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Analysis of Factors Influencing Robusta Coffee (Coffea canephora) Productivity in Sultan Kudarat Province, Mindanao, Philippines

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Abstract

This research examines the factors affecting the productivity of Robusta coffee in Sultan Kudarat province. Utilizing quantitative data from personal interviews with farmers, the study employs multiple linear regression analysis (MLRA) to identify key determinants of productivity. The findings indicate that factors such as capital, age of trees, frequency of extension visits, number of coffee trees, and access to credit significantly impact productivity levels. The study suggests that farmers should adopt innovative farming techniques, such as rejuvenation, to enhance yields. Additionally, it recommends that the provincial government play a more active role in promoting productivity by partnering with private organizations to disseminate advanced coffee production methods. This collaboration could help bridge knowledge gaps, provide better access to resources, and ultimately improve the overall productivity and sustainability of Robusta coffee farming in the region.

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1. Introduction

Coffee is cultivated in over 50 countries along the equatorial region known as "The Bean Belt." According to the Food and Agriculture Organization (FAO), Brazil was the leading global coffee producer in 2014, with a production volume of 2.8 million metric tons of Green Coffee Beans (GCB), followed by Vietnam, Colombia, Indonesia, and Ethiopia. Globally, the Philippines ranked 25th, producing 37,727 metric tons of GCB.

The Robusta variety, which accounted for 69% of the country's total coffee production in 2015, remains the most commonly grown coffee type in the Philippines (Philippine Coffee Industry Roadmap 2017-2022). Coffee, second only to oil as a global export, is a key economic crop in many of these top-producing nations, with studies highlighting the industry's profitability (Dait, 2013).

In Mindanao, the SOCCSKSARGEN region emerged as the leading coffee producer with an output of 1.80 thousand metric tons, followed by the Davao Region and the Autonomous Region in Muslim Mindanao (PSA, 2021). Notably, Sultan Kudarat province produced 12,263.02 metric tons in 2020, significantly surpassing the combined output of 1,518.53 metric tons from the other four coffee-producing provinces in the region (PSA SOCCSKSARGEN, 2021). However, coffee production in the second quarter of 2021 showed a slight decline, reaching 5.87 thousand metric tons, down by 0.3% compared to the same period in 2020.

Although coffee production spans the entire province of Sultan Kudarat, the municipalities of Senator Ninoy Aquino, Kalamansig, and Lebak are recognized as the top producers. With approximately 19,064 hectares of the province's 25,171 hectares of coffee-planted land, the region predominantly produces Robusta coffee, which accounted for 56.6% of total output during the period. The 2017-2022 Philippine Coffee Industry Roadmap highlights several factors contributing to the decline in coffee production, including a shift toward other crops, aging coffee trees with limited rejuvenation, poor farming practices due to inadequate knowledge of modern coffee technologies, and limited access to certified planting materials and credit.

From 2011 to 2019, coffee yields in the Philippines decreased by an average of 3.7% per year, while yield per bearing tree declined by 3.4% annually. This drop in productivity is attributed to the aging of coffee trees, minimal rejuvenation efforts, and substandard farm management practices. Despite the recognized importance of coffee production and processing for commodity development, the country's coffee output has continued to decline, driven by outdated production methods, crop diversification, and a lack of post-harvest and processing infrastructure (PSA, 2018).

Given the strategic importance of Sultan Kudarat province in the national coffee industry—owing to its favorable topography, substantial land area, large number of coffee growers, and access to both local and national markets, there is significant potential to revitalize coffee production in the region. This study aims to characterize the current state of coffee production in Sultan Kudarat and investigate the factors contributing to declining productivity, thereby addressing the challenges faced by the province's coffee industry and identifying opportunities for improvement.

2. Methodology

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2.1. Locale of the Study

Sultan Kudarat is a province located in the SOCCSKSARGEN Region of Mindanao, with Isulan as its capital and Tacurong City as its commercial hub. Geographically, the province is situated in the southwestern part of Central Mindanao, bounded by Maguindanao and North Cotabato to the north, South Cotabato and Sarangani to the south, Davao del Sur to the east, and the Moro Gulf and Celebes Sea to the west. It covers a total land area of 5,298.34 square kilometers (2,045.70 sq. mi).

Two prominent mountain ranges, the Alip Mountain Range in Columbio and the Daguma Mountain Range spanning Bagumbayan, Isulan, and Esperanza, define the province's landscape. Sultan Kudarat's western coastline, which includes the municipalities of Lebak, Kalamansig, and Palimbang, is also lined with mountain ranges, creating a natural barrier between the central plains and the sea. Additionally, mountains on the eastern side of the province leave flatlands in between, which are highly suitable for agriculture.

The province is composed of 11 municipalities and 1 city, with a total of 249 barangays. Of these, 3 municipalities are coastal towns, while the rest are situated inland. Tacurong City, the smallest administrative unit by land area, is the most urbanized area in the province and serves as its commercial center.

Sultan Kudarat experiences a Type IV climate characterized by heavy rainfall from April to November. Unlike many other provinces in the Philippines, it is generally free from typhoons due to its location outside the country's typhoon belt.

The economy of Sultan Kudarat is predominantly agricultural. Its major crops include rice, corn, coconut, coffee, bananas, mangoes, durian, and African palm. The province is self-sufficient in poultry, swine, and root crops, and it is one of the few regions in the Philippines that produces Irish potatoes.

With its mountainous terrain, Sultan Kudarat is particularly suited for coffee cultivation, and it has emerged as the country's leading coffee producer, surpassing even the traditional coffee-growing province of Batangas. In recognition of its contribution to the coffee industry, the Department of Agriculture Regional Field Office XII is positioning Sultan Kudarat to be recognized as the Coffee Capital of the Philippines.

2.2. Respondents and Sampling Design

The respondents of this study are coffee farmers engaged in Robusta coffee bean production, selected from the top three coffee-producing municipalities: Senator Ninoy Aquino, Kalamansig, and Lebak. These municipalities represent the core of coffee cultivation in Sultan Kudarat.

The study employed probability sampling, specifically simple random sampling, to ensure that all coffee farmers had an equal chance of being selected as respondents. Simple random sampling is a subset of a statistical population where each member has an equal probability of being chosen, ensuring unbiased representation. The list of coffee farmers was obtained from the Department of Agriculture, and the selection process was carried out using random draws to maintain fairness and randomness in the sampling.

A total of 94 respondents were selected based on a 10% margin of error. This sample size reasonably balances accuracy and feasibility, providing reliable insights while maintaining manageable data collection.

2.3. Method of Data Collection

Primary data for this study were collected through a pre-structured questionnaire, which was pre-tested prior to the field survey to ensure its effectiveness. The questionnaire covered key areas such as socio-demographic information, coffee production data, factors affecting productivity, and the challenges faced by farmers. Data collection and analysis were scheduled for the second semester of the School Year 2021-2022.

In addition to the questionnaire, transcripts from focus group discussions (FGDs) were utilized to gather in-depth insights into coffee farming in the province and to validate the responses from the survey. The FGDs were conducted by the researcher, and additional relevant data were obtained from a previously transcribed FGD conducted by the Sultan Kudarat State University.

Secondary data were collected from various sources, including online research journals, similar studies, and reports from government agencies such as the Department of Trade and Industry (DTI), the Department of Agriculture (DA), and the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD).

2.4. Method of Data Analysis

The study utilized both descriptive and inferential statistics for data analysis. Descriptive statistics provide summary metrics that represent the characteristics of the data set, either for the entire population or a sample. These statistics are categorized into measures of central tendency, including mean, median, and mode, and measures of variability (or spread), such as standard deviation, variance, minimum and maximum values, kurtosis, and skewness (Investopedia, 2021).

Inferential statistics, on the other hand, were employed to draw conclusions—such as decisions, estimates, predictions, or generalizations—about the larger population based on the information from a sample. The two primary types of statistical inference used in this study are estimation and hypothesis testing (Scott, 2009). Descriptive statistics, including frequency counts, averages, and percentages, were used to analyze the production practices of coffee farmers

To determine factors that influence Robusta coffee productivity, multiple linear regression (MLR) was employed. MLR is a statistical method that uses several explanatory (independent) variables to predict the outcome of a response (dependent) variable. The goal of MLR is to model the linear relationship between these variables. MLR is an extension of ordinary least squares (OLS) regression, incorporating more than one explanatory variable. The general MLR equation is as follows:

The multiple linear regression model for this study was:

$$Y_i = \beta X_1 + \beta X_2 + \beta X_3 + \beta X_4 + \beta X_5 + \beta X_6 + \beta X_7 + \beta X_8 + \beta X_9 + \beta X_{10} + \beta X_{11} + \beta X_{12} + \beta X_{13} + \varepsilon i$$

Where: X_1 = land (ha)
X_2 =capital (PhP)
X_3 = planting distance (cm)
X_4 = inorganic fertilizer (kg)
X_5 = pesticide/insecticide (li)
X_6 = age of coffee tree (no. of years)
X_7 =family labor (number)
X_8 = hired labor (number)
X_9 = number of coffee trees (number)
X_{10}= age of farmer (number)
X_{11} = government intervention (dummy)
X_{12} =access to credit (dummy)
X_{13} =tenurial status (dummy)
X_{14}=membership to organization (dummy)
X_{15}= seminars and trainings (number)
X_{16}= extension visit (number)

3. Results and discussion

3.1. Respondent's Profile

Table 1 shows that 34% of farmer respondents fall within the age range of 51 to 70 years, with the oldest being 70 and the youngest 22, resulting in an average age of 49. This suggests that, on average, the farmers are relatively young. Additionally, 69% of the respondents are male. These findings are somewhat similar to those of Bekele et al. (2020), who reported an average age of 42 years among coffee farmers in Southwest Ethiopia, with a minimum age of 26.

Table 1. Percentage distribution of Robusta coffee farmer respondents in terms of socio-demographic characteristics of coffee farmers in Sultan Kudarat Province, 2021.

Variables		Percentage
Age		
25 and below		5
26-30		4
31-40		18
41-50		22
51-60		34
61 and above		16
Total		**100**
Minimum	22	
Maximum	70	
Average	49	
Gender		
Male		69

Female	31
Total	100

3.2. Robusta Coffee Yield per Hectare per Year

The data indicates that 22% of coffee farmers harvested between 501 to 600 kilograms per hectare per year, followed by 17% who harvested between 601 to 700 kilograms per hectare. The average yield across the sample was approximately 600 kilograms per hectare. This aligns with a report by USAID, which noted that Cavite Robusta farmers typically harvest between 600 and 700 kilograms per hectare. However, this yield is significantly lower than previous averages, which reached up to 1,000 kilograms per hectare and falls far short of Vietnam's average of 2,700 kilograms per hectare. According to an article in Pinoy Business Idea, a well-maintained one-hectare coffee farm in the Philippines can produce about 1,200 kilograms of green coffee beans, highlighting the potential for increased productivity with improved farm management practices.

Table 2. Yield of Robusta coffee per hectare per year in Sultan Kudarat Province, 2021.

Yield in Kilograms		Percentage
300 and below		14
301-400		13
401-500		9
501-600		22
601-700		17
701-800		11
801-900		1
901 and above		13
Total		**100**
Minimum	132	
Average	600	
Maximum	1,200	

3.2. Factors Influencing Robusta Coffee Productivity

Among the 16 independent variables examined, six were found to have a statistically significant impact on the productivity of Robusta coffee at the 1%, 5%, and 10% significance levels. These variables are: capital, age of coffee trees, number of extension visits, number of seminars and trainings, number of coffee trees, and access to credit. Other variables, including size of coffee farm, planting distance, fertilizer use, pesticide use, family labor, hired labor, farmer age, government intervention, tenurial status, and membership in organizations, were not found to have a significant effect on productivity.

Capital, which refers to the total amount invested in coffee production (measured in pesos), was found to have a significant positive effect on productivity at the 5% level. This suggests that farmers with secure capital are better able to finance farm activities and provide necessary inputs, resulting in higher yields. Ayoola et al. (2012) support this finding, noting that inadequate capital limits farmers' ability to maintain farms properly, leading to poor weed control and lower productivity. In contrast, Bukuru and Tabitha (2021) did not find a significant link between capital and productivity.

The age of coffee trees was found to have a significant negative effect on productivity (-1.337) at the 10% level, implying that as coffee trees age, productivity declines. Specifically, each additional year of tree age reduces productivity by 1.3%. This finding is consistent with the results of Yusiska et al. (2019), Purba et al. (2018), and Rahmanta et al. (2019), all of whom found that older coffee trees tend to be less productive.

The number of extension visits was found to significantly improve productivity at the 1% level. This contrasts with the findings of Gebe (2020), who reported that the frequency of farm visits by extension workers did not affect coffee productivity. In this study, 36% of farms were visited quarterly by extension agents, 32% were visited annually, and 4% received no visits at all. The significant role of extension agents in transferring new technologies to farmers highlights their importance in improving productivity, supporting Wambua's (2020) study, which also found no significant effect of extension visits on coffee output.

The number of seminars and trainings attended was found to have a significant negative effect on productivity at the 5% level (t-value of -1.721). Surprisingly, this indicates that as the number of trainings and seminars attended increases, productivity decreases. This contradicts the expectation that additional knowledge and skills gained through such activities would improve productivity. Bhattarai (2020) also found that training had a significant impact on productivity, though the relationship was positive.

The number of coffee trees was significant at the 10% level (t-value of 1.514), with more trees associated with higher productivity. On average, farms had 834 coffee trees, although research suggests that 1,000 to 2,000 trees per hectare is ideal. This finding aligns with the studies of Purba and Supriana (2018) and Bekele and Guadie (2020), who also found that the number of coffee trees significantly affects productivity.

Access to credit was significant at the 5% level, indicating that access to financial resources positively impacts productivity. Only 14% of the respondents in this study had access to credit, highlighting the financial constraints faced by most farmers. Debashis and Debajit (2013) emphasized that access to credit can help farmers purchase necessary inputs, thereby improving productivity. Wambua (2020) similarly found that access to credit significantly affects coffee output.

While several variables were not found to be statistically significant, their relationships with productivity still offer insights. For example, coffee farm size was positively associated with productivity, though not significant, suggesting that larger farms may yield more.

Planting distance had a positive coefficient (0.097), indicating a potential benefit from optimizing row spacing, as suggested by FAO and Dado (2020).

Inorganic fertilizer had a small positive effect (coefficient 0.046), consistent with the findings of Bekele and Guadie (2020), while pesticide use had a slightly larger positive impact (0.094). However, Purba and Supriana argued that excessive pesticide use may harm soil health, thereby reducing productivity over time.

Tenurial status (land ownership) was positively related to productivity (coefficient 0.006), implying that owning land could encourage better farm management. However, this variable was not statistically significant in this study, contrary to Wambua's (2020) findings.

Similarly, family labor had a negative impact on productivity (-0.023), suggesting that increasing reliance on family members for labor may decrease efficiency. On the other hand, hired labor had a positive effect, supporting the idea that professional labor improves farm productivity, as found by Rahmanta (2019).

Farmer's age was positively correlated with productivity, suggesting that more experienced farmers may be better at managing coffee production. However, Bekele and Guadie (2020) did not find farmer age to be significant. Finally, government intervention had a positive coefficient (0.18), though not statistically significant, indicating that subsidies may have some influence on productivity, contrary to the findings of Kuguro (2016).

Table 2. Factor Affecting Robusta Coffee Productivity in Sultan Kudarat using Multiple Linear Regression Analysis,2021.

	Standard Error	Coefficient	t
(Constant)	.946		-.481
Coffee farm	.119	.132	1.223
Capital	.240	.356	1.822**
Planting Distance	.214	.097	.917
Inorganic Fertilizer	.030	.046	.460
Organic	.063	.094	.783
Pesticide/Herbicide	.113	-.156	-1.337*
Age of coffee tree	.107	.431	2.957***
Number of extension visits	.141	-.291	-1.721**
Number of coffee trees	.169	.168	1.514*
Family labor	.075	-.023	-.215
Hired labor	.128	.121	1.099
Age of farmer	.260	.115	.912
Government intervention	.067	.011	.097
Access to credit	.083	-.217	-1.902**
Tenurial status	.085	.031	.339
Membership to organization	.067	.076	.604

**Significant at 10%*
***Significant at 5%*
****Significant at 1%*

4. Conclusions and recommendations

This study identified six key factors that significantly impact the productivity of Robusta coffee: capital, age of coffee trees, number of extension visits, number of seminars and trainings, number of coffee trees, and access to credit. Capital and access to credit were found to positively influence productivity, emphasizing the importance of financial resources in sustaining and enhancing farm activities. Conversely, the age of coffee trees showed a negative impact, indicating that as trees grow older, productivity declines.

The positive effect of extension visits highlights the role of agricultural support in promoting productivity through the adoption of new technologies, while the surprising negative effect of seminars and trainings suggests that further investigation is needed into the effectiveness of such programs. Moreover, the number of coffee trees directly contributed to higher yields, reinforcing the importance of optimal planting strategies.

While several other factors, such as farm size, planting distance, and labor, did not show statistically significant relationships with productivity, their potential influence cannot be ignored. These factors, along with pesticide and fertilizer use, still play a role in coffee production and should be considered in future research and policymaking aimed at improving productivity.

Based on the findings of this study, several recommendations can be made to improve the productivity of Robusta coffee:

Enhance Access to Capital and Credit. Given the significant positive effect of capital and access to credit on productivity, policies should focus on providing farmers with greater financial support. This could include increasing access to affordable credit, offering financial incentives, and establishing programs that assist smallholder farmers in securing funds for farm inputs and infrastructure.

Revitalize Aging Coffee Trees. The negative impact of older coffee trees on productivity suggests that farm rejuvenation programs should be implemented. This could involve promoting the adoption of practices like replanting or grafting with improved, high-yielding varieties. Governments and agricultural agencies could offer subsidies or technical assistance to support such efforts.

Strengthen Agricultural Extension Services. Since the number of extension visits has a significant positive effect on productivity, enhancing the availability and quality of extension services is crucial. Governments and development organizations should invest in training and deploying more agricultural extension agents, focusing on regular farm visits and effective technology transfer to improve farmer knowledge and farm management practices.

Evaluate the Effectiveness of Seminars and Trainings. The unexpected negative effect of seminars and trainings on productivity calls for a reassessment of the content and delivery of these programs. A thorough evaluation of the curriculum should be conducted to ensure it aligns with the practical needs of farmers. Additionally, training should be more hands-on and targeted to specific farm-level issues, ensuring that knowledge gained is applicable and leads to tangible productivity improvements.

Promote Optimal Planting Density and Tree Management. Given the direct relationship between the number of coffee trees and productivity, farmers should be encouraged to adopt optimal planting densities and best practices in tree management. Extension services should offer guidance on ideal planting patterns and help farmers manage tree growth to maximize yields per hectare.

Support for Young and Beginning Farmers. As the study revealed the negative impact of aging coffee trees and suggested that older farmers might be more knowledgeable, it may be beneficial to provide targeted support to younger or less experienced farmers. Mentorship programs that pair older, experienced farmers with younger ones could help bridge the knowledge gap and improve farm productivity.

Integrated Pest and Fertilizer Management. Although the effects of pesticides and fertilizers were not statistically significant, they remain essential components of coffee production. Further research and extension efforts should focus on promoting sustainable, efficient use of these inputs, ensuring they are applied in ways that maximize productivity while minimizing environmental impact.

Conflicts of Interest

The authors have disclosed no conflicts of interest.

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