

## Research Article

# Smallholder Coffee Productivity as Affected by Socioeconomic Factors and Technology Adoption

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Despite the increase in area under coffee in Kenya in the last decade, productivity has been on the decline. Numerous production technologies have been developed through on-station research but there has been limited on-farm research to assess the impact of these technologies at the farm level. On the other hand, smallholder farmers are endowed differently and this would positively or negatively affect the adoption of recommended technologies and hence coffee productivity. This study was carried out to evaluate the effects of socioeconomic factors and technology adoption on smallholder coffee productivity at the farm level. The study employed stratified random sampling where 376 farmers were randomly sampled from six cooperative societies which had been preselected using probability proportional to the size sampling technique. The effects of socioeconomic factors and technology adoption on coffee productivity were analyzed using the stochastic Cobb-Douglas production function. The study revealed that off-farm income, access to credit, type of land tenure, and land size had significant positive effects on coffee productivity. Therefore, coffee farmers should be encouraged to diversify their income sources and to embrace credit financing, as the government reviews land use policies to avail adequate agricultural land. The study further revealed that the adoption of recommended application rates of manure, fungicides, and pesticides had significant positive effects on coffee productivity. The adoption of these technologies should therefore be enhanced among small-scale farmers to improve coffee productivity at the farm level.

## 1. Introduction

The economic prosperity of some advanced as well as less developed countries is dependent on agriculture, which is a major source of food, income, and employment [1]. In Kenya, agriculture accounts for 18% of the total formal employment and directly contributes approximately 26% of the annual gross domestic product (GDP) [2]. The sector supplies 65% of Kenya's total exports and is thus the largest contributor of foreign exchange earnings in the country through the export of horticulture, tea, and coffee [3]. Coffee is among the most traded commodities and also among the most consumed beverages in the world [4]. In Kenya, coffee is the fourth leading foreign exchange earner after tourism, tea, and horticulture and contributes about 8% of the total agricultural output in the country [5].

Despite the increase in area under coffee in Kenya in the last decade, productivity has been on the decline and this has attracted a lot of policy concerns in the country. This has generated research interest towards the development of production technologies aimed at improving coffee yields and quality. However, according to Muzari et al. [6], there is a large gap between the actual productivity of a smallholder farmer and the feasible productivity that is achievable with the available technology. The introduction of innovations has been proposed as one of the many solutions that can potentially improve agricultural performance and boost agricultural productivity [7]. Unfortunately, agricultural productivity may be hindered by the inability of farmers to adopt innovations such as improved production practices, inputs, and varieties [8]. This may result from the inability of the farmers to comply with the conditions associated with

the adoption of such technologies such as recommended method and period of application.

Coffee productivity can reportedly be increased through expansion of the total acreage under the crop, adoption of scientifically generated technologies, and increased efficiency of the allocation of scarce production resources for output maximization [9]. For example, various studies reported a positive and significant effect of the adoption of Coffee Berry Disease (CBD) and Coffee Leaf Rust (CLR) resistant cultivars on coffee productivity [10–12]. Deviations from the optimal frontier production function in coffee can be due to under- or overutilization of the factors of production and random exogenous shocks such as climate change, uncertainty of factor prices, and market variations [6]. Cheserek and Gichimu [13] noted that climate change had rendered significant proportions of traditional coffee growing zones less suitable for coffee production, thus causing a shift from optimal to suboptimal coffee growing zones, which affects crop yields and quality.

The Kenyan Government has established a research institute known as Coffee Research Institute (CRI) which has conducted extensive on-station research on coffee production and management in the country and recommended various production technologies. These include improved coffee varieties which are released together with their agronomic recommendations including plant spacing, fertilizer application, pest and disease control, and canopy management [5]. However, CRI has conducted limited on-farm research to assess the impact of research recommendations on coffee productivity at the farm level. This is important considering that it is at the farm level where the recommended technologies interact with the prevailing socioeconomic environment. In addition, research centers examine the impacts of one agricultural technology focusing on a single technology adoption with less regard to interdependence among technologies [14]. Moreover, the trials are carried out in either the research stations or demonstration plots with little consideration of the farmer characteristics and dynamics at the farm level. Therefore, there is limited quantitative information on farmer-related or on-farm production constraints and yield gaps.

The objective of this study was to determine the effect of socioeconomic factors and technology adoption on coffee productivity among the smallholder coffee farmers in Embu County, Kenya. The study conducted an in-depth analysis of total factor productivity through optimum input allocation in combination with the socioeconomic characteristics among the smallholder coffee farmers. In order to determine the impact of the released technologies on productivity, the study examined the effect of these recommended technologies and socioeconomic characteristics on coffee yields at the farm level. The findings provide clear understanding of how the technical factors interact with socioeconomic factors at the farm level and their ultimate effects on coffee productivity. This will guide the policymakers to put in place sustainable intervention measures to ensure that released

technologies will have the desired impact on productivity. The study first sought to assess the socioeconomic factors and levels of adoption of recommended technologies among smallholder coffee farmers. This was followed by an empirical analysis of how socioeconomic factors and technology adoption affects coffee productivity.

## 2. Materials and Methods

*2.1. Description of the Study Site.* The study was conducted in Manyatta and Runyenjes subcounties in Embu County, Kenya, where most of the marketed coffee is produced by smallholder farmers. The area is located in Upper Midland (UM) zone, 2–3 agroecological zones, within an altitude range from 1600 to 1800 m above sea level [15]. The rainfall pattern in the study area is bimodal but the annual quantity ranges between 1120 and 1495 mm. The average temperatures range from a minimum of 12°C in July to a maximum of 30°C in March and September [5].

*2.2. Sampling Procedure and Sample Size.* The study applied multistage stratified random sampling to select the farmers to be interviewed. Two cooperative societies were randomly selected from Runyenjes subcounty and four from Manyatta subcounty. Probability proportional to size sampling criteria was employed to sample the respondents from the farmers who were members of the selected cooperative societies. The sample size for the study was 376 smallholder coffee farmers selected using the formula of Cochran [16] as described as follows:

$$n_o = \frac{Z^2 pq}{e^2}, \quad (1)$$

where  $n_o$  is the required sample size,  $Z$  is the  $t$  value at 95% confidence level from normal table (1.96),  $p$  is the probability that respondent has characteristic being measured,  $q$  is  $(1-p)$  probability that respondent has no characteristic being measured, and  $e$  is 5% level of significance.

Assuming 50% probability that the respondent had the characteristic being measured, the sample size was calculated as follows:

$$n_o = \frac{(1.96)^2 (0.5)(0.5)}{(0.05)^2} = 384. \quad (2)$$

Since the estimated target population was only 20,000 farmers, the sample size was adjusted using the equation recommended [16] for small size finite population correction as follows:

$$n = \frac{n_o}{1 + ((n_o - 1)/N)} \quad (3)$$

$$n = \frac{384}{1 + ((384 - 1)/20,000)} = 376 \text{ farmers.}$$

The number of farmers from each cooperative society was determined using the following formula applied by [15]:

$$k = \frac{p}{M} * 376, \quad (4)$$

where  $k$  is the number of farmers to be interviewed,  $p$  is the number of members in a cooperative society, and  $M$  is the total number of smallholder coffee farmers in the selected cooperative societies.

**2.3. Data Collection.** The primary data were obtained from sampled farmers using structured questionnaires covering one crop season (one production year). The key primary variables collected were coffee output (yield) versus level of adoption of recommended technologies including improved varieties, proper tree spacing, types and rates of fertilizers, pesticides and fungicides applied, and method of canopy management adopted. Data were also collected based on the socioeconomic factors of the respondents such as gender, age, family size, farming experience, and availability of off-farm income. The study was based on the firm theory that the main objective of smallholder farmers is profit maximization through cost minimization and improved production.

**2.4. Data Analysis.** Descriptive statistics were used to analyze the demographic characteristics of the farmers that were hypothesized to influence coffee productivity. To determine the effect of recommended technologies and socioeconomic factors on coffee productivity, the stochastic Cobb-Douglas production function was used as proposed by Aigner et al. [17] and Seyoum et al. [18]. In this study, the Cobb-Douglas production model was specified as

$$\ln Y = \ln \beta_0 + \sum_i \beta_i \ln X_i + \sum_j \beta_j Z_j + \sum_k \beta_k D_k + \varepsilon, \quad (5)$$

where  $\ln$  is the natural logarithm;  $Y$  is the observed coffee output;  $\beta_0, \beta_i, \beta_j,$  and  $\beta_k$  are the vector parameters estimated;  $X_i$  is the number of inputs;  $Z_j$  is the values of socioeconomic factors;  $D_k$  is the dummy variables for the adoption of recommended technologies (1 denotes adopted; 0 denotes nonadoption); and  $\varepsilon$  is an error term. The Cobb-Douglas production model was preferred because it has the advantage of allowing for statistical inference and the estimated coefficients are easy to interpret.

### 3. Results

**3.1. Demographic Characteristics of the Respondents.** The social characteristics of the respondents are summarized in Table 1. Out of the 376 farmers that were interviewed, 74.7% were male, while 25.3% were female. The majority (84.6%) of the farmers were aged between 41 and 60 years with farmers below 30 years constituting only 1.1%. The household size ranged from 1 to 9 family members with the majority (69.7%) having 4–6 members. Most of the farmers (75.8%) had attained secondary education and above with only 3.2% lacking formal education. The majority (90.1%) of the respondents had 10 years and above of experience in coffee

farming with only 9.8% having less than 10 years of farming experience (Table 1).

**3.2. Economic Factors of the Respondents.** Table 2 shows descriptive statistics of the selected economic characteristics of the respondents. The majority (77.6%) of the sampled farmers owned one acre of land and below and most of them (83%) had allocated half an acre and below to coffee production. Only 14.1% of the sampled respondents were purely farmers with the rest (85.9%) earning some off-farm income from other economic activities. Less than half (43.4%) of the sampled respondents had land ownership rights in form of land title deed, implying that the majority of the respondents did not have security of land tenure (Table 2). The majority of the respondents (86.4%) received extension services either from their cooperative society (77.7%) or from research institutions (8.8%). The number of extension visits ranged from none to three but most of the respondents (49.5%) were visited twice. Credit facilities for financing coffee farming were accessible to 70.5% of the sampled farmers but 29.5% of the farmers did not access credit due to various reasons (Table 2). Most of those who could not access credit cited uncertainty in coffee returns as the major hindrance.

**3.3. Appropriation of Production Inputs.** Input use was found to vary with the scale of production and farm size and among different farmers (Table 3). These variations were in both the type of input used and the application rates. Only 38% of the farmers used the recommended rate of NPK fertilizer per tree while 36% used more than the recommended rate. Most of the farmers (41.2%) applied more than the recommended rate of CAN fertilizer per tree while 35.4% applied the recommended rate of CAN. The majority of the farmers (90%) applied manure at the recommended rate of 20–40 kg per tree. Only 33.5% of the farmers who were growing traditional varieties that are susceptible to CBD and CLR applied fungicides at the recommended rate of 2–3 liters or kg per acre. The majority of them (51.6%) exceeded the recommended application rate of fungicides. However, this study established that the majority of the farmers (52.1%) used the recommended pesticide rate of 1–2 liters per acre (Table 3).

**3.4. Coffee Varieties and Their Management.** Table 4 shows the descriptive statistics of agronomic practices of coffee management. The recommended coffee varieties for the study area were Ruiru 11 and Batian due to their production potentials and resistance to major coffee diseases. However, the majority of the farmers (67.2%) were still dependent on the traditional varieties (SL28, SL34, and K7) that are relatively less yielding and susceptible to the major coffee diseases. A high proportion of farmers (59.3%) had practiced a change of cycle on their coffee trees in the last ten years. Annual coffee pruning was a popular practice adopted by 98.4% of the farmers but tree capping was not a common

TABLE 1: Frequencies of key social characteristics of the respondents.

Social factors	Description	Frequency	Percent
Gender of the farmer	Male	281	74.7
	Female	95	25.3
Age of the farmer	18–30 years	4	1.1
	31–40 years	26	6.9
	41–50 years	158	42
	51–60 years	160	42.6
	61 and above	28	7.4
Household size	1–3	74	19.7
	4–6	262	69.7
	7–9	40	10.6
Level of formal education	None	12	3.2
	Up to primary school	79	21
	Up to secondary school	245	65.2
	Up to tertiary colleges	40	10.6
Experience in coffee farming	10 years	37	9.8
	10–20 years	231	61.4
	Above 20 years	108	28.7

TABLE 2: Descriptive statistics of economic factors of the sampled farmers.

Economic factors	Description	Frequency	Percent
Total land size	Less than 0.5 acres	111	29.5
	0.5–1.0 acres	181	48.1
	1.01–1.5 acres	39	10.4
	More than 1.5 acres	45	12
Land size under coffee	Less than 0.25 acres	153	40.7
	0.25–0.5 acres	159	42.3
	0.51–1.0 acres	51	13.6
	More than 1.0 acres	13	3.5
Monthly off-farm income	Less than 10,000 Kes	109	29
	10,000–20,000 Kes	188	50
	More than 20,000 Kes	26	6.9
	No off-farm income	53	14.1
Land ownership	With title deed	163	43.4
	Without title deed	213	56.6
Access to extension services	From cooperative society	292	77.6
	From research institutions	33	8.8
	No extension	51	13.6
Extension visits per season	Once	85	22.6
	Twice	186	49.5
	Thrice	54	14.4
	None	51	13.6
Credit access	Yes	265	70.5
	No	111	29.5

practice as only 15.4% of the farmers were practicing it. The majority of the farmers (94.4%) maintained 2 heads per stem as recommended.

**3.5. Coffee Production.** Descriptive statistics for coffee production across the sampled farms are shown in Table 5. The number of coffee trees among the sampled farmers ranged from 30 to 2000 trees which averaged 262 trees per farmer. The cherry production ranged from 100 to 12,000 kg which averaged 1106.24 kg while *buni* (dried cherry)

production ranged from 1 to 430 kg which averaged 27.85 kg per farm. The results revealed variations in coffee productivity with cherry output per tree ranging from 0.62 to 20 kg which averaged 4.66 kg. On the other hand, cherry output per acre ranged from 82 to 21,368 kg with a mean of 2433.75 kg (Table 5).

**3.6. Effect of Socioeconomic Factors and Technology Adoption on Coffee Productivity.** A stochastic Cobb-Douglas production function was used to show the effect of socioeconomic

TABLE 3: Descriptive statistics for fertilizer and manure application rates.

Farm inputs per application	Description	Frequency	Percent
NPK rate per tree	0–99	61	16.2
	100–199	37	9.8
	200–300	143	38.0
	More than 300 g	135	36
CAN rate per tree	0–99 g	51	13.6
	100–199 g	36	9.8
	200–300 g	134	35.4
	More than 300 g	155	41.2
Amount of manure per tree	Less than 20 kg	22	5.8
	20–40 Kg	338	90.0
	More than 40 Kg	16	4.2
Amount of fungicides per acre	Less than 2 L/Kg	56	14.9
	2–3 L/Kg	126	33.5
	More than 3 L/Kg	194	51.6
Amount of pesticides per acre	Less than 1 L	69	18.4
	1–2 L	196	52.1
	More than 2 L	111	29.5

TABLE 4: Descriptive statistics of coffee management practices among farmers.

Tree management	Categories	Frequency	Percent
Coffee variety	Ruiru 11	110	29.3
	Batian	13	3.5
	SL 28	220	58.5
	SL 34	25	6.6
	K7	8	2.1
Change of cycle	Yes	223	59.3
	No	153	40.7
Pruning	Yes	370	98.4
	No	6	1.6
Capping	Yes	58	15.4
	No	318	84.6
Heads per stem	1	9	2.4
	2	244	64.9
	3	111	29.5
	Above 3	12	3.2

factors and technology adoption on coffee productivity (Table 6). Multiple regression analysis revealed that the coefficient for farmers' engagement in off-farm income-earning activities was positive (0.080) and significant at 5% level ( $P = 0.028$ ), implying that engagement in off-farm activities increases coffee yield by about 8%. Land ownership had a positive (0.091) and significant coefficient at 5% level ( $P = 0.011$ ), implying that owning land increases coffee output by 9.1%. The coefficient for land size under coffee was positive (0.353) and highly significant at 1% level ( $P = 0.001$ ), implying that increasing the land size by 10 percent increases coffee output by 3.5%. Access to credit had a positive (0.074) and significant coefficient at 5% level ( $P = 0.030$ ), implying that availability of credit increases coffee output by 7.4%.

TABLE 5: Descriptive statistics for coffee production in the study area.

Production	Min	Max	Mean	Std. error	Std. deviation
Trees owned (no)	30	2000	262	9.923	192.408
Cherry output/tree (kg)	0.62	20	4.6624	0.13291	2.57716
Cherry output (kg/yr)	100	12000	1106.24	55.551	1077.18
<i>Buni</i> output (kg/yr)	1	430	27.85	2.194	42.538
Cherry output/acre (kg)	82	21368	2433.75	104.320	2022.838

On technology adoption, the coefficient for the recommended manure rate was positive (0.196) and significant at 1% level ( $P = 0.001$ ), implying that the coffee yield for adopters of recommended manure rate was 19.6 percent higher than that of nonadopters. The coefficient for recommended rate of fungicides was also positive (0.118) and significant at 5% level ( $P = 0.010$ ), implying that the yield obtained by adopters of recommended fungicide rate was 11.8% higher than that obtained by nonadopters. In addition, the recommended rate of pesticides had a positive (0.088) and significant coefficient at 5% level ( $P = 0.012$ ), indicating that the yield obtained by adopters of recommended fungicide rate was 8.8% higher than that obtained by nonadopters. The absolute  $t$  values for significant variables were relatively higher indicating an increase in the difference between the variables and the null hypothesis. Variance Inflation Factor (VIF) was lower than 5 for all predictor variables, implying significant multicollinearity among independent variables used in the model (Table 6).

#### 4. Discussion

Most socioeconomic factors including gender and age of the farmer, education level, coffee farming experience, household size, and extension services were not found to significantly influence coffee productivity. However, off-farm income, access to credit, land ownership (tenure), and land size had a significant effect on coffee productivity. The study revealed that 85.9% of the farmers were earning some off-farm income and 70.5% were accessing credit facilities. These two factors may have played a significant role in cushioning farmers' financial constraints and ability to mitigate costs and risks associated with the adoption of new technologies, thus reducing crop failures and increasing productivity. Access to credit and off-farm income also increases the ability of the farmer to access key farm inputs at the required time and increases household risk-bearing ability against production and market risks. The significant effect of off-farm income on productivity has also been reported in other studies [19–21]. Access to credit had a positive and significant elasticity in explaining variations in coffee yield. The significant effect of credit accessibility on farm productivity was also reported in previous studies



TABLE 6: Multiple regression for socioeconomic and technical factors affecting coffee productivity.

Dependent var. (output)	Beta	SE	<i>t</i>	Sig	VIF
Constant	4.924	0.618	7.972	0.001	
Gender of the farmer	0.046	0.062	1.356	0.178	1.376
Age of the farmer (years)	-0.031	0.037	-0.768	0.444	1.883
Level of education	-0.029	0.037	-0.803	0.423	1.539
Farming experience (years)	0.016	0.044	0.438	0.662	1.575
Household size (number)	0.012	0.042	0.352	0.725	1.398
Off-farm income	0.080	0.064	2.223	0.028**	1.539
Land ownership (tenure)	0.091	0.047	2.579	0.011**	1.477
Access to extension services	-0.046	0.072	1.383	0.169	1.321
Land size (acres)	0.353	0.046	7.521	0.001***	2.631
Credit access (yes = 1; no = 0)	0.074	0.054	2.197	0.030**	1.341
Fertilizer rate	0.069	0.046	1.955	0.053	1.472
Manure rate	0.196	0.068	5.580	0.001***	1.474
Fungicide rate	0.118	0.061	2.619	0.010**	2.409
Pesticide rate	0.088	0.040	2.543	0.012**	1.432
Variety adoption	-0.017	0.044	-0.527	0.600	1.290
Coffee spacing	0.001	0.044	0.045	0.964	1.224
Pruning	0.012	0.179	0.386	0.700	1.185
Capping	-0.015	0.064	-0.453	0.651	1.267
Heads per stem	-0.022	0.045	-0.654	0.515	1.359

Highlighted factors were significant at \*\*\*1% and \*\*5%

[19, 22, 23]. Access to credit and availability of off-farm income would also finance investment in capital-intensive technologies for increased production efficiency and productivity per unit area to avoid diseconomies of scale.

Land size is an issue of concern in the study area as the majority of the sampled farmers have less than one acre of land. Land size is assumed to have a direct influence on the size of the coffee farm as farmers with bigger land sizes are able to allocate more land to coffee. The increase in land size increases the scale of production and motivates the farmers to adopt new technologies, hence increasing coffee productivity. Bigger land sizes would also allow some trials on new technologies without affecting the scale of the main crop hence promoting adoption. Studies by Gebeyehu [10] and Senkondo et al. [24] also reported a significant effect of land size on coffee productivity. Chepng'etich et al. [25] and Ng'ombe [26] also made a similar observation on sorghum and maize, respectively. However, the studies by Minai et al. [20] and Musaba and Bwacha [23] found the land size to be negatively related to coffee and maize productivity, respectively. Apart from land size, ownership was also found to have a positive significant influence on coffee productivity. Challa and Tilahun [21], Musaba and Bwacha [23], and Cherukut et al. [27] also reported significant effects of land tenure on farm productivity. Land ownership allows the farmers to make long-term production decisions and facilitate access to credit by offering the land as collateral.

Although most farmers had adopted the recommended or higher rates for all the inputs that were sampled, most of

them had no significant effect on coffee productivity apart from manure, fungicides, and pesticides. This was attributed to the fact that farmers are driven by output maximization and would be motivated to use high-yielding methodologies that would guarantee high productivity but at a relatively lower cost. The significant effect of organic manure on coffee productivity was also reported by Gebeyehu [10], Chemura et al. [28, 29], and Dzung et al. [30]. Increased usage of organic manure increases plant height and stem thickening resulting in increased production [30]. Organic soil fertility management is among the important attributes of sustainable and climate-smart agriculture through the improvement of the physicochemical and biological soil properties [10]. The use of organic manure improves soil organic matter which enhances moisture retention as a climate change strategy in water-stressed areas [29]. In addition, organic manure causes increased microbial activity and availability of macronutrients in the soil [29]. However, Mignouna et al. [22] reported the negative effect of manure use on maize productivity explained but attributed it to inappropriate application rates.

This study established that the majority of the farmers (62.7%) in the study area were still growing traditional varieties that are susceptible to fungal diseases such as CBD and CLR. This necessitated the use of fungicides to control these diseases. The application of fungicides at the recommended rates had a positive and significant effect on coffee yield. Positive interaction of fungicides and coffee yields has been reported in several previous studies [10, 24, 31]. Apart from controlling the fungal diseases, copper-based fungicides enhance leaf retention, thus promoting chlorophyll process and nutrient uptake, resulting in healthy tree growth and high marketable yields [32]. An amount of pesticide used was found to be positively related to coffee yields in the study area. A similar observation was made by Gebeyehu [10], Lechenet et al. [31], Popp et al. [33], and Ngeywo et al. [34]. Coffee is susceptible to more than 850 species of insect pests including leaf miners, berry moths, berry borers, stem borers, thrips, and aphids [35]. Some of them like the berry borer can cause bean yield losses of 30–35%. Others like the stem borers may lead to the death of the coffee tree but most of them only weaken the plant, resulting in yield reduction [35]. Some insect pests also act as vectors for the transmission of coffee diseases. The appropriate use of pesticides in coffee production is therefore expected to increase the yields and quality of coffee, thus improving productivity per unit area.

Cherry yields in the study area averaged 4.67 kg per tree which was slightly higher than the current national average of 4.26 kg for traditional varieties and 10 kg per tree for the improved varieties [36]. Coffee production was hypothesized to be a function of factor inputs, recommended technologies, and socioeconomic characteristics in the farm environment. The study established that the majority of the farmers had adopted the recommended or higher rates of application for all the farm inputs that were sampled. The low yields can therefore be attributed to the low adoption of the improved varieties since only 29.3% and 3.5% of the sampled farmers were growing Ruiru 11 and Batian varieties,

respectively. Low yields can also be caused by the untimely application of farm inputs, poor method of application, or wrong choice of inputs especially fungicides and pesticides. For effective and sustainable management of CBD and CLR, Alworah and Gichuru [32] recommended timely fungicide application, proper choice of chemicals, and adoption of good agricultural practices. The low yields may also be attributed to climate change effects which include changes in rainfall patterns and increase in diurnal temperatures, both of which have a significant influence on the dynamics of pests and diseases [37].

## 5. Conclusions

This study demonstrated variations in technology adoption and socioeconomic factors of the sampled farmers. Consequently, there were significant variations in coffee productivity among small-scale farmers. Adoption of the recommended application rates of manure, fungicides, and pesticides had a significant positive effect on coffee productivity. The study therefore recommends the adoption of these and other recommended technologies for improved coffee productivity at the farm level. The policymakers should therefore put the necessary measures in place to persuade the farmers to adopt recommended technologies for improved coffee productivity. The study established that the availability of off-farm income, access to credit, adequate land size, and confidence of land ownership have a pivotal role in enhancing the adoption of recommended technologies at the farm level. Coffee farmers should therefore be encouraged to diversify their income sources and to embrace credit financing. On the other hand, the government should review land use policies and land tenure systems to avail adequate agricultural land and for long-term investments.

## Data Availability

Most of the data used to support the findings of this study are included in the paper. Additional data are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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