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ARTICLE

Reducing Tourism Costs and Its Economic Impact on Agriculture: A Dynamic CGE Approach for Kenya

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ABSTRACT

Kenya's economy is predominantly anchored in agriculture and tourism, yet the synergistic potential between these sectors remains underexplored. This study investigates the economic impact of reducing tourism costs on Kenya's agricultural sector, focusing on productivity, household welfare, and labour market dynamics. Employing a dynamic Computable General Equilibrium (CGE) model calibrated with 2019 data, we simulate a 10% reduction in tourism costs. Our findings reveal significant positive spillover effects on agriculture, with key metrics showing a 1.32% increase in intermediate consumption and a 1.66% rise in domestic demand for agricultural products by 2030. These gains translate into substantial welfare improvements, particularly for rural households, and contribute to enhanced food security, aligning with SDG 2 (Zero Hunger). The policy also stimulates broader economic growth (SDG 8), evidenced by a steady rise in GDP. However, the benefits are tempered by persistent gendered disparities, as female-headed households experience lower gains in income and employment. The study underscores the importance of strengthening sustainable tourism-agriculture linkages (SDG 12) as a strategy for inclusive development. We conclude that while reducing tourism costs is a potent catalyst for economic growth, its long-term sustainability requires careful design to ensure the financial viability of tourism operators and government revenue. It must be integrated with targeted gender-responsive interventions and strategies to build resilient cross-sectoral value chains to ensure equitable distribution of benefits and fully realise the sustainable

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development potential of this intersectoral relationship.

Keywords: Agri-Tourism; Computable General Equilibrium (CGE) Model; Sustainable Development Goals (SDGs); Gender Disparities; Leisure

1. Introduction

Kenya's economy is firmly rooted in agriculture, which employs a significant portion of the workforce and contributes substantially to the country's Gross Domestic Product (GDP)[1]. According to the International Trade Administration[1], agriculture dominates the Kenyan economy, accounting for 40% of the overall workforce, with a staggering 70% of the rural workforce engaged in agricultural activities. Moreover, agriculture contributes approximately 33% to Kenya's GDP, underscoring its vital role in the country's economic development[2]. Tourism is also a significant sector, with Kenya registering a total of 134,600 international visitor arrivals in January 2024, representing a decrease of 9,300 from the previous month[3]. The tourism sector generated Sh142.5 billion in revenue in the first half of 2024, a 21.3% increase compared to the same period in 2023[3].

The synergistic relationship between tourism and agriculture in Kenya is increasingly framed within the paradigm of sustainable and eco-tourism, which aims to balance economic viability with environmental conservation and social equity[4]. This approach moves beyond simple conservation to foster agroecological practices and create value chains that protect Kenya's unique ecosystems, which are the very foundation of its tourism appeal[5]. However, this potential is fraught with complex trade-offs. The expansion of these sectors risks habitat degradation, water depletion, and increased carbon emissions from travel and intensification[6, 7]. Furthermore, the benefits of tourism development are often unevenly distributed, with evidence suggesting it can exacerbate gendered inequalities in income and access to opportunities[8, 9]. These disparities are often rooted in deeper structural issues within tourism governance. As Stone & Nyaupane demonstrate in the context of Botswana, tourism promotion is frequently designed through a "Western gaze"[10], misrepresenting and excluding local residents. Therefore, a critical examination is essential to navigate these tensions and ensure that economic benefits are achieved in a truly sustainable and equitable manner.

Theoretical frameworks such as Hirschman's theory of intersectoral linkages and Becker's theory of leisure consumption provide a foundation for understanding the relationships between tourism and agriculture[11, 12]. Additionally, Balaguer & Cantavella-Jordá's Tourism-Led Growth Hypothesis suggests that tourism can drive economic growth and development through linkages with other sectors, including agriculture[13].

Despite the importance of agriculture in Kenya, many small-scale farmers face numerous challenges, including limited access to markets, finance, and technology, which hinder their productivity and potential[14, 15]. Furthermore, the sector's growth is also threatened by the limited availability of training programs in astro-tourism[16], which could potentially diversify and increase tourism revenues. However, tourism has been recognized as a key driver of socioeconomic development in Kenya, with the potential to contribute significantly to the country's economy, create jobs, and stimulate local economic growth[17, 18].

Empirical studies have also explored the relationships between tourism, agriculture, and economic development in Kenya. Research has shown that tourism can have a positive impact on agriculture, leading to increased agricultural productivity, diversification, and growth[19–21]. Additionally, tourism has been found to contribute to poverty reduction, and income inequality in various contexts. However, the redistributive effects of tourism are more nuanced, with some studies finding that tourism can lead to increased income inequality[19, 22], while others suggest that tourism can reduce income[20].

This study investigates the economic impact of reducing tourism costs on Kenya's agricultural sector, focusing on agricultural productivity, household welfare, and labour market. By examining the linkages between tourism and agriculture, this research aims to provide insights into the potential benefits of promoting tourism-agriculture linkages and reducing tourism costs to enhance the overall economic performance of Kenya's agricultural sector. Compounding these challenges is the overarching threat of climate

change, which simultaneously jeopardises tourism assets (e.g., biodiversity, landscapes) and threatens to increase the cost of travel, potentially suppressing future tourist demand[23]. This creates a pivotal dilemma for policymakers: strategies that successfully stimulate tourism growth must also account for the sector's environmental footprint and its vulnerability to external climate and geopolitical shocks[17]. Within this complex landscape, understanding the specific economic impacts of tourism policies on key sectors like agriculture while explicitly considering their environmental and social implications becomes not just an academic exercise but a practical necessity for planning resilient and inclusive development. Therefore, the main research question to be explored is: "What are the economic impacts of reducing tourism costs on Kenya's agricultural sector, and how can promoting tourism-agriculture linkages contribute to sustainable economic growth and development in Kenya?"

The study employs a dynamic Computable General Equilibrium (CGE) model, with 2019 as the reference year for Kenya. The advantages of using a dynamic CGE model include its ability to account for intersectoral linkages, economy-wide effects, and temporal dynamics, providing a comprehensive understanding of the impacts of reducing tourism costs on Kenya's agricultural sector and the broader economy[24, 25]. The main findings of this study reveal substantial gains in agricultural output, household income, and consumption of agricultural products, contributing to improved welfare and food security. Additionally, tourism's leisure aspect sees a significant increase in entertainment activities. Nevertheless, gender and regional disparities remain, with female-headed households and rural areas experiencing lower increases in household income and tourism-related employment.

The remainder of the study is organized as follows: Following the introduction, Section 2 provides a comprehensive overview of the agricultural and tourism sectors in Kenya. Section 3 delves into the literature review, examining existing research and studies related to the topic. Section 4 outlines the methodology employed in the study. The findings are presented in Section 5, followed by the conclusion and policy recommendations in Section 6.

2. Overview of the Agricultural and Tourism Sectors in Kenya

The recovery of Kenya's tourism industry from the devastating impact of the COVID-19 pandemic is clearly illustrated in **Figure 1**[26]. The graph shows a dramatic decline in international visitor arrivals in 2020, followed by a steady upward trend. As of January 2024, the country recorded 134,600 international visitor arrivals, a modest decrease from the previous month but well within the positive trajectory established since the pandemic. This consistent return to monthly arrivals above the 100,000 mark a level seen consistently before the pandemic highlights the sector's resilience and Kenya's enduring appeal as a premier tourist destination.

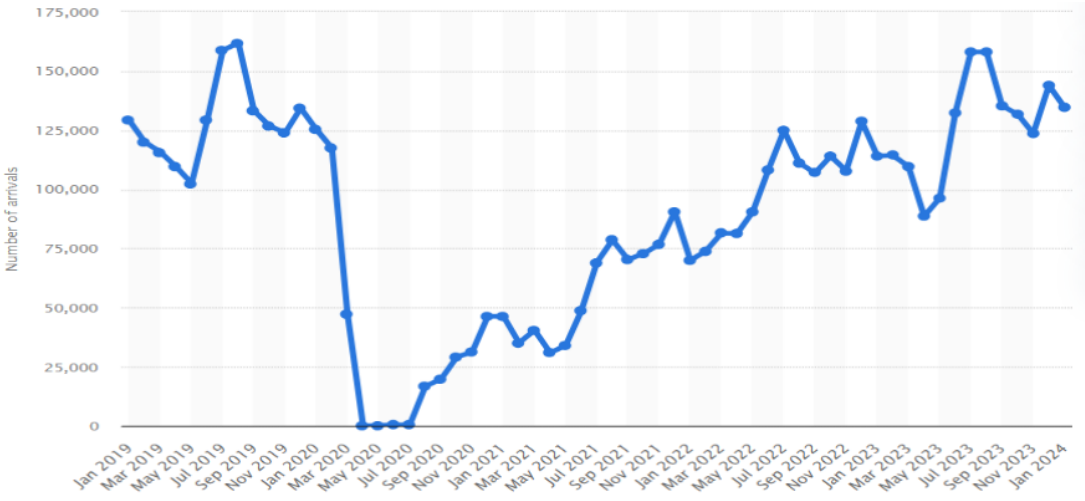

Figure 1. Monthly Number of International Visitor Arrivals in Kenya.

Source: Statista[26].

According to **Table 1**[2], the agricultural sector in Kenya is primarily driven by tea production, which accounted for 570,300 tons in 2023. This is followed by wheat production at 292,100 tons, and then maize production at 185,400 tons. The remaining products, in order of tonnage, are: paddy rice (137,400), coffee (32,400), pyrethrum (30,300), Sisal (25,600), sugar cane (5,500), and cotton (3,900).

It is interesting to note that tea production is more than double the production of wheat, the second most prominent crop, highlighting the significance of tea in Kenya's agricultural sector. Additionally, the high production levels of maize and paddy rice suggest that Kenya is self-sufficient in staple food crops. However, the relatively low production levels of coffee and sugar cane may indicate opportunities for growth and investment in these areas. Furthermore, the small scale of cotton production suggests that Kenya may rely on imports to meet domestic demand.

Table 1. Agriculture 2019–2024.

	Unit	2019	2020	2021	2022	2023
Contribution of Agriculture, Forestry and Fishing to GDP	Per Cent	20.9	22.7	21.5	21.0	21.8
Sale of Selected Crop to Marketing Boards						
Maize	000 Tonnes	316.7	261.3	228.4	149.5	185.4
Wheat	000 Tonnes	348.8	280.8	241.9	181.9	292.1
Coffee	000 Tonnes	33.6	24.4	28.2	41.9	32.4
Tea	000 Tonnes	458.9	569.5	537.8	535.0	570.3
Cotton	000 Tonnes	3.0	3.4	1.3	3.8	3.9
Sugarcane	Million Tonnes	4.4	6.8	7.7	8.8	5.6
Pyrethrum (extract equivalent)	Tonnes	7.4	5.7	11.5	22.2	30.3
Sisal	000 Tonnes	22.3	28.5	28.9	32.2	25.6
Rice Paddy	000 Tonnes	96.4	108.5	111.6	123.9	137.4
Recorded Milk Production	mn litres	685.9	684.4	801.9	754.3	806.6

[1] *Includes purchases by National Cereals and Produce Board and Millers.*
[2] *Deliveries to factories/ginneries.*

Source: Kenya National Bureau of Statistics [2].

3. Literature Review

This literature review aims to examine the complex relationships between tourism, agriculture, and economic development in Kenya. The review will explore theoretical frameworks and empirical studies to understand the interactions between these sectors and their impact on the Kenyan economy.

3.1. Theoretical Background Research Gaps

The theoretical background for this study draws on several key concepts and frameworks from economics, tourism studies, and sustainable development.

- Hirschman's (1958) Theory of Intersectoral Linkages [11]

  This theory posits that economic development relies on the creation of linkages between different sectors of the economy. In the context of tourism and agriculture, this means that tourism can drive economic growth by creating demand for agricultural products, stimulating agricultural production, and generating income for farmers.

- Becker's (1965) Theory of Leisure Consumption [12]

  This theory highlights the importance of time allocation between work and leisure activities. In the context of tourism, this means that tourists allocate time and resources to leisure activities, which can generate income and employment opportunities for local communities.

- Balaguer and Cantavella-Jordá's (2002) Tourism-Led Growth Hypothesis [13]

  This hypothesis proposes that tourism can drive economic growth through the creation of jobs, income, and government revenue. In the context of Kenya, this means that tourism can contribute to economic development by generating foreign exchange earnings, creating employment opportunities, and stimulating local economic growth.

- Sustainable Tourism Development Paradigm (UNWTO, 2005)[27]

  This paradigm emphasises the need for tourism to be managed in a way that maximizes economic, social, and environmental benefits while minimizing negative impacts. In the context of Kenya, this means that tourism development should be managed to ensure that it contributes to sustainable economic growth, poverty reduction, and environmental conservation.

Overall, these theoretical frameworks provide a foundation for understanding the relationships between tourism, agriculture, and economic development in Kenya, and highlight the potential for tourism to contribute to sustainable economic growth and development.

3.2. Tourism and Agriculture

The relationship between tourism and agriculture is complex and multifaceted. As the world's population grows and economic development increases, understanding the intersections between these two sectors is crucial for sustainable development.

Tourism and agriculture are interconnected sectors that can complement each other in various ways. Studies have shown that conservation land leases can positively impact local communities in Kenya[28], while agritourism can contribute to sustainable regional and local development in Ukraine[29]. Understanding tourist demands and preferences is crucial for the growth of agritourism[30]. However, the assumption that nature-based tourism managed by or linked to local communities will automatically result in development and conservation is often challenged in practice. Coria & Calfucura critically analyse this nexus[31], labelling the outcomes for indigenous communities as the good, the bad, and the ugly. They find that communities frequently fail to implement successful projects due to a combination of isolation, a lack of financial resources, management skills, and infrastructure. This highlights a significant implementation gap between the theoretical potential of tourism-agriculture linkages and the reality on the ground, where projects can fail to deliver meaningful benefits or even exacerbate existing vulnerabilities. Agriculture plays a significant role in Kenya's economy[1], and farm tourism has potential in the Philippines[32]. Additionally, Isingizwe & Cirella highlight Kenya's vision for agricultural transformation and inclusive growth[33], while Valle & Yobesia discuss the decline of traditional agricultural exports and the growth of tourism as an alternative source of foreign exchange in Kenya[34]. Burnett & Rowntree also highlight the degradation of landscapes and the potential for sustainable exploitation of resources[35]. Overall, tourism and agriculture can mutually benefit from each other, but careful consideration of local communities, institutional frameworks, and tourist preferences is essential for sustainable development.

In conclusion, the synergy between tourism and agriculture has the potential to drive economic growth, improve livelihoods, and promote sustainable development, but it requires careful planning, management, and collaboration among stakeholders.

3.3. Tourism and Economy Growth

Tourism's impact on a nation's economy has been extensively researched, with findings ranging from positive to varied. Ghartey[36] found that tourism positively impacts Jamaica's economic growth, while Du et al.[37] found a varying effect across different countries. Several studies, including those by Paramati et al. and Alam & Paramati[38, 39], highlight tourism's importance for sustainable economic growth, particularly in emerging and developing economies. De Siano & Canale[40] further emphasised the need for effective management of the tourism sector in Italy to ensure its positive contribution to economic growth.

In Kenya, tourism is a vital contributor to the economy, accounting for a significant portion of the country's GDP[1, 33]. The sector has grown as a major alternative to traditional agricultural exports for generating foreign exchange[34]. Njoya & Seetaram[41] found that tourism development can lead to substantial economic growth and poverty reduction. However, external factors like terrorism and political instability can negatively impact the industry, as highlighted by Njoya et al.[17], who advocated for product diversification and crisis management preparation. Overall, the literature suggests that tourism is a key driver of economic growth, but its sustainability depends on careful management and mitigation of external shocks.

3.4. Tourism, Poverty, and Income Inequality

The relationship between tourism, poverty, and income inequality is complex, with research yielding mixed results.

While some studies suggest tourism can exacerbate inequality, others find it can help reduce it. For example, Mahadevan et al.[42] and Mahadevan & Suardi[8] found that tourism reduces poverty but increases income inequality in Indonesia. Similarly, Zaroki et al.[43] found tourism has a positive effect on economic well-being but a negative effect on income equality. In Spain, Incera & Fernández[22] also found tourism could increase income inequality.

Conversely, Kumail et al.[20] discovered tourism can reduce income inequality in Indonesia. As discussed in Section 3.3, Njoya & Seetaram[41] and Valle & Yobesia[34] highlighted tourism's potential to reduce poverty in Kenya, and this is further supported by the International Trade Administration and Isingizwe & Cirella[1, 33]. The importance of tourism for sustainable economic growth and poverty reduction in developing countries is also a point of emphasis for Alam & Paramati and Paramati et al.[38, 39]. The overall impact of tourism on poverty and inequality is contingent on various factors, including context, management, and policy interventions. Effective management and policy are crucial to ensure that tourism benefits the poor and reduces inequality.

3.5. Redistributive Effects of Tourism

The redistributive effects of tourism have been examined by various researchers, yielding mixed results. Xuanming et al. analysed the redistributive effects of tourism in China[19], finding that tourism can lead to increased income inequality in certain regions. Croes explored the redistributive effects of tourism in developing countries[44], highlighting the potential of tourism to reduce poverty and inequality. However, the study also noted that the redistributive effects of tourism vary depending on the context and management of tourism.

In the context of Kenya, Njoya & Seetaram examined the impact of tourism on poverty and inequality[41], finding that tourism can be a significant driver of poverty reduction. However, the study also noted that the redistributive effects of tourism are limited by issues such as leakage and unequal distribution of benefits.

Overall, the literature suggests that the redistributive effects of tourism are complex and context-dependent, and can lead to either increased or reduced income inequality. Effective management and policy interventions are crucial to ensure that tourism benefits the poor and reduces inequality. Further research is needed to fully understand the redistributive effects of tourism and to identify strategies for maximizing its benefits for local communities.

3.6. Eco-Tourism, Climate Vulnerabilities, and Gendered Dimensions

While the potential for tourism-agriculture linkages is established, a robust analysis must also consider the sustainability framework within which this growth occurs. Recent literature increasingly frames tourism within the contexts of climate change, technological innovation, and social equity, moving beyond purely economic metrics.

The synergy between tourism and agriculture is often explored through the lens of eco-tourism and sustainable practices. Studies show that agritourism can be a significant driver for sustainable regional development, fostering environmentally friendly practices and improving local livelihoods[4, 29, 30]. Crucially, the integration of agriculture and tourism (agritourism) can be a direct driver of improved agricultural eco-efficiency. As Wang et al. found in China's river basins[45], deeper integration leads to more efficient use of inputs like labour, water, and land, and after a certain threshold, a significant reduction in polluting inputs like pesticides and fertilisers. However, to truly capture the full environmental impact, assessments must look beyond carbon dioxide. Wang et al. argue that incorporating non-CO_2 greenhouse gases like methane and nitrous oxide is critical[46], as focusing solely on CO_2 leads to a significant underestimation of agriculture's ecological footprint and the potential benefits of sustainable practices. The case of the Burren Ecotourism Network in Ireland demonstrates how community-based networks can successfully align economic profits with environmental sustainability and social cohesion, embodying a "degrowth" mindset that prioritizes holistic health over mere volume and revenue[4]. This approach is vital, as tourism development is not without its ecological trade-offs. A political ecology lens, as applied by Ghoddousi et al. in the Brazilian Pantanal[5], reveals the complex power dynamics and potential for conflict between conservation goals, tourism revenue, and the rights of local communities and non-human entities. This underscores the necessity of a holistic approach to ensure tourism development does not lead to habitat degradation or social displacement.

Furthermore, the long-term viability of tourism itself is under threat from climate change. Gössling & Scott posit that rising costs driven by climate mitigation necessities [23], adaptation measures, and disruptive extreme weather events will become the primary driver of tourist demand responses. This creates a critical feedback loop: tourism growth, if not managed sustainably, contributes to the carbon emissions that threaten its own future economic foundation [6]. This necessitates a pivot towards low-carbon strategies. Technological innovation offers pathways, such as leveraging AI and IoT for smart hospitality, which can enhance guest experiences while achieving significant energy savings [47]. More radically, Burns & Benz-Schwarzburg even explore virtual wildlife tourism as a potential future form of ecotourism that could eliminate negative environmental impacts and ethical concerns altogether [48].

However, the benefits of these strategies are not automatically equitable. This is particularly evident in gender disparities, a critical gap in tourism-agriculture linkage research. As our findings show, female-headed households often experience lower gains. This aligns with broader patterns where tourism can exacerbate existing inequalities. Mahadevan & Suardi found that while tourism contributes to poverty reduction [8], it can also lead to increased income inequality. This gendered dimension of tourism policy is further complicated by evidence that men and women may approach sustainability decisions differently. Torres-Delgado et al. found that women in destination management roles tend to be more cautious and demanding regarding data quality and show a stronger orientation towards reducing environmental risks [9], suggesting that inclusive policymaking is crucial for effective and balanced outcomes.

Finally, the Kenyan context adds layers of vulnerability. The sector is highly susceptible to external shocks, such as terrorism and political unrest, which can cause severe economic contractions and disproportionately impact urban households and formal sector employment [17]. This vulnerability highlights the importance of policies that not only stimulate growth but also build resilience through diversification, crisis management, and strengthening domestic tourism [17, 34].

In conclusion, the literature affirms that for tourism-agriculture linkages to be truly sustainable and equitable, they must be designed to mitigate environmental degradation, be resilient to climate and political shocks, harness technology responsibly, and actively address gendered inequalities in benefits and decision-making.

4. Methodology

This study utilizes a dynamic Computable General Equilibrium (CGE) model to examine the economic impact of reducing tourism costs on Kenya's agricultural sector. The model is based on the recursive dynamic PEP-1-T model [49], which provides a comprehensive framework for analyzing the economy. CGE models are built upon input-output models [50] and have strong microeconomic foundations [51]. The theoretical underpinnings of CGEs are rooted in the works of Arrow & Debreu and Shoven & Whalley [52, 53].

CGE models can be categorized into three main types: static single-country CGE models, multisector dynamic CGE models, and global multiregional CGE models.

4.1. Model Presentation

Due to the complexity of CGE models, fully detailing the modeling process can be challenging. To address this, we provide a concise overview of the model's structure and calibration process, supplemented by the model code for replication purposes. The model is programmed in GAMS V.25.1 software, using the MPSGE framework to solve the general equilibrium problem.

4.1.1. Model Assumptions

The dynamic PEP-1-t model assumes a single representative household, government, and foreign household (Rest of the World, ROW), with government revenue generated from import tariffs, local indirect taxes, and export taxes. The model also assumes that production factors comprise labour (skilled and unskilled) and capital (physical, land, and natural resources), and that production technology follows a Constant Elasticity of Transformation (CET) function for domestic and exported commodities and a Constant Elasticity of Substitution (CES) function for optimal quantities of goods supplied locally and from abroad.

4.1.2. Model Description

The dynamic PEP-1-t model, developed by Decaluwé et al. [49], is employed to analyse the economy. The model features a representative household that maximizes its util-

ity by consuming a basket of commodities, subject to its income from factor sales to firms [25]. Firms produce value-added and intermediate inputs, which are combined to create the final product. This product is then sold domestically and exported, with the choice of domestic and foreign volumes determined by substitutability and trade margins (CET function). Households consume both domestic and foreign commodities, with imperfect substitution (Armington CES function). The model determines optimal quantities through cost minimization, with intermediate consumption modeled using a Leontief function and value added modeled as a CES function. Labour and capital are mobile across sectors, with industry-specific factor remuneration [49]. Household consumption is modeled using an extended linear expenditure system (LES) of the Stone-Geary utility function [25], comprising minimum subsistence consumption and supernumerary expenditures.

The nested structure of production is illustrated in **Figure 2**, depicting a multi-sectoral economy where total output is derived from value added and intermediate consumption [49]. The model analyses economic shocks and policy changes across sectors using CES and Leontief functions.

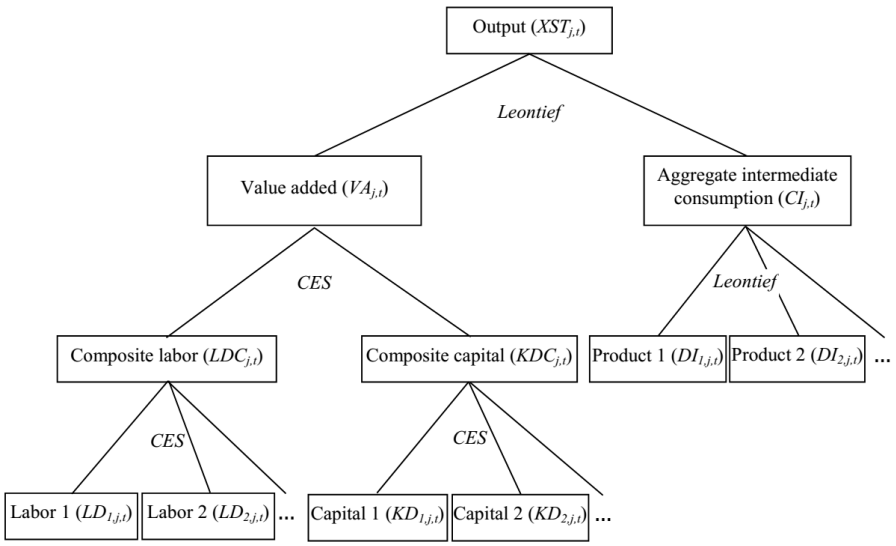

Figure 2. Nesting Structure of Production in the CGE Model.

Source: Authors.

4.1.3. Social Accounting Matrix (SAM) Description

This study employs a Social Accounting Matrix (SAM) based on 2019 data from the Kenya National Bureau of Statistics (KNBS), which illustrates the interlinkages among domestic sectors and interactions with the rest of the world. The standard KNBS SAM provides a comprehensive snapshot of the economy but does not include a disaggregated account for tourism activities or data on visitor numbers. To parameterise the tourism sector within the CGE model, external data on the volume of foreign and domestic visitors and their associated expenditure were collected from Statista (2024) and the Kenya Association of Travel Agents (KATA, 2024). This external data was used to calibrate the tourism-specific parameters in the model's equations. The SAM itself consists of 90 accounts, categorised into factors of production (6), economic agents (25), taxes and transfers (3), factor income earning and expenditure accounts (5), activity accounts (19), local commodities (19), exportable commodities (11), accumulation account (1), and inventory account (1). This framework ensures a consistent representation of the economy where the sum of each account's expenditures aligns with its receipts [54].

4.1.4. Description of GDP

Understanding the details of GDP is crucial for evaluating policies, particularly those aimed at reducing the gender pay gap while maintaining economic stability. This study focuses on the output approach to GDP, which highlights the economy's production capacities. The GDP at basic price (GDP_BP_t) is calculated as:

$$GDP\_BP_t = \sum_j PVA_{j,t} \cdot VA_{j,t} + TIPT_t \quad (1)$$

where $VA_{j,t}$ represents value added; $PVA_{j,t}$ represents value added price; $TIPT_t$ represents total government revenue from production taxes (excluding taxes directly related to capital and labour use).

The GDP at market price (GDP_MP_t) is then computed as:

$$GDP\_MP_t = GDP\_BP_t + TPRCTS_t \tag{2}$$

where $TPRCTS_t$ represents total government revenue from taxes on products and imports.

The real GDP at market price $(GDP\_MP\_REAL_t)$ is calculated as:

$$GDP\_MP\_REAL_t = \frac{GDP\_MP_t}{PIXCON_t} \tag{3}$$

where $PIXCON_t$ represents the consumer price index, computed as:

$$PIXCON_t = \frac{\sum_i PC_{i,t} \cdot \sum_h CO_{i,h}}{\sum_i PCO_i \cdot \sum_h CO_{i,h}} \tag{4}$$

where $CO_{i,h}$ represents the basic level of household consumption in commodity i; $PC_{i,t}$ and PCO_i represent the counterfactual and basic values of the consumer price of commodity i, respectively.

4.1.5. Dynamic Framework

The dynamic framework links one period to the next through dynamic assignments, which are categorized into two groups: statements that updating variables growing at a constant rate per period and equations controlling capital accumulation. Most variables grow over time, with the population index pop_t growing at a population rate n_t set at unity in the first period and subsequent periods are calculated as:

$$pop_t = pop_{t-1}(1 + n_{t-1}) \tag{5}$$

Labour supply $(LS_{l,t})$ grows at the same rate as the population index pop_t, due to population growth, participation rate shifts, or a combination of both represented by:

$$LS_{l,t} = LS_l^O pop_t \tag{6}$$

Equivalent to: $LS_{l,t+1} = LS_{l,t}(1 + n_t)$.

The capital accumulation rule is represented by:

$$KD_{k,j,t+1} = KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t} \tag{7}$$

where $KD_{k,j,t+1}$ is the stock of type k capital in industry j in period $t+1$; $KD_{k,j,t}$ is the type k capital investment in sector j; $\delta_{k,j}$ is the depreciation rate of capital k used in sector j.

4.2. Model Details for Tourism and Labour Market

After presenting the reference model, we now delve into the specifics of how tourism and the labour market are captured.

4.2.1. Tourism Equations Block

The demand for domestic tourism (CDD_t) is calculated as:

$$CDD_t = \chi \cdot DVtou_t \cdot \left[\frac{PIXCON}{PTOU_t}\right]^{\xi_d} \tag{8}$$

where $DVtou_t$ is the current level of domestic tourism consumption; $PTOU_t$ is the price level of tourism (initially set at unity); $PIXCON_t$ is the consumer price index; χ is a shift parameter; ξ_d is the price elasticity demand for domestic tourism (with $\xi_d > 1$).

The current level of domestic tourism consumption $(DVtou_t)$ is a fixed proportion of the total tourism consumption $(TVtou_t)$, which also includes foreign tourism consumption $(FVtou_t)$. These are given by:

$$DVtou_t = Y_{dv} \cdot TVtou_t \tag{9}$$

$$FVtou_t = Y_{fv} \cdot TVtou_t \tag{10}$$

with $Y_{dv} + Y_{fv} = 1$

The demand for foreign tourism (CDF_t) is modeled similarly to CDD_t:

$$CDF_t = \chi \cdot FVtou_t \cdot \left[\frac{e_t}{PTOU_t}\right]^{\xi_f} \tag{11}$$

where $FVtou_t$ is the current level of foreign tourism consumption; e_t is the exchange rate; ξ_f is the price elasticity demand for foreign tourism ($\xi_f > 1$).

Total expenditure of domestic visitors $(YDtou_t)$ and foreign visitors $(YFtou_t)$ are given by:

$$YDtou_t = \varsigma_d \cdot CDD_t \tag{12}$$

$$YFtou_t = \varsigma_f \cdot CFD_t \tag{13}$$

with ς_d and ς_f representing the shares of income allocated to domestic and foreign tourism, respectively.

Domestic tourism visitors $(CDtou_{i,t})$ and foreign tourism visitors $(CFtou_{i,t})$ are computed by:

$$CDtou_{i,t} = \psi_{i,d} \cdot YDtou_t \cdot \frac{PTOU_t}{PC_{i,t}} \tag{14}$$

$$CFtou_{i,t} = \psi_{x,f} \cdot YFtou_t \cdot \frac{PTOU_t}{PE\_fob_{x,t}} \quad (15)$$

with $\psi_{i,d}$ and $\psi_{x,f}$ representing the shares of commodity i in domestic tourism consumption and commodity x in foreign tourism consumption, respectively.

Prices paid by domestic tourists ($PDTOU_t$) and foreign tourists ($PFTOU_t$) are calculated by:

$$PDTOU_t = \prod_i PC_{i,t}{}^{\psi_{i,d}} \quad (16)$$

$$PFTOU_t = \prod_x PE\_fob_{x,t}{}^{\psi_{x,f}} \quad (17)$$

4.2.2. Labour Market Bloc

The unemployment rate ($unempl_{l,t}$) is calculated as:

$$unempl_{l,t} = unemplO_l \cdot \left[\frac{PIXCON_t}{W_{l,t}}\right]^{\alpha_w} \quad (18)$$

where $unemplO_l$ is the initial level of unemployment rate of type l labour; $W_{l,t}$ is the wage rate related to labour l; α_w is the elasticity of employment to real wage. Given the labour market landscape, the level of employment does not really vary with respect to wage rate. Thus, the elasticity of employment is set at unity.

Equation (18) shows that employment is positively related to inflation and negatively linked to the real wage.

The total time used by a household ($TS_{Ls,h,t}$) has three components: work time ($LMS_{Ls,h,t}$); time spent producing home goods ($LZS_{Ls,h,t}$); leisure time ($LES_{Ls,h,t}$). The maximum hours per day is set at 14.

The work time by household h of skilled gender LS ($LMS_{Ls,h,t}$) is given by:

$$LMS_{Ls,h,t} = \frac{LMBS_{Ls,h,t}}{\beta^s_{Ls,h}} \quad (19)$$

where $LMBS_{Ls,h,t}$ is the total income that ensures household h a subsistence wage after working $LMS_{Ls,h,t}$ units of time; $\beta^s_{Ls,h}$ is the minimum income (hold constant) that ensures household h that subsistence wage per unit of time. This value is close to household income $YH_{h,t}$ and is computed from:

$$\begin{aligned} LMS_{Ls,h,t} = MAXHOUR_{Ls,h,t} \\ -\frac{\alpha^s_{Ls,h}}{1-\alpha^s_{Ls,h}} \cdot \frac{YH_{h,t}}{\beta^s_{Ls,h}} \end{aligned} \quad (20)$$

where $MAXHOUR_{Ls,h,t}$ is the maximum work hours per day (set at 14), and $\alpha^s_{Ls,h}$ is a share parameter calibrated under constant return to scale by equation (23). Note that the subscript Ls depicts skilled household while unskilled household is referred to as Lns. For simplification, all the transformation under Ls and done in the same manner with Lns.

The subsistence income ($LMBS_{Ls,h,t}$) is derived from a CES production function:

$$\begin{aligned} LMBS_{Ls,h,t} = \Big[\alpha^s_{Ls,h} \cdot LMS_{Ls,h,t}{}^{\rho^s_{Ls,h}} \\ +(1-\alpha^s_{Ls,h}) \cdot YH_{h,t}{}^{\rho^s_{Ls,h}}\Big]^{\frac{1}{\rho^s_{Ls,h}}} \end{aligned} \quad (21)$$

The solution to the maximization program for $LMBS_{Ls,h,t}$ is:

$$LMBS_{Ls,h,t} = \left[\frac{\alpha^s_{Ls,h}}{1-\alpha^s_{Ls,h}}\right]^{\frac{1}{\rho^s_{Ls,h}-1}} \cdot YH_{h,t} \quad (22)$$

The calibration of $\alpha^s_{Ls,h}$ is given by:

$$\alpha^s_{Ls,h} = \frac{LMBSO_{Ls,h}{}^{\rho^s_{Ls,h}-1}}{LMBSO_{Ls,h}{}^{\rho^s_{Ls,h}-1} + YHO_h{}^{\rho^s_{Ls,h}-1}} \quad (23)$$

This assumes constant returns to scale. As a result, household income (YHO_h) positively affects subsistence income ($LMBS_{Ls,h,t}$), which in turn positively affects work time ($LMS_{Ls,h,t}$). Therefore, increased female participation in the labour market leads to higher subsistence income.

The time spent producing home commodities ($LZS_{Ls,h,t}$) is:

$$LZS_{Ls,h,t} = TS_{Ls,h,t} - \vartheta^s_{Ls,h} \cdot LMS_{Ls,h,t} \quad (24)$$

Since $TS_{Ls,h,t} = LZS_{Ls,h,t} + LES_{Ls,h,t} + LMS_{Ls,h,t}$, we can derive:

$$\begin{aligned} TS_{Ls,h,t} - LZS_{Ls,h,t} = LES_{Ls,h,t} \\ +LMS_{Ls,h,t} = \vartheta^s_{Ls,h} \cdot LMS_{Ls,h,t} \end{aligned} \quad (25)$$

This leads to:

$$\vartheta^s_{Ls,h} = 1 + \frac{LES_{Ls,h,t}}{LMS_{Ls,h,t}} \quad (26)$$

Thus, $\vartheta^s_{Ls,h} > 1$ measures the change in leisure time with respect to labour time, indicating that a one percent increase in labour time leads to a more than one percent decrease in time spent producing home goods. If leisure time vanishes, the household reduces the increased time spent on work proportionally.

Given the fixed total time ($TS_{Ls,h,t}$), leisure time is computed in the market clearing condition:

$$\begin{aligned} TS_{Ls,h,t} = LZS_{Ls,h,t} \\ +LES_{Ls,h,t} + LMS_{Ls,h,t} \end{aligned} \quad (27)$$

The quantity of home goods produced ($ZS_{h,t}$) is modeled as a CES function of time ($LZS_{Ls,h,t}$) as follows:

$$ZS_{h,t} = AS_h \left[\sum_{Ls} \delta^s_{Ls,h} \cdot LZS_{Ls,h,t}{}^{-\rho^s_{Ls,h}} \right]^{\frac{-1}{\rho^s_{Ls,h}}} \tag{28}$$

where $\delta^s_{Ls,h}$ is a share parameter defined under constant returns to scale, $\rho^s_{Ls,h}$ is the substitution parameter, and AS_h is a shift parameter.

The model assumes that all home goods produced are consumed only by household members, so total demand $CZS_{h,t}$ equals total supply $ZS_{h,t}$ to satisfy the market clearing condition:

$$CZS_{h,t} = ZS_{h,t} \tag{29}$$

The utility of category Ls of household h, $U_{Ls,h,t}$, depends on: leisure time $LES_{Ls,h,t}$; volume of home goods consumed $CZS_{h,t}$; consumption of other commodities not produced at home $C_{i,h,t}$.

It is expressed as:

$$U_{Ls,h,t} = [LES_{Ls,h,t} - MINLES_{Ls,h,t}]^{\beta^s_{Ls,h}} \cdot \left[\prod_{hom} (CZS_{hom,h,t} - CZmins_{hom,h,t})^{\beta^{gs}_{hom,h}} \right] \cdot \left[\prod_{i} (C_{i,h,t} - Cmin_{i,h,t})^{\beta^{gs}_{i,h}} \right] \tag{30}$$

where $MINLES_{Ls,h,t}$, $CZmins_{hom,h,t}$, and $Cmin_{i,h,t}$ are the minimum levels of time spent producing home goods, minimum consumption for home and outside goods, respectively.

Household welfare is captured by equivalent variation $EV_{h,t}$ as follows:

$$EV_{h,t} = [CTH_{h,t} - \textstyle\sum_i PC_{i,t} \cdot Cmin_{i,h,t}] \prod_i \left(\frac{PCO_i}{PC_{i,t}} \right)^{\gamma^{LES}_{i,h}} - [CTHO_h - \textstyle\sum_i PCO_i \cdot Cmin_{i,h,t}] \tag{31}$$

Let $Ygen_{h,l,t}$ be the type l labour income gained by household category h, and $LSS_{l,t}$ be the total labour supply. Then:

$$Ygen_{h,l,t} = \lambda_{h,l} \cdot LSS_{l,t} \tag{32}$$

where $\lambda_{h,l}$ is a parameter depicting the share of category h household income in the total.

4.3. Closure of the Model

The model is closed by exogenising various variables, including the nominal exchange rate (numéraire), government expenditure, public sector investment volume, current account balance, capital stock (determined by capital accumulation rule), minimum consumption, inventory changes volume, world prices of imports and exports, and labour market and tourism variables such as maximum hours for activities, total time used by household, minimum time spent on leisure, total tourism consumption, price level of tourism, income earned by foreign and domestic visitors, and gender ratio between average women's and men's wage. Additionally, slopes, marginal rates, and tax rates are treated as exogenous parameters, allowing the model to be simulated and analysed for policy changes and shocks impacts on the economy.

4.4. Model Implementation

The model's equations are implemented in GAMS V.25.1 software through the following steps:

- Declaration of sets: regions, activities, factors of production, and time.
- Declaration and assignment of basic parameters: baseline data is extracted from the Social Accounting Matrix (SAM).
- Model calibration.
- Declaration and definition of variables and equations.
- Initialization of variables with SAM values to ensure the model can reach the benchmark.
- Model declaration and solve statement: the CNS solver is used.
- Application of different scenarios.

4.5. Deriving the Scenario

This study examines the impact of a single scenario: a 10% reduction in tourism costs ($PTOU_t$) to stimulate tourism activity in Kenya. This shock is introduced through equations 8 and 11, which capture the initial effects on tourism demand, subsequently influencing the broader economy. By analyzing this scenario, we can assess the potential benefits of reducing tourism costs on Kenya's economic growth and development.

4.6. Sensitivity Analysis

To evaluate the robustness of our results, we conduct a sensitivity analysis by modifying certain external parameters, specifically the elasticities whose values are not endogenously determined within the model, such as CES (Constant Elasticity of Substitution) and CET (Constant Elasticity of Transformation) elasticities. We will vary the CES elasticity by +/- 10% to assess the impact on our results, providing insight into the model's sensitivity to changes in these key parameters.

5. Results

This section provides an in-depth examination of the consequences of reducing tourism costs in Kenya, organized into four distinct subsections. For the purpose of this analysis, 'short-term' impacts refer to the year 2024, while 'long-term' impacts refer to the year 2030. The first subsection investigates the distributional effects on household categories, analyzing the impact on household consumption, income, spending and welfare. The second subsection explores the broader macroeconomic implications, including the effects on GDP, output, trade, etc. The third subsection focuses on the labour market and leisure, assessing the effects on employment, unemployment, and leisure time. The final subsection presents a sensitivity analysis, testing the robustness of the results and examining the sensitivity of the findings to alternative assumptions.

5.1. Impact on Household Categories

5.1.1. Results

Reducing tourism costs has a far-reaching impact on the economy, with the agricultural sector being a key beneficiary. A 10% decrease in tourism costs triggers a positive ripple effect, leading to increased household income, consumption, and welfare across various segments.

As shown in **Table 2**, this reduction in tourism costs stimulates agricultural commodity consumption across most household categories with both short-term and long-term benefits. Additionally, rural households see significant gains, with poorest households experiencing a 0.05% increase in consumption, median households experiencing a 0.02% rise in consumption, and wealthiest households experiencing a 0.02–0.03% increase in consumption. Moreover, in urban areas, the poorest households reap the most benefits, with consumption increasing by 0.12% in 2024 and 0.15% in 2030. Meanwhile, median household consumption initially dips by 0.02% in the short-term, but recovers and increases by 0.01% in the long-term, mirroring the trend for wealthiest households. However, it is important to note that there are discrepancies between rural and urban areas, with rural households experiencing higher income increases and welfare impacts compared to urban households. Moreover, the reduction in tourism costs also leads to an increase in household income, with rural households experiencing a 0.56% increase in income in the short-term and a 0.61% increase in the long-term. Meanwhile, urban households experience a 0.03% increase in income in the short-term and a 0.06% increase in the long-term. As a consequence of these changes in income and consumption, the welfare impact is significantly high, especially for rural poorest households, with rural households experiencing a welfare impact of 4.58% in 2024 and 2.57% in 2030. Similarly, median rural households experience a welfare improvement of 2.23% in the short-term and 1.28% in the long-term. In addition, the wealthiest rural households experience a welfare improvement of 1.65% in the short-term and 1.03% in the long-term. These welfare impacts are a direct result of the increases in household income and consumption, highlighting the importance of addressing the disparities in income and consumption patterns between rural and urban areas. This analysis highlights the potential for targeted policies to reduce tourism costs and boost economic growth, particularly in rural areas and among low-income households.

Table 2. Percentage Change in Household Consumption, Spending, Welfare, and Income by Category and Year.

	2024	2030	2024	2030	2024	2030	2024	2030
	Household Consumption of Agriculture Products		Household Spending in Agriculture		Household Welfare		Household Income	
hrur0	0.05	0.05	0.65	0.69	4.58	2.57	0.58	0.61
hrur5	0.02	0.02	0.34	0.38	2.13	1.28	0.28	0.30

Table 2. *Cont.*

	2024	2030	2024	2030	2024	2030	2024	2030
	Household Consumption of Agriculture Products		Household Spending in Agriculture		Household Welfare		Household Income	
hrur9	0.02	0.03	0.23	0.27	1.65	1.03	0.16	0.19
hurb0	0.12	0.15	0.10	0.14	0.87	0.60	0.03	0.06
hurb5	−0.02	0.01	0.14	0.17	−0.30	0.03	0.07	0.09
hurb9	0.01	0.01	0.15	0.19	1.39	0.88	0.09	0.11

Note: hrur0 (rural poor). hrur5 (rural median). hrur9 (rural rich); hurb0 (urban poor). hurb5 (urban median). hurb9 (urban rich); Unemp (Unemployment rate).
Source: Model results (GAMS V.25.1).

Therefore, policies aimed at reducing tourism costs and promoting agricultural consumption can have a positive impact on household welfare, particularly for rural households.

5.1.2. Discussion

The analysis demonstrates that reducing tourism costs has a profoundly positive impact on agriculture, particularly for rural households and low-income households, with a 10% decrease in tourism costs leading to increased household income, consumption, and welfare across various segments. This significant increase directly supports the achievement of SDG 8 (Decent Work and Economic Growth) by stimulating inclusive economic growth. Furthermore, by boosting agricultural productivity and enhancing food security, this strategy contributes meaningfully to SDG 2 (zero hunger). Thus, this finding is significant because it highlights the potential for tourism to drive economic growth and improve livelihoods in rural areas[28–30, 32]. Moreover, the analysis underscores the importance of considering tourism's redistributive effects, given that the benefits of reducing tourism costs are not evenly distributed across all households. Therefore, policies aimed at reducing tourism costs and promoting agricultural consumption can help to address these disparities and promote more equitable economic growth. Overall, the findings of this analysis support the importance of agritourism development and the potential for tourism to drive economic growth and improve livelihoods in rural areas, while also highlighting the need for careful management and policy interventions to ensure that the benefits of tourism are shared equitably among all stakeholders.

In summary, the results have far-reaching implications for society, indicating that reducing tourism costs can lead to economic growth, increased household income, consumption, and welfare, with benefits extending to the agricultural sector and potentially reducing poverty and income inequality. Rural households, particularly the poorest, experience higher income increases and welfare impacts, highlighting the need to address rural-urban disparities. Targeted policies to reduce tourism costs can boost economic growth, especially in rural areas and among low-income households, leading to significant welfare impacts and improved social welfare. The results suggest both short-term and long-term benefits, indicating sustained positive impacts on the economy and society, particularly for rural and low-income households, demonstrating the potential for reducing tourism costs to have a positive and lasting impact.

5.2. Other Macroeconomic Variables

5.2.1. Results

Table 3 displays the macroeconomic impact on the agricultural sector, whilst **Figure 3** illustrates the effects on three variables: GDP, government revenue, and firms' revenue. Notably, a 10% reduction in tourism costs yields a greater increase in GDP and government revenue relative to firms' revenue. Specifically, from 0.11% in 2020, the GDP increase rises to 0.14% in 2030. Over the same period, government revenue grew from 0.12% to 0.14%. In contrast, firm revenue experiences a relatively smaller impact, ranging from −0.01% to 0.05% in the short-term, and a more pronounced increase of 0.05–0.10% in the long-term.

According to **Table 3**, the decrease in tourism costs leads to a price reduction, notably in domestic prices, producer prices, and composite prices of commodities, ranging from −0.09% to −0.1%. Consequently, demand, consumption, and production of agricultural commodities increase significantly in the short-term and long-term. In particular, domestic demand rises by 1.63% in 2024 and 1.66% in 2030, while imports increase by 1.49% and 1.51%, and exports by 0.68% and 0.69%. Moreover, the total intermediate demand

of the agriculture sector increases by 1.07% in the short-term and 1.11% in the long-term. Additionally, composite demand rises by 1.61% in the short-term and 1.65% in the long-term. Regarding consumption, intermediate consumption for the agricultural sector increases by 1.30% in 2024 and 1.32% in 2030. These increases surpass those of intermediate demand, indicating that firms operating in the agricultural sector will substantially boost production through raw material usage to meet growing tourist demand in both the short-term and long-term.

Table 3. Percentage Change in Macroeconomic Variables Following a 10% Reduction in Tourism Costs.

	2024	2030	2024	2030	2024	2030
	Basic		CES (− 10%)		CES (+ 10%)	
Government consumption	0.15	0.21	0.06	0.13	0.19	0.25
Intermediate consumption	1.30	1.32	1.28	1.30	1.31	1.33
Domestic demand	1.63	1.66	1.62	1.65	1.63	1.67
Intermediate demand	1.07	1.10	1.28	1.30	1.09	1.11
Exports	0.68	0.69	0.64	0.66	0.70	0.71
Imports	1.49	1.51	1.59	1.58	1.43	1.45
Composite demand	1.61	1.65	1.62	1.64	1.62	1.65
Gross Fixed Capital Formation (GFCF)	0.33	0.35	0.28	0.31	0.35	0.37
Capital demand	1.37	1.39	1.36	1.38	1.37	1.40
Labour demand	0.93	0.93	0.93	0.94	0.92	0.93
Composite price	−0.09	−0.10	−0.03	−0.05	−0.11	−0.12
Domestic price	−0.09	−0.10	−0.03	−0.06	−0.12	−0.12
Producer price	−0.05	−0.05	−0.03	−0.03	−0.06	−0.06
Wage rate	0.24	0.26	0.23	0.25	0.24	0.27
Production	1.30	1.32	1.28	1.30	1.31	1.33

Source: Model results (GAMS V.25.1).

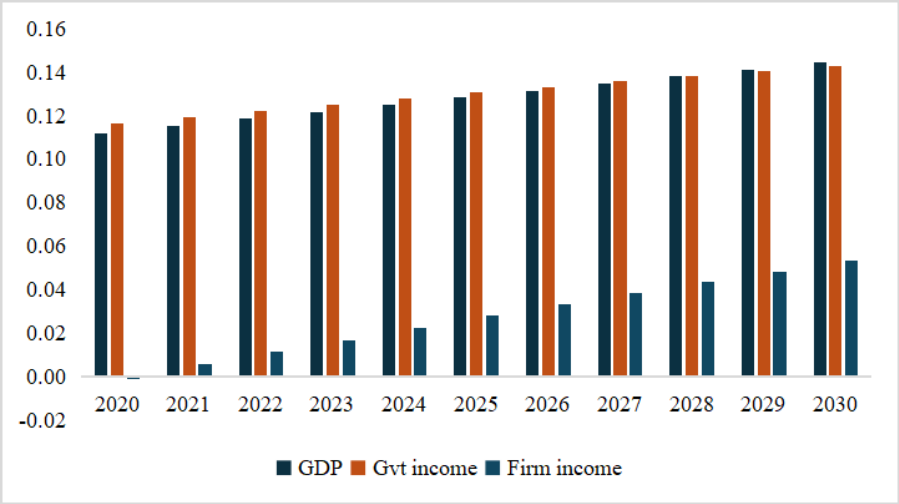

Figure 3. Percentage Change in GDP, Government Revenue and Firm Income (2020–2030).

Source: Model results (GAMS V.25.1).

The growth in production and productivity has positive implications for the agricultural sector, leading to increased food security (advancing SDG2), improved livelihoods for farmers, and enhanced competitiveness in domestic and international markets. Moreover, the synergistic relationship between tourism and agriculture, particularly through the lens of eco-tourism and sustainable practices highlighted in the introduction, promotes more efficient resource use and sustainable management practices. This underscores the study's relevance to SDG 12 (Responsible Consumption and Production) by fostering sustainable linkages between key economic sectors.

The GDP impact suggests a modest but positive effect, with a 0.11% increase in 2020 rising to 0.14% in 2030, indicating a gradual but steady contribution to economic growth. This growth is likely driven by firms' increased investment in new capital assets, such as machinery and equipment, and expansion of production capacity, leading to improved productivity and competitiveness. Additionally, the positive impact on GDP is also expected to have a ripple effect on other sectors, such as processing, manufacturing, and services, contributing to broader economic growth and development. Furthermore, the growth in GDP is also likely to have a positive impact on households, leading to increased consumption and employment opportunities.

Furthermore, fixed investments rise by 0.33% in the short-term and 0.35% in the long-term, indicating a positive impact on the overall investment climate in the agricultural sector, as measured by GFCF (Gross Fixed Capital Formation). The growth in GFCF suggests that firms are more likely to invest in new capital assets, such as machinery and equipment, and expand their production capacity, leading to potential long-term economic growth and development.

5.2.2. Discussion

The results demonstrate the reduction in tourism costs would have a profound impact on the agricultural sector, leading to a significant increase in economic growth [1, 33, 36–39]. As tourism costs decrease, the sector would experience a boost in productivity and competitiveness, resulting in an increase in GDP and government revenue [36, 38]. This growth would be driven by firms' increased investment in new capital assets and expansion of production capacity, leading to improved productivity and competitiveness [38, 39]. Isingizwe & Cirella also found that a reduction in tourism costs would lead to a significant increase in agricultural GDP [33], highlighting the potential for growth in the sector. The increase in economic growth would also have a ripple effect on other sectors, contributing to broader economic development and improvement in living standards [1]. Additionally, the growth in the agricultural sector would lead to increased food security, improved livelihoods for farmers, and enhanced competitiveness in domestic and international markets [32].

However, this projected agricultural intensification, driven by rising tourist demand, necessitates a critical discussion of its potential environmental externalities. This creates a fundamental tension between economic gains and ecological preservation, a core concern of political ecology [5]. The pursuit of higher yields could encourage practices that lead to habitat loss through land conversion, soil degradation from excessive chemical inputs, and water depletion from intensified irrigation, threatening the very biodiversity that often underpins a destination's appeal [7, 35]. Furthermore, an intensification focused solely on output would likely increase emissions of potent non-CO_2 greenhouse gases from agriculture, such as methane from livestock and nitrous oxide from fertilisers, an impact often overlooked in standard analyses [46]. Also, this analysis must be situated within the broader carbon footprint of the tourism system itself. Our policy scenario aims to stimulate tourist arrivals, yet this growth carries an inherent climate cost. As Cajiao et al. demonstrate [6], despite technological efficiencies, tourism's carbon emissions remain significant due to increased trip frequency and longer distances. This presents a paradox: policies successful in boosting tourism may inadvertently contribute to the global climate crisis, which in turn threatens the sector's long-term viability, as rising costs and disruptions from climate change become primary drivers of tourist demand [23]. Therefore, the positive economic results shown here are contingent upon channeling this growth through sustainable and agroecological practices to ensure that the pursuit of SDG 8 (decent work and economic growth) does not undermine the natural capital that supports both sectors, aligning outcomes with SDG 12 (responsible consumption and production).

Building on these findings, the reduction in tourism costs would also have a significant impact on trade, leading to an increase in demand for agricultural commodities, higher imports and exports, and an improvement in the trade balance [30]. As tourism costs decrease, the sector would experience an increase in demand for agricultural commodities, resulting in higher imports and exports [30]. This would lead to an improvement in the trade balance and contribute to broader economic growth and development [1]. The growth in production and productivity would also lead to an increase in agricultural exports, making the sector more competitive in international markets [32]. Additionally, the reduction in tourism costs would lead to an increase in foreign direct investment in the agricultural sector, as investors take advantage of the improved business environment and increased profitability [39]. This would lead to an increase in technol-

ogy transfer and knowledge spillovers, further increasing productivity and competitiveness in the sector [28]. Also, this analysis must be situated within the broader carbon footprint of the tourism system itself. Our policy scenario aims to stimulate tourist arrivals, yet this growth carries an inherent climate cost. As Cajiao et al. demonstrate [6], despite technological efficiencies, tourism's carbon emissions remain significant due to increased trip frequency and longer distances. This presents a paradox: policies successful in boosting tourism may inadvertently contribute to the global climate crisis, which in turn threatens the sector's long-term viability, as rising costs and disruptions from climate change become primary drivers of tourist demand [23]. Therefore, the positive economic results shown here are contingent upon channeling this growth through sustainable and agroecological practices to ensure that the pursuit of SDG 8 (decent work and economic growth) does not undermine the natural capital that supports both sectors, aligning outcomes with SDG 12 (responsible consumption and production).

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Furthermore, the reduction in tourism costs would also have a profound impact on the agricultural sector's production and productivity, leading to increased efficiency, innovation, and competitiveness. As tourism costs decrease, firms would invest in new capital assets and expand production capacity, leading to improved productivity and competitiveness [38]. The growth in production would be driven by increased efficiency and innovation, leading to higher yields and better-quality products [32]. Additionally, the reduction in tourism costs would lead to an increase in the adoption of new technologies and practices, further increasing productivity and competitiveness in the sector [28]. The increase in production and productivity would also lead to an increase in food security, improved livelihoods for farmers, and enhanced competitiveness in domestic and international markets [32]. Overall, the reduction in tourism costs would have a positive impact on the agricultural sector, leading to increased production, productivity, and competitiveness.

In addition to the benefits to production and productivity, the reduction in tourism costs would also lead to an increase in demand and consumption of agricultural products. As tourism costs decrease, the sector would experience an increase in domestic demand for agricultural commodities, leading to higher consumption and sales [30]. This would be driven by increased consumer spending and confidence, leading to higher demand for high-quality and diverse agricultural products [32]. Additionally, the reduction in tourism costs would lead to an increase in demand for agricultural products from the tourism industry itself, such as hotels, restaurants, and other tourist facilities [1]. This would lead to an increase in the production and supply of agricultural products to meet the growing demand, resulting in higher consumption and sales. Overall, the reduction in tourism costs would have a positive impact on demand and consumption in the agricultural sector, leading to increased sales, revenue, and growth.

Moreover, the reduction in tourism costs would also have a positive impact on the income of farmers and agricultural businesses. As tourism costs decrease, the sector would experience an increase in revenue and profitability, leading to higher incomes for farmers and agricultural entrepreneurs [36]. This would be driven by increased sales and consumption of agricultural products, as well as improved productivity and competitiveness [38]. Additionally, the reduction in tourism costs would lead to an increase in foreign direct investment in the agricultural sector, resulting in higher incomes for farmers and agricultural businesses through technology transfer and knowledge spillovers [39]. This influx of investment would facilitate technology transfer and knowledge sharing, leading to even greater productivity gains and competitiveness in the sector [28]. The increase in

income would also lead to improved livelihoods for farmers and their families, as well as increased economic growth and development in rural areas[32]. Overall, the reduction in tourism costs would have a positive impact on income in the agricultural sector, leading to increased prosperity and economic well-being for farmers and agricultural businesses.

Overall, the reduction in tourism costs would have a far-reaching impact on the agricultural sector, driving growth, productivity, and prosperity for farmers, businesses, and the broader economy. However, while these results highlight significant positive spillovers, the policy scenario of a sustained 10% reduction in tourism costs warrants careful consideration regarding the long-term financial sustainability of the tourism sector itself. The reduction in $PTOU_t$ (tourism price level) directly implies lower revenue per tourist for tourism operators, including hotels, tour companies, and related services. This compression of profit margins could undermine the viability of these businesses, particularly small and medium-sized enterprises (SMEs), unless the price reduction is offset by a sufficient increase in tourist volume or a reduction in operational costs through efficiency gains.

Furthermore, the government revenue increases shown, while positive, may be tempered in reality. A significant portion of government revenue from tourism comes from value-added taxes (VAT) on services, airport taxes, and park fees. A sustained decrease in the price base of tourism services could reduce the absolute tax collection per tourist, even if the overall volume increases. The net positive effect on government revenue shown in the model assumes that the volume increases more than compensates for the lower price, but this is contingent on highly elastic demand, which may be vulnerable to external shocks like those documented by Njoya et al.[17].

Therefore, for this policy to be sustainable, it must be designed not as a simple price cut but as a strategic investment in cost efficiency. This could involve public-private partnerships to reduce operational costs for operators (e.g., investing in renewable energy to lower utility bills, streamlining regulatory processes) and improve value-for-money, thereby protecting margins while making Kenya a more competitive destination. The gains in agricultural linkages then become a crucial secondary revenue stream and a risk diversification strategy for the tourism sector, helping to offset potential margin pressures and enhance overall resilience.

5.3. Impact on the Labour Market and Leisure

This section explores the impact of reducing tourism costs on the labour market and related outcomes. We analyse the effects of decreasing tourism costs on labour demand, leisure, and unemployment, providing insights into the potential benefits and trade-offs of such a policy change.

5.3.1. Labour Demand

1) Results

The results of **Table 3** indicate that a 10% fall in tourism cost led to an increase in labour demand in the agricultural sector; however, firms require additional capital to enhance their productivity, as highlighted previously. Moreover, the demand for capital increases by 1.37% in 2024 and 1.39% in 2030. Meanwhile, labour demand increases by 0.93% in both the short and long terms. In comparison to other sectors of the economy, **Table 4** shows that the agricultural sector records the highest increase, which means that in Kenya, most of the population work in that sector. Overall, the impact of tourism on the activity sectors in Kenya is mitigated; nonetheless, these impacts vary across households' qualifications and gender. Furthermore, the agricultural sector is the only sector in which labour demand is increasing regardless of household category, with 1.43% in 2024. Additionally, among men, labour demand, apart from the agricultural sector, by skilled households is increasing in the chemical sector, textile and clothing, printing and publishing, metal and machines, construction, trade, hotels and restaurants, public administration, health, and education. In contrast, it falls in three sectors: other manufactured sector, water and electricity, and transport, likely due to factors such as competition from imported goods and services, decreased demand, shifts towards more environmentally friendly options, competition from tourism-related businesses, displacement of local industries, changes in consumer behavior and preferences, environmental and resource constraints, and skills mismatch between the local workforce and tourism industry demands. Moreover, by examining the gender aspect, labour demand for female-headed households, in contrast to male-headed, decreases significantly, especially for unskilled females.

Overall, the results suggest that males are more likely to benefit from the impacts of tourism on the activity sectors, with labour demand increasing in most sectors. In contrast,

females, especially unskilled females, are more likely to experience a decrease in labour demand. This may indicate a gender imbalance in the benefits of tourism on employment opportunities.

Table 4. Labour Demand by Household Category (in Percentage).

	LSKM	LSKM	UnLKM	UnLKM	LSKF	LSKF	UnLKF	UnLKF
	Skilled Males		Unskilled Males		Skilled Females		Unskilled Females	
	2024	2030	2024	2030	2024	2030	2024	2030
AAGR	1.43	1.44	1.34	1.37	1.04	1.03	0.53	0.53
AFOOD	0.00	−0.01	−0.09	−0.08	−0.39	−0.41	−0.89	−0.91
ACHEM	0.57	0.57	0.48	0.51	0.18	0.17	−0.33	−0.33
ACLTH	0.21	0.18	0.13	0.11	−0.17	−0.22	−0.68	−0.72
APAPR	0.34	0.36	0.26	0.29	−0.04	−0.04	−0.55	−0.54
AMACH	0.34	0.33	0.25	0.26	−0.05	−0.07	−0.56	−0.57
AMOTH	−0.11	−0.10	−0.20	−0.16	−0.50	−0.49	−1.00	−0.99
APUB	−0.14	−0.15	−0.23	−0.21	−0.53	−0.54	−1.03	−1.04
ACONS	0.40	0.39	0.31	0.33	0.01	−0.01	−0.50	−0.51
ATRAD	0.26	0.26	0.17	0.19	−0.13	−0.14	−0.63	−0.64
AHOTL	0.19	0.17	0.10	0.11	−0.20	−0.23	−0.71	−0.73
ATRAN	−3.41	−3.64	−3.50	−3.70	−3.79	−4.02	−4.27	−4.50
ACOMM	0.02	−0.01	−0.07	−0.07	−0.37	−0.40	−0.87	−0.90
AFSRV	0.00	−0.01	−0.09	−0.07	−0.38	−0.41	−0.89	−0.90
AREST	0.00	−0.01	−0.09	−0.07	−0.39	−0.40	−0.89	−0.90
AOSRV	0.11	0.11	0.02	0.05	−0.28	−0.29	−0.79	−0.78
AADMN	0.37	0.51	0.28	0.44	−0.02	0.11	−0.53	−0.39
AHEAL	0.18	0.20	0.10	0.13	−0.20	−0.20	−0.71	−0.70
AEDUC	0.24	0.28	0.15	0.22	−0.15	−0.12	−0.65	−0.61

Source: Model results (GAMS V.25.1).

2) Discussion

The results on labour demand align with the literature review, which suggests that tourism can positively impact agricultural employment [11, 12]. Moreover, Hirschman's work highlights intersectoral linkages between tourism and agriculture, while Becker's theory of leisure consumption explains tourist behavior and preferences. Furthermore, Balaguer & Cantavella-Jordá's tourism-led growth hypothesis emphasises tourism's role in driving economic growth and generating employment in rural areas [13]. Additionally, Njoya et al.'s study specifically examines tourism's impact on poverty reduction and income inequality in Kenya [17], finding that tourism can reduce poverty and income inequality, but its impact depends on factors like leakage and unequal distribution of benefits. Consequently, the study highlights the importance of tourism in promoting sustainable development and reducing poverty in rural areas.

Overall, the results suggest that tourism can have both positive and negative impacts on labour demand in the agricultural sector, underscoring the need for careful policy interventions to maximize benefits and minimize negative impacts, particularly for female employment opportunities. The findings also highlight the importance of considering gender disparities in the distribution of benefits and negative impacts of tourism on employment opportunities.

In terms of policy implications, the results suggest that policymakers should prioritize investments in the agricultural sector to increase productivity and labour demand. Additionally, policies aimed at promoting gender equality and addressing the gender imbalance in the benefits of tourism on employment opportunities are crucial. This could include initiatives such as training and skill development programs for unskilled females, as well as policies to address structural barriers that limit women's access to employment opportunities in the tourism and agricultural sectors.

5.3.2. Leisure and Unemployment

1)Results

The results presented in **Table 5** highlight the gendered impact of a 10% decrease in tourism costs in Kenya on work and leisure times, as well as unemployment rates. The ta-

ble shows that men, particularly in rural areas, experience increased leisure time, while women, especially in urban areas, face decreased leisure time. This exacerbates existing gender-based disparities in work and family responsibilities. Additionally, the table reveals a decrease in unemployment rates for women, potentially increasing economic empowerment and gender equality, while skilled males experience increased unemployment rates. The results emphasise the importance of considering gendered impacts in economic analyses and policymaking.

Table 5. Leisure and Unemployment Impacts (in Percentage).

	LSKM	LSKM	UnLKM	UnLKM	LSKF	LSKF	UnLKF	UnLKF
	Skilled Males		Unskilled Males		Skilled Females		Unskilled Females	
	2024	2030	2024	2030	2024	2030	2024	2030
hrur0	0.91	1.05	0.90	1.04	−0.68	−1.18	−0.65	−1.13
hrur5	0.46	0.56	0.43	0.51	−0.58	−0.91	−0.52	−0.82
hrur9	0.19	0.23	0.17	0.20	−0.46	−0.68	−0.43	−0.65
hurb0	0.36	0.52	0.39	0.55	−1.36	−1.89	−1.52	−2.13
hurb5	0.28	0.39	0.30	0.42	−0.83	−1.18	−0.89	−1.27
hurb9	0.18	0.24	0.10	0.12	−0.61	−0.87	−0.50	−0.72
Unemp	0.05	0.04	0.00	0.00	−0.16	−0.18	−0.42	−0.44

Note: hrur0 (rural poor), hrur5 (rural median), hrur9 (rural rich); hurb0 (urban poor), hurb5 (urban median), hurb9 (urban rich); Unemp (Unemployment rate).
Source: Model results (GAMS V.25.1).

2)Leisure Time

A 10% reduction in tourism costs has a positive impact on unemployment rates for females, with a decrease in unemployment rates for both skilled and unskilled women. Skilled women see a decrease in unemployment rates by −0.16% in 2024 and −0.18% in 2030, while unskilled women experience a more pronounced decrease of −0.42% in 2024 and −0.44% in 2030. This suggests that the reduction in tourism costs leads to increased job opportunities for women, particularly in sectors that are more accessible to unskilled workers. The decrease in unemployment rates for females may lead to greater economic empowerment and gender equality, as it increases their participation in the labour market and provides a steadier income. This, in turn, can lead to improved economic outcomes for women and their families, as well as increased autonomy and decision-making power.

On the other hand, skilled males experience a slight increase in unemployment rates, potentially due to changes in industry demands or job market competition. They see an increase in unemployment rates by 0.05% in 2024 and 0.04% in 2030. Unskilled males, however, are not impacted by the reduction in tourism costs, suggesting that the unemployment rate for this group remains stable.

Overall, the result suggests that a reduction in tourism costs can have a positive impact on unemployment rates for females, particularly unskilled women, while potentially leading to a slight increase in unemployment rates for skilled males.

3)Discussion

The results presented highlight the gendered impact of a 10% decrease in tourism costs in Kenya on work and leisure times, as well as unemployment rates [11, 12]. The results show that men, particularly in rural areas, experience increased leisure time, while women, especially in urban areas, face decreased leisure time, exacerbating existing gender-based disparities in work and family responsibilities [17, 42]. However, the observed increase in leisure time, albeit unequally distributed, also presents a potential positive outcome in the form of enhanced mental health and well-being. Buckley provides a comprehensive framework arguing that tourism and leisure activities significantly contribute to mental health [55].

The reduction in tourism costs leads to increased job opportunities for women, particularly in sectors that are more accessible to unskilled workers, resulting in decreased unemployment rates for females [13]. This decrease in unemployment rates for females may lead to increased economic empowerment and gender equality, as women are more likely to participate in the labour market and earn a steady income [17, 36, 38, 43]. However, skilled males experience a slight increase in unemployment rates, potentially due to changes in industry demands or job market competition [12]. However, the finding that skilled males experience a slight increase in

unemployment rates, potentially due to changes in industry demands or job market competition, highlights the need for careful policy interventions to address the gendered impacts of tourism on employment opportunities, consistent with the work of Balaguer & Cantavella-Jordá[13].

Overall, the results suggest that a reduction in tourism costs can have a positive impact on unemployment rates for females, particularly unskilled women, while potentially leading to a slight increase in unemployment rates for skilled males[11]. These findings emphasise the importance of considering gendered impacts in economic analyses and policy-making[17].

5.4. Sensitivity Analysis

The robustness of these results is demonstrated through sensitivity analysis, a standard practice in CGE analyses. We conducted two modifications to the CES elasticity parameters in the Armington import function to test the model's sensitivity. The first modification involved a 1% reduction in CES parameter values, represented in **Table 3** as CES (− 10%), while the second modification involved a 10% increase in CES parameter values, depicted in **Table 3** as CES (+ 10%). As shown in **Table 3**, most variables exhibit minimal changes in both the short-term and long-term scenarios, indicating the model's robustness. Notably, variables such as domestic demand, composite demand, GFCF, and labour demand demonstrate stability, with their values remaining consistent with the basic results for both modifications, highlighting the model's reliability.

6. Conclusions

This study has utilised a dynamic Computable General Equilibrium (CGE) model to quantify the economic impact of a 10% reduction in tourism costs on Kenya's agricultural sector. The findings compellingly demonstrate that such a strategy transcends mere sectoral stimulus, serving as a powerful mechanism for achieving broader sustainable development objectives, notably SDG 2 (Zero Hunger), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production).

The analysis confirms a strong positive synergy between tourism and agriculture. The policy shock stimulates a significant rise in demand for agricultural commodities, resulting in a 1.66% increase in domestic demand and a 1.32% growth in intermediate consumption by 2030. This surge in economic activity drives substantial welfare gains, with the most vulnerable rural households experiencing a 2.57% improvement, thereby directly contributing to poverty reduction and enhanced food security (SDG 2). Macroeconomic indicators further validate this growth, showing a steady rise in GDP and government revenue, underpinned by increased investment and productivity within the agricultural sector (SDG 8).

However, the benefits are not universally equitable. The study identifies persistent gendered and geographical disparities. Female-headed households and unskilled female workers garner disproportionately lower gains in income and employment, while rural areas, despite absolute improvements, continue to lag behind urban centres. This underscores a critical limitation: while effective for aggregate growth, tourism cost reduction alone is insufficient to overcome deep-rooted structural inequalities.

Furthermore, it is essential to acknowledge the potential environmental trade-offs. Tourism-driven agricultural intensification, if not managed sustainably, poses a risk of environmental degradation, including habitat loss, water depletion, and soil erosion. This creates a critical tension between economic gains and ecological preservation. Therefore, the strategic imperative is to channel this growth through a framework of eco-tourism and sustainable practices (SDG 12), ensuring that economic benefits are not achieved at the expense of the natural ecosystems that form the foundation of Kenya's tourism appeal.

Therefore, to fully harness the potential of tourism-agriculture linkages for inclusive and sustainable development while ensuring the financial health of the tourism sector, we propose the following targeted policy recommendations:

1. Implement Strategic Tourism Cost Incentives Linked to Sustainability: The government should develop fiscal instruments. This could include conditional tax breaks or subsidies for tourism operators who demonstrably (a) achieve efficiency gains (e.g., through green energy adoption), and (b) source a significant percentage of their inputs (especially food and beverages) from local producers engaged in verified sustainable practices (e.g., organic, agroecological farming). This approach reduces net costs for operators while simultaneously

strengthening resilient, eco-friendly sectoral linkages and ensuring local value retention.

2. Invest in Low-Carbon and Sustainable Rural Tourism Infrastructure: Public and private investment should focus on enhancing eco-friendly infrastructure including renewable energy systems (e.g., solar-powered lodges), sustainable water management, digital connectivity, and cold storage facilities in agricultural regions. This enables rural communities to participate effectively in the value chain while minimizing the environmental footprint and preserving natural capital.
3. Mainstream Gender-Responsive Programmes in the Green Economy: Policy interventions must be explicitly designed to close the gender gap within the green economy. This requires investing in skills training and access to finance for women in sustainable agriculture and eco-tourism ventures, and promoting female entrepreneurship in organic agro-processing and community-based tourism.
4. Foster Stakeholder Dialogue for Resilient Value Chains: Policymakers must facilitate collaboration between tourism operators, agricultural cooperatives, and financial institutions. The goal is to develop stable procurement contracts, shared logistics, and financial products that de-risk investment for farmers and ensure a consistent, high-quality supply of local produce for the tourism industry. This secures a key market for agriculture and a reliable, sustainable supply chain for tourism, enhancing the viability of both sectors.

Author Contributions

Conceptualization, R.N.T. and C.M.D.; methodology, R.N.T.; software, R.N.T.; validation, N.D.N., M.-J.M.T. and C.M.D.; formal analysis, R.N.T.; investigation, M.-J.M.T. and C.M.D.; resources, N.D.N.; data curation, N.D.N.; writing—original draft preparation, R.N.T., N.D.N., M.-J.M.T. and C.M.D.; writing—review and editing, N.D.N., M.-J.M.T. and C.M.D.; visualization, M.-J.M.T.; supervision, C.M.D.; project administration, R.N.T. All authors have read and agreed to the published version of the manuscript.

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