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Determinants of coffee production in Papua New Guinea: Evidence from three coffee-producing provinces

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Presentation outline

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Background information

- Coffee is one of the most tradeable agricultural commodities in the world and plays a pivotal role in several economies (Sengupta et al., 2020).
- The most frequently cultivated coffee species for commercial purposes are *Coffea Arabica* (i.e., Arabica) and *Coffea robusta* (i.e., Robusta) (Winston et al., 2005).
- Coffee has seasonal variation, with years of high production followed by years of low production and vice versa (Volsi et al., 2019).
- Coffee production is influenced by climatic conditions, pests and diseases, market price, technology, labour, and finance (Trevisan, 2018; Folnovic, 2020).

The presentation is based on the following publication:

Ezebilo, E.E. and Afolami, C.A. (2022). Determinants of coffee production in major coffee-producing provinces of Papua New Guinea: Challenges and opportunities. NRI Discussion Paper No. 2022

The above publication is an extension of the following publications:

1. Afolami, C.A., & Ezebilo, E.E. (2021). Strategies for improving coffee production and processing in Papua New Guinea: Lessons from the top five coffee-producing countries. NRI Discussion Paper No. 184.

2. Ezebilo, E.E. (2021). Strategic initiatives to boost the competitiveness of coffee production in Papua New Guinea. NRI Spotlight Vol. 14, Issue 6.

3. Ezebilo, E. (2021). How Papua New Guinea can boost its coffee production. Business Advantage, Opinion and Analysis. 01 July 2021. https://www.businessadvantagepng.com/how-papua-new-guinea-can-boost-its-coffee-production-analysis/#comments

Objectives of the study

1. To determine how farm characteristics and farm operations influence the quantity of coffee produced in Eastern and Western Highlands Provinces (EHP and WHP) and Morobe Province (MP).

2. To examine coffee grower's demographic characteristics influence the quantity of coffee produced in EHP, WHP and MP.

Choice of study areas

- Considering the restriction posed by limited fund for research, we sought to conduct survey in three provinces of the 15 coffee-producing provinces.
- First, all the provinces where coffee are grown in commercial quantity were identified.
- Second, the identified provinces were classified into four regions (Highlands, Momase, New Guinea Islands and Southern).
- Third, the regions were classified into the dominant coffee variety found there. This results in Arabica for areas located in high elevation (Highlands region) and Robusta for located in lower elevation (coastal areas).

Continuation of Choice of study areas

- As Arabica and Highlands region account for the majority of the total quantity of coffee produced in PNG, two provinces were selected randomly from the seven provinces in the region.
- One province was selected from eight provinces in other regions.
- For the Highlands region, Eastern Highlands and Western Highlands provinces were selected
- Morobe Province was selected from other regions corresponding to three provinces used as the study areas.

Data Collection

- Face-to-face interviews guided by questionnaire was used for data collection.

- First, literature review on coffee production and challenges associated with it was conducted.

- Second, questions were drafted and sent to an expert on the subject who provided her comments. The comments was addressed and the draft passed to her for comments again.

- 15 to 20 Research Assistants were recruited in each of the selected provinces. The Assistants were mainly university students.

- The Assistants were trained in interview techniques for one day in each of the provinces by Researchers from PNG NRI.

Continuation of Data Collection

- Pre-test interviews were conducted in each of the study site to test the questions for the study before the main survey.

- An official of Department of Primary Industry who was part of the data collection team provided the areas where coffee growers can be found.

- As we do not have a list of all coffee growers in each of the study areas, we used convenience sampling and snowball approach.

Survey team approached coffee growers for interview and those who accepted were interviewed.

Continuation of Data Collection

- The survey in each of the selected provinces were conducted in the months of June, July and September 2021.

❑ Questions for the interviews consist of:

- Coffee grower's characteristics
- Farm characteristics and coffee production
- Access to extension services from CIC and Productive Partnership in Agriculture Project (PPAP)
- Processing and marketing of coffee
- Impact of COVID-19 on coffee production.

Data Analysis

Data was analysed using quantitative methods, which consist of:

- Descriptive statistics. It was used to describe the characteristics of the respondents and that of the farm.
- Inferential statistics. It was used to examine the influence of some factors on the quantity of coffee produced.

Specifically, Ordinary Least Squares (OLS) regression models was applied after several tests to arrive at the final model.

The assumption of OLS regression model is that the variance of the error terms are equal (Verbeek, 2007),i.e. homoscedastic.

To know whether our OLS model meets the assumption, the Breusch-Pagan test (Greene, 2003) was conducted for the two models (FARM ATTRIBUTES model and Grower ATTRIBUTES model)

Results of the test were:

FARM ATTRIBUTES model: Test statistic was 1154.43 and the critical chi-squared value was 26.22 at 12 degrees of freedom at 1 percent statistical significance level,

The null hypothesis of homoscedasticity in the model was rejected

GROWER ATTRIBUTES model:

Test statistic was 493.89
The critical chi-squared value was 24.73 at 11 degree of freedom at 1 percent

We also rejected the null hypothesis of homoscedasticity in GROWER ATTRIBUTES model

Our results of the test for the two models indicate that the error terms does not have equal variance (heteroscedasticity).

In order to correct for the heteroscedasticity, the log-linear form of OLS was applied. It entails the transformation of continuous variables in the model to log form and corrected with the White's heteroscedastically consistent variance estimator.

After correction for heteroscedasticity in each of the two OLS model, we then conducted another set of Breusch-Pagan tests on the corrected models.

The results of Breusch-Pagan tests on the corrected models were:

FARM ATTRIBUTES model: Test statistics was 33.57

GROWER ATTRIBUTES model: Test statistics was 11.59

The above results showed that the problem of heteroscedasticity was reduced

Farm characteristics and operations (FARM ATTRIBUTES) as well as coffee grower's characteristics (GROWER ATTRIBUTES) that might have influenced the quantity of coffee produced was estimated using two OLS models.

The functional form for the FARM ATTRIBUTES model is the following (1):

$$Log(COFFEE_{prod}) = \beta_0 + \beta_1 Log(TREE\_AGE) + \beta_2 OTHER\_CROPS + \beta_3 PRUNE + \beta_4 RUST +$$

$$\beta_5 BORER + \beta_6 ARABICA + \beta_7 REGION + \beta_8 REPLANT + \beta_9 LABOUR +$$

$$\beta_{10} FARM\_SCALE + \beta_{11} PPAP + \varepsilon$$

Where $COFFEE_{prod}$, TREE_AGE, OTHER_CROPS, PRUNE, RUST, BORER, ARABICA, REGION, REPLANT, LABOUR, FARM_SCALE, PPAP and ε are coefficients associated with:

- The average quantity of coffee produced in number of 60kg bags,
- tree age in years,
- other crops cultivated on coffee plot,
- number of times coffee trees are prunned per year,
- presence of coffee leaf rust disease on coffee plot,
- presence of coffee berry borer on the coffee plot,
- coffee variety cultivated,
- region of PNG where coffee plot is located,
- replanting of coffee,
- type of labour used,
- scale of coffee production,
- whether a coffee farm benefits from PPAP and
- error term which is Independently Identically Distributed (IID).

The functional form for the GROWER ATTRIBUTES model is the following (2):

$$Log(COFFEE_{prod}) = \beta_0 + \beta_1 INCOME + \beta_2 GENDER + \beta_3 EDU + \beta_4 AWARE +$$

$$\beta_5 HHOLD + \beta_6 MARITAL + \beta_7 Log(EXPERIENCE) + \beta_8 COOP + \beta_9 TRAIN + \varepsilon$$

Where INCOME, GENDER, EDU, AWARE, HHOLD, MARITAL, EXPERIENCE, COOP and TRAIN are coefficients associated with:

- Household disposable annual income in PNG Kina,
- gender of the interviewee,
- awareness of the economic productive age of coffee tree,
- interviewee's household size,
- Interviewee's marital status,
- number of years the interviewee has been growing coffee,
- membership of coffee cooperative,
- participation in training on coffee production, and
- error term which is Independently Identically Distributed (IID).

Findings from the Study

Of the 510 coffee growers that were interviewed, most were smallholders (60%) and only a few had plantations (6%), see Figure 1.

Figure 1 Categories of coffee growers in %

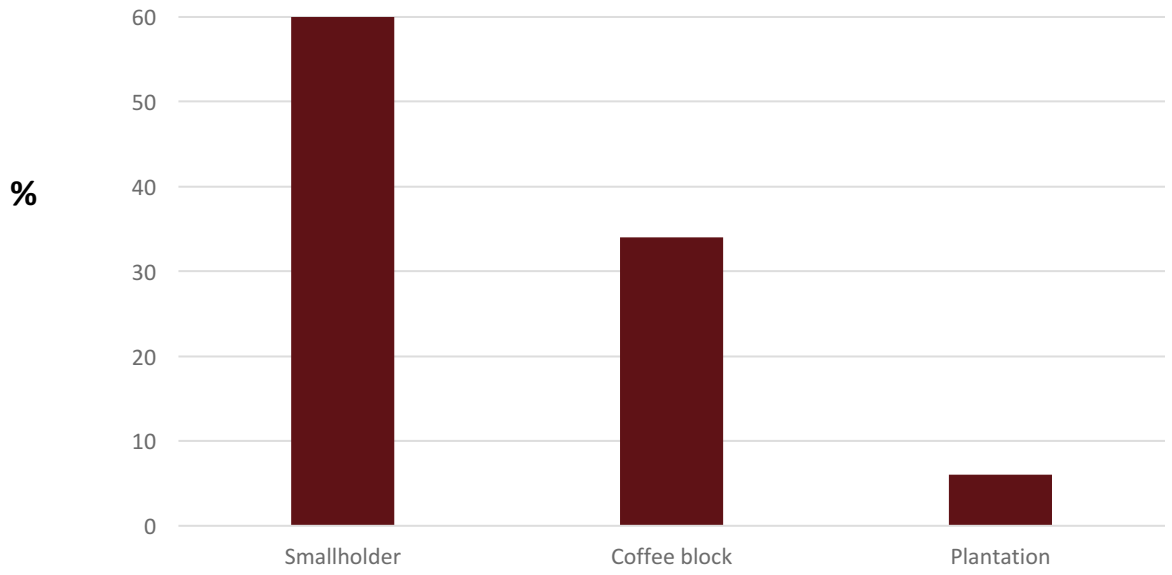

Table 1. Description of variables used in our inferential analysis

Variable	Description of variable	Mean/%
$COFFEE_{prod}$	Quantity of coffee produced from 2018 to 2020 in 60kg bag	(42.11)
TREE_AGE	Age of coffee trees on the coffee field in years	(20.98)
OTHER_CROPS	Other crops are grown with coffee on the same plot: Yes = 1 No = 0	71
PRUNE.	Number of times coffee trees was pruned per year	(1.63)
RUST	Coffee plots affected by leaf rust disease: Yes = 1 No = 0	70
BORER	Coffee plot affected by coffee berry borer: Yes = 1 No = 0	59
ARABICA	Coffee variety grown on the coffee plot: Arabica = 1	55
REGION	Location of coffee plot: Highlands region = 1 Momase region = 0	79
REPLANT	Coffee trees were replanted in the last 10 years: Yes = 1 No = 0	69

Continuation of Table 1

LABOUR Type of labour often used for operations: Family labour = 1 71
Others = 0

FARM_SCALE Scale of coffee production linked to farm size:
Smallholder = 0 60
Coffee block = 1 34
Plantation = 2 6

PPAP Farm benefit from Production Partnership in Agriculture Project: Yes = 1 10
No = 0

INCOME Household annual disposable income in Papua New Guinea Kina (19,513)

GENDER The gender of the interviewee: Female = 1 19
Male = 0

EDU The highest educational level attained by the interviewee: High school: 1 38
Others: 0

AWARENESS Interviewee knows about productive age of coffee tree: Yes = 1 76
No = 0

Continuation of Table 1

HHOLD	The interviewee's household size in number of persons	(6.31)
MARITAL	The interviewee's marital status: Married = 1 Others = 0	77
EXPEREINCE	Number of years that the interviewee has growing coffee	(24.09)
COOP	Interviewee is a member of a cooperative society: Yes = 1 No = 0	22
TRAIN	Interviewee received training on coffee production in the last 3 years: Yes = 1 No = 0	24

Mean is in parenthesis; USD 1 = PGK 3.3 when the study was conducted in 2021

Table 2. OLS results of farm characteristics and operations influencing quantity of coffee produced

VARIABLE	COEFFICIENT	T-VALUE
Constant	0.81	2.28**
Log(TREE_AGE)	0.26	2.71***
OTHER_CROPS	-0.25	-1.95*
PRUNE	0.09	2.58***
RUST	-0.16	-1.11
BORER	0.10	0.77
ARABICA	0.28	2.14**
REGION	0.84	5.80****

*, **, ***, **** are statistical significance at 10%, 5%, 1% and 0.1%

Continuation of Table 2.

REPLANT	-0.03	-0.19
LABOUR	-0.57	-4.37****
FARM_SCALE	0.41	3.28***
PPAP	0.29	1.64*
R^2	0.28	
Adjusted R^2	0.25	
F-value	9.39****	

Findings from the OLS model (Table 2) show that:

- An increase in the age of a coffee tree
- An increase in the number of pruning of coffee tree
- Presence of Arabica coffee
- Planting of coffee in the Highlands region
- An increase in the scale of production (coffee plot size) of coffee
- Presence of coffee plots that benefits from PPAP

result in an increase in the quantity of coffee produced

Findings from the OLS model (Table 2) show that:

- The growing of coffee and other crops on the same plot
- The use of family labour in farm operations

result in a decrease in the quantity of coffee produced.

Coefficients associated with:

Presence of leaf rust, berry borer and replanting of coffee trees were not statistically significant. It means these variables do not matter in the quantity of coffee produced in the study areas.

Four most important variables in the OLS model (Table 2) using the magnitude of coefficients (elasticity) are:

- Region where coffee plot is located
- Labour type used in coffee production
- Coffee production scale (coffee plot size)
- Implementing PPAP on a coffee plot

Table 3. OLS results of coffee grower's characteristics influencing quantity of coffee produced

VARIABLE	COEFFICIENT	T-VALUE
Constant	0.12	0.37
INCOME	0.00	5.21****
GENDER	0.06	0.25
EDU	0.39	2.46**
AWARE	0.42	2.10**
HHOLD	0.01	0.19

*, **, ***, **** are statistical significance at 10%, 5%, 1% and 0.1%

Continuation of Table 3.

MARITAL	0.13	0.71
Log(EXPERIENCE)	0.44	4.79****
COOP	0.29	1.86*
TRAIN	0.42	2.62**

R^2	0.19
Adjusted R^2	0.16
F-value	6.09****

Findings from the OLS model (Table 3) show that:

- An increase in household income
- Attainment of at least a high school education
- Being well informed about the productive age of a coffee tree
- An increase in the number of years that a coffee grower has been engaged in coffee production
- Participation in the training on coffee production
- Being a member of a coffee cooperative

Results in an increase in the quantity of coffee produced

Gender,
Household size, and
Marital status of the coffee grower

does not matter in the quantity of coffee produced.

Four most important variables in the OLS model (Table 3) using the magnitude of coefficients (elasticity) are:

- Being aware of the productive age of a coffee tree,
- Participation in the training on coffee production
- Attainment of high school education
- Membership of a coffee cooperative

All the eight most important coefficients in the two OLS models are important in developing a strategy for boosting coffee production in the study areas and potentially in all coffee-producing provinces of PNG.

Conclusions and recommendations

PNG has several opportunities for coffee production. However, several factors have restricted the country from achieving its full potential in coffee production.

If the intention is to make PNG one of the top coffee-producing countries using findings from the areas studied, the following should be considered:

- ✓ Encourage large scale coffee production by revitalising several abandoned coffee plantations and addressing the issues associated with making customary land available for development.

- ✓ Provide facilities for coffee production in areas that are most suited for growing coffee.
- ✓ Hired labour should be used in coffee production to increase quantity produced.
- ✓ Development projects on coffee production such as PPAP should be encouraged.
- ✓ There is a need for the continuous training of coffee grower on modern coffee production techniques and on how to address problems associated with pests and diseases.

- ✓ Coffee growers should be encouraged to form and join coffee cooperatives.
- ✓ Adult literacy program for coffee growers and other farmers should be developed and implemented.

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PNG NRI website and social media

For more information on PNG NRI activities, see PNG NRI website and social media sites:

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