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Research Article

Decomposition of the Coffee Value Chain Among Smallholder Farmers in Embu and Kirinyaga Counties in Central Kenya

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The coffee value chain is lengthy and complex with numerous actors and this exposes the farmers to inherent financial risks. This study sought to decompose the coffee value chain and its dynamics. The study was undertaken in Embu and Kirinyaga counties in Central Kenya and the target population was smallholder coffee farmers. The study used multistage stratified sampling techniques to draw a sample of 385 respondents. Majority (97%) of the sampled farmers were processing and marketing their coffee through cooperative societies. Socioeconomic analysis of these farmers showed that majority were middle-aged, fairly educated and with adequate coffee farming experience but their cherry production was very low averaging 2.3 kgs per tree for 2022/2023 crop year. The cooperative societies were playing key roles in the coffee value chain including farmers' training, input and credit provision, coffee processing and marketing. There were numerous coffee marketing challenges, including high middlemen involvement, which lowered the coffee prices and reduced the trade volumes. Value adding activities such as roasting, grinding, and packaging were rare and farmers' involvement in the upstream value chain was minimal. The local demand for the produced coffee was very low with domestic consumption taking only 2% of the output. The multilevel mixed effect model results revealed that value adding and farmer involvement were found to have a significant positive influence on the traded volumes and coffee prices while middlemen involvement had a negative influence. There is need for enhanced value adding and farmers involvement in the upstream value chain as well as strengthening the cooperative societies' role in coffee marketing for more accountability and increased incomes.

Keywords: domestic consumption; farmer involvement; marketing; value adding

1. Introduction

Agriculture is predominantly the anchor pillar in majority of the developing and emerging economies especially in the sub-Saharan Africa [1]. Coffee is one of the most traded agricultural commodities in the world, a highly appreciated beverage and a source of livelihood for millions of smallholder farmers, mostly in middle- and low-income countries [2, 3]. There are about 25 million smallholder coffee farmers globally, contributing about 70%–80% of total coffee production, and around 125 million people derive their livelihood worldwide from the subsector [4]. The coffee industry is one of the most important commercial value chains globally, though associated with several social, economic, and environmental bottlenecks that impair its sustainability [5]. The global coffee demand has increased by more than 60% in the last decade, and this calls for expansion of production and market [2, 3].

Kenya's economy is commodity based relying on exports of agricultural crops [6]. Total export earnings from agriculture, for example, increased by 7.9% in 2020 mainly on the account of increases in the value of domestic exports of tea, horticulture, coffee, titanium, ores, and concentrates [7]. The coffee subsector is among the important agricultural subsectors in Kenya due to its enormous contribution to foreign

exchange earnings, on-farm and off-farm employment and household incomes among rural populations. The subsector ranks fourth after tea, tourism, and horticulture [6]. Important changes are happening in the coffee value chain, due to increasing modern production and trade practices, quality and safety standards, and welfare of smallholder farmers especially in emerging economies [8]. Consequently, the coffee value chain has become lengthy and complex, with an increasing number of production stages and a high number of economic actors with highly diversified end products. The value chain entails production, processing, and value addition, marketing and consumption nodes regulated by various institutional frameworks [8].

Coffee production occurs in about 170 countries which are majorly developing countries while subsequent activities are largely in developed countries. This represents a vertical relationship in the value chain [8, 9]. Coffee is consumed at different magnitudes by all the countries in the world and this has led to a consumption growth rate of 2% per year [10]. Unfortunately, most coffee producing countries are not among the major coffee consumers [10] except a few including Ethiopia, Costa Rica, Colombia, and Brazil, who consume a significant percentage of their own coffee. This interaction in the market has led to more integration and less vertical value chains. Sustainable purchasing of products based on consumer preferences and product value is an important element of the value chain [11]. Most traders see the value chain as a business unit and tend to focus the analysis towards the end of the value chain, where the consumers are aiming to get final products that have certain attributes that exceed their expectations [9]. Consequently, the farmer is usually at a greater economic risk from both environmental and social fronts.

The primary actors in the coffee value chain are the input suppliers, producers (farmers), and traders [12]. The production node is the engine of the value chain as it provides the raw materials to support the entire value chain. The input suppliers are involved in the provision of key production inputs to farmers either directly or through the coffee cooperatives. The coffee farmers undertake all the production activities and deliver the harvested coffee cherries to the factory for processing and subsequent marketing. The smallholder farmers are mainly organized into cooperatives which operate wet mill factories that conduct primary processing of freshly harvested coffee cherries on behalf of the farmers. A small percentage (2%–3%) of the farmers have their own factories where they individually undertake the primary processing of their coffee. The resultant product is parchment coffee which is then subjected to secondary milling in a dry mill [8] to remove the husk resulting in green beans of different grades and quality. However, most of the dry mills are owned by private companies who are mainly coffee traders participating in the final value addition and marketing processes. The green beans, which are also known as clean coffee, are the main product that is usually exported to the coffee consuming countries. The marketing of green beans is handled through the coffee auction or through direct sales to exporters. A small percentage of green beans are value added locally and exported either as roasted or ground beans with minimal domestic consumption [13].

The coffee traders dominate the upstream value chain but the coffee farmers bear the biggest cost burden from production to secondary processing and even part of the marketing cost. Although the relationship and participation of the different value chain actors should determine the sustainability of the sector [12], the coffee value chain is greatly influenced by the traders. Beyond the production node, the farmers are rendered mere price takers with no bargaining power due to their low involvement in the upstream value chain, inadequate market information, and lack of bargaining power. Therefore, the farmers are always at the receiving end of the coffee value chain and this puts them at a high economic risk as at times they are left with minimal or no take home income after offsetting the entire production and processing cost. On the other hand, the opportunistic nature of the other value chain actors enables them to enjoy almost a risk-free business [14]. Other actors involved in the coffee value chain include the supporting and enabling actors such as extension providers, research bodies, and financial institutions.

The smallholder farmers produce over 95% of Kenyan coffee under different production systems. Unfortunately, coffee production in Kenya has always been characterized by low farm productivity, climate change vagaries, lack of market liberalization, and price volatilities in the international market. These challenges introduce more inherent financial risks for producers [15]. Consequently, coffee productivity has been on the decline which has been worsened by low uptake of technology and lack of adequate farmer-driven value addition among the smallholder farmers [16]. In addition, the weakening structures at the production level, intensification of vertical integration, power consolidation, and profits maximization at the retailer's end have significantly reduced the producers shares at the final price [9]. The coffee pricing is based on the coffee quality and the prevailing demand in the international market. This has turned the coffee market from a producer driven market to a buyer driven market. Consequently, the upstream marketing sector has become more competitive and modern processing techniques at the factories are on the increase. This is associated with higher productivity and improved prices [17].

Value chain analysis is considered a strategic tool for evaluating customer's perceived value of a certain product or service [5]. The coffee value chain is vulnerable to abrupt changes that often disrupt or modify the market performance [18]. For instance, some of the coffee roasters and importers, who previously concentrated mainly on coffee marketing, have now amalgamated into coffee production and processing [17]. This further complicates the already complex coffee value chain. In addition, the increasing quality and sustainability demands by the European Union and other emerging coffee markets such as Japan and Korea has increased the production and marketing costs thus increasing the producers' profit margins [19]. Coffee value chain decomposition is necessary in understanding the specific roles of the various economic actors, understand the source of leakages/wastage, the various nodes and intermediaries,

low-cost distribution channels/pathways, risks and benefits for profit maximization from coffee and its products. Previous studies only characterize the value chains without considering the complexities and the impact on income variations. This study sought to characterize the coffee value chain dynamics for enhanced household incomes from coffee.

2. Materials and Methods

2.1. Study Area. The study was undertaken in Kirinyaga (0°30′0.00″ N 37°19′59.99″ E) and Embu (0°31′52.03″ N 37°27′2.20″ E) counties in Central Kenya. The dominant agro ecological zones in the study areas are upper midland 1 (UM 1) and upper midland 2 (UM 2) [20]. Specifically, Manyatta and Kirinyaga subcounties were the study areas. Rainfall is bimodal with long rains from mid-March–June and the short rains from October to December. Majority of coffee farmers in the study areas are smallholders that are characterized by low productivity at the farm level due to diseconomies of scale and technical inefficiencies. These farmers majorly process and market their coffee through their affiliated coffee cooperative societies but a few of them practice individual processing and marketing in collaboration with private millers and marketers. The study area is one of the dominant coffee growing areas in Kenya and have both categories of farmers (registered in cooperatives and others doing independent processing). This integration provided a basis for situational analysis of their involvement in coffee marketing.

2.2. Research Design. The study adopted a cross-sectional survey research design. The design is suited for gathering information about a population at a single point in time. This design enabled the researcher to yield both qualitative and quantitative data about the characteristics of the coffee value chain. The study deployed a semistructured questionnaire to collect the required data with adequate precision from a sample of coffee farmers, postulated to be a representative of the entire target population.

2.3. Sample Size. A total of 385 respondents were sampled for the study based on the Cochran [21] sampling formula as described below. The formula was applicable because the size of the target population was more than 10,000.

$$n = \frac{Z^2 pq}{E^2}, \tag{1}$$

$$= \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 385 \text{ respondents},$$

where n = required sample size, $Z = z$ value at 95% confidence level from normal table (1.96), p = probability that respondent has the characteristic being measured, q = probability that a respondent has no characteristic being measured (1–p) and $E = 5\%$ level of significance.

2.4. Sampling Technique. The study adopted multistage stratified sampling techniques to draw the sample from the target population and key informats. The technique provides an equal chance or opportunity for each respondent to be selected. The major coffee growing subcounties (Manyatta in Embu County and Kirinyaga West in Kirinyaga County) and the main cooperative societies in the two target counties were sampled. In addition, the coffee farmers (key informants) that were practicing independent processing were selected. Probability proportional to size criteria was used to determine the actual number of respondents from each of the two subcounties and from each of the selected cooperatives based on the membership size. Finally, systematic random sampling was used to draw the respondents from the six cooperative societies selected.

2.5. Data Collection. Primary data was collected on the characteristics of the coffee value chain from production, processing, marketing and consumption; including the value chain actors at every node and their role in coffee marketing and pricing. Data on the socioeconomic demographics of the coffee farmers were also considered to understand the profile of the sampled cooperative societies.

2.6. Data Analysis. The primary data collected was processed, coded, and analyzed for meaningful inferences. To evaluate the nature and characteristics of the coffee value chain, the study adopted the multilevel mixed effect model and Bayesian regression model. The model is best suited for conditional modelling in which the mean of the marketed volume is described by a linear combination of the predictor variables and the error term is independent and normally distributed.

$$Z = V_C^{\wedge}(1 - A)^{-1}, \tag{2}$$

$$\sum_{k=1}^{n} z_{ki} = 1\forall^i\left(w_{ij} z_{ki}\right), \tag{3}$$

where Z indicate the downstream coffee output (volume) decomposition, z_{ki} represents coffee output i from farmer, k, $w_{ij} z_{ki}$ represents the probability that certain part of total coffee output (i) by individual farmers (k) reaches the market along the value chain. Each i^{th} column of Z is characterized by a discrete probability distribution. The downstream coffee output of the individual farmer k add up consistently to 1.

2.7. Mixed Effect Model for Marketed Volume. Mixed effect model allows both fixed and random effects of variables with nonindependence of the variables. The model incorporates fixed effects (trade volumes/output decomposition) and the random effects (for explanatory variables and the dynamics of the value chain).

$$Z_{ki} = X\beta + Y_u + \varepsilon, \tag{4}$$

where Z_{ki} = downstream coffee output, y = vector observations with mean $E(Y) = X\beta$, β = unknown vector of fixed effects, u = unknown vector of random effects with mean $E(u) = 0$, ε = vector of random errors, X = matrix for fixed effects relating to observations y, and ki = matrix for random effects relating to observation y.

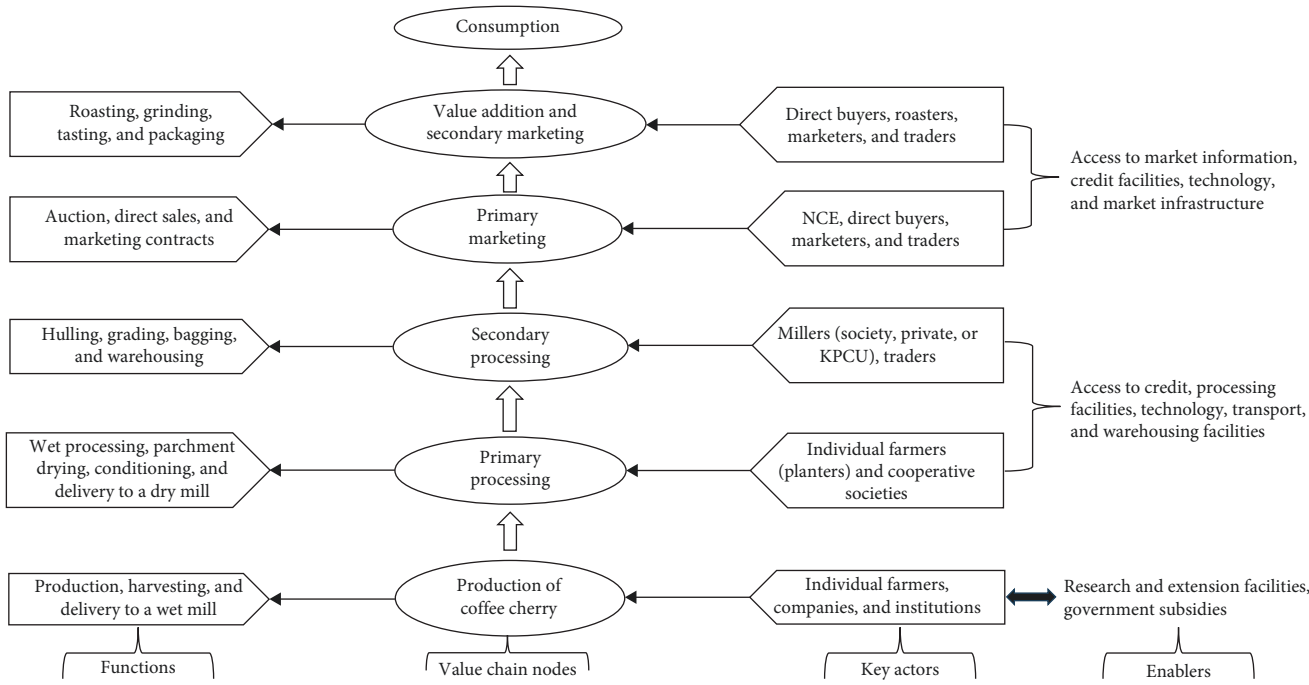

FIGURE 1: Coffee value chain decomposition in the study areas.

3. Results

3.1. Desktop Analysis of the Coffee Value Chain in Kenya. This study started with a desktop analysis of the coffee value chain in Kenya which revealed that the coffee value chain in Kenya is majorly comprised of production, value addition, marketing, and consumption nodes. The production node starts with input supply and is therefore characterized by backward linkages from the cooperative and other institutions through provision of inputs either on credit or through subsidies. The value addition node consist of primary processing in wet mills, secondary processing in the dry mills, and market driven value addition including roasting, grinding, branding, and packaging. The marketing node involves the sale of coffee either locally or internationally to facilitate the ultimate consumption node. The value addition, marketing, and consumption nodes forms the forward linkages. Figure 1 illustrates the various value chain activities, primary economic actors, and the various enablers involved at each node from production to consumption, as compiled from the desktop analysis. This information was very useful in guiding the data collection in the study area.

3.2. Production Node of the Coffee Value Chain. Production node forms the basis of the coffee value chain and the coffee farmers are primary actors. This section provides the socioeconomic characteristics of the farmers before analysing the coffee production aspects and the secondary actors in the production node.

3.2.1. Socioeconomic Characteristics. The socioeconomic characterization of the farmers in the study area (Table 1) revealed that most (61%) of the sampled farmers were male while 72% were middle aged between 41 and 60 years. Majority (86%) of the respondents had attained secondary school education and beyond, implying that they were likely to be conversant with the dynamism of the coffee value chain. About 78% of the farmers had off-farm income from different enterprises other than coffee farming, out of which 66% were engaged in informal jobs while 31% had formal employments. In terms of land ownership, majority (89%) had title deeds while the remaining (11%) were producing coffee on hired or family land without ownership guarantee. Approximately 84% of the sampled farmers had more than 10 years experience in coffee production. Majority (89%) of the respondents confirmed that they had access to credit facilitated by the cooperative societies.

3.2.2. Coffee Production in the Study Area. Table 2 presents the average land size and the average farm sizes held by the farmers in the study area, as well as the average coffee production volumes and prices. The average size of the entire land holdings was 1.1 acre, while farm size under coffee production averaged 0.5 of an acre. The average coffee cherry output per farm was 672 kgs of which translated to 1791 kgs per acre and ~2.3 kgs per tree. The cherry prices ranged from Kshs 70 to Kshs 115 per kilogram which averaged Kshs 91.60.

3.2.3. Secondary Actors in the Production Node. Apart from the farmers who are the primary actors in the production node, this segment of the value chain consist of other actors who provide support services including extension, credit, and input supply (Table 3). Majority (97%) of the sampled farmers were registered members of the cooperative societies. Therefore, apart from coffee processing, the cooperative societies played key roles such as provision of inputs (21%), credit (54%), farmer training (7%), and marketing (19%). Research centres were among the major input suppliers for both seedlings and technical knowledge transfer supporting 38% of the farmers. The government through the relevant

Table 1: Socioeconomic characteristics of the respondents.

Variables	Categories	(%)	Std. err.	Logit [95% conf. interval]	
Gender	Male	61.3	0.02486	0.56313	0.66058
	Female	38.7	0.02486	0.33942	0.43687
Age (years)	<30	2.86	0.00852	0.01589	0.05111
	31–40	6.51	0.01260	0.04429	0.09473
	41–50	32.29	0.02389	0.27783	0.37156
	51–60	40.36	0.02507	0.35547	0.45375
	61–70	13.80	0.01763	0.10687	0.17645
	>70	4.17	0.01021	0.02562	0.06706
Education level	None	2.34	0.00773	0.01220	0.04455
	Primary	9.90	0.01526	0.07274	0.13326
	Secondary	49.21	0.02555	0.44221	0.54233
	Diploma	28.66	0.02310	0.24326	0.33394
	Degree	9.89	0.01526	0.07274	0.13326
Off-farm employment	No	22.08	0.02117	0.18197	0.26518
	Yes	77.92	0.02117	0.73482	0.81803
Type of off-farm employment	Formal	31.00	0.02675	0.25996	0.36493
	Informal	66.33	0.02733	0.60763	0.71484
	Formal and informal	2.67	0.00932	0.01334	0.05261
Off-farm income (annual in KES)	<10,000	8.00	0.01569	0.05407	0.11683
	10,000–20,000	29.67	0.02642	0.24743	0.35113
	>20,000	62.33	0.02802	0.56681	0.67669
Land ownership	No title deed	11	0.01809	0.07911	0.15097
	With title deed	89	0.01809	0.84903	0.92089
Farming experience	<10 years	16.33	0.02138	0.12548	0.20986
	10–20 years	35.33	0.02764	0.30101	0.40943
	>20 years	48.33	0.02890	0.42691	0.54018
Credit access	No	10.9	0.01603	0.08217	0.14563
	Yes	89.1	0.01603	0.85437	0.91783

Abbreviations: conf., confidence; KES, Kenya Shillings; Std. err., standard error.

Table 2: Descriptive statistics for coffee production in the study area.

Variable	Obs	Mean	Std. dev.	Min	Max
Land size	385	1.081818	1.110348	0.25	7.5
Farm size	385	0.536494	0.893857	0.125	7.25
Cherry output (kgs) per farm	385	671.6857	599.6469	100	4811
Cherry output (kgs) per acre	385	1791.443	1049.231	100	6800
Cherry price (in Kshs) per kg	385	91.59675	8.714012	70	115

Abbreviations: Obs, observations; Std. dev., standard deviation.

Table 3: Support services provided by secondary actors.

Services	Variables	(%)	Std. err.	Logit [95% conf. interval]	
Cooperative roles	Input provision	21.47	0.02304	0.20324	0.29379
	Credit provision	53.71	0.02574	0.50517	0.58610
	Training	7.27	0.01325	0.05060	0.10348
	Marketing	19.35	0.02208	0.18500	0.29522
Input supply	Government	7.43	0.01462	0.05019	0.10867
	Research centres	38.39	0.02710	0.33215	0.43842
	Private suppliers	1.86	0.00752	0.00833	0.04089
	Cooperatives	52.32	0.02783	0.46840	0.57748
Back and forth linkages	No	38.16	0.02495	0.33386	0.43170
	Yes	61.84	0.02495	0.56831	0.66614

Abbreviations: conf., confidence; Std. err., standard error.

Table 4: Descriptive statistics for value addition.

Variables	Category	(%)	Std. err.	Logit [95% conf. interval]	
Sorting and grading	Yes	94.03	0.01209	0.91156	0.96006
	No	05.97	0.01209	0.03994	0.08844
Primary processing	Yes	97.40	0.00818	0.95216	0.98597
	No	2.60	0.00814	0.01403	0.04784
Roasting, grinding, and packaging	Yes	16.10	0.01876	0.12747	0.20140
	No	83.90	0.01876	0.79859	0.87253
Impact of value addition on coffee prices	Low	4.17	0.01021	0.02562	0.06706
	Moderate	47.66	0.02552	0.42677	0.52681
	Large	48.18	0.03878	0.41054	0.56346

Abbreviations: conf., confidence; Std. err., standard error.

Table 5: Characteristics of the marketing node.

Variables	Categories	(%)	Std. err.	Logit [95% conf. interval]	
Policy guidelines	Payment duration	0.93	0.00656	0.00230	0.03680
	Pricing	13.49	0.02335	0.09509	0.18786
	Quality	85.11	0.02433	0.79660	0.89305
	Volumes traded	0.47	0.00465	0.00064	0.03275
Farmer involvement	Farm gate	1.04	0.00517	0.00388	0.02746
	Cooperative	93.51	0.01257	0.90551	0.95582
	Milling	4.68	0.01077	0.02959	0.07312
	Coffee marketing	0.78	0.00627	0.00165	0.03900
Middlemen involvement	Low extent	1.96	0.00973	0.00732	0.05147
	Moderate extent	56.86	0.03476	0.49921	0.63545
	Large extent	40.20	0.03441	0.33636	0.47127
	Very large extent	0.98	0.00692	0.00242	0.03877
Market challenges	Market imperfection	19.37	0.02025	0.15697	0.23665
	Inadequate skills	28.80	0.02320	0.24457	0.33562
	Lack of value addition	25.92	0.02245	0.21751	0.30567
	Delayed payments	22.25	0.02131	0.18343	0.26720
	Transaction costs	3.66	0.00963	0.02177	0.06106
Price variations	Low extent	4.19	0.01026	0.02576	0.06741
	Moderate extent	47.91	0.02559	0.42912	0.52942
	Large extent	40.31	0.02513	0.35486	0.45338
	Very large extent	7.59	0.01357	0.05318	0.10728
Payment period	After 3 months	0.78	0.00370	0.00130	0.02081
	After 6 months	60.47	0.02505	0.55456	0.65275
	After 1 year	38.74	0.02496	0.33964	0.43749

Abbreviations: conf., confidence; Std. err., standard error.

ministries provides inputs such as subsidized fertilizers to 7% of the farmers. Majority (62%) confirmed the occurrence of backward and forward linkages either with the cooperative or other institutions (actors) that facilitated access to key inputs, quality improvement, product certification, and coffee marketing. Such institutions included financial institutions, millers, marketers, and certification bodies.

3.3. Value Addition Node of the Coffee Value Chain. Table 4 provides the descriptive statistics of coffee value addition and its impact on coffee prices. Sorting and grading is a form of primary value addition being performed by 94% of the farmers. Majority (97%) were conducting primary processing such as sorting with only (3%) not conducting any primary processing of which they were selling at farm gate. Upstream value addition (high up the value chain) activities such as roasting, grinding, or packaging was not common practice with (84%) concurring not to be involved. Only (16%) of the respondents who happen to be involved high up the value chain were engaged on those activities. These value addition activities to a large extent (96%) improved coffee prices ultimately enhancing the profitability of coffee and the household incomes.

3.4. Marketing Node. The statistics on the characteristics of the marketing node of the value chain are provided in Table 5. The respondents reported existence of policy

Table 6: Descriptive statistics for coffee consumption.

Variable	Category	(%)	Std. error	Logit [95% conf. interval]	
Domestic coffee consumption	No	97.40	0.00814	0.95216	0.98597
	Yes	2.60	0.00814	0.01403	0.04784
Brewing skills	No	93.49	0.01687	0.89265	0.96122
	Yes	6.51	0.01687	0.03878	0.10735
Cultural beliefs on coffee consumption	No	43.46	0.02540	0.38544	0.48498
	Yes	56.54	0.02540	0.51502	0.61456
Consumption guidelines	No	48.57	0.02551	0.43588	0.53584
	Yes	51.43	0.02551	0.46416	0.56412

Abbreviations: conf., confidence; Std. err., standard error.

guidelines that guide on the product disposal and they majorly (85%) focus on the coffee quality and the rest on pricing (13%). On the aspect of farmer involvement in coffee marketing, only 1% were selling at the farm gate. Majority (93.5%) are involved in the coffee marketing up to the cooperative society level while only 4.7% are involved in the milling process. Only 0.78% are involved in the actual marketing at the auction or at export level. The respondents also confirmed the existence of the middle men in the coffee marketing at various levels. The opinion of 57% of the respondents was that the middle men involvement was to a moderate extent while 40% opined that it was to a large extent. The main marketing challenges as reported by the respondents included inadequate skills (29%), lack of value addition (26%), delayed payments (22%), market imperfections (19%) and transaction costs (4%). The respondents also confirmed the occurrence of price variations with majority (88%) opining that the extent of these variations was moderate to large. Only a meagre 0.8% of the respondents reported that they received their payment within 3 months from the date of coffee delivery. Most of the farmers (60.5%) received their pay after 6 months while 38.7% waited for up to 1 year.

3.5. Coffee Consumption Node. Consumption is one of the desired objectives of coffee production. Domestic consumption of locally grown coffee was found to be very low with only 2.6% of the respondents partaking it (Table 6). Majority (93%) reported that they did not have brewing skills thus preventing them from partaking their own coffee. Other factors that negatively influenced domestic coffee consumption included existence of cultural beliefs (56.5%) and consumption guidelines (51%) on the dietary and health issues as reported by respondents. The consumption cultures include: foreign or imported coffee considered of good quality, coffee consumption associated with the rich, unconfirmed health concerns associated with coffee consumption, changing consumer tastes and preferences among others.

3.6. Coffee Output and Value Chain Characteristics. Analysis of the distribution of the coffee output (kgs) across the farms is presented in Figure 2. Results for trace, density plot, histogram, and autocorrelation plots indicated a normal distribution of the coffee output across the farms.

Bayesian regression results for the value chain characteristics and coffee output across the farms are presented in Table 7. The results indicate the impact of the explanatory variables on coffee output entering the value chain. Back and forth linkages had significant impact on influencing the volumes, implying that presence of backward and forward linakges improved marketed volumes by 3% and 6%, respectively ceteris paribus. Linkages would reduce the leakages and transactional friction along the value chain for higher volumes and improved household incomes. Value addition and middlemen involvement both had 32% strength in influencing the outflow volumes along the value chain. Policy guidelines on quality, markets, and volume traded improved marketed volumes by 14% while farmer involvement along the value chain influenced the outflow volumes by 10% ceteris paribus.

3.7. Multilevel Mixed Effect Model (Output Decomposition). The results of the mixed effect model for coffee output decomposition along the value chain nodes are presented in Table 8. The residual random effect results from the fitted model had a correlation coefficient of 0.6544, which is above the conventional threshold of 0.5, implying substantial clustering among the predictor variables. The findings revealed that value addition had a significant positive effect (0.322, $p \leq 0.003$) in increasing the probability of high output prices and the downstream flow of coffee to the consumer. Middlemen involvement had a significant negative (0.310, $p \leq 0.037$) influence on the output flow and prices along the value chain. Involvement of the farmers in coffee marketing was found to positively and significantly (0.102, $p \leq 0.005$) influence the downstream output. The land size, back and forth linkages, policy guidelines, and the level of domestic coffee consumption did not significantly influence the downstream output flow.

4. Discussion

Commodity value chain is described as the value adding activities all the way from basic factors of production through backward linkages to the ultimate end use product delivered to the consumer [22]. Coffee value chain development is critical as it supports many livelihoods. The primary coffee value chain actors are those that transact coffee and its products along the value chain including input suppliers,

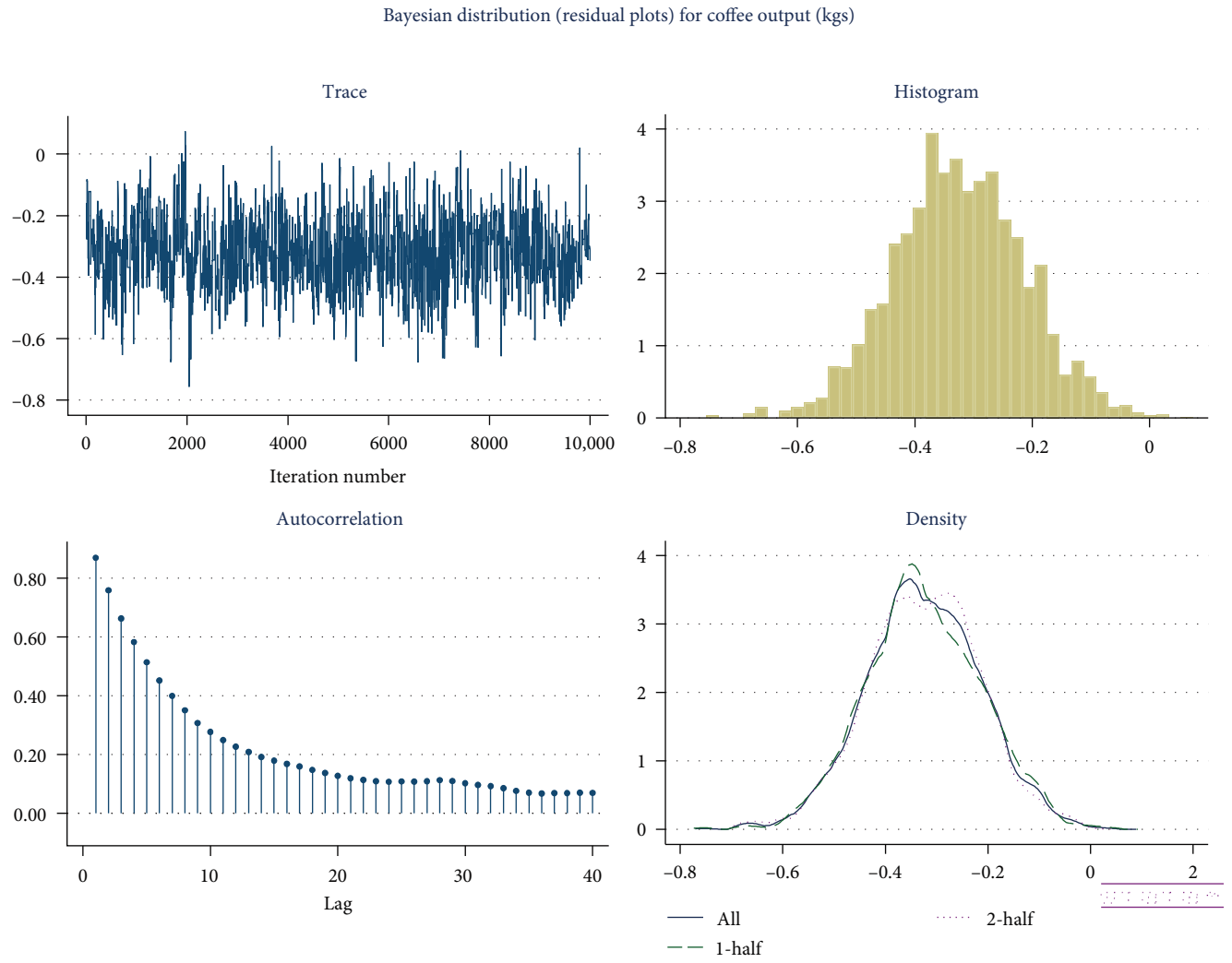

FIGURE 2: Residual plots for Bayesian distribution for coffee output (kgs).

TABLE 7: Bayesian regression results for coffee value chain and output.

Log (output) kgs	Mean	Std. dev.	MCSE	Median	Equal-tailed [95% cred. interval]	
Land size	0.04121	0.04112	0.00315	0.04161	−0.11990	0.03537
Backward linkages	0.03341	0.16670	0.02958	0.02040	−0.26644	0.38226
Forward linkages	0.06829	0.14458	0.01841	0.07099	−0.22788	0.34633
Policy guidelines	0.14005	0.14510	0.02244	0.14139	−0.15092	0.41411
Domestic consumption	0.02026	0.09685	0.00952	0.02035	−0.20385	0.17098
Brewing skills	0.05151	0.19390	0.02747	0.05110	−0.42162	0.34277
Value addition	0.32488	0.11095	0.00580	0.32699	−0.54153	0.40669
Middlemen involvement	0.32318	0.14892	0.01491	0.32739	−0.59717	0.36435
Farmer involvement	0.10050	0.03683	0.00552	0.09821	0.02883	0.17775
_cons	4.25259	0.42934	0.10679	4.32996	3.23488	4.95697
sigma2	0.67489	0.05099	0.00134	0.67243	0.58016	0.78105

Abbreviations: _cons, constant; Cred., credible interval; MCSE, Monte Carlo standard error; Std. dev., standard deviation.

farmers, processors, and final consumers. This study sought to decompose the entire coffee value chain by exposing the activities and main actors involved at every value chain node. Since the farmer is the main actor in the coffee production node, understanding their socioeconomic characteristics is crucial. The study revealed that coffee production was dominated by middle aged to elderly farmers, ranging between 41 and 70 years who were majorly men. Similar observation was

Table 8: Multilevel mixed effect model for coffee output and pricing.

Log (volume)	Coef.	Std. err.	z	$p>z$	[95% conf. interval]	
Land size	−0.03750	0.04229	−0.89	0.375	−0.12038	0.04539
Backward linkages	0.05071	0.17519	0.29	0.772	−0.29266	0.39408
Forward linkages	0.06506	0.15031	0.43	0.665	−0.22954	0.35966
Policy guidelines	0.13404	0.13677	0.98	0.327	−0.13403	0.40211
Domestic consumption	−0.02491	0.10266	−0.24	0.808	−0.22613	0.17631
Value addition	0.32166	0.11001	2.92	**0.003**	0.10604	0.53727
Middlemen involvement	−0.30981	0.14874	−2.08	**0.037**	−0.60133	−0.01830
Farmer involvement	0.10289	0.03649	2.82	**0.005**	0.03137	0.17440
_cons	4.21270	0.36687	11.48	0.000	3.49365	4.93176

Note: Values in bold are significant at 95% level of confidence.
Abbreviations: coef., coefficient; conf., confidence; _cons, constant; Std. err., standard error.

made in Nepal by Bhattarai et al. [23] where the average age of the coffee farmers was 58 years. Most of the farmers had obtained adequate formal education and had more than 10 years of experience in coffee production. This implied that they were able to make appropriate production decisions and were well conversant with the coffee value chain dynamics. Good education coupled with adequate farming experience are critical factors that help the farmers to comprehend and implement the technical information and to make informed decisions [24–26]. A study by Gebre [27] found education to influence the willingness of a farmer to accept new ideas and innovations.

The sampled farmers confirmed that they had off-farm income from other engagements other than coffee production and this helped them in financing coffee production activities and cushioning them against random shocks and economic risks. Bhattarai et al. [23] reported significant and positive impact of income diversification on coffee productivity in intercropping farming systems. Similarly, Prasetyo et al. [14] concurred that extra income would motivate the farmers to focus and sustain their coffee plantations. The sampled farmers also reported that access to credit enabled them to finance the cost of production. The importance of credit access was also observed among smallholder coffee farmers in Nepal as reported by Bhattarai et al. [23]. Majority of the farmers in the study area were legal land owners and this enabled them to make long term production decisions which is crucial for sustainable production of perennial crops such as coffee. This would also enable the farmers use the land as collateral for credit access.

Coffee production is usually concentrated majorly in the emerging economies while consumption is largely in the developed economies. The coffee production in the study area was mainly dominated by smallholder farmers with entire land sizes averaging 1 acre and coffee farm sizes averaging 0.5 acres. This is attributed to land subdivision, urban expansion, and more competing uses other than agricultural production as reported by Murimi et al. [28]. Prasetyo et al. [14] reported that small coffee farm sizes is a significant factor limiting the household income of coffee farmers. The average cherry production (1791 kgs/acre) was far below the documented potential of 40 kgs of cherry per tree attainable by the Kenyan coffee varieties as reported by Gichimu [29]. The low production may be attributed to low adoption of recommended practices [30], high cost of production, and lack of farming incentives as caused by several factors including poor prices, delayed payments, [25] and the long value chain of coffee [14], among others. The low production negatively impacted the coffee volumes entering the value chain. Coffee prices varied across the study area, with a price range of KES 70 (Kenya Shillings) and KES 115, averaging KES 90 depending on the trade volumes, quality and grade of the coffee, value adding capability, market trends, exchange rate volatilities, and marketing efficiency among others [6].

The coffee farmers in the study area were majorly organized into cooperative societies which played the key roles of coffee processing and marketing on behalf of the farmers. Similar findings were reported by Aragie [22] that smallholder farmers mainly market their coffee through the cooperatives which undertake primary processing and subsequent marketing through the auction. The cooperative societies also played other supporting roles in value chain development such as credit provision, enhanced input acquisition, farmers' training, and facilitation of quality certification. Other secondary actors in the production node included private suppliers, research centres, and the government through the ministry of agriculture and cooperatives. The institutional role in facilitating coffee production has been observed by other researchers including Kyaw, Ahn, and Lee [31], Bergquist and Dinerstein [32], Bhattarai et al. [23], Gebre [27] and Prasetyo et al. [14]. These institutional services enhance the backward as well as the forward linkages critical in value chain integration.

Value addition is important in enhancing the utility of a product and subsequently the prices. Coffee value addition in the study area was found to be minimal, with the cooperatives only facilitating primary processing (sorting, pulping, drying, and grading) and sometimes secondary processing (dry milling). The upstream value addition activities including roasting, blending, grinding, packaging, and branding are done mainly by the local and international roasters who buy the processed coffee in form of green beans from the cooperatives mainly via the coffee auction. These activities take place in the higher value chain nodes without involvement of the farmers and the cooperatives. This is attributed to the vertical integration of the coffee value chain as reported by Utrilla-Catalan et al. [9] and Canwat [8]. Similar findings were reported by Aragie [22] that direct participation of

smallholder farmers in the coffee value chain does not go beyond delivering the cherry to the cooperative societies. Low involvement of the farmers in the coffee value addition denies them the opportunity to enjoy the enhanced product value thus exposing them to economic exploitation which is a disincentive to production sustainability. Lack of downstream value addition also contributes to low local demand for coffee and its products consequently impacting on domestic consumption.

Marketing is a critical node in value chain development. This study established that there exist policy guidelines on production, marketing, and consumption of coffee as an export crop. The sampled farmers confirmed the existence of policy guidelines particularly on coffee quality aspects and pricing. These policies were meant to boost the competitiveness of coffee in the international market. Utrilla-Catalan et al. [9] reported that large exporting countries cover a higher share of trade, to the detriment of small exporting countries. Price volatility mainly affects small-scale farmers and traders in producing countries who do not have access to hedging instruments [9]. Other policy guidelines focused on payment duration and trade volumes. These policy guidelines are meant to regulate and formalize trade in coffee and its products in order to protect both the producer and the consumer. The smallholder coffee farmers were rarely involved in the marketing process as their last stage of involvement in the coffee value chain did not go beyond delivering the cherry to the cooperative societies. This finding corroborates an earlier report by Aragie [22] that direct participation of smallholder farmers in the coffee value chain was minimal. Similarly, Jebesa [33] reported low participation of smallholder farmers (both livestock and crops) in the agricultural markets in Ethiopia.

This study further established that middlemen who are commonly referred to as brokers were largely involved in the coffee marketing process. Similarly, Prasetyo et al. [14] observed that there were many players in the coffee value chain that reduced the farmers' profits in Indonesia. However, it is important to note that in Kenya, some brokers are licensed to trade the coffee on behalf of the farmers and to ensure proper documentation throughout the process until the farmer is paid [34]. The sampled farmers further acknowledged a number of marketing challenges such as low value addition which reduces the market value of coffee, delayed payments by the cooperatives due to the long value chain, inadequate marketing skills leading to market imperfections and high transaction costs "eating up" on the returns. Similar findings were reported by Jebesa [33], Chandio et al. [35], and Prasetyo et al. [14] who argued that smallholder coffee farmers are usually unable to enjoy a decent living due to low returns from coffee sales. Payment duration was annually to biannually with delayed payments being a major farmer's concern in sustainable financing of coffee production.

Kenya's domestic coffee consumption is apparently very low compared to her trading partners such as Ethiopia, Brazil, Colombia, and Costa Rica [2, 3]. The sampled farmers reported that they lacked brewing and roasting skills, which negatively impacted on domestic coffee consumption. Availability of coffee roasting and brewing skills would promote value addition of domestically produced coffee which would in turn improve its local demand. Existence of coffee consumption guidelines and cultural beliefs also impacted on the domestic coffee consumption. The cultural beliefs and myths such as the negative side effects of caffeine, addictiveness of coffee, association of coffee with the rich contributed significantly to low domestic consumption. This underscored the need for promotion of domestic coffee consumption through capacity building on roasting and brewing and awareness creation on the benefits of coffee consumption in order to negate the cultural beliefs. This would enhance domestic consumption and ultimately create a local demand for the produced coffee thus reducing overreliance on the international market. Similar findings were reported by Tadesse, Tesfaye, and Abera [25].

On the output decomposition along the value chain, the study established that lack of farmers' involvement in the upstream value chain increases their vulnerability for exploitation by the middle men which ultimately reduces their incomes thus demoralizing them into reduced production. This situation is worsened by poor governance in the cooperative societies, elite capture, and free riding as reported by Orr, Donovan, and Stoian [36] which denies them the necessary negotiation skills and market information to enhance their bargaining power on behalf of the farmers. This observation corroborates the findings of Peralta, Shupp, and Arslan [37] that many agricultural markets in rural areas have been characterized by weak institutions with informal engagements between the marketing agents and brokers. On the other hand, the middlemen or brokers were largely involved in the marketing process which increased the transactional costs and complexity of the value chain. Similar observation was reported by Otekunrin, Momoh, and Ayinde [38]. Although the coffee prices in the international market are based on the coffee quality and the prevailing demand and supply [9], the smallholder farmers are rarely provided with the accurate market feedback. The economic actors with their opportunistic behaviour engage in an unfair competition among themselves [32] resulting in farmer exploitation, leakages, and transactional friction in the marketing process. Availability of effective linkages between farmers and the marketing agents would facilitate effective disposal of the produce and ensure that the farmers' interests are protected.

5. Conclusion and Recommendations

This study revealed that the coffee value chain is predominantly comprised of smallholder farmers as the primary actors, brokers/middlemen, and traders who include coffee millers and buyers. The farmers are majorly organized into cooperatives which play key roles in the coffee value chain including farmers' training, input and credit provision, coffee processing and marketing. Value addition activities such as roasting, grinding, and packaging are rare and the involvement of the farmers in the upstream value chain is minimal. High involvement of middlemen at the expense of the farmer, alongside other marketing challenges, increases the transactional friction reducing the returns from coffee

production. Domestic coffee consumption is also significantly low thus reducing the local demand and increasing overreliance on the international market. Enhancement of value addition, farmer involvement in the upstream value chain activities, and reduction of middlemen involvement are critical in enhancing output flow and coffee prices. Besides, there is need for strengthening the cooperative societies for enhanced bargaining power and capacity to source international buyers directly which would reduce the lenghth and complexity of the coffee value chain for better returns.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

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