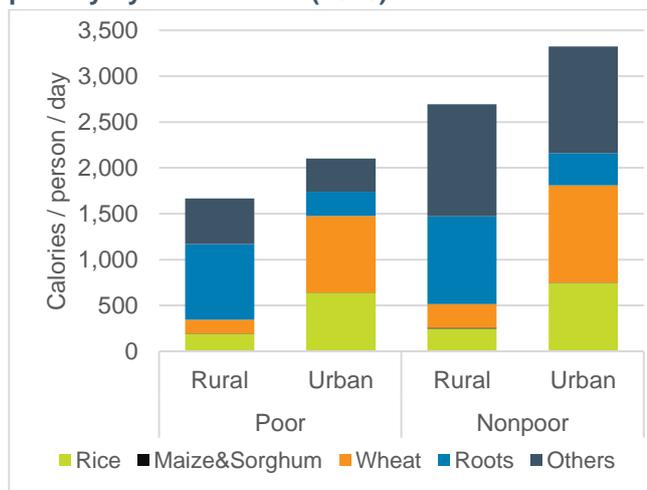
² Both income and price elasticities for a specific commodity vary across household groups due to differences in consumption patterns and income levels across regions and among poor and non-poor households. A more detailed discussion of the model data, inputs, and assumptions can be found in the full working paper: <https://www.ifpri.org/country/papua-new-guinea>

³ These figures are based 2009/10 HIES data that were collected when per capita PNG's Gross National Income (GNI) was approximately \$1,500.

especially poor and low-income households, did not experience significant welfare improvements since 2009/10 when the HIES was conducted, suggesting food security continues to challenge many PNG households.

Figure 2 shows the estimated average calories consumed per person per day for both rural and urban (poor and non-poor) households in 2018. The calorie consumption level is much lower among rural and urban poor households than non-poor households. For the rural poor, the average calorie consumption level is about 1,500 Kcal per person per day, just about 50 percent of the level for an average non-poor urban household. We use these baseline calorie consumption levels to simulate the impact that COVID-19 has had on consumption across different households in PNG.

Figure 2: Estimated total calories per person per day by food source (2018)



Source: Authors' calculation from the data. *Note: Maize and sorghum comprise a very small amount of calorie consumption which does not show clearly on figure

Model simulations

This research note focuses on the COVID-19 related shocks to household welfare.

However, the full working paper presents effects of other production shocks including: 1) a potential negative productivity shock for maize and sorghum due to the Fall Army Worm spread; 2) a reduction in pig production due to African Swine Fever; and 3) a decline

in sweet potato production due to an El Niño Southern Oscillation (ENSO) event.

COVID-19 related scenarios are designed to estimate the impact of 1) changes in international prices for specific goods, 2) increased marketing costs in international and domestic trade, and 3) business closures and social distancing restrictions.

Specifically, we model:

1. [A 30 percent rise in the imported rice price](#) reflecting rice export restrictions and logistics complications in rice exporting countries.
2. [A 60 percent decline in domestic poultry production](#) due to restrictions in transportation and movement that hamper distribution and sales of breeding stock
3. [A 30 percent decrease in the price of major PNG agricultural exports](#) including coffee, cocoa, tea, and other export crops.
4. [A 30 percent increase in domestic trade margins](#) for both export and import agricultural and nonagricultural products due to restrictions of movement of people (traders)
5. [A 30 percent increase in domestic trade margins](#) for commodities traded within each region within PNG.
6. [A 10 percent decrease in urban household income](#) due to economic recession following business closures domestically and abroad.
7. [Combined effects of all the Covid-19 related shocks](#) (Simulations 1-6).

We first discuss the simulation results of the impacts of Covid-19-related shocks individually, and then discuss the combined effects of all of the Covid-19 related shocks.

Table 1 summarizes the baseline values of the key indicators in the simulation model. These include: 1) total production by crop type, 2) price (PGK / kg) by crop type, 3) household income by household type, and 4) consumption (total kilocalories per person per day). Each of the indicators considers

differences across regions and household type (poor / non-poor).

Table 1: Baseline values of key indicators in simulation model

Key indicators	Base
Production (metric ton)	
Maize/sorghum	18,478
Sweet Potato	705,116
Poultry	12,006
Swine	78,357
Total Agriculture (million Kina)	47,149
Price (2018 Kina/kg)	
Maize/sorghum	6.6
Sweet Potato	4.0
Poultry	44.9
Swine	14.6
Household Incomes (2018 Kina/person/year)	
Rural Poor	4,504
Rural Nonpoor	11,829
Urban Poor	9,617
Urban Nonpoor	25,532
Total (average)	9,937
Consumption (Kilocalories / person / day)	
Rural Poor	1,666
Rural Nonpoor	2,693
Urban Poor	2,104
Urban Nonpoor	3,323
Total (average)	2,310

Source: Authors' calculations

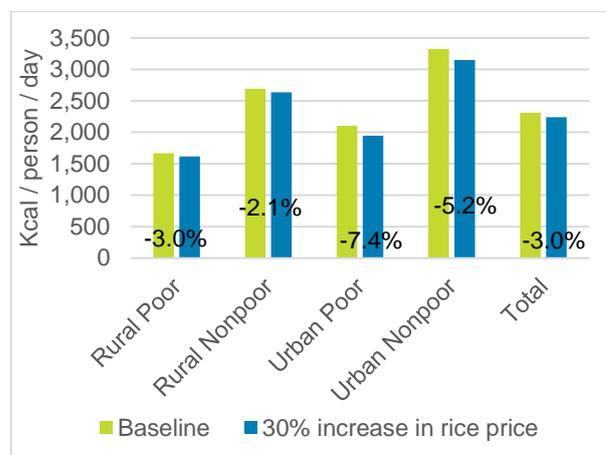
Simulation 1: 30 percent rise in imported rice price

Since more than 95 percent of rice consumed in PNG is imported, the domestic rice price also rises by 30 percent.⁴ Higher rice prices lead to reduced consumption of rice and, because consumers have less income available for consumption of other goods, consumption of other food falls as well.

Thus, total consumption of calories falls by 2.1 – 3.0 percent for rural households and 5.2 – 7.4 percent for urban households. However, it is important to note that some households are not meeting the minimum calorie consumption threshold (2,250 kcal/person/day) in

the baseline, demonstrating that these households are already food insecure regardless of a price increase (Figure 3).

Figure 3: Decrease in calories consumed due to imported rice price increase



Source: PNG Economywide multimarket model simulation results.

Simulation 2: 60 percent decline in poultry production

It is important to note that the impacts of each modeled shock vary across each of the model's 20 household groups (4 regions x rural/urban/metro x poor/non-poor). For example, given a 60 percent decrease in poultry production, the decreases in poultry consumption among non-poor households are larger than among poor households.

This is due to: 1) lost income from poultry production and 2) a sharp increase in poultry prices. Note also that non-poor households consume more poultry compared to poor households, and a greater share of non-poor households are poultry producers due to capital requirements for poultry rearing (enclosures, feed, etc.).

While total calorie consumption declines are not substantial in this simulation (decreasing by 0.4 - 0.6 percent), declines in poultry consumption may have greater nutritional effects on households given already deficient protein intake among both rural and urban households (Schmidt et al., 2020).

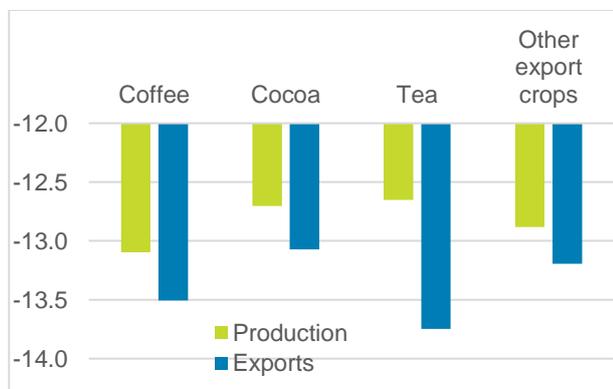
⁴ See Schmidt et al. (2020) for a detailed description of PNG's international rice trade.

Simulation 3: 30% decrease in price of major PNG agricultural exports

Between February and July, 2020 the international cocoa price fell by 22.6 percent, from \$2.72/kg to \$2.10/kg due to Covid-19, influenced by falling global demand for luxury goods, such as processed chocolate.⁵ This fall in demand has been seen across other agricultural export crops as well.

Since almost all of PNG's coffee, cocoa and tea production is sold on world markets, the simulated fall in world prices translates to similar decreases in domestic production (between 12-14 percent) (Figure 4). However, export crops make up a small share of overall household incomes in PNG, thus average household incomes only fall by 0.5 percent and household calorie consumption is minimally affected as well (on average decreasing -0.12 percent for all households nationwide).

Figure 4: Percent changes in production and exports due to 30% decrease in major agricultural exports



Source: PNG Economywide multimarket model simulation results.

Simulation 4: 30% increase in trade margins for both export and import agricultural and nonagricultural products

We assume a 30 percent increase in trade margins for PNG's exports and imports to assess the potential impact from restrictions on movement of people (traders) and goods due to COVID-19. For exported goods, the

increase in transportation (logistics) price between producers and the port has an effect of lowering the producer price relative to the international border price. For imported goods, such as rice, the increase in trade margins raises the consumer price relative to the border price.

As a result, the producer prices for coffee falls by 4.0 percent and the producer price of rice rises by 3.8 percent. Given these changes in price incentives, production of coffee falls by 13.1 percent and production of rice increases by 1.0 percent.⁶ Producer and consumer prices of the three non-tradable commodities (sweet potato, poultry and swine) fall slightly as the higher margins lead to reduced incomes for producers of export crops and reduced purchasing power for consumers of imported goods. National average calorie consumption falls by only 1.9 percent, however in urban households (who on average consume more rice), consumption falls by 3.3 and 2.9 percent in poor and non-poor households, respectively.

Simulation 5: A 30% increase in domestic trade margins

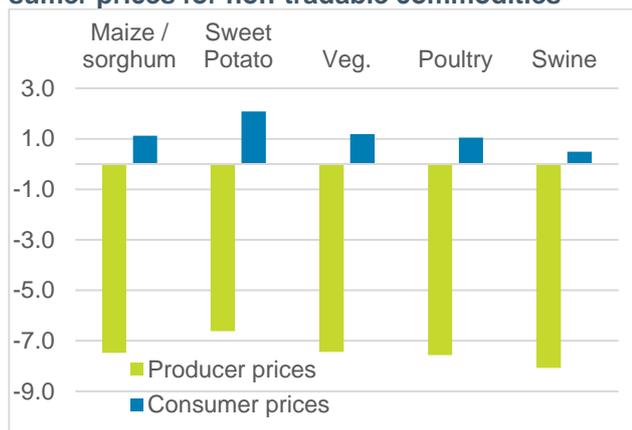
Given that most domestic agri-food trade flows from rural to urban areas in PNG, this simulation highlights the possible impact on rural producer prices due to transportation and food marketing bottlenecks. Because consumer demand decreases (due to increased prices from higher trade margins), consumer prices rise by slightly less than the amount of the kina marketing cost increase.

Although the consumer price of a good at the market increases, the producer price of the respective good decreases more due to the inability (or high cost) of transporting produce to market (Figure 5). Household incomes decrease between 1.2 and 3.9 percent and consumption decreases by between 1.6 and 3.3 percent.

⁵ The international cocoa price has recently recovered somewhat to \$2.46 in September 2020, a decline of only 9.5 percent relative to February 2020 (calculated from World Bank, 2020).

⁶ See previous work on rice production in Papua New Guinea and the limited incentives for expanding rice production in the country (McKillop et al., 2009; Gibson, 2001)

Figure 5. Percent changes in producer and consumer prices for non-tradable commodities



Source: PNG Economywide multimarket model simulation results.

Simulation 6: A 10 percent decrease in urban household income

To simulate the effect on decreases in urban activity, we exogenously impose a 10 percent decrease in the productivity of tradable non-agriculture (local manufacturing) and a 13 percent fall in productivity of non-tradable non-agriculture (services). Given these shocks, nonagricultural production declines by about 10 percent.

Incomes of urban poor and non-poor households fall by 10.4 and 10.6 percent, respectively, while incomes of rural households decline by only 0.9 to 1.0 percent. Calorie

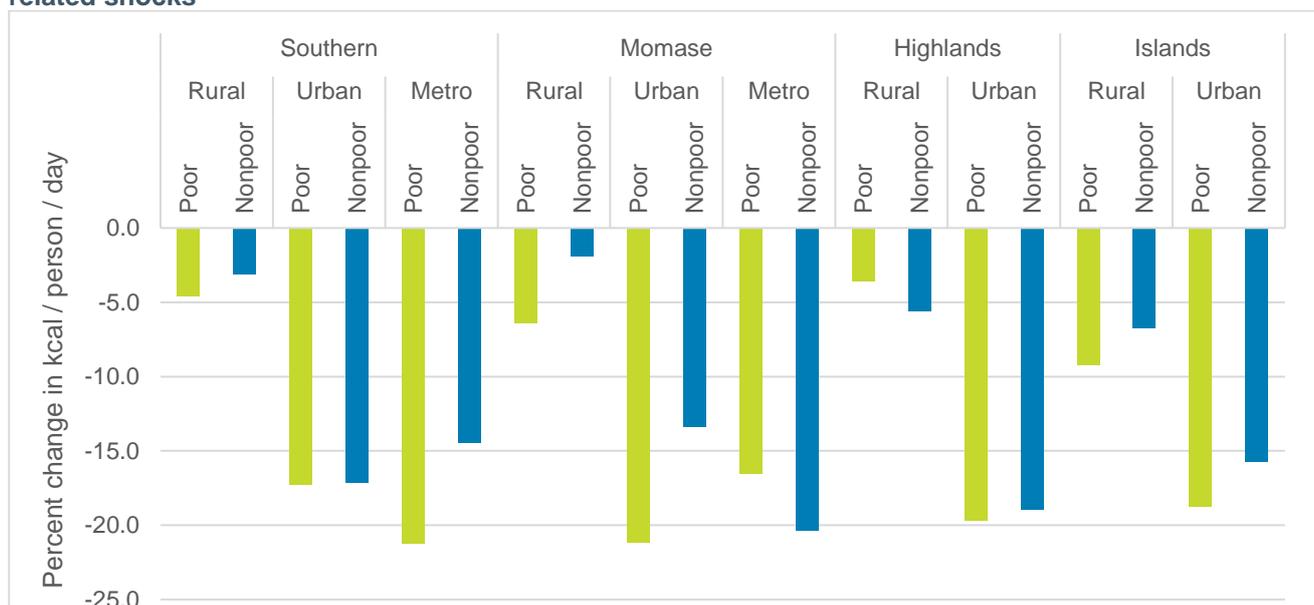
consumption of urban households also falls by 8.5 percent for urban poor households and by 7.4 percent for urban non-poor households, whereas rural calorie consumption decreases by less than 1 percent.

Simulation 7: Combined effects of the Covid-19 related shocks (Simulations 1-6)

Combining the potential effects of COVID-19 including: a fall in urban production (manufacturing); an increase in domestic and international trade margins; ongoing fluctuations in global demand; a decrease in domestic poultry production; and an increase in the imported rice price suggests that the overall impact of COVID-19 on PNG households may be quite large.

Household incomes fall steeply, particularly in urban areas where the decline ranges between 12 and 15 percent in various regions. Food consumption declines even more sharply, due to both higher prices and lower incomes. Calorie consumption of urban poor households falls almost 20 percent nationwide, and 21 percent for poor Southern metro households (Figure 6). Households for which members have suffered a permanent loss of jobs are likely to have an even larger drop in income and calorie consumption.

Figure 6: Percentage changes in total calorie intake per person per day due to combined COVID-19 related shocks



Source: PNG Economywide multimarket model simulation results.

Conclusions and Policy Implications

This analysis strongly suggests that the urban poor are particularly vulnerable to food insecurity due to the impact of Covid-19 on PNG's agriculture and trade. Lower economic activity in urban areas (assumed to reduce urban non-agricultural incomes by 10 percent), increases in marketing costs due to domestic trade disruptions, and 30 percent higher imported rice prices combine to lower urban incomes by almost 15 percent for both poor and non-poor urban households. Urban poor households, however, suffer the largest drop in calorie consumption – 19.8 percent, compared to a 15.8 percent decline for urban non-poor households.

Rural households are much less affected by the Covid-19 related shocks modeled in these simulations. Rural household incomes, affected mainly by reduced urban demand and market disruptions, fall by only about four percent. Nonetheless, calorie consumption for the rural poor and non-poor falls by 5.5 and 4.2 percent, respectively. About half of these declines are because of higher rice prices on average rice consumption. Given that higher rice prices reduce purchasing power for other commodities, households are forced to reduce consumption of other food products as well.

PNG has an opportunity to learn from its experience with the COVID-19 pandemic and build more resilient systems that can support more timely and efficient responses to a variety of unexpected shocks. Based on other country experience, safety net programs that are targeted (for example) at vulnerable households, as well as pregnant and lactating

women and young children have demonstrated success in providing support quickly to families in need. PNG could roll out a portfolio of pilot safety net programs that have a robust design and evaluation program to learn which mechanisms work best for a targeted population and environment, and then expand successful pilots as and where needed (maintaining proper evaluation methods).

In addition, investments in market infrastructure (roads, ports and the marketplaces, themselves) could lower marketing costs and benefit both producers and consumers. Lowering the costs of trade and thereby increasing the efficiency of markets may also add to food security by minimizing the effects of local production shortfalls and reducing the frequency and severity of shocks to household incomes and food consumption.

Finally, PNG lacks important and up-to-date data on household production and consumption, market structure and performance, and current food prices across the country. More data collection and analysis are needed to better understand the market inter-connections between regions and across agricultural products, including how these inter-connections affect household welfare. Given the uncertainty in data and behavioral parameters of the model, the results of this exercise must be treated with caution. Nonetheless, the broad magnitudes of the simulation results, since they are determined largely by the structure of the PNG food economy reflected in the model, point to key policy issues as highlighted above, as well as areas for further investigation.

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