Pelita Perkebunan 42(2) 2026, 75–88
DOI: 10.22302/iccri.jur.pelitaperkebunan.v42i2.759
ISSN: 0215-0212 / e-ISSN: 2406-9574

Linking Cocoa Production Specialization with Consumption Forecasts to Assess Global Supply and Demand Dynamics

Rizky Yanuarti[1*)], Dani Widjaya[1)], Mohammad Rondhi[1)], Orawan Srisompun[3)] Joni Murti Mulyo Aji[1)], Anik Suwandari[1)], Rokhani[2)], Julita Hasanah[1)], and Cindera Rossa Damascena[1)]

[1)]Agribusiness Study Program, Faculty of Agriculture, University of Jember, Jl. Kalimantan, Tegalboto, Jember, Indonesia.
[2)]Agricultural Extension Study Program, Faculty of Agriculture, University of Jember, Jl. Kalimantan, Tegalboto, Jember, Indonesia.
[3)]Department of Agricultural Technology, Faculty of Technology, Mahasarakham University, Thailand.
[*)]Corresponding author: rizkyyanuarti@unej.ac.id
Received: 15 June 2026 / accepted: 10 August 2026

Abstract

Cocoa plays a strategic role in the global agricultural economy, yet cocoa-producing regions do not necessarily represent the main centers of cocoa consumption. This study analyzes the relationship between cocoa production specialization and consumption dynamics across Africa, America, and Asia. Location Quotient (LQ) analysis was used to identify countries where cocoa functions as a base agricultural subsector, while autoregressive integrated moving average (ARIMA) models were applied to forecast future cocoa consumption trends. Data from the Food and Agriculture Organization (FAO) indicate that Africa remains the dominant cocoa-producing region, followed by America and Asia, although production growth patterns vary across countries. The LQ results show that cocoa is a base subsector in selected countries within each region, with particularly strong specialization in several American and African countries. In Asia, cocoa specialization is more limited, with Indonesia and Timor-Leste standing out as notable cases. Despite Africa's dominance in production, its per capita cocoa consumption remains the lowest among the three regions, reflecting the export-oriented structure of its cocoa sector. The Kruskal–Wallis test confirms significant regional differences in cocoa consumption patterns. ARIMA forecasts indicate relatively stable consumption in America, moderate growth in Africa, and stronger growth potential in Asia. By combining LQ and ARIMA, this study distinguishes between regions that are specialized in cocoa production and regions with expanding consumption demand. The findings provide useful insights for cocoa trade planning, agricultural policy, and sustainable supply-chain development.

Keywords: Cocoa production; cocoa consumption; location quotient; ARIMA; production specialization; consumption forecasting

INTRODUCTION

The agricultural sector represents a cornerstone of the global economy, underpinning the sustenance and livelihood of billions around the globe (Feldman & Biggs, 2012; Pawlak & Kołodziejczak, 2020). The agricultural subsector consists of many commodities which crucial for human life, particularly in developing countries and countries in the Asian continent. Staple food commodities such as rice, corn, wheat, etc., hold a significant position in meeting daily human consumption needs (Grote *et al*., 2021; Rusdi, 2023). In addition to the food crops subsector, another equally important subsector for supporting the global economy is the plantation subsector. Some plantation

commodities with valuable market prices in international trade include cocoa.

Cocoa occupies a unique and significant position in the global market, driven by its indispensable role in the production of chocolate and a variety of other food and cosmetic products (Krauss & Barrientos, 2021; Neilson *et al*., 2018). As a commodity, cocoa is primarily grown in the equatorial regions of the world, with West Africa, particularly Côte d'Ivoire and Ghana, leading global production (Merem *et al*., 2020). These countries, along with others like Ecuador, Nigeria, and Cameroon, contribute to the majority of the world's cocoa supply, making the crop a vital component of their economies (Tsowou & Gayi, 2019).

The global market for cocoa is characterized by its volatility, with prices influenced by a variety of factors including weather conditions, political stability in producing countries, and changes in global demand (Hoffmann *et al*., 2020). The demand for cocoa is largely driven by the confectionery industry, which is sensitive to changes in consumer preferences and economic conditions (Neilson *et al.*, 2018). In recent years, there has been a growing interest in premium, sustainably produced cocoa, reflecting broader trends towards environmental sustainability and social responsibility in global consumption patterns.

Cocoa's position in the global market is also shaped by its supply chain dynamics. The majority of cocoa is produced by smallholder farmers (Abbott *et al*., 2018), who often face challenges such as limited access to markets, fluctuating prices, and the impacts of climate change. These factors can lead to significant disparities in income and living conditions for farmers, highlighting the importance of sustainable sourcing practices and investment in agricultural development in cocoa-producing regions.

Furthermore, the global cocoa market is influenced by major chocolate producers and confectionery companies, as well as by policies and initiatives aimed at promoting sustainable production practices. Initiatives such as the Cocoa & Forests Initiative and the International Cocoa Organization's work are examples of efforts to improve the sustainability of cocoa production and address challenges such as deforestation, child labor, and farmer poverty. In recent years, the global cocoa market has seen shifts towards greater transparency and sustainability, with consumers increasingly aware of and concerned about the origins and production conditions of the cocoa in their chocolate products. This has led to greater emphasis on certified cocoa, which meets certain environmental and social standards, and direct trade practices that aim to ensure a fairer distribution of profits along the supply chain.

However, it is important to understand cocoa dynamics as it plays a pivotal role of the global commodities market. Given this context, it becomes imperative to map out which countries and continents are considered cocoa bases and which are not. This endeavor is not only crucial for grasping the current landscape of cocoa production but also for identifying the potential of various regions to become future cocoa powerhouses. Existing FAO-based studies on cocoa largely remain descriptive and lack integrated, forward-looking analysis. This study advances the literature by jointly applying Location Quotient (LQ) and ARIMA models at a global comparative level to identify cocoa base countries and dynamic production trends, revealing structural mismatches between production concentration and global market dynamics. The findings provide evidence-based insights to inform sustainability transitions in global cocoa markets.

MATERIAL AND METHODS

This study adopts a quantitative descriptive methodology, utilizing a descriptive approach to elucidate the variables under investigation through comprehensive definitions and detailed descriptions drawn from various sources. The descriptive method employed in this research entails elucidating the production data of various plantation commodities across the continents of Africa, America, and Asia. The quantitative aspect of the study involves the collection of production data from eight plantation commodities: coffee, cocoa, pepper, rubber, tea, cloves, coconut, and sugarcane. Data for the research is sourced from the Food and Agriculture Organization (FAO) website for the years 2017-2022, encompassing the output of each commodity measured in tons for a given year. Subsequently, the collected data undergoes analysis using the Location Quotient (LQ) methodology.

The Location Quotient (LQ) analysis is used to identify base and non-base sectors, serving as an initial step in understanding the growth of a sector in a specific region. Essentially, this technique provides a relative comparison between the capabilities of a sector in the investigated area and the capabilities of the same sector in a broader region (Carroll *et al*., 2008). The theory of economic base is based on the notion that a region must enhance the direct flow from outside the area to grow effectively, namely by increasing exports (González-Pernía & Peña-Legazkue, 2015). The calculation of LQ is used to assess the potential of coffee commodities compared to other plantation sectors across three continents. The formula to find the Location Quotient (LQ) analysis is as follows:

$$LQ = \frac{vi/vt}{Vi/Vt}$$

Explanation:

vi : Total production of cocoa in a country
vt : Total production of cocoa in a continent
Vi : Total production of 8 plantation commodities in a country
Vt : Total production of 8 plantation commodities in a continent

From the formula, the calculation results are obtained with the following classification:

a. LQ > 1 means that cocoa is the leading subsector in the country and has the potential to be developed as a driver of the continent economy.

b. LQ < 1 means that cocoa is not a leading subsector in the country and has less potential to be developed as a driver of the continent economy.

Kruskall Wallis employed to understand whether or not there is significant difference in the cocoa consumption per capita from three continent. The data obtained from Food and Agricultural Organization (FAO) 2024 covering 1961-2021. The examination on cocoa consumption is intensify by utilizing autoregressive integrated moving average (ARIMA) model. ARIMA which is given by Box and Jenkins (1976), is used for modelling and prediction of cocoa consumption per capita data from three continents. Building an ARIMA model involves four key stages: identification, estimation, diagnostic checking, and application or forecasting. In the identification stage, the goal is to enhance the stationarity and normality of the data, and the general structure of the model is determined. During the estimation stage, the model parameters are calculated using the maximum likelihood method. Diagnostic checks are then conducted to identify any shortcomings and select the optimal model. The time needed to model a particular problem effectively is variable. To identify the best-fitting model, it's necessary to evaluate the autocorrelation and partial autocorrelation functions of the differenced data (Praveen & Sharma, 2020).

RESULTS AND DISCUSSION

Geographical Overview of Cocoa

Insights into the key cocoa-producing regions in Africa, America, and Asia determined by employing Location Quotient Analysis (LQ). Location Quotient (LQ) analysis is a statistical tool used to assess the concentration of a particular industry, sector, or activity within a specific region compared to a larger reference area, typically a nation or state. By using LQ, regional economic specialization and competitive advantages identification can be made. This study compares the potential of cocoa with several other commodities such as coffee, pepper, rubber, tea, cloves, coconut, and sugarcane.

Figure 1 shows cocoa production trend from three continents with data from Food and Agricultural Organization (FAO) 2024. Cocoa production from three continents during the years of 2010-2022 experienced positive and upward trends. Africa ranked first in terms of cocoa production. The highest cocoa production occurred in 2021 and 2022 reaching more than 4 million tons. Production trend of cocoa trending to rise with R^2 value 0.9387. Similarly, production trends in America experience positive trends with R^2 value 0.9543. Meanwhile in Asia, even though there is positive trend with R^2 value 0.0774 but the production within the years is dynamic. The highest production record was in 2010 with 0.8 million tons, then experienced decline up until 2017 but manage to increase its production in 2018-2022. Positive production trend indicates that the region has great ability to increase its economic growth with cocoa.

Completing cocoa production insight with LQ, Table 1 shows the analysis for each continent. LQ analysis is used to assess the significance of a sector (cocoa production) in a country relative to the role of the cocoa sector at the continental level or the role of the cocoa sector in a continent relative to the global level. Based on Table 1, it can be observed that the cocoa sector in each continent (Africa and America) has LQ values > 1. The highest LQ value is found in the America, specifically at 9.32. An LQ value > 1 indicates that the cocoa sector is a leading subsector on that continent and can drive the global economy. Detailed LQ analysis for each continent must be done to get broad understanding of cocoa producing countries.

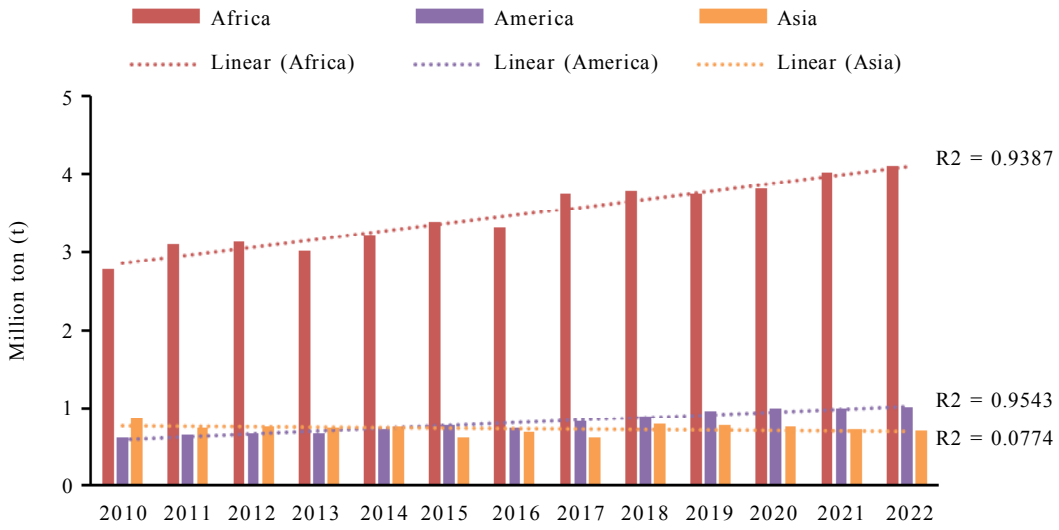

Figure 1. Cocoa production from three continents 2010 – 2022

Source: Secondary data processed, 2026.

Each continent has a different number of countries producing plantation commodities such as coffee, cocoa, pepper, rubber, tea, cloves, coconut, and sugarcane. Africa has 32 producing countries, America has 33 producing countries, and Asia has 32 producing countries. Some countries have an LQ value of 0, which can occur when the country does not produce cocoa during the period from 2017 to 2022. Based on Table 2, it is known that there are 7 countries (21.88%) with LQ values > 1, indicating that cocoa is the leading subsector in those countries and has the potential to be developed as a driver of the continent's economy. Meanwhile, there are 25 countries (78.13%) with

Table 1. Results of LQ calculations for cocoa commodities from various continents

Continent	2017	2018	2019	2020	2021	2022	Average	Criteria
Africa	1.78	1.78	1.63	1.69	1.54	1.48	1.65	Base
America	10.54	10.48	9.38	8.75	8.38	8.39	9.32	Base
Asia	0.70	0.72	0.75	0.67	0.66	0.70	0.70	Non Base

Source: Secondary data processing, 2026.
Note: Base: cocoa is the leading subsector in the country; Non-Base: cocoa is not a leading subsector in the country.

Table 2. Results of LQ analysis of cocoa from African countries

Country	2017	2018	2019	2020	2021	2022	Average	Criteria
Angola	0.02	0.02	0.02	0.01	0.01	0.01	0.02	Non Base
Benin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Burkina Faso	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Burundi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Cabo Verde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Cameroon	5.30	5.70	5.53	5.15	5.13	5.12	5.32	Base
Central African Republic	0.03	0.02	0.01	0.01	0.01	0.01	0.01	Non Base
Chad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Comoros	0.01	0.01	0.01	0.01	0.01	0.01	0.01	Non Base
Congo	0.14	0.19	0.21	0.29	0.59	0.72	0.36	Non Base
Côte d'Ivoire	11.89	11.93	12.13	11.98	10.79	10.33	11.51	Base
Democratic Republic of the Congo	0.18	0.23	0.26	0.27	0.20	0.22	0.23	Non Base
Djibouti	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Egypt	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Equatorial Guinea	2.08	0.00	1.97	1.96	1.14	1.84	1.50	Base
Eswatini	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Ethiopia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Gabon	0.01	0.02	0.01	0.01	0.01	0.01	0.01	Non Base
Ghana	16.48	14.86	15.70	15.21	16.03	15.84	15.69	Base
Guinea	1.26	4.06	1.14	1.00	0.95	0.97	1.56	Base
Guinea-Bissau	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Kenya	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Liberia	0.84	0.10	0.97	1.34	1.47	1.30	1.00	Base
Madagascar	0.09	0.11	0.09	0.11	0.10	0.12	0.10	Non Base
Malawi	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Mali	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Mauritius	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Morocco	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Mozambique	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Namibia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Niger	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Nigeria	3.24	3.59	3.39	4.58	3.48	3.46	3.62	Base
LQ > 1							7	
LQ < 1							25	
Percentage LQ > 1							21.88	
Percentage LQ < 1							78.13	

Source: Secondary data processing, 2026.
Note: Base: cocoa is the leading subsector in the country; Non-Base: cocoa is not a leading subsector in the country.

LQ values < 1, meaning that cocoa commodities in those countries have not been able to become a leading subsector to boost the economy of the African continent. Côte d'Ivoire and Ghana show highest LQ values, indicating good potential for these countries to develop cocoa agriculture as a support for the global economy. This is in line with research findings stating that Côte d'Ivoire and Ghana is classified as a cocoa base country in Africa (Abu *et al*., 2021).

The continent of America has 12 countries with LQ values > 1 (Table 3), equivalent to 36.36%, while the remaining 63.63% have LQ values < 1. The country with the highest LQ value is Saint Vincent and the Grenadines, at 78.92. The high LQ values in some American countries, such as Dominica, Grenada, and small island nations like Saint Vincent and the Grenadines, can be attributed to the relatively small denominator (i.e., the total production of other plantation commodities in

Table 3. Results of LQ analysis of cocoa from American countries

Country	2017	2018	2019	2020	2021	2022	Average	Criteria
Argentina	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Bahamas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Barbados	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Belize	0.18	0.07	0.07	0.08	0.09	0.08	0.09	Non Base
Bolivia (Plurinational State of)	0.78	0.70	0.65	0.60	0.57	0.58	0.65	Non Base
Brazil	0.38	0.37	0.37	0.37	0.41	0.36	0.38	Non Base
Colombia	4.50	3.27	3.14	1.76	1.85	1.68	2.70	Base
Costa Rica	0.16	0.15	0.21	0.19	0.19	0.19	0.18	Non Base
Cuba	0.02	0.09	0.11	0.12	0.14	0.13	0.10	Non Base
Dominica	77.99	78.57	73.45	71.15	67.28	67.31	72.62	Base
Dominican Republic	17.97	15.65	15.13	13.86	11.54	11.93	14.35	Base
Ecuador	27.40	34.76	31.80	29.98	25.39	40.35	31.61	Base
El Salvador	0.06	0.06	0.05	0.05	0.05	0.05	0.05	Non Base
Grenada	59.88	66.36	53.44	50.74	51.06	30.16	51.94	Base
Guatemala	0.56	0.47	0.41	0.43	0.44	0.43	0.46	Non Base
Guyana	0.32	0.45	0.45	0.41	0.37	0.42	0.40	Non Base
Haiti	2.01	2.48	2.89	1.37	1.31	0.65	1.78	Base
Honduras	0.23	0.29	0.18	0.19	0.19	0.17	0.21	Non Base
Jamaica	0.30	0.24	0.41	0.32	0.50	0.36	0.36	Non Base
Mexico	0.58	0.56	0.50	0.55	0.49	0.48	0.53	Non Base
Nicaragua	1.13	1.07	1.09	1.09	1.13	1.24	1.13	Base
Panama	0.33	0.24	0.33	0.28	0.36	0.62	0.36	Non Base
Paraguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Peru	15.21	14.24	13.31	15.02	15.20	16.39	14.90	Base
Puerto Rico	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Saint Kitts and Nevis	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Saint Lucia	2.47	2.03	1.79	1.56	2.70	2.67	2.20	Base
Saint Vincent and the Grenadines	95.36	84.78	78.10	72.81	70.43	72.03	78.92	Base
Suriname	0.04	0.05	0.05	0.05	0.05	0.04	0.05	Non Base
Trinidad and Tobago	32.15	29.92	22.39	17.62	16.70	16.35	22.52	Base
United States of America	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Uruguay	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Venezuela (Bolivarian Republic of)	7.97	8.83	9.17	8.05	7.95	12.20	9.03	Base
LQ > 1							12	
LQ < 1							21	
Percentage LQ > 1							36.36	
Percentage LQ < 1							63.64	

Source: Secondary data processing, 2026.

Note: Base: cocoa is the leading subsector in the country; Non-Base: cocoa is not a leading subsector in the country.

2017-2022), which is limited to only coffee and cocoa. Nevertheless, cocoa production remains a crucial component of these countries' economies, underscoring its significance as a key agricultural commodity. According to Brown *et al*. (Brown *et al*., 2025), the Windward Islands nations (Dominica, Grenada, and Saint Vincent and the Grenadines) are classified as cocoa-exporting countries under Standard International Trade Classification (SITC-1 072). More specifically, Aban (2022) reports in his dissertation that cocoa exports in Grenada experienced a significant increase of up to 74.8% in 2021, thereby contributing to improved economic growth. Additionally, there are four countries in American continent with LQ values = 0, which is because these countries did not produce cocoa during the period from 2017 to 2022.

Based on Table 4, it can be observed that the continent of Asia has the fewest number of countries with LQ > 1 compared to the continents of Africa and America, with only 2

Table 4. Results of LQ analysis of cocoa from Asian countries

Country	2017	2018	2019	2020	2021	2022	Average	Criteria
Afghanistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Azerbaijan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Bangladesh	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Bhutan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Brunei Darussalam	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Cambodia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
China, mainland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
China, Taiwan Province of	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Georgia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
India	0.07	0.06	0.07	0.07	0.07	0.08	0.07	Non Base
Indonesia	14.60	16.30	16.59	15.19	14.93	15.70	15.55	Base
Iran (Islamic Republic of)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Japan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Kyrgyzstan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Lao People's Democratic Republic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Malaysia	0.95	0.79	0.96	0.67	0.57	0.60	0.76	Non Base
Maldives	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Myanmar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Nepal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Oman	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Pakistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Philippines	0.20	0.22	0.28	0.26	0.29	0.35	0.27	Non Base
Republic of Korea	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Singapore	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Sri Lanka	0.43	0.54	0.37	0.33	0.30	0.34	0.39	Non Base
Tajikistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Thailand	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Timor-Leste	6.13	5.05	5.51	4.76	4.68	5.24	5.23	Base
Türkiye	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Uzbekistan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
Viet Nam	0.00	0.00	0.16	0.12	0.14	0.11	0.09	Non Base
Yemen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Non Base
LQ > 1							2	
LQ < 1							28	
Percentage LQ > 1							6.25	
Percentage LQ < 1							93.75	

Source: Secondary data processing, 2026

Note: Base: cocoa is the leading subsector in the country; Non-Base: cocoa is not a leading subsector in the country

countries (6.25%), while the remaining 93.75% have LQ values < 1. Among the countries analyzed, only Indonesia and Timor-Leste have an LQ greater than 1, indicating that cocoa is a base sector in these countries, with an average LQ of 15.55 and 5.23, respectively. This suggests that these two countries produce cocoa in quantities that exceed their domestic consumption needs, likely contributing significantly to export markets. On the other hand, the majority of the countries, such as China, and India, have LQ values of 0.00 or close to zero, classifying them as non-base for cocoa production. These countries either do not produce cocoa at all or produce it in minimal quantities, indicating that cocoa is not a significant part of their agricultural sector or economy. Countries like Malaysia, Philippines, and Sri Lanka have LQ values below 1 but above zero, suggesting some cocoa production activity, though it remains a non-base sector in their economies.

Global Trend Consumption of Cocoa

Cocoa is a highly traded commodity, central to the global chocolate industry, with demand driven predominantly by consumer markets in Europe, North America, and increasingly in Asia. While Africa, particularly countries like Côte d'Ivoire and Ghana, dominates cocoa production, the processing and consumption take place largely in developed countries. The global trade of cocoa involves complex supply chains (Widhiyoga & Wijayati, 2022), where beans are exported from producing nations to be processed into chocolate products elsewhere. Price volatility in the cocoa market is common (Kumar *et al.*, 2022), influenced by factors such as climate conditions, geopolitical issues, and changing consumer preferences (Igbatayo, 2023), especially the growing demand for ethically sourced and premium chocolate (Cadby *et al.*, 2021).

Global demand for cocoa is increasing, as the world continues its insatiable appetite for chocolate products (Beg *et al*., 2017). Demand for cocoa in the three continents can be revealed by analyzing the consumption. Figure 2 shown the consumption data for three continents from Food and Agriculture Organization (FAO). America rank first in term of cocoa consumption despite being second in its production. Conversely, Africa rank lowest in cocoa consumption despite Africa's dominant position in world cocoa production. The continent has been estranged from consuming some of the by-products of cocoa, including chocolate due to some economics constraint such as low economic growth, which made it difficult to access cocoa by product (Squicciarini & Swinnen, 2016).

Kruskal-Wallis analysis was conducted to examine whether there are significant differences (Okoye & Hosseini, 2024) in per capita cocoa consumption across the three continents: Africa, Asia, and America, using secondary data from the FAO. The results, as presented in Table 5, show a chi-square value of 122.399 with 2 degrees of freedom, and a p-value (Asymptotic Significance) of 0.000. Since the p-value is less than the conventional threshold of 0.05, it indicates that the differences in cocoa consumption per capita between these continents are statistically significant. This suggests that cocoa consumption patterns vary significantly across Africa, Asia, and America.

Cocoa consumption patterns vary significantly across Africa, Asia, and America due to several economic, cultural, and industrial factors. Cocoa consumption per capita is relatively high in America and parts of Europe where chocolate products are highly popular (Abt *et al*., 2018). These regions have a long-established chocolate industry, with high consumer demand for a wide variety of chocolate products, and they are home to some of the world's largest chocolate manufacturers. In contrast, Africa, despite being the largest producer of raw cocoa, has relatively

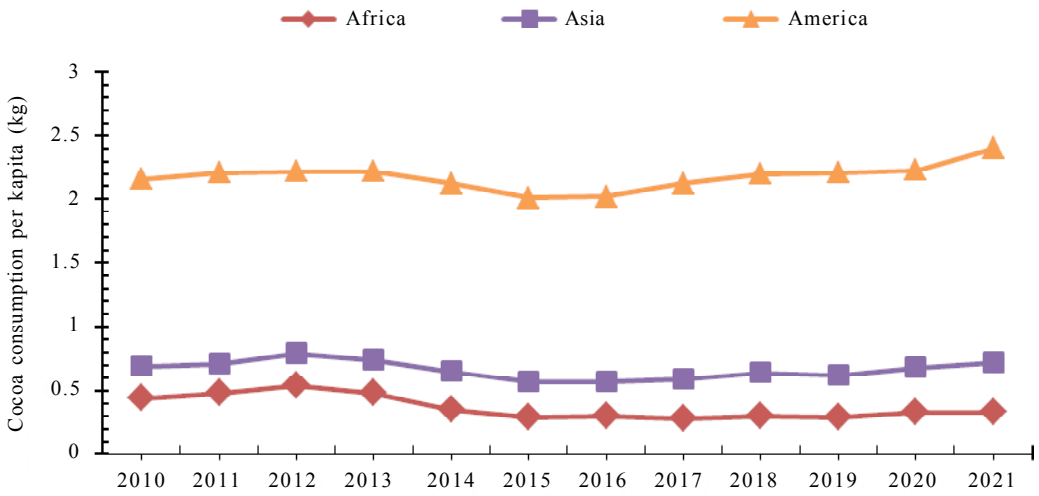

Figure 2. Consumption growth of cocoa bean per capita from three continents (2010-2021).
Source: Secondary data processing, 2026.

Table 5. Result of Kruskall Wallis analysis on cocoa consumption from Africa, Asia, America

Chi-Square	df	Asymp. Sig.
122.399	2	0.000

Source: Secondary data processing, 2026.

low per capita cocoa consumption (Squicciarini & Swinnen, 2016). This is largely because cocoa is primarily cultivated for export rather than for domestic consumption, and chocolate products are less ingrained in African diets due to economic factors, limited processing infrastructure, and lower consumer purchasing power.

Cocoa consumption has historically been lower in Asia but is steadily rising, especially in countries like China, India, and Japan where increasing urbanization, rising incomes, and changing consumer preferences have spurred the growth of the chocolate market (Voora *et al*., 2019). However, consumption in Asia still lags behind America due to traditional dietary preferences (Schottenhammer, 2024) and the relatively recent introduction of chocolate products in certain countries. The differences in infrastructure, economic development, cultural tastes, and the availability of processed cocoa products are key factors that contribute to the significant variation in cocoa consumption patterns across these continents. However, if further examination done by forecasting global consumption of cocoa then consumption trends for several years can be portray. These projections are valuable for informing government strategies aimed at boosting marketing strategy, market penetration, and the widespread cultivation of cacao. The study uses a time series model to predict future values by examining historical trends of the variable. It is crucial to accurately assess the future production potential of crops by analyzing past patterns (Fan *et al.*, 2019). Time series models serve as valuable tools for forecasting agricultural production and supporting the formulation of effective agricultural policies for the future.

This study creates short-term forecasts for cocoa consumption per capita for each continent, which are crucial for effective cacao development and timely policy making. Short-term forecasts are considered more accurate due to smaller error estimates (Duan *et al*., 2021). The study applies the Box-Jenkins

ARIMA model to predict consumption trends in Africa, America, Asia for the upcoming years (2022-2027). The selection of the best model is based on smallest sum of squares residual, Akaike info criterion (AIC), Schwarz criterion (SC), and Hannan–Quinn information criterion (HQC) (Ismaila *et al.*, 2022); and model accuracy is assessed using Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) for predictions (Rabbani *et al.*, 2021). The study identifies ARIMA (1,1,3) for Africa, ARIMA (1,1,2) for Asia, and ARIMA (2,1,3) for America as the best models for forecasting. The most suitable model for consumption per capita for each continent was determined by assessing its goodness of fit, with a focus on minimizing the sum of squares residual, AIC, SC, HC and ensuring a normal distribution of ACF and PACF spikes. Table 6 shows the forecast result of cocoa consumption per capita for each continent.

The forecast results for cocoa consumption per capita from 2021 to 2027, as shown in Table 6, indicate differing trends across Africa, Asia, and America. In Africa, the per capita cocoa consumption is projected to increase slightly from 0.317 kg in 2022 to 0.346 kg in 2027. Although the growth is modest, it shows a slow upward trend. In Asia, a more pronounced increase in cocoa consumption is expected, starting at 0.788 kg in 2022 and reaching 0.958 kg by 2027. This reflects a growing demand for cocoa in the region, likely driven by rising consumer interest and economic growth. Meanwhile, in America, the forecast indicates a stable consumption pattern, with per capita consumption remaining around 1.102–1.103 kg throughout the forecast period. This stability suggests that the American cocoa market is mature, with little fluctuation expected over the next few years. Overall, the forecasts show slow growth in Africa, more substantial growth in Asia, and stability in America, reflecting different stages of cocoa consumption development across the continents.

The ARIMA forecast results for cocoa consumption per capita from 1961 to 2021 across Africa, Asia, and America provide insights into distinct consumption trends for each continent (Figure 3). In Africa (model ARIMA 1,1,3), the forecast shows a gradual decline in cocoa consumption per capita, with the confidence intervals widening over time, indicating growing uncertainty in the future predictions. This suggests a downward trend with increasing variability in consumption patterns. In contrast, the forecast for Asia (ARIMA 1,1,2) shows a steady upward trend in cocoa consumption, reflecting potential growth in demand as urbanization and economic development continue. However, as with Africa, the confidence intervals also widen, indicating increased uncertainty in the long-term forecast. In America (ARIMA 2,1,3), the forecast is relatively flat, indicating stable cocoa consumption over the period, with narrower confidence intervals suggesting that

Table 6. Forecasting of cocoa consumption per capita along with 95 % confidence interval from 2022 to 2027

Year	Forecast result of cocoa consumption per capita (kg)		
	Africa	Asia	America
2022	0.317	0.788	1.103
2023	0.323	0.819	1.102
2024	0.329	0.852	1.102
2025	0.334	0.886	1.103
2026	0.340	0.921	1.103
2027	0.346	0.958	1.102

Source: secondary data analysis, 2026.

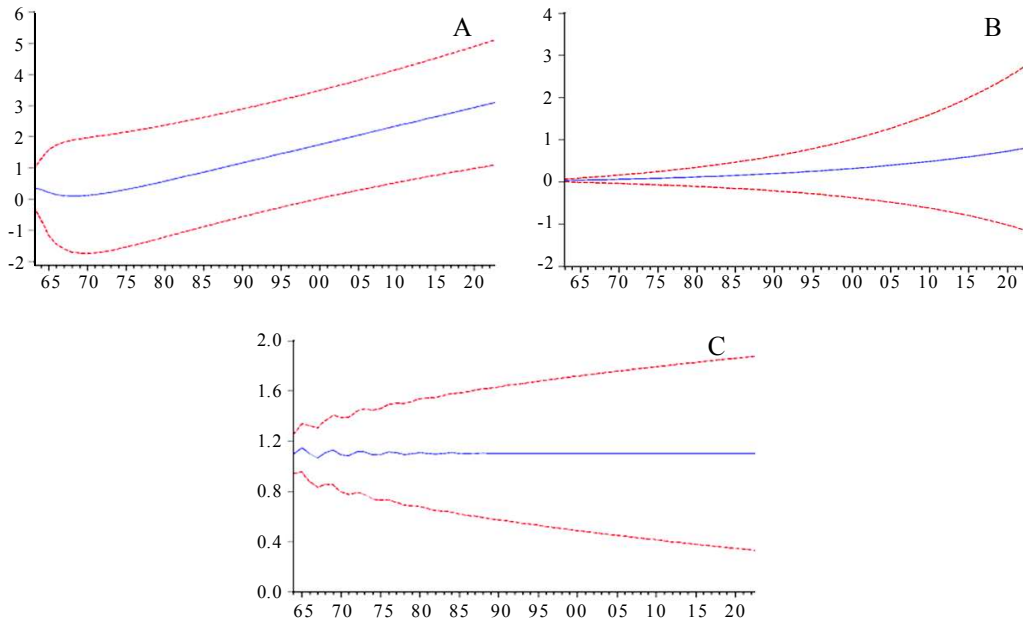

Figure 3. Forecast result of cocoa consumption per capita from (A) Africa, (B) Asia, and (C) America. Blue line: point forecast; Red line: the confidence interval bounds

future predictions are more certain and less volatile. Overall, these results suggest that while Africa may experience a decline in cocoa consumption and Asia a rise, America is likely to see continued stability in consumption trends.

Forecasted trends in cocoa consumption per capita reveal distinct regional differences based on economic development, cultural factors, and market conditions. Africa's modest growth is tied to its export-driven cocoa industry and lower domestic demand (Hashmiu *et al*., 2024). Asia shows the highest growth potential, driven by economic expansion, changing consumer preferences, and increasing chocolate production. Meanwhile, America's stable consumption reflects a mature market with limited room for growth. These results are consistent with broader global trends in cocoa consumption and provide insight into the future dynamics of the cocoa industry in these three regions. This discussion connects the forecasted results with the underlying social, economic, and industrial factors that shape cocoa consumption patterns across the continents.

Moreover, sustainability in the cocoa industry has become a critical issue due to concerns over deforestation, child labor, poor working conditions, and environmental degradation in cocoa-producing regions (Boeckx *et al*., 2020). Efforts are being made to promote more sustainable cocoa production through certification programs like Fair Trade, Rainforest Alliance, and organic farming practices, which aim to improve both environmental stewardship and the livelihoods of smallholder farmers (Middendorp *et al*., 2020). The future outlook for cocoa also includes addressing the impacts of climate change, as rising temperatures and unpredictable weather patterns threaten cocoa yields. Innovations in agroforestry, improved agricultural techniques, and resilient cocoa varieties are seen as necessary steps for

ensuring long-term sustainability. As consumer demand shifts towards more ethical and environmentally conscious products, companies and producers are increasingly pressured to adopt practices that promote sustainability, transparency, and fair treatment throughout the cocoa supply chain.

CONCLUSION

Cocoa production and consumption in Africa, America, and Asia show distinct regional patterns, confirming that production strength does not automatically translate into high domestic consumption. Africa remains the leading cocoa-producing region, but its per capita consumption is relatively low because cocoa production is largely export-oriented and constrained by purchasing power. America shows a stronger alignment between cocoa production specialization and consumption stability, while Asia has lower production specialization but greater potential for future consumption growth. The LQ analysis identifies countries where cocoa functions as a base agricultural subsector, reflecting the spatial concentration of cocoa production capacity, whereas the ARIMA models estimate the temporal trajectory of cocoa consumption. Therefore, these two methods are complementary: LQ explains where cocoa production is economically concentrated, while ARIMA indicates where cocoa consumption is likely to grow. This combined approach helps distinguish cocoa-producing bases from future consumption markets and provides a clearer perspective on global cocoa supply and demand dynamics. The findings indicate that cocoa policy should not rely only on production expansion. Africa requires strategies that improve domestic value addition and consumption while maintaining export competitiveness; America should focus on sustaining productivity and market stability; and Asia requires policies that strengthen supply capacity, processing industries, and market development. Long-term stability in the global cocoa sector will depend on stronger coordination between production specialization, consumption growth, price stability, sustainable farming practices, and equitable trade.

REFERENCES

Aban, K.A. (2022). *A Study Into the Use of Agri-Entrepreneurship to Minimize Unemployment in Rural Grenada*. Benguet State University. La Trinidad, Benguet, Philippines, Thesis.

Abbott, P.C.; T.J. Benjamin; G.R. Burniske; M.M. Croft; M. Fenton; C.R. Kelly; M. Lundy; F. Rodriguez Camayo & M.D. Wilcox (2018). *An Analysis of the Supply Chain of Cacao in Colombia*. United States Agency for International Development–USAID. Cali, Colombia. 208 p.

Abt, E.; J. Fong Sam; P. Gray & L.P. Robin (2018). Cadmium and lead in cocoa powder and chocolate products in the US market. *Food Additives & Contaminants: Part B*, 11(2), 92–102.

Abu, I.O.; Z. Szantoi; A. Brink; M. Robuchon & M. Thiel (2021). Detecting cocoa plantations in Côte d'Ivoire and Ghana and their implications on protected areas. *Ecological Indicators*, 129, 107863.

Beg, M.S.; S. Ahmad; K. Jan & K. Bashir (2017). Status, supply chain and processing of cocoa–A review. *Trends in Food Science & Technology*, 66, 108–116.

Boeckx, P.; M. Bauters & K. Dewettinck (2020). Poverty and climate change challenges for sustainable intensification of cocoa systems. *Current Opinion in Environmental Sustainability*, 47, 106–111.

Brown, J.C.; X. Matschke & J.R. Rojas Rodríguez (2025). International cocoa trading arrangements between industrialized and developing countries 1951–1999: A structural gravity analysis. *Research Papers in Economics*,

No. 2025-12. University of Trier, Department of Economics. Trier, Germany. 58 p.

Cadby, J.; T. Araki & A.H. Villacis (2021). Breaking the mold: Craft chocolate makers prioritize quality, ethical and direct sourcing, and environmental welfare. *Journal of Agriculture and Food Research*, 4, 100122.

Carroll, M.C.; N. Reid & B.W. Smith (2008). Location quotients versus spatial autocorrelation in identifying potential cluster regions. *The Annals of Regional Science,* 42(2), 449–463.

Duan, J.; H. Zuo; Y. Bai; J. Duan; M. Chang & B. Chen (2021). Short-term wind speed forecasting using recurrent neural networks with error correction. *Energy*, 217, 119397.

Fan, C.; Y. Zhang; Y. Pan; X. Li; C. Zhang; R. Yuan; D. Wu; W. Wang; J. Pei & H. Huang (2019). Multi-horizon time series forecasting with temporal attention learning. Proceedings of the 25th ACM SIGKDD International Conference on Knowledge Discovery & Data Mining, p. 2527–2535.

Feldman, S. & S. Biggs (2012). International shifts in agricultural debates and practice: An historical view of analyses of global agriculture. ***In:*** W. Campbell & S. López Ortíz (Eds). *Integrating Agriculture, Conservation and Ecotourism: Societal Influences*, p. 107–161. Springer. Dordrecht.

González-Pernía, J.L. & I. Peña-Legazkue (2015). Export-oriented entrepreneurship and regional economic growth. *Small Business Economics*, 45(3), 505–522.

Grote, U.; A. Fasse; T.T. Nguyen & O. Erenstein (2021). Food security and the dynamics of wheat and maize value chains in Africa and Asia. *Frontiers in Sustainable Food Systems*, 4, 617009.

Hashmiu, I.; F. Adams; S. Etuah & J. Quaye (2024). Food-cash crop diversification and farm household welfare in the Forest-Savannah Transition Zone of Ghana. *Food Security*, 16(2), 487–509.

Hoffmann, M.P.; J. Cock; M. Samson; N. Janetski; K. Janetski; R.P. Rötter; M. Fisher & T. Oberthür (2020). Fertilizer management in smallholder cocoa farms of Indonesia under variable climate and market prices. *Agricultural Systems*, 178, 102759.

Igbatayo, S.A. (2023). Climate change and agroforestry resilience strategy in West Africa's cocoa supply chain dynamics. ***In:*** S. Eslamian & F. Eslamian (Eds). *Disaster Risk Reduction for Resilience*, p. 361–385. Springer. Cham.

Ismaila, A.R.B.; I. Muhammed & B. Adamu (2022). Modelling land surface temperature in urban areas using spatial regression models. *Urban Climate*, 44, 101213.

Krauss, J.E. & S. Barrientos (2021). Fairtrade and beyond: Shifting dynamics in cocoa sustainability production networks. *Geoforum*, 120, 186–197.

Kumar, K.A.; C. Spulbar; P. Pinto; I.T. Hawaldar; R. Birau & J. Joisa (2022). Using econometric models to manage the price risk of cocoa beans: A case from India. *Risks*, 10(6), 115.

Merem, C.E.; A.Y. Twumasi; J. Wesley; D. Olagbegi; M. Crisler; C. Romorno; M. Alsarari; P. Isokpehi; A. Hines & S.G. Ochai (2020). Exploring cocoa farm land use in the West African Region. *International Journal of Agriculture and Forestry*, 10(1), 19–39.

Middendorp, R.S.; O. Boever; X. Rueda & E.F. Lambin (2020). Improving smallholder livelihoods and ecosystems through direct trade relations: High-quality cocoa producers in Ecuador. *Business Strategy & Development*, 3(2), 165–184.

Neilson, J.; B. Pritchard; N. Fold & A. Dwiartama (2018). Lead firms in the cocoa–chocolate global production network: An assessment of the deductive capabilities of GPN 2.0. *Economic Geography*, 94(4), 400–424.

Okoye, K. & S. Hosseini (2024). Mann–Whitney U test and Kruskal–Wallis H test statistics in R. ***In:*** R Programming, p. 225–246. Springer. Singapore.

Pawlak, K. & M. Kołodziejczak (2020). The role of agriculture in ensuring food security in developing countries: Considerations in the context of the problem of sustainable food production. *Sustainability*, 12(13), 5488.

Praveen, B. & P. Sharma (2020). Climate variability and its impacts on agriculture production and future prediction using autoregressive integrated moving average method (ARIMA). *Journal of Public Affairs*, 20(2), e2016.

Rabbani, M.B.A.; M.A. Musarat; W.S. Alaloul; M.S. Rabbani; A. Maqsoom; S. Ayub; H. Bukhari & M. Altaf (2021). A comparison between seasonal autoregressive integrated moving average (SARIMA) and exponential smoothing (ES) based on time series model for forecasting road accidents. *Arabian Journal for Science and Engineering*, 46(11), 11113–11138.

Rusdi, M. (2023). Variety of staple foods: Perceptions of Indonesian society on other staple foods of rice. *AKADEMIK: Jurnal Mahasiswa Humanis*, 3(1), 41–48.

Schottenhammer, A. (2024). The role of cacao and chocolate in transpacific exchange part I, cacao comes to Asia. *TRANS-PACIFIC Research Notes*, 4(2), 1–47.

Squicciarini, M.P. & J. Swinnen (2016). The Economics of Chocolate. Oxford University Press.

Tsowou, K. & S.K. Gayi (2019). Trade reforms and integration of cocoa farmers into world markets: Evidence from African and non-African countries. J*ournal of African Trade*, 6(1/2), 16–29.

Voora, V.; S. Bermúdez & C. Larrea (2019). *Global Market Report: Cocoa*. International Institute for Sustainable Development. Winnipeg, Canada.

Widhiyoga, G. & H. Wijayati (2022). The challenges faced by cocoa-based industries from Indonesia in global value chains. *Husnayain Business Review*, 2(2), 1–10.

-o0o-