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Research Article

In-Depth Assessment of Key Factors Affecting Coffee Production in Tanzania

Raphael Mbunduki*

Department of Agricultural Economics and Business, College of Agricultural Science and Fisheries Technology, University of Dar es Salaam, Dar es Salaam, Tanzania

Abstract

Coffee has been among the traditional cash crops and one of the main contributors to foreign earnings in Tanzania. Consequently, earnings from its exports have remained low due to various production challenges which in turn affects export growth. These challenges have never been properly and intensively recognized for better decision-making. Therefore, this study was set to provide an in-depth assessment and understanding of key factors affecting coffee production in Tanzania.The study used simple random sampling to collect information from 364 respondents in four highly coffee-growing districts in Ruvuma, Mbeya, and Songwe regions. Qualitative and quantitative data were collected through structured questionnaires from small-scale farmers. Data were then analyzed by using a statistical Package for Social Sciences (SPSS) and Excel. From the findings, poor agronomic practices such as inadequate application of fertilizer, poor pesticides and disease control, and aged low-yield coffee trees were found to be the main factors that strongly explain the relationship with low coffee production output due to their significant results. Furthermore, using regression the other variables found to significantly affect coffee production output level were limited access to finance and inadequate extension services. Based on the findings, sustainability of the coffee sector development, intensive government intervention is needed by putting more priority on training farmers best agronomic practices in the right way. This way, small farmers can be aware of the importance of the application of required agronomic practices as a key factor in the scale-up of productivity and production output. The Bank of Tanzania can also efficiently address the challenge of small-scale farmers in obtaining soft loans at a reasonable cost from financial institutions by creating an enabling environment. This should include the provision of a special loan facility to commercial banks connected with conditions to beneficial banks to lend to farmers at an indicative rate that can be affordable to small-scale coffee growers. These findings will inform policymakers and coffee stakeholders in the coffee value chain on the best actions and decision-making to enhance the sector's performance.

Keywords

Fertilizer Application, Pesticides and Diseases Control, Irrigation Infrastructure, Timely Pruning and Weeding, Aged Coffee Trees, Extension Services, Loans, Tanzania

*Corresponding author: mase.raphael@gmail.com (Raphael Mbunduki)

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1. Background of the Study

Coffee is the most traded crop in terms of volume in the world market. More than 131,694,000 60 kg bags were traded in 2020 [4]. Major supplies of Arabica coffee in the world are Central and Latin American, the Far East, Central Asian, and African Countries. The major producer of coffee in the world is Brazil, which exports more than 30% of the total global coffee exports (Table 1).

Coffee is a perennial crop, which is grown in many parts of Tanzania including Mbeya, Ruvuma, Sogwe, Kilimanjaro, Kigoma, and Kagera regions. The crop has remained among the most important cash crops in the country's foreign exchange earnings. It is grown by approximately over 450,000 of the population who directly derive their livelihood from coffee growing and related businesses [14]. Apart from the direct benefits derived from coffee growing in terms of foreign exchange earnings for the country and raw materials to local industries, the majority of small-scale farmers fulfil their basic needs through coffee production.

More importantly, the sector has been more influential in the national economic growth as it is estimated to contribute 5 percent of the total national exports; and generate export earnings averaging 100 million United states dollar (USD) per annum over the last 30 years [10]. Mainly, of the total production, two types of coffee are grown of which 70% are Arabica, and 30 percent are Robusta.

With the proceeding of the economic liberalization under the SAP, as part of the country's Agricultural Sector Development Strategy (ASDS), the Government launched the Coffee Industry Development Strategy (CIDS) in 2011. The CIDS has been aimed at enhancing income across the entire value chain by increasing the production, productivity, and quality of Tanzanian coffee to compete in the world market. The CIDS forecasts coffee production of at least 100,000 MT and earnings of 150 million USD from exports by 2021.

Despite all the efforts that have been taken by the government, the performance of the coffee sector has been low in terms of productivity and crop quality which has affected production output and competition in the global market. The annual coffee production average is 65.2 million tons recorded in 2021/22, which is far below the potential of the country to produce over 200,00 Metric tonnes (MT) without expanding the area under cultivation [4, 8]. In terms of productivity, currently, the average production per hectare is estimated to be 0.5 t ha^{-1} of clean coffee compared to the potential of over 3.0 t ha^{-1} of most varieties under the best management practices [6].

This performance of the coffee sector in Tanzania is regarded to be much lower compared to other countries growing coffee in Africa such as Ivory Coast, Uganda, and Ethiopia which produce an annual average of 106.5million, 337.2 tonnes and 442.5tonnes million, respectively.

The record also shows coffee prices have been low and inefficient throughout the coffee production and marketing value chain. For instance, in 2021, the approximation coffee average price for Tanzania was about USD 2.42/kg while Ethiopia recorded an average price of USD 3.41/kg [4]. The exhibited coffee price trend in the last thirty years is explained to be very far below the world and other regional countries' coffee prices.

The low sector performance and lack of better pay have resulted in farmers in some areas uprooting coffee plants and shifting to other alternative crops such as horticultural produce [9].

Therefore, this study intends to assess which factors are critically affecting coffee production in Tanzania focussing on main coffee growing districts in the Southern Highland zone of Tanzania.

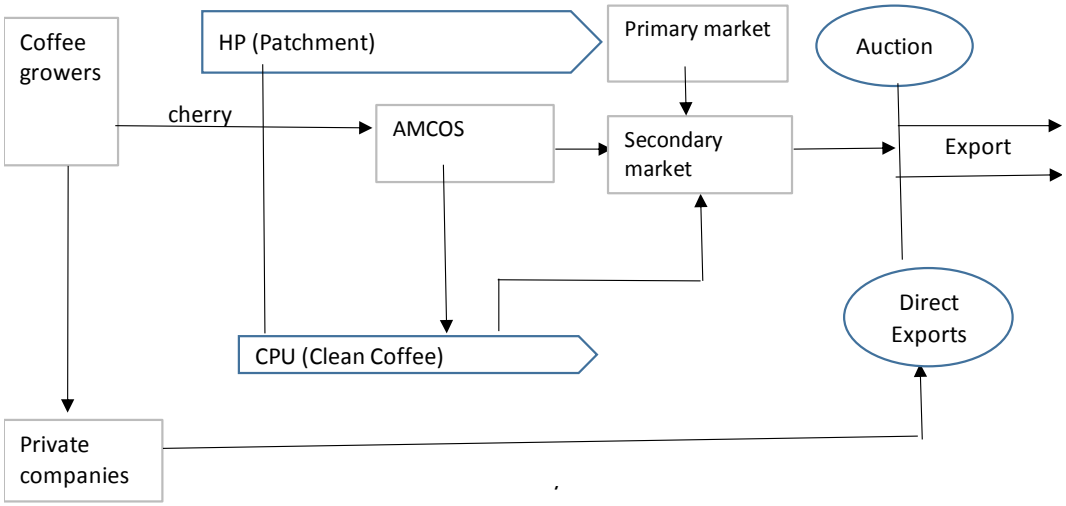
2. Structure of the Coffee Marketing in Tanzania

The present coffee marketing structure in Tanzania comprises individual farmers, coffee estates on the production side and private companies.

Figure 1. bellow explores major marketing channels in the study area and findings from the study revealed that, there are basically three marketing channels identified specifically coffee growers, private companies and Agricultural Marketing Cooperate Societies (AMCOS).

Based on the field information, smallholder's farmers who process their coffee at home (HP) are ungraded coffee parchment with low quality which normally sold through primary market. Coffee parchment hulling, grading and sorting is done by the private traders and AMCOS. In the study area, majority of small farmers are members of AMCOS to whom they sell their coffee in the modality of warehouse receipt. In this system coffee growers deliver their coffee to the primary societies (AMCOS) in which they are members. In delivering stage famers receive advance payments and after a week they are paid the remaining balance based on announced market price after a week.

Coffee quality improvement requires a well-designed area for cleaning, cheering out, drying transport and storage. The Central Pulpery Unit (CPU) have designed for developing high quality coffee. Majority of primary cooperatives own CPU, to accomplish coffee processing to obtain high quality coffee parchment which is then taken to private coffee curing factories to produce clean coffee ready to sell to existing auctions mainly located in Mbozi and Mbinga. The discussion with farmers and Key Informants (KIS) revealed that, the direct exports is mainly done by private traders.



Source: Author's designer, 2023

Figure 1. *Marketing channels for coffee beans in Tanzania.*

3. Coffee Marketing in Tanzania and Other Major Coffee Producing Countries

Tanzania's share of coffee exports out of Africa's total exports was 4.9% and 0.5% out of world trade of coffee in the year 2021 making it 26th the coffee largest of coffee in the world (Table 1). Tanzania's coffee is exported mostly in the form of clean coffee mainly to EU 27 external Trade (Brexit), Japan, United State, Morocco, Russia, India, South Korea, South Africa and Australia (Table 1). Tanzania has been ranked as the third largest coffee exporters in East Africa next to Uganda and Ethiopia. However, total share of coffee exported to world market is approximately to be less than one percent [4]. The export price per kilogram of coffee from Tanzania over the last five years has exhibited with a general downward trend [9]. For instance, in 2017 the export prices 2.99 USD per kg but by 2021, it had decreased to 2.31 USD per kg [14]. The lowest price was recorded in 2019, when it was 1.98 USD per kg. One of the reason for coffee prices decreasing in the world market is low quality of coffee that cannot compete with production from other countries especially coffee from South America.

Table 1. *Exports of all forms of coffee by major exporting countries ('000' 60 kg bags).*

	2014	2015	2016	2017	2018	2019	2020
Brazil	31,650.6	37,335.2	37,562.8	34,269.2	30,924.6	35,637.4	40,697.9
Colombia	9,669.9	10,954.4	12,716.4	12,831.4	12,984.6	12,808.0	13,672.2
Vietnam	19,717.8	26,097.1	21,943.5	29,721.3	25,092.2	31,385.1	27,400.2
Indonesia	9,254.8	6,174.8	8,378.7	6,545.4	8,197.6	4,538.8	6,333.9
Mexico	3,132.0	2,479.5	2,458.0	2,232.9	2,910.6	2,888.1	2,627.0
India	5,032.6	5,130.9	5,262.3	6,086.1	6,541.5	5,967.2	6,027.9
Côte d'Ivoire	1,962.1	1,489.2	1,418.4	1,432.0	854.6	1,522.5	2,104.3
Uganda	3,671.9	3,442.4	3,595.6	3,543.1	4,774.0	4,223.2	4,526.1
Ethiopia	2,870.1	3,116.7	2,985.0	3,000.7	3,773.4	3,589.0	3,921.2
Tanzania	934.8	718.0	708.9	904.8	664.1	856.0	1,069.2

Source: ICO, 2021

Table 2. Tanzania's Export in the World and African's Coffee Trade Exports.

	2018	2019	2020	2021
World	163,693.0	172,461.0	164,953.0	175,347.0
Africa	17,354.0	18,620.0	18,686.0	18,514.0
Tanzania	783.0	1,175.0	926.0	900.0
Tanzanian's share in Africa	4.5	6.3	5.0	4.9
Tanzania's share in World	0.5	0.7	0.6	0.5

Source: International Coffee Organization, 2021

Table 3. Major Tanzania's' coffee destinations in the world.

	2019	2020	2021
EU 27 external Trade (Brexit)	30,366.0	30,628.0	35,165.0
Japan	15,552.0	11,231.0	11,524.0
United State	3,168.0	3,220.0	2,487.0
Morocco	3,034.0	2,987.0	5,115.0
Russia	1,434.0	1,476.0	1,282.0
India	3,070.0	1,131.0	1,265.0
South Korea	1,467.0	1,097.0	874.0
South Africa	872.0	1,192.0	452.0
Australia	988.0	720.0	1,097.0
Other countries	3020	2777	3873

Source: Trade Data Monitor 2022

4. Literature Review

The results of the study conducted by Velmourougane & Bhat [16] conducted in India found that, pest and disease management, water and nutrients management, lack of infrastructures facilities such as irrigation and roads as the main challenges to produce quality coffee at the farm level.

Common results were found in Ethiopia when [3] conducted a study to review coffee production and marketing. According to the review, lack of competitiveness, lack of infrastructure, inadequate of access to services, low value addition, inadequate of technology transfer and research; and rainfall variability were among major constraints of coffee production in Ethiopia. Another study [2] employed qualitative approach examined challenges for coffee agrichain in Brazil by considering the growing demand and also the competitiveness between the coffee countries producers.

They found that, increased use of pesticides and climate change were among the main factors constrained Brazilian coffee sector performance in terms of high quality coffee supply.

Andrew & Philip [1] conducted the study to evaluate the profitability of coffee production as well as the constraints that farmers face during the production process in Kigoma. The Method applied in aliasing data was gross margin approach. The results revealed that, input prices, high taxes, research contribution and Central Pulpery Unit, shortage of extension services, unreliable markets, and low coffee prices, low quality of coffee transportation and delayed payment constituted the major problems that faced coffee produces.

Mapunda et al., [7], Conducted the study to examine the contribution of agricultural inputs credit accessed through Warehouse Receipt System (WRS) of coffee farms productivity in Mbinga – Rukwa. The method applied was Ordinary Least Square (OLS)to analyses the data obtained from household survey. The results obtained show that, factors such as extension services and credit access through WRS had a significant effect on coffee yield.

Kangile et al., [5] conducted the study to determine the status, constraints, key drivers and impact of coffee certifications using descriptive statistics and the endogenous switching regression (ESR) model for data analysis. Results revealed that, the level of coffee certification was low, being constrained by unawareness and inaccessibility, preference of coffee diseases, failure in realizing prices advantages, and certification were the factor constraining the improvement of household income.

Mhando [9], conducted an empirical study in Tanzania on how to unlocking institution constraints to increase coffee production and related constraints. The findings of the study indicate that; the Tanzania coffee sector is challenged by lack of political will to develop an increase the productivity of coffee. The study further show that institutional constraints have led to failure to support research and extension activities, limited production and distribution of hybrid seedlings.

The study by Sumbuo & Mbwaga [13] in Kilimanjaro and Songwe in Tanzania assessed the sustainability of agricultural marketing cooperatives. Questionnaire were given to 86 farmers and 32 leaders of the primary cooperative associations. Findings revealed that, unfavorable coffee prices, access to extension services, pests and coffee diseases, unrelia-

ble coffee markets, shortage and untimely accessibility of farm inputs were the main challenges affected coffee sector in terms prices and sustainability.

Ruoja [12] used multiple approaches to include questionnaires, interviews and documentary review in data collection to examine the extent to which coffee production and exportation has contributed to poverty reduction among farmers in Tanzania. The study found that, low prices for coffee both in local and international markets and bureaucracy were revealed to be challenge facing coffee exportation.

Otieno et al., [11] tried to assess the current production situation and available technologies and practices for enhancing coffee production in Mbeya using excel 2016 version for analysis. Conferring to the findings, there is a direct association between existing poor agronomic practices, poor extension services and low yield old coffee trees with low coffee production output

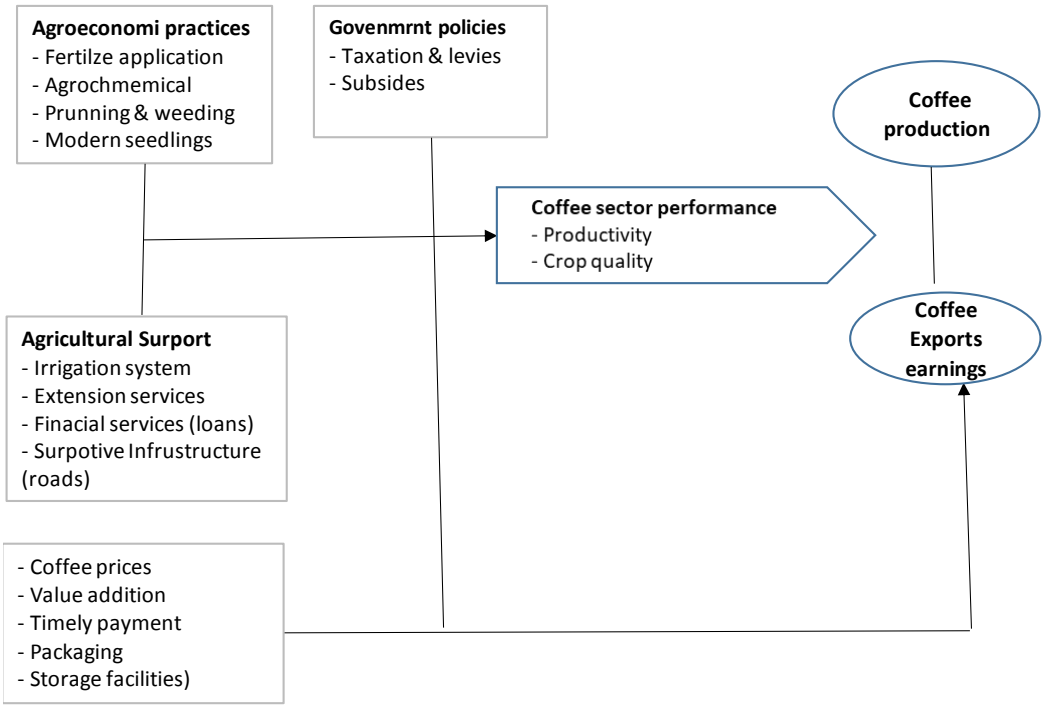
A lot of coffee production constraints assessments have been conducted in different countries producing coffee including Tanzania using different methodology and approach. For Tanzania, majority of the study that have been conducted to cover one region and even in some few districts growing coffee which cannot draw the big picture in making conclusion. In particular, for Tanzania the undertaken studies have not been able to cover major coffee-producing areas in the country in general especially in the Southern Highlands zone where Arabica coffee is mostly grown. So this study was designed to cover major coffee-producing regions in the Southern Highlands zone of Tanzania and come up with possible solutions and recommendations for the constraints underpinning coffee production in Tanzania.

5. Conceptual Framework

This framework provides the guideline for identifying important variables for effective and efficient data collection for attaining the research objective. There are numerous evidence that low coffee production and productivity in Tanzania are due to the use improper agronomic practices such as limited use of inputs (improved seeds that are potentially high yielding and resistance to diseases and pests, fertilizer and pesticides) [14].

Other factor assumed to affect the performance of the coffee sector are inadequate agricultural supports (extension services, financial services in particular accessibility of soft loans and supportive infrastructures such as roads). According to Tanzania Coffee Board (TCB) report [14], financial institutions and extension officers have a major role on dedicated resources to assist smallholder coffee growers to improve productivity and crop quality.

As majority of smallholder's farmers do not apply proper agronomic practices the sector has remained confronted with low productivity which affects the production level and low quality of coffee crops. International coffee markets have put benchmarks for the coffee quality which if not met may affect its competitiveness in the global market. Therefore, it is presumed that, proper agronomic practices provide assurance for enhancing coffee performance in terms of productivity and crop quality.



Source: Author design

Figure 2. *Conceptual Framework.*

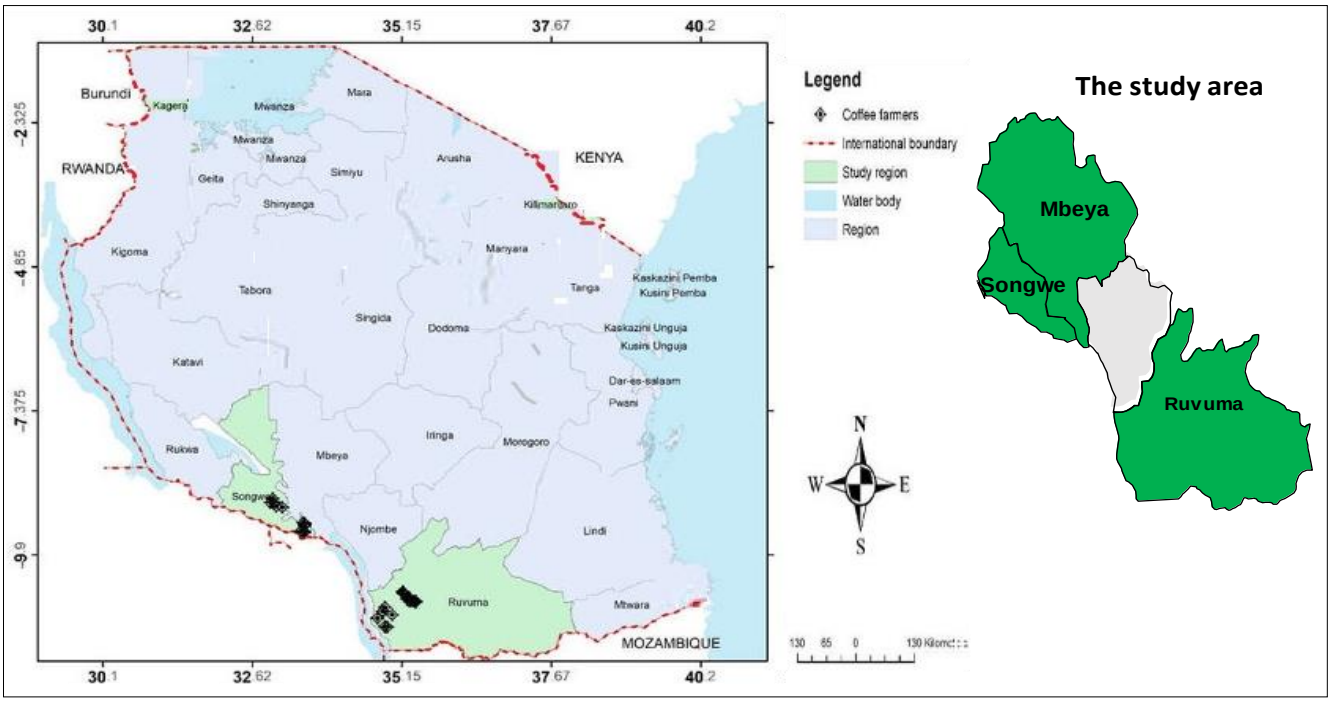
6. Methodology

This study used d a cross-sectional research design. This method, apart from being cost effective it is also suitable for description purpose and able to determine the relationship between variables. This design save time as it is enable the researcher to collect data from many different individuals at a single point in time.

The study was conducted in three main coffee-producing regions in the Southern Highlands zone namely Mbeya, Ruvuma, and Sogwe (Figure 3). The three regions were sampled from the Southern Highland zone which are amongst the leading regions in coffee production in Tanzania especially mild arabica coffee which is highly demanded in the world market. These regions serve as promising areas for acquiring reliable data since they consisted of coffee farmers and where coffee estates and auctions are also occurring.

Almost 28,116 farmer's cooperatives (AMCOs) with at least 200-300 coffee growers are found from these regions [15]. The most leading districts in coffee growing in the regions are Mbinga and Nyasa in Ruvuma region, Mbeya and Rungwe in Mbeya region and Mbozi in Songwe region. In 2022, the total production from the three regions stood at 28,116 tonnes equivalent to about 43.1% of the total national production [14].

Therefore, the choice for these districts, as a study area is purposive and this was because it has a greater potential for Arabica coffee production compared to other areas.



Source: Tanzania Coffee Board

Figure 3. *Geographical Distribution of the Study Area.*

6.1. Sample Size and Selection

Sample size determination has been adopted by the Israel (1992) approach of determination of sample size. For assurance of determination of acceptable sample size, things such as the purpose of the study, population size, the risk of selecting a bad sample, and committing a sampling error were all taken into consideration. To ensure the sampling criteria are adhered to, during the selection of the sample, for the level of correctness an error of ±5 percent is accepted as a range in which the population is estimated and at a 95 percent confidence interval that the sample has to represent a true population with the provided precision. As the researcher is aware that, there is a possibility of variability in the distribution of attributes under study due to heterogeneous population, thus a large sample was appropriate.

As the population size exceeds 100,000 and for the sake of maintaining the precision level of ±5 percent at 95 percent confidence interval, in this study then a sample of not less than 300 were recommended.

6.2. Population and Sample Selection Procedure

A sampling included coffee growers who are members of AMCOS from the three regions namely Mbeya, Songwe, and Songea.

Coffee growers were selected from AMCOS's viewpoint

as a unit of assessment. A checklist of questions was applied to understand the view of KIIS who were normally those who are closely dealing with coffee growers. KIIs were district cooperative officers and agriculture extension officers from the selected districts of the study regions. The information from KIIs was gathered to validate information obtained from coffee growers.

To collect the representative sample, a purposive and random sampling procedure was applied in selecting AMCOS from the intended districts. In the first stage, purposive sampling was applied in selecting districts (normally this was considered for those districts with high coffee growing). Four districts were selected namely Mbinga, Mbeya, Rungwe, and Mbozi. The second stage was a random sampling applied in selecting wards. Then, in the third stage, random sampling was applied to the selection of AMCOS. All these stages involved collaboration with the district Cooperative Assistance Registrar (at the regional office) and district cooperative officers in respective districts. Finally, from the list of AMCOS developed in the third stage, a required sample size of respondents was proportionally obtained from each AMCOS. Farmers who were selected are those with at least two years of experience in coffee growing.

6.3. Sample Size Determination

Therefore, determining the sample in line with the level of precision and confidence level is as explained in the equation below: -

$$S = \frac{X^2\ NP(1-P)}{d^2(N-1)+X^2P(1-P)} \quad (1)$$

where S = Sample size, X=z value (assumed to be 1.96 for 95% confidence interval), N= Population size, P = population proportional (assumed to be 0.5 since is provides the maximum sample size), d= degree of accuracy (5%), expressed as proportional (0.05). Accordingly, Mbozi districts consist of 1,970 coffee growers, Mbinga, 2,813 coffee growers, Mbeya DC consists of 1,070 coffee growers, and Rungwe 1,082 coffee growers making a total of 3,635 target coffee growers.

$$n = \frac{1.96^2 \text{ x } 6935 \text{ x } 0.5\text{x } 0.5}{0.05^2(6935-1)+1.96^2\text{x}0.5\text{x}0.5} = 364$$

Therefore, the targeted sample size was at least 364 from all selected districts.

6.4. Data Collection Methods

The study used both primary and secondary data sources to complement information required to answer the objective of the study. The researcher therefore applied three important complementary methodologies such as the desk review, group discussions and key informant interview.

A desk review for obtaining secondary data involved reviewing various reports from reputable institutions such as Tanzania Coffee Board (TCB), International Coffee Organization (ICO) and Bank of Tanzania (BOT) various reports. This was done to examine the global and local development of coffee industry, understand the local and global coffee marketing structure, identify coffee production, understand the potential opportunities of global and local coffee industry and possible ways in addressing coffee challenges.

Primary data were sourced from sample of respondents using the interview and the structured questionnaire for farmers and observation from 34 villages from the selected districts. The primary data include information such as socioeconomic characteristics and information on the input used by farmers in production. The questionnaire specifically targeted coffee growers who had been active for the last two seasons.

Data from key informants such mainly district cooperative officers were also collected using a checklist questionnaire. The coverage of multiple sources of information helped to verify information obtained from different sources selected by the researcher.

6.5. Data Processing and Analysis

Data were coded, summarized, and analysed using Statistical software for Social Science Software version (SPSS) version 13. The socioeconomic characteristics of the sampled coffee farmers were analysed using descriptive statistics and summarised and presented in percentage, frequency, mean, and standard deviation. The regression analysis was performed to determine factors affecting coffee production. For qualitative data, Excel was used for analysis and tracking themes in qualitative data obtained from focus discussions and in-depth interviews.

7. Statistical tool and Econometric Model

The regression analysis mode was applied to estimate predictors of coffee production and marketing among the coffee smallholder farmers in the study area. This method has been widely used by researchers to estimate the relationship between dependent and independent variables. To obtain a special view on the factors constraining coffee production and among coffee smallholders' farmers, a multiple regression was done to find out how independent variables could be used to predict the level of coffee production output performance. Some important variables were taken on the basis of perceptions.

Multiple regression model of the form bellow was used,

$$Y=\beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\ldots\ldots\beta_8X_8+\ \mu \quad (2)$$

Where, Y is the dependent variable which is the level of coffee output production and *X1, X2, X3..... X8* are the independent variables. β0 is the intercept term and *β1, β2, β3, ... β8* values are the regression coefficients and μ is the error term.

The model in this study are as follows: -

$$CPO = \beta_{0+}\beta_1 FE + \beta_2 PD + \beta_3 IR + \beta_4 PW + \beta_5 HC + \beta_6 EX + \beta_7 IN + \beta_8 LF + \mu \quad (3)$$

Where: CPO is the dependent variable (Coffee production output) and FE, PD, IR, PW, *HC*, *EX*, *IN*, *LF*) are independent variables representing = fertilizer application, pesticide and disease control, irrigation infrastructures, timely pruning and weeding, hybrid coffee varieties, extension services, inadequate infrastructure and loans from financial institutions, respectively.

8. Results and Discussion

8.1. Descriptive Statistics

Findings are presented in the context of age, sex, education level, location of the respondent, land size possession, and experience in coffee growing (Table 4).

From Table 4, in assessing the age of the respondents engaging in coffee production the large number of farmers who were aged in coffee production were ranging between 36 years to 60 years of age, while farmers with age 60 years old and above were 22% of the total sample. Males were more than three-thirds of the total sample. The highest level of education reached was normally distributed implying that, all farmers involved in the study had completed at least primary education level and therefore were able to read and write. Furthermore, the majority (88.7%) had small plots of less than 5 acres. The summary statistics further showed that 84.6 % of the coffee farming households are involved in coffee production activities, signifying a large population in the study area coffee growing is the main driver for their livelihood. The large proportion of respondents was found to have enough experience (16 years and above) in coffee production in the study areas.

Table 4. *Sample characteristics.*

	Frequency (n)	**Percent (%)**
Age of respondent		
Below 18	46	11
18-35	73	17
36-60	211	50
60 and above	93	22
Sex of Respondent		
Male	358	84.6
Female	65	15.4
Education level of respondent		
Primary education and below	241	57.0
Secondary	89	21.0
Certificate	75	17.7
Diploma and Degree	18	4.3
Location		
Mbeya DC	77	18.2
Mbinga	137	32.4
Mbozi	188	44.4
Rungwe	21	5.0
Land		
Less 5 acres	375	88.7
5-10	28	6.6
10-15	18	4.3

	Frequency (n)	Percent (%)
15 and above	2	0.5
Experience in coffee growing		
1-5	78	18.4
6-10	93	22.0
11-15	78	18.4
16 and above	174	41.1
Limited access to finance	102	24.1

Source: Author's Computation (2023)

Access to financial support through loans from FIs is very important for increasing production output and crop quality as it is needed for purchasing farm inputs such as fungicides, insecticides, and fertilizers. However, during the study it was observed that, small-scale farmers have limited access to finance through loans.

The study confirms this as 24.1 percent of the total respondents mentioned access to loans from FIs as a challenge to production. This is due to hard conditions on obtaining loans from commercial banks as smallholder farmers regarded to be riskier for loan recovery. Limited access to finance through borrowing has mainly explain by high-borrowing costs, lack of collateral or security to pledge for a loan, and shortcake of cash flow due to poor savings habits by small-scale farmers.

8.2. Application of Agronomic Practice

The production and productivity of coffee can be improved by using improved agronomic and best management practices.

However, the performance in terms of yield was extremely low with an estimation of 1kg per tree per crop season. This was explained by poor agronomic practices by the majority of smallholder farmers. Of the total respondents (66.0%) responded not to apply organic and industry fertilizers such as Urea, (Calcium Ammonium Nitrate (CAN), Ammonium Sulphate (SA) and Di-Ammonium Phosphate (DAP) to their coffee farms (Table 5). This was contrary to our expectations as it was expected to see the use of fertilizers at the required level increase as the availability of fertilizer with subsidized prices by the government.

The study also indicates that the large number of the respondent were not applying agrochemicals such as Red copper and Byton in controlling fungicides. This was exhibited as only 36.9% of the respondents agreed to apply agrochemicals to manage specific weeds, pests, or disease-causing organisms. The reason not to practice agrochemicals application was mainly on account of high costs in purchasing such inputs and hence made some farmers purchase less inputs.

Table 5. *Implementing Improved Agronomic Practice.*

	Response %		
	Agree	Disagree	Not sure
Application of fertilizer	32.3	66.0	1.7
Pesticides and diseases control	36.9	58.2	4.9
Timely wedding and pruning	91.1	4.0	4.9
Availability of extension services	25.9	70.9	3.2
Supportive infrastructure such as roads	22.0	75.8	2.2
Presence of irrigation infrastructure	28.6	69.6	1.7
Replacement of egged coffee trees with high yield coffee tress	69.6	28.6	1.7

Source: Author's Computation (2023)

Besides agrochemical application, timely weeding and pruning are assumed to be a determinant of enhancing coffee harvest. From the findings, it was found that the majority of farmers are aware of the importance of timely weeding and pruning. This is because, majority of respondents were punctual in timely weeding and pruning with 91.1 % agreeing that, it is normally done at an appropriate time.

Availability of extension services are long-term goal that the government set for agriculture sector development. However, in the coffee sector, the results from the study show that about 70.9% of the respondents agreed that the unavailability of extension services is a critical challenge. Small-scale holder's farmers claimed that, throughout the crop season, they were not visited by extension officers and they remained with their traditional way and their own experience in coffee production.

In the study area, infrastructure facilities observed to be very limited. All weather roads heading to production farms cover few kilometres and during the reins they are impassable. This is because 75.8 % of the respondents were agreed that, infrastructures such as roads are inadequately maintained and pose difficulty in crop transportation especially during the rainy season.

The decline in rainfall and unpredictable rainfall patterns in the study areas has been explained to affect crop production as well due to low rainfall. This has resulted in the premature fall of coffee flowers and beans. This challenge can be only resolved by applying an irrigation system to ensure production throughout the year. However, the unavailability of irrigation infrastructures was reported as a production problem by 69.6% of the total respondents to be affected by the unavailability of irrigation infrastructures around their farms. The irrigation system was found to be a large problem despite the presence of potential in the construction of irrigation systems in their farms such as rivers.

From the field study, it was observed that appropriate measures have been taken by farmer's cooperatives Unions to place farmers in advantageous positions to improve productivity and crop quality. Farmers were given new and improved seeds that could yield more products, and resist disease hence ensuring quality production. This support was made possible by Tanzania Coffee Research Institute (TaCRI) providing free of charge new varieties of coffee seedlings to AMCOs to support farmer's groups to use improved coffee varieties (Figure 4).

Source: Fieldwork, 2023

Figure 4. *Modern Seedlings Nursery.*

8.3. Econometric Model Results for Coffee Production

The findings (Table 6) from the study showed that, variation in the independent variables could account for variation of dependent variable which is the level coffee production output by 17.2% calculated from the coefficient of determination, which is 0.30. With this findings, the independent variables are good predictors of the coffee production output in Tanzania. As displayed in (Table 6) the coefficient of R is 0.172 suggesting that, 17.2% changes of coffee production output are explained by the various independent variables used in the model and the rest of 82.8% changes is due to other determinants not including in the model.

Table 6. *Model summary of regression analysis.*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.172[a]	.030	.005	.410

Predictors: (Constant), fertilizer application, Pesticide and disease control, Irrigation infrastructures, timely pruning and weeding, hybrid coffee varieties, extension services, inadequate infrastructure and loans from financial institutions.

Source: Author's Computation (2023)

Table 7. *Regression coefficient.*

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	1.135	.140		2.869	.000
Fertilizer application	.033	.061	.029	0.544	.004
Pesticides and diseases control	.018	.038	.025	0.468	.003
Availability of irrigation infrastructure	.003	.047	.004	.068	.035
Timely pruning and weeding	.103	.047	.116	2.165	.031
Replacing old /aged coffee trees with hybrid coffee varieties	.203	.097	.112	2.084	.004
Availability of extension services	.046	.056	.044	.828	.008
Transport infrastructure such as roads	.008	.053	.008	.150	.051
Loans from financial institutions	.002	.038	.002	.043	.066

Dependent Variable: Coffee production output
Source: Author's Computation (2023)

From the findings (Table 7) we have the following workable model: -

$$CPO = 1.135 + 0.033FE + 0.018PD + 0.003\ IR + 0.103PW + 0.020HC + 0.046EX + 0.008\ IN + 0.002\ LF$$

The coefficients used in developing the model regression equation were derived from the regression coefficients table (Table 7).

From the total of eight variables estimated to constrain coffee production output, all except irrigation infrastructures and pruning and weeding are found to be factors that considerably affect coffee production output level. Organic fertilization application, pests, and diseases control, replacing old /aged coffee trees with hybrid coffee varieties, availability of extension services, adequate infrastructure such as roads, and availability of loans from financial institutions are statistically significant at the level of 5% (Table 7). The results suggest that coffee farmers who practice agronomic practices have high probability to increase their coffee production output than those who are not applying agronomic practices. Therefore, with these findings, the independent variables are good predictors of the coffee output production enhancement in Tanzania.

The coefficient of organic fertilizer application is positive and significant (0.033) implying that a 1% increase in proper organic fertilizer application, increases coffee production output by 3.3% ceteris paribus. This is because coffee is considered a more nutrient-consuming plant, hence proper application of fertilizers (either organic or inorganic) is assumed to favour coffee productivity.

The findings also indicated that an infestation of coffee diseases due to poor pesticide and disease control has a positive coefficient (0.018) and is statistically significant at P<=0.000. This results implies that, with pesticides and disease control, as increases by 1% level the coffee output production increases by 1.8%. The findings support the proposition that pesticides and diseases affect significantly the productivity level of coffee. The application of fungicides which are used to control diseases was explained by farmers its prices are high and the majority of farmers fail to purchase and apply the right quantity at the recommended rate and time.

The finding also indicated that the coefficient of timely pruning and weeding is positive (0.103) but not statistically significant at a 5% level, tends to increase coffee production output, ceteris paribus. The findings imply that, smallholder farmers pursuing timely pruning and weeding (the common practice takes place when weeds are not longer than 10cm, and pruning is done immediately after harvest) causes an increased yield and therefore they can enhance productivity and production.

The coefficient of replacing old coffee trees with hybrid coffee varieties is positive (0.203) and statistically significant at 5%. This indicated that, replacing and planting hybrid coffee varieties contribute to enhancement of coffee production output. According to Mhando, [9], the poor distribution of hybrid seedlings which has been caused by a lack of political will has resulted in coffee production in Tanzania not reaching its potential at its optimum production level.

The coefficient of availability of extension services, (0.046) depicts that a 1% increase in the provision of extension ser-

vices tends to increase the coffee production output by 4.6% keeping other variables constant. This suggests that improvement in coffee production level requires the availability of extension services to smallholder farmers to speed up the proper agronomic practices. This finding supports the results indicated by Andrew & Philip [1] who suggest shortage of extension services among others constituted the major problem that faced coffee producers and has been the main factor for low production. Hence, farmers in the study areas still have the chance to enhance coffee production if proper extension services are available at the appropriate time.

The analysis of factors constraining coffee production output found that poor infrastructure such as roads from farmers' residences to their corresponding coffee farm plots would reduce coffee production output. This is exhibited as the coefficient of adequate infrastructure such as roads is positive (0.008) indicating that a 1% improvement in infrastructure including roads tends to increase the production output by 0.8 % ceteris paribus. This depicts that, with improved infrastructures, it is easier for farmers to access and take inputs to the farm and the transportation of produce from the farm thereby increasing production. Lack of infrastructure has been explained to be a major constraint for coffee production in most of developing countries. The same result was revealed by Degaga, [3] in his study conducted in Ethiopia.

Another variable found to have an expected sign being positive and significant is the availability of loans from financial institutions with 0.002 indicating that 1% of increases in coffee production output is associated with a 0.2% increase in loans from financial institutions such as banks keeping other factors constant. In other words, availability and affordable loans from commercial banks and other financial institutions support farmers to expand their production output.

9. Summary and Conclusion

The main objective of this study was to assess in-depth and understand key constraints that dwarf coffee production in Tanzania; while also drawing lessons based on experiences around the globe.

The descriptive statistics analysis reveals that the majority of coffee growers are those who own small plots of less than an acre and not more than 5 acres (88.7%) and are normally found to apply their traditional way of coffee growing due to inadequate extension services. Meanwhile, small-scale coffee growers are constrained by the availability of capital due to improper financial support especially loans for purchasing farm inputs such as fungicides, insecticides, and fertilizers. However, access to loans was highly explained by smallholder farmers as a critical problem for their farm operations and expansion of production. Only 24.1% of the total respondents had access to loans from FIs' due to the hard conditions on obtaining loans imposed and the high interest rates charged as small holder famers regarded to be riskier for loan recovery. Therefore, credit service on good terms to coffee growers must be available for them to carry out value addition activities and earn a higher level of profit.

Given that, Tanzania has a favorable climate for coffee production, the country is at a great advantage using the existing potential to expand the production. However, proper agronomic practices are much needed as the results from the study found that, for those farmers applying proper agronomic practices have a large probability of enhancing coffee production.

For this reason, an improvement of coffee production output and quality plight in the study area requires intensive government intervention to train small scale farmers on the importance of applying the best agronomic practices across the value chain including the use of farm inputs to increase crop harvest and export growth.

To attain this goal, necessary extension programs must be considered including educating small holder famers on the importance of applying proper agronomic practices such as the use of required quantity of fertilizers, timely weeding, and pruning, use of agrochemicals for controlling coffee berry diseases provision of transportation infrastructures and irrigation systems where necessary.

More importantly, coffee seeds and seedlings must be of the best appropriate cultivar quality.

Quality and productivity improvement must be addressed at all levels. To achieve this, here is a dire need for training farmers in skills needed to sample coffee plantations so that only productive plants are retained and or replaced by improved seed at appropriate times. Moreover, agricultural extension officers need to train farmers to maintain the age of coffee plants at the economically productive stage to ensure stable yield which may enhance coffee export growth.

Given the importance of rapid transit of coffee, the road authorities such as (Tanzania Rural Road Agency (TARURA) and local government authorities should open rural access roads all-weather by rehabilitation and building bridges and culverting to allow easy transport of coffee from production farms to warehouses and auctions.

Abbreviations

AMCOS: Agricultural Marketing Cooperate Society
BOT: Bank of Tanzania Various Reports
CAN: Calcium Ammonium Nitrate
CIDS: Coffee Industry Development Strategy
CPU: Central Pulpery Unit
DAP: Di-Ammonium Phosphate
EU: European Union
FIs: Financial Institutions
ICO: International Coffee Organization
IMF: International Monetary Fund
MT: Metric Tonnes
SA: Ammonium Sulphate
SAP: Structural Adjustment Program
SPSS: Statistical Software for Social Science Software

TaCRI: Tanzania Coffee Research Institute
TARURA: Tanzania Rural Road Agency
TCB: Tanzania Coffee Board
USD: United State Dollar
WRS: Warehouse Receipt System

Author Contributions

Raphael Mbunduki is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of Interest.

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