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Returns on labour inputs to smallholder for cash crops in Papua New Guinea

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SUMMARY

- Smallholders in Papua New Guinea are more likely to grow and sell a crop when they receive more income for their labour inputs. This is an important determinant of whether a crop will be produced.
- Smallholders produce and sell more when prices are higher and less when prices are lower.
- Estimates of returns on labour inputs for 26 lowland and highland crops are given here. These figures can be updated as new price, yield or other data becomes available.
- At current prices, the greatest returns on labour inputs come from vanilla, kava, betel nut, oil palm, some temperate climate vegetables, sweet potato, Irish potato and firewood.
- Balsa, nutmeg, improved cocoa, *galip* nut, peanuts and charcoal give a good return.
- Cocoa grown in the traditional manner and Arabica coffee give a moderately good return.
- There is a low rate of return for turmeric, cashew, Robusta coffee, rubber, cardamon, pepper, copra, rice and patchouli.
- Several other factors also influence smallholder engagement with cash cropping.

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INTRODUCTION

The amount of money that smallholders receive per day of labour input is an important determinant of whether a crop will be produced in Papua New Guinea (Bourke & Harwood 2009, pp. 411–419). It is not the only factor that influences smallholders' decisions on whether to grow and sell a crop, but it is an important one. What they can grow and sell also depends on environmental conditions and, particularly, on marketing arrangements and costs.

This paper presents estimates of the cash return per labour input for smallholders in PNG. The findings do not necessarily apply to those producing on a larger scale, particularly if they have replaced labour with mechanised cultivation and harvesting.

METHODS AND DATA SOURCES

This analysis is based on best available estimates of crop yield, price received by growers (after marketing costs), cash outlays and labour inputs.

Crop yield. Yield data is for crops grown under smallholder conditions in PNG, not those achieved under larger-scale or plantation conditions. Available data on smallholder and experimental yields for many food crops is summarised in Section 2.4 (pp. 147–167) of Bourke and Harwood (2009). Smallholder and plantation yield data for export tree crops is summarised in the section on each crop in that book. Actual crop yields may be more than or less than the figures used here, depending on the physical environment, quality of planting material and inputs into crop production.

Price to growers. This is the price that the growers receive for their produce, after transport and marketing costs have been paid for. Prices vary over time, particularly for export crops, but also for some domestically marketed foods. Hence, different prices may significantly alter the returns that farmers achieve. Growers selling fresh food in nearby fresh food or roadside markets are likely to receive a higher price than those selling in distant markets where transport costs and damage to produce are greater. Updated price data for many fresh foods is published by the International Food Policy Research Institute (2022).

Cash outlays. Figures used here are from discussion with growers and several crop specialists, some published data and extrapolation. Figures used in this analysis may underestimate current costs given recent inflation. The main cash outlays for most crops grown by smallholders are for basic tools and, sometimes, planting material. They are generally low, except for Irish potato, kava and balsa where the cost of planting material, and disease control for potato, are greater.

Labour inputs. Recorded data on labour inputs per unit area (person-days per hectare) is drawn from Table 5.20.2 (p. 415) in Bourke and Heywood (2009). Other figures on labour inputs follow Hale (ca 1978). Anderson (1976) provides data on labour inputs for 12 vegetable crops grown by commercial growers in the Goroka area.

FINDINGS

The rate of return on each day's labour input for 26 crops has been calculated, with the key figure of returns per labour input given in the final column of Table 1. This exercise shows that vanilla, kava, betel nut and oil palm give the greatest returns at current prices; temperate climate vegetables sold locally, sweet potato, Irish potato, and firewood from short rotation coppice agroforestry also give a high rate of return on labour inputs. Balsa, nutmeg, improved cocoa, *galip* nut, peanuts and charcoal give a good rate. Cocoa grown in the traditional manner and Arabica coffee give a moderately good return. There is a low rate of return for the other crops in this analysis (turmeric, cashew, Robusta coffee, rubber, cardamon, pepper, copra, rice and patchouli) (Table 1).

Table 1. Returns on labour inputs for some lowland and highland crops for smallholders in Papua New Guinea

Crop	Product	Period to first harvest (years)	Yield[1] (kg/ha)	Price to growers[2] (K/kg)	Gross returns (K/ha)	Cash outlays[3] (K/ha)	Net returns (K/ha)	Labour inputs[4] (person-days per ha)	Returns (Kina/ person-day)
Vanilla[5]	Cured pod	1	240	200.00	48,000	200	47,800	290	165
Kava	Dry root	5	2,500	20.00	50,000	3,000	47,000	295	159
Betel nut[6]	Nuts	4	4,800	4.00	19,200	200	19,000	150	127
Oil palm	Fresh fruit	3	12,000	0.75	9,000	400	8,600	70	123
Tomato[7]	Fruit	0.3	7,000	3.00	21,000	150	20,850	225	93
Carrots[7]	Roots	0.4	9,000	2.00	18,000	150	17,850	215	83
Sweet potato	Tubers	0.3	12,000	1.20	14,400	100	14,300	250	57
Potato, Irish[8]	Tubers	0.3	18,000	1.80	32,400	10,000	22,400	400	56
SRC trees[9]	Firewood	2	10,400	0.90	9,360	150	9,210	170	54
Balsa[10]	Round log	5	200 m^3	35.00/m^3	7,000	1,860	5,140	115	45
Nutmeg[11]	Dried nuts	4	1,000	5.50	5,500	140	5,360	130	43
	Dried mace		200	1.00	200		200		
Cocoa, improved[12]	Dry bean	3	600	5.70	3,420	150	3,270	80	41
Galip nut	Nut-in-kernal	7	9,000	1.00	9,000	400	8,600	210	41
Peanuts[13]	Nut-in-kernal	0.3	1,500	6.00	9,000	100	8,900	220	40
SRC trees[14]	Charcoal	2	2,100	4.00	8,400	150	8,250	220	38
Cocoa, traditional	Wet bean	3	800	1.50	1,200	150	1,050	40	26
Arabica coffee	Parchment	3	900	4.50	4,050	150	3,900	275	14
Tumeric	Wet root	2	10,000	0.40	4,000	800	3,200	330	10
Cashew	Nuts	2	600	2.50	1,500	200	1,300	150	9
Robusta coffee	Parchment	3	1,000	2.50	2,500	150	2,350	275	9
Rubber	Cup lump	5	650	1.40	910	100	810	100	8
Cardamon	Dry capsule	2	250	6.50	1,625	350	1,275	200	6
Pepper	Dry corms	2	800	2.50	2,000	350	1,650	325	5
Coconut	Copra	7	500	0.60	300	50	250	65	4
Rice	Paddy	0.25	1,300	0.80	1,040	140	900	215	4
Patchouli	Dry leaf	1	700	1.25	875	150	725	200	4

Notes

1. Yield figures are best estimates for crops grown under smallholder conditions.

2. Prices were updated in 2022 where data are available.

3. For most crops, cash outlays are for planting material (including transport; allowing for 15% losses) and tools. For long term crops, costs have been averaged over a 10 year period.

4. Labour inputs for establising long-term crops have been averaged over a 10 year period and added to annual maintenance and harveting inputs.

5. The price of A grade vanilla was K200-220/kg in late 2022. The price for B grade was lower. The price of vanilla varies considerably over time depening on the global price and marketing arrangements. See for example the figure of global vanilla prices over a 37 year period in Bourke and Harwood (2009 p375).

6. Yield and price data for betel nut were provided by Dr Tim Sharp, Curtin University, Perth.

7. Tomato and carrot have been selected to illustrate returns for temperate climate vegatables in Eastern Highlands. Labour inputs are from Anderson (1976), who also provides labour input estimates for 10 other vegetables. Vegetable yields are calculated from experimental data in three highland provinces, summarized in Table 2.4.10 in Bourke and Harwood (2009 p160); price to growers are derived from Goroka market prices (International Food Policy Research Institute, 2022).

8. Successful commercial Irish potato production relies on purchased 'clean seed' and chemical control of late blight. Yields and costs are much lower where 'clean seed' and chemical control of disease are not used.

9. Yield and labour inputs for firewood from short-rotation coppice (SRC) agroforestry follow Nuberg et al. (2017).

10. Cash outlays for balsa are for seedlings (1300/ha at K1.20/seedling; with 15% loss gives 1100 trees/ha), plus transport (K200) and tools (K100).

11. Nutmeg trees provide two economic products - nuts and mace (seed covering).

12. Improved cocoa production includes pruning cocoa trees, managing shade trees and managing Cocoa Pod Borer (Keane, 2017).

13. Figures for peanuts are for small-scale production without mechanical cultivation. In locations where large plots are grown with mechanical soil cultivation, labour inputs are lower and cash outlays are higher.

14. Yield and labour inputs for charcoal from short-rotation coppice (SRC) agroforestry follow Nuberg et al. (2017).

DISCUSSION

Smallholders are more likely to grow and sell a crop when they receive more income for their labour inputs. They produce and sell more when prices are higher and less when prices are lower. This can be seen by highlanders' response to changes in the price of Arabica coffee. The price of coffee, and hence returns on their labour, has been low in recent decades. Total coffee production by smallholders is static and production per person has declined greatly since the late 1980s.

Changes in the real income, and hence spending power, of highland coffee producers can be illustrated by changes in returns from coffee. Currently, a grower who sells 100 kg of parchment coffee in a highland centre can purchase about 100 kg of imported rice. Over the past 40 years, sale of 100 kg of parchment coffee would have allowed them to buy up to 300 kg of imported rice – and sometimes 500 kg of rice when coffee prices were at their peak.

In response to lower prices over the past 20 years, many villagers who live close to Mount Hagen and Goroka have removed their coffee trees. They have replaced these with sweet potato, cabbage, carrots and other food crops, as fresh food gives a much higher return on labour inputs, as long as people farm reasonably close to major market centres. The increased production of fresh food rather than coffee by many villagers living near Mount Hagen and Goroka, and who have good access to the Highlands Highway, is logical. Villagers say that they can earn more money for their efforts from selling fresh food where there are good transport links to markets. The analysis presented here supports this.

However, there are fewer options for villagers to grow and sell fresh food where access to markets is limited by high transport costs and delays in transporting perishable produce to markets. In a nation-wide study, Gibson and Rozelle (2003) reported that the longer time needed to travel to transportation reduced the price that farmers received for their crops (such as sweet potato) and increased the price that households pay for purchased food (such as rice). In these locations, people have to rely on selling non-perishable products, including coffee. Where marketing and transport costs are prohibitively expensive, villagers have few opportunities to gain cash income from agricultural enterprises. In these locations, household cash income is generally very low.

The responsiveness of smallholders to price change can also be seen with copra and vanilla. The significant decline in copra production in PNG from the 1970s to the 1990s was due in part to low cash returns on labour inputs (Sharp et al. 2022, p. 5). In a recent study, these authors found that growers in West New Britain had increased the sale of mature coconuts at roadside stalls in response to low copra prices as they obtained better returns from selling mature ('dry') nuts than from making copra (Sharp et al. 2022, p. 58).

Vanilla exports increased rapidly from about one tonne in 1997 to about 200 tonnes by 2003 in response to the rapid increase in global prices in that period. Production declined rapidly after 2004 as global prices decreased (Bourke & Harwood 2009, p. 376). The same response has occurred in the past decade, with exports increasing from about 50 tonnes/year in 2012–2014 to 410 tonnes by 2021, again in response to higher global prices (Grant Vinning, pers. comm., November 2022).

Returns per day are not fixed as the figures used to calculate this vary over time and between locations, particularly price, marketing cost and, to a lesser degree, crop yield and labour inputs. The price of export commodities can change significantly over time, particularly those that are traded in smaller volumes globally. For example, the price to growers of A grade vanilla was K200–220/kg in late-2022 in PNG. It has been much higher than this price in recent years, but also as low as K20/kg in earlier years. The price for kava was about FJ$100/kg (K160) in Fiji in 2022 which is very much higher than the price of FJ$20/kg (K32) in the period 2006–2014 (Markham, 2022). Both vanilla and kava have shown significant changes in international price over the past 30 years.

The price that producers receive after expenses incurred in growing, processing and marketing their produce also depends on marketing costs, the distance from market locations and other factors. Villagers growing coffee, cocoa and copra receive very different prices for their produce depending on how far they live from centres where they can sell their produce. Where the cost of transporting

produce to market is high to very high, the returns to growers are reduced and may make production of that crop unattractive to growers.

The demand, and hence price, for fresh food in open air markets is often greater in larger urban centres than in small government centres, missions stations or villages. This can be seen in price data for selected foods from Kiunga urban, Ningerum urban, Kuda Village and Nomad station in Western Province (Table 2). The first two locations are connected by road on the Kiunga to Tabubil highway, the last two locations are remote with no road connection to other centres. This trend does not occur with prices for the same fresh foods in Gulf Province where there are data from the provincial capital, Kerema; a district centre, Baimuru; and a village market, Kaivukovu (Table 3).

Table 2. Prices (kina/kg) of selected items in Kiunga, Ningerum, Kuda and Nomad open air markets, Western Province in 2013

Commodity	Kiunga	Ningerum	Kuda	Nomad
Staples				
Banana	1.54	1.82	0.81	0.41
Cassava	1.53	1.63	0.95	
Sago	1.15	1.45	0.54	
Sweet potato	1.45	3.89	0.61	0.65
Taro	2.16	3.31	1.81	0.66
Vegetables				
Aibika	4.47	3.07	0.61	0.56
Ferns	3.09	2.31		0.66
Tulip leaves	9.72	7.74	5.83	
Edible nuts				
Coconuts	2.05	2.87		0.37
Peanuts	15.77	21.33		4.25
Stimulants				
Betel nut		33.09		
Betel pepper		111.40		1.40
Tobacco		181.25		4.50

Source: Bourke and Kanua (2022)

Table 3. Prices (kina/kg) of selected items in Kerema, Baimuru and Kaivukovu open air markets, Gulf Province in June 2022

Commodity	Kerema	Baimuru	Kaivukovu
Staples			
Banana	1.54	1.50	1.86
Cassava	2.69	1.49	1.41
Sago	1.74	0.98	
Sweet potato	1.96	2.99	2.73
Taro	3.79		
Vegetables			
Aibika	1.49	1.67	2.20
Ferns	1.74		1.00
Tulip leaves	6.17	2.18	5.00
Edible nuts			
Coconut	1.19	0.83	
Peanuts	9.11	19.32	
Stimulants			
Betel nut	2.67	13.71	5.24
Betel pepper	4.29	20.37	
Tobacco		287.50	466.67

Source: Owen Hughes and Matthew Kanua, pers. comm., 2022

However, there are much greater differences in price for the stimulants betel nut, betel pepper and tobacco in different markets. In the markets surveyed in Western Province, these stimulants were very much more expensive in Ningerum township than in remote Nomad (Table 2). In the markets surveyed in Gulf Province, large differences in price for the stimulants were also recorded, with prices lower in the provincial capital of Kerema (Table 3).

There are limited opportunities in PNG to sell some of the products listed in Table 1, including kava, balsa, nutmeg, rubber and larger volumes of *galip* nut (*Canarium indicum*). The rate of return on labour inputs is irrelevant where there are limited opportunities to market the produce. For example, the calculated returns on balsa and *galip* nut are reasonably high. However, they can only be sold if the smallholder lives near a marketing centre, such as Kokopo or Keravat in East New Britain.

Generally smallholders do not conduct an analysis of potential returns on the labour inputs prior to commencing a new agricultural enterprise. Rather they plant the novel crop, then decide whether it is worthwhile persisting with it once they evaluate the financial rewards for the effort required to grow, process and sell the crop.

There is sometimes a lag in response to changes in returns by smallholders. For example, villagers may enthusiastically commence rice production, often in response to encouragement by an outsider. However, their interest fades over several years as they realise that they are not getting the returns that they had hoped for or were promised. People may also fail to benefit from a spike in the price for a commodity, partly because of the time lag between when they plant a crop and when it is ready for harvest. If they do not respond quickly, by the time they increase the harvesting rate or plant more of the crop, the price has fallen again.

There is very limited production and sale in PNG of the nine crops which give an estimated return of K10 per day or less (Table 1), despite the significant promotion of some of these crops over many years, particularly rice. Some villagers still produce limited amounts of crops that give a low rate of return for their labour inputs, particularly if alternative cash crops or cash earning activities are not available. This is the situation with rubber in Western Province and Arabica coffee in locations distant from the Highlands Highway where few alternatives are available. Sometimes people process a crop, such as copra, for a short period if they need cash to pay for expenses such as school fees. However, once their needs for cash have been met, they reduce or cease production.

There are other examples where production of a certain crop has been strongly promoted by outsiders but has failed because returns to smallholders are unacceptably low. These include pyrethrum at very high altitude locations; pepper, chili and cardamon at a number of lowland and intermediate altitude locations; and peanuts intended for processing into peanut butter in the Markham Valley (as distinct from being sold to intermediate traders for sale in the Highlands).

The unsuccessful effort to promote rice production by smallholders from the early 1920s to the present is perhaps the greatest example where promotion by authorities has not resulted in significant production because returns are unacceptably low to smallholders. The situation among Mekeo people in the Bereina area of Central Province is typical of many communities where rice was vigorously promoted, in that region from the 1920s to the late 1970s (MacWilliam 2013, pp. 66–71, 150–152). Despite significant support for rice production by the Department of Agriculture and the Catholic mission in the area over many decades, virtually no rice is grown there. Betel nut and betel pepper are the main cash crops and provide significant income to Mekeo villagers (Mosko 2005).

Some other influences on smallholders' decision making on cash crop production

The extent to which smallholders participate in the cash economy is also partly determined by the level of activity in the indigenous exchange economy, which can fluctuate in response to major life events, such as births, marriages, and deaths (Curry 2003). Villagers may devote more effort to producing crops for sale prior to a major cultural or social event when their needs for cash are great and less time when social needs are less. Similarly, when people are desperate to obtain cash to purchase food because the supply of subsistence food is inadequate, they may decide to produce and sell agricultural produce even when returns

on labour inputs are low. This has been observed during food shortages induced by drought (Bourke 2000).

Changes in technology have the potential to improve the returns that growers receive. An example is adoption of 'clean seed', that is, planting material that is free of viruses or other diseases. Such planting material is available for some people growing potato and sweet potato in commercial volumes in the Highlands. Other technologies which can potentially reduce labour inputs include using planting material with greater yield potential, and better processing techniques.

The greater return from 'improved cocoa' compared with traditional cocoa deserves comment. 'Improved cocoa' production requires adoption of a number of practices to counter the devastating impact of Cocoa Pod Borer (Keane 2017). These practices require a higher labour input but give a significantly greater cash return on labour inputs (Table 1). However, a study in East New Britain found that the significant lifestyle changes and labour intensive farming methods required for the effective control of Cocoa Pod Borer were incompatible with existing smallholder farming systems, values and livelihoods. To adopt a high input cropping system required more than a technical fix and some training; it also required abandoning a lifestyle that provided status and identity and which was therefore highly resistant to change (Curry et al. 2015).

Women and men may respond differently to changes in prices of agricultural commodities. Sharp et al. (2022) summarise this as:

> Importantly, the impact of changing returns to labour on smallholder participation in different cash earning activities is shaped by the relative returns to men and women. Even in situations where export cash cropping offers the highest returns to labour at the household level, if women are not adequately remunerated for their labour, or they do not see their work to be benefitting themselves or the household, they may choose to focus their labour on activities for which they have greater control over the financial returns.

CONCLUSIONS

Returns on labour input have a large influence on rural people's decisions on what to grow for sale. This exercise provides a broad guide as to which commodities are more likely to be produced by smallholders in PNG. Returns on their labour inputs are not the only factor that influences peoples' decision on what to produce and how much to sell, although it is an important one. Decisions also depends on being able to market the produce; the cost of transporting produce to markets; possible differences in returns between women and men; and, in some situations, a willingness to adopt more demanding production techniques.

The data presented here should be used cautiously. Figures in Table 1 can be updated as new price, yield or labour inputs information becomes available. The spreadsheet is available on line (https://devpolicy.org/publications/policy_briefs/PB23-Table-1_Returns-on-labour-for-PNG-crops_Jan2023.xlsx).

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