

The Impact of Food Wastage, Access and Availability on Economic Growth: A Study of BRICS Countries

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ABSTRACT

This research paper investigates the impact of food wastage, access, and availability on economic growth in 10 BRICS countries—Brazil, China, Egypt, Ethiopia, India, Indonesia, Iran, Russia, South Africa, and the United Arab Emirates—a mix of Emerging Market and Developing Economies (EMDEs) and Advanced Economies (AEs). These nations face challenges related to food variables, affecting both health and economic performance. In this panel data study, the selected independent variables include food wastage (disaggregated into retail, out of home consumption, and household), food access, and food availability, with economic growth as the dependent variable. Through a random effects regression analysis, the findings reveal that total food wastage and food access have a significant positive impact on economic growth, with higher household-level food waste and increased prevalence of undernourishment correlating with higher GDP growth rates, indicating that even with rising food wastage and limited food access, economic value is being built into high-waste sectors in the short run. In contrast, food availability, as measured by average protein supply, exhibits no impact on economic growth. These findings have important implications for policymakers in BRICS countries. They address food insecurity and require inclusive growth that ensures access to nutrition while minimizing waste. Policymakers can use these insights to develop public campaigns on portion planning, composting, and food redistribution through NGOs or apps that can reduce waste without limiting consumption. To align development with sustainability, policymakers should integrate measures like green GDP and track undernourishment alongside economic indicators. This may involve strategies to strengthen local food production and social safety nets, building resilience and ensuring long-term, food-secure growth.

Keywords: Food Wastage, Food Access, Food Availability, BRICS, Economic Growth

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1. Introduction

Food is the most essential resource for human survival. Beyond nourishing our bodies, it fuels entire economies — with food systems representing \$10 trillion or over 12% of global GDP and accounting for more than 40% of all jobs worldwide (World Economic Forum, 2025). Yet, despite its vital role, food is often taken for granted. Every time someone mindlessly tosses away a half-eaten sandwich, discards a half-drunk smoothie, lets vegetables rot in the fridge, or leaves expired products lying in the pantry only to be thrown out later, they unknowingly contribute to a major global crisis: food wastage. Food wastage is defined as ‘food that is appropriate for human consumption but is discarded or left to spoil’ (Bos-Brouwers et al., 2014). Though the issue goes beyond what ends up in the trash. Food wastage is deeply interconnected with food availability and access. Food availability, represents the consistent presence of sufficient quantities of food, and one pillar to achieving food security. Globally, food production is enough to feed everyone on the planet (Capone et al., 2014). Despite this, food insecurity and malnutrition persist, largely due to inequities and inefficiencies in how food

is distributed. Furthermore, food access refers to ‘the percentage of the population whose habitual food consumption is insufficient to provide the dietary energy levels that are required to maintain a normal active and healthy life’ (FAOSTAT, n.d.). Most nations and economies, even the prosperous ones, struggle to achieve a good balance of these three aspects.

The latest reports confirm the magnitude of this issue. According to 2022 data from the United Nations Food and Agriculture Organization (FAO), approximately 1.3 billion tonnes of food are wasted globally each year, equivalent to 132 kilograms per person (European Commission, 2024). Moreover, nearly one-third of all food produced is wasted. This staggering figure includes both avoidable waste and unavoidable waste (Albion Environmental, n.d.). The difference between avoidable and unavoidable waste, as the name suggests, is whether the food could have been consumed. Avoidable waste refers to edible food that is discarded unnecessarily, while unavoidable waste describes inedible food that cannot be eaten or sold, such as peels, bones, or shells. Together, these forms of waste suggest that significant change is required in both infrastructure and consumer behavior. Another concern countries are faced with is physical availability: having sufficient food in a region through production, imports, or distribution. On the other hand, economic access determines whether the food available is affordable for its people.

A study conducted for 165 countries over the 2014-2018 period aimed to examine the impact of food wastage on economic growth, specifically its effects on GDP per capita in middle-income countries with high undernourishment rates (Cm, 2022). Using Ordinary Least Squares and Generalized Linear Model, the study explored the relationship between food wastage, poverty, and economic performance. The findings revealed a strong positive relationship between food wastage and poverty, suggesting that economic development influences food wastage patterns. The study concluded that targeted measures can help reduce waste, improve food accessibility, and break the cycle of poverty and food insecurity.

Research for the MENA region analyzed food loss and waste (FLW) across different stages of the Food Supply Chain (FSC), focusing on developing countries (Sawaya, 2017). Using secondary data from FAO reports, the paper emphasizes FLW as a complex issue occurring at all FSC levels, driven by structural causes like shortage of cold chains, processing facilities, and market infrastructure, as well as systemic causes related to policies and regulations. It discusses FAO’s regional framework aiming to reduce FLW by 50% in 2024, highlighting improvements close to farm (post-harvest, handling, storage and processing) and close to the fork (retail and consumption). The findings demonstrate that tailored interventions, such as infrastructure investments and updated regulations, are necessary to reduce global FLW and its environmental and economic costs.

This issue is further illustrated by Kotykova and Babych’s (2019) study in Ukraine. The study aimed to assess the economic, environmental, and social impacts of FLW, specifically evaluating economic damage, lost revenue, and food insecurity caused by inefficiencies while identifying potential benefits for waste reduction. Using the methodology proposed by FAO, the authors calculated FLW across various products, including cereals, vegetables, potatoes, meat, milk, and fruits, for different regions in Ukraine, from 2015-2017. The findings were that FLW results in significant economic damage and lost revenue, including per 100 hectares of agricultural land and per 100 people. In addition, the study emphasizes that reducing food waste also yields positive environmental and social outcomes.

In the context of sustainable community design, another study focuses on examining the interrelationship of food consumption, economic growth, and community well-being in Japan (Bimmoy, 2022). It highlights Japan’s economic resilience in shaping healthy economic development, technological opportunity, and effective utilization of resources. The authors

argue that attaining a zero food-waste community requires resource mobilization among stakeholders, using different mechanisms and technologies to prevent, reuse, and reutilize food waste. It is essential that a shared understanding of common challenges is established.

Food loss challenges are also critical in Indonesia, a BRICS member and a large agricultural producing country (Malahayati & Masui, 2021). More than 20 million tonnes of food are wasted annually, with around half lost on-farm before processing and consuming. The situation is very concerning as agricultural land shrinks and the population grows rapidly. In response, the Indonesian government has promoted improving yield and productivity, while reducing on-farm food loss. Using the Computable General Equilibrium (CGE) model, the study compared the economic and environmental impact of these policies. Results show that while yield improvements could increase GDP by 0.74% compared to the Business as Usual (BAU) by 2030, reducing on-farm food loss is more effective, increasing GDP by 0.93% and lowering cropland demand and agricultural GHG emissions. The combination of both policies yields an increase in Indonesia's Gross Domestic Product (GDP) by 0.17 %, but the analysis underscores that waste reduction is potentially more economically profitable.

Beyond national studies, research has examined food waste within the framework of the circular economy (Tamasiga et al., 2022). A bibliometric review of 155 journal articles published between 2015 and 2021 mapped trends and patterns in food waste and circular economy. Eight broad themes emerged, including anaerobic digestion, life cycle assessments, bio-based approaches, consumer behavior and attitudes, and policy challenges. The analysis stresses the urgent need to promote the collaboration of governments, the private sector, educational institutions, and researchers, to accelerate the adoption of circularity. It also highlights opportunities like acceptance of upcycled food, targeting specific areas of the food supply chain, and quantifying both food waste and emissions of greenhouse gases.

Similarly, a global content analysis of 500 relevant materials explored the relationships between food surplus/food waste and economic/environmental sustainability. Conducted by NVivo 12 Plus software, the study examined data from seven countries, six organizations, and six continents, identifying recurring themes around the conflicts of the sharing economy and for regulated sustainability (Huang et al., 2020).

Another study by Sheikh et al. (2022) in the context of developing countries between 1990 and 2021 aimed to examine the effect of food wastage, food security, and the environment on the economic growth across low-, lower-middle-, and upper-middle-income countries. Using the Method of Moments Quantile Regression and data sourced from the World Development Indicators and FAO, the study assesses key variables including labor force growth rate, gross fixed capital formation, food waste, food access, food availability, food stability, food utilization, and carbon dioxide emissions. The study concludes that while factors like labor force, gross capital formation, and secondary school enrollment influence economic growth in developing countries, food waste, food accessibility, and CO₂ emission have a significant negative impact, particularly in low-income nations, showing the urgent need for targeted policies on waste reduction and resource sustainability.

Finally, a study comparing South Korea and the United States (Chrobog, 2014), aimed to investigate the underlying causes of global food waste by examining how South Korea's strict government policies and economic incentives have successfully reduced waste and turned it into economic opportunities, while the U.S. lacks any strategies. The paper relies on data analysis and other research available to find significant economic loss from food waste, providing gaps with online research and personal interviews.

These studies emphasize the connection between food waste, food security, economic growth, and environmental sustainability, urging for policies and practices that promote efficient resource use, reduce waste across all stages of the FSC, and integrate economic incentives with infrastructure and regulations to achieve the sustainable development goals. While existing research has explored the impacts of food wastage on economic growth, there remains a lack of regional comparative analysis. Most studies are country-specific, theoretical, or qualitative in nature. However, understanding the complex relationship between food variables, such as wastage, access, and availability, and key macroeconomic indicators like GDP growth, unemployment, inflation, and population size is crucial.

Thus, this research explores the macroeconomic impact of food wastage, access, and availability in the BRICS countries, pre- and post-pandemic in 2019 and 2022. The BRICS includes 10 countries—Brazil, China, Egypt, Ethiopia, India, Indonesia, Iran, Russia, South Africa, and the United Arab Emirates. The focus on the BRICS countries is to represent a diverse sample that includes both advanced economies and emerging market and developing economies. This allows for a comprehensive examination of how food wastage influences developmental indicators across different economies. The research reflects detailed insights of how food wastage interacts with food security and economic growth, providing a global perspective on the issue. Utilizing recent data from sources like World Bank Database and FAOSTAT, the research aims to provide a worldwide account of the economic impact of food wastage while examining differences in food food access, availability, and stability between 2019 and 2022, disruptions caused by the COVID-19 pandemic. By analyzing key indicators such as GDP growth, unemployment, inflation, and population size, it offers a nuanced understanding of the macroeconomic consequences of food wastage, both pre- and post-pandemic.

2. Methodology

This study aims to analyze the impact of food wastage, access, availability on economic growth in BRICS countries during the years 2019 and 2022. The specific objectives of this study are:

1. To assess the impact of overall food wastage and its forms (retail, out of home consumption, and household) on the economic growth of BRICS countries.
2. To evaluate the effect of food availability on economic growth in BRICS countries.
3. To examine the role of food access on economic growth in BRICS countries.

2.1 Sample and Research Design

This study focuses on a sample of 10 BRICS countries (Brazil, China, Egypt, Ethiopia, India, Indonesia, Iran, Russia, South Africa, and the United Arab Emirates) comparing data from two specific years: 2019 and 2022. These years were intentionally selected to capture economic patterns before and after the COVID-19 pandemic, which had widespread impacts on food systems and economic growth. These selected countries represent a mix of emerging market and developing economies (EMDEs) as well as advanced economies (AEs), allowing for a global perspective on how food wastage, access, and availability have an effect on macroeconomic indicators.

Regression analysis is a set of advanced statistical methods used to examine the estimation of relationships between a dependent variable and one or more independent variables. It includes several variations, such as linear regression, multiple linear regression, and nonlinear regression. This technique helps to understand how changes in predictors (independent variables) influence an outcome (dependent variable). In this study, regression analysis is used to investigate how food wastage, access, and availability impact economic growth in BRICS

countries. This study employs panel data analysis, which combines both cross-sectional and time-series data. Cross-sectional data refers to data collected from multiple countries at a single point of time, while time-series data refers to data collected from a single country across multiple time periods. Panel data combines these two types of including multiple cross-sections observed over multiple time periods, allowing for a more comprehensive analysis.

In this study, panel data is constructed using two cross-sectional datasets from the years 2019 and 2022, covering the aforementioned countries. The analysis includes independent variables with regards to macroeconomic food wastage, access, and availability—to examine their impact on economic growth, measured through the GDP growth rate. Panel data deals with omitted variable bias due to heterogeneity in the data (Torres-Reyna, 2007). It achieves this by controlling that we cannot observe, are not available, and/or can not be measured but still have a correlation with the independent variables.

To analyze the impact of food-related variables on economic growth, two regression models were used. Model 1 uses total food wastage as a single independent variable. Model 2, on the other hand, divides food wastage into three components: retail, out of home consumption, and households. This dual-model approach allows both a broad and detailed perspective on the relationship between food wastage and economic growth.

When working with panel data, it is essential to choose the appropriate regression model. In this study, two separate Hausman tests were conducted for Model 1 and Model 2, both of which yielded p-values greater than 0.05 ($p_{\text{Model1}}=0.443$, $p_{\text{Model2}}=0.859$). This shows that the random effects regression model is most suitable for both models. The regression equation for random effects regression can be represented as follows:

$$y_{it} = \alpha + \beta'x_{it} + u_i + e_{it}$$

In this context, y_{it} represents the dependent variable, α is the intercept (constant) term, β' is the vector of coefficients, and x_{it} is the vector of explanatory variables for each country i ($i = 1, \dots, N$) in each year t ($t = 1, \dots, T$). In the random-effects approach, each country i is associated with a unique random component u_i . These effects are assumed to be uncorrelated with the variables. The term e_{it} represents the term of error.

2.2 Variables and Hypotheses

In order to understand the effect of food-related indicators on economic growth, the study considers the following dependent variable for the analysis:

1. Economic Growth (gdpgr): GDP growth rate (Annual %) serves as the dependent variable, representing a key indicator of a country's economic performance. This variable, sourced from the World Bank Database, measures the annual percentage change in a nation's gross domestic product, reflecting the overall increase or decrease in economic activity over time.

The study considers three food-related independent variables for the purpose of the analysis. These are:

1. Food Wastage (total_fw): Food wastage, proxied by the average of food waste per capita in retail, out of home consumption, and households. Data has been sourced from the United Nations Environment Programme (UNEP) database.
 - a. Retail (fw_retail): Food waste per capita in retail refers to the quantity of food, measured in kilograms, that is discarded or left uneaten at the retail level of the food supply chain. This includes food that is discarded by retailers due to spoilage,

- damage, or exceeding expiration dates, as well as food that is simply not purchased by consumers
- b. Out of Home Consumption (fw_oohc): Food waste per capita out of home consumption refers to the food discarded by the food service sector, which includes restaurants, schools, hospitals, and canteens.
 - c. Household (fw_household): Food waste per capita households accounts for the amount of food and inedible parts discarded by households, measured in kilograms. This includes food discarded during meal preparation, such as peelings, bones, or uneaten portions. It also covers food that spoils before consumption including items that expire or go bad in the refrigerators or pantries. In addition, it includes food not consumed at meals, like leftovers that are eventually thrown away.

The hypothesis to be tested for this variable is:

- H_{01} : There is no significant effect of food wastage on economic growth in the context of BRICS nations.
 - H_{a1} : There is a significant effect of food wastage on economic growth in the context of BRICS nations.
2. Food Access (food_access): The prevalence of undernourishment, which also represents the share of the population whose food consumption falls below the minimum energy levels needed for a healthy and active lifestyle. Data on prevalence of undernourishment for the study periods are collected from the Food and Agriculture Organization (FAO) database. The hypothesis to be tested is:
 - H_{02} : There is no significant effect of food access on economic growth in the context of BRICS nations.
 - H_{a2} : There is a significant effect of food access on economic growth in the context of BRICS nations.
 3. Food Availability (food_avail): Average protein supply (g/cap/day, 3-year average, 2017–2019) serves as a proxy for food availability. The data for this variable has been sourced from FAO. The hypothesis has been formulated as follows:
 - H_{03} : There is no significant effect of food availability on economic growth in the context of BRICS nations.
 - H_{a3} : There is a significant effect of food availability on economic growth in the context of BRICS nations.

To isolate the effect of the independent variables on GDP growth, the study includes three control variables, all sourced from the World Bank Database:

1. Inflation Rate (inflation): This variable measures the annual percentage change in consumer prices. The World Bank defines the inflation rate as the yearly percentage change in the cost of a basket of goods and services, usually measured using the Consumer Price Index (CPI). The CPI tracks the mean change over time in prices paid by consumers for a fixed basket of goods and services. The inflation rate reflects how much more or less expensive the basket becomes compared to the previous year.
2. Population Size (population): The natural logarithm of total population is used in the analysis. Population represents the total number of residents in a country. Population size can vary widely across countries, taking the natural log of population allows for more accurate comparisons.
3. Unemployment Rate (unemployment): This variable represents the percentage of the labor force that is unemployed but actively seeking employment. The portion of the

labor force without work, but available for and actively looking for jobs. It includes all individuals who are either employed or unemployed.

Table 1. Variables of the study

Variables	Symbol	Definition
Economic Growth	gdpgr	The annual percentage change in a country's GDP.
Food Wastage	total_fw	The average per capita food waste across retail, out-of-home consumption, and households.
Retail	fw_retail	The per capita amount of food wasted at the retail level.
Out of Home Consumption	fw_oohc	The per capita food waste generated by the food service sector.
Household	fw_household	The per capita food waste from households.
Food Access	food_access	The percentage of the population whose food consumption is insufficient to meet the minimum dietary energy requirements.
Food Availability	food_avail	The average daily protein supply per capita (in grams), averaged over 2017–2019.
Inflation Rate	inflation	The annual percentage change in consumer prices based on the Consumer Price Index (CPI).
Population Size	population	The natural logarithm of a country's total population.
Unemployment Rate	unemployment	The percentage of the labor force that is without work but actively seeking employment.

2.3 Model Diagnostics

In order to carry out a random effects regression, the model requires that there is no multicollinearity. Multicollinearity occurs when two or more independent variables are highly correlated with each other, which can distort the estimation of regression coefficients and lead to unreliable results. Ideally, independent variables should not exhibit strong correlations. Two techniques used to test multicollinearity are a manual assessment through the usage of a correlation matrix and variance inflation factor (VIF). For both Model 1 (which uses total food wastage) and Model 2 (which includes all three components of food wastage: retail, out of home consumption, and household), these diagnostics were performed. The correlation matrices for the independent variables are presented in Table 2 (Model 1) and Table 3 (Model 2). In both models, all correlation coefficients fall within the acceptable threshold range of -0.8 to 0.8, indicating no strong correlation between predictors. In both models, $VIF < 10$ (Mean $VIF_{Model1}=1.521$, Mean $VIF_{Model2}=1.815$), which falls within the accepted threshold for multicollinearity.

Table 2. Correlation matrix of independent variables (Model 1)

Variables	gdpgr	total_fw	food_access	food_avail	inflation	population	unemployment
gdpgr	1.000						
total fw	0.535	1.000					
food access	0.434	0.010	1.000				
food avail	-0.147	0.075	-0.666	1.000			
inflation	-0.160	0.030	0.395	-0.264	1.000		
population	0.176	-0.159	0.110	-0.018	-0.154	1.000	
unemployment	-0.378	-0.287	-0.080	-0.214	-0.015	-0.180	1.000

Source: STATA Output

Table 3. Correlation matrix of independent variables (Model 2)

Variables	gdpgr	fw_retail	fw_oohc	fw_household	food_access	food_avail	inflation	population	unemployment
gdpgr	1.000								
fw_retail	0.149	1.000							
fw_oohc	0.327	0.082	1.000						
fw_household	0.441	-0.198	0.192	1.000					
food_access	0.434	-0.138	-0.062	0.071	1.000				
food_avail	-0.147	0.000	0.129	0.044	-0.666	1.000			
inflation	-0.160	-0.273	-0.134	0.157	0.395	-0.264	1.000		
population	0.176	-0.029	0.448	-0.295	0.110	-0.018	-0.154	1.000	
unemployment	-0.378	-0.125	-0.007	-0.272	-0.080	-0.214	-0.015	-0.180	1.000

Source: STATA Output

3. Results and Discussion

This section interprets the results of the regression analysis, which examines the impact of food wastage, access, and availability on economic growth in BRICS countries.

Table 4. Descriptive statistics

Variable	Obs	Mean	SD	Min	Max
gdpgr	20	3.589	3.086	-3.071	8.364
total_fw	20	39.781	10.947	18.507	67.923
fw_retail	20	15.926	9.334	2.67	49.93
fw_oohc	20	30.771	8.833	8.43	47.55
fw_household	20	72.647	30.154	33.37	162.95
food_access	20	7.375	5.784	2.5	22.2
food_avail	20	92.04	17.78	67.2	125.6
inflation	20	11.221	12.868	-1.931	43.488
population	20	8.206	0.617	6.975	9.154
unemployment	20	8.288	8.239	2.331	33.268

Source: STATA Output

Table 4 presents descriptive statistics for key food-related variables across the 10 BRICS countries in 2019 and 2022. The GDP growth rate (gdpgr) shows a mean of 3.589% with a high standard deviation of 3.086%, indicating moderate but variable growth rates across these countries. High variability in GDP growth points to significant differences in economic performance, ranging from a contraction of -3.071% to a robust growth of 8.364%. Total food wastage (total_fw), which combines retail, out of home consumption, and household sectors, averages 39.781 kg per capita with a standard deviation of 10.947 kg, reflecting broad differences in overall food waste patterns and resource inefficiencies across the BRICS nations. Food wastage in retail (fw_retail) averages 15.926 kg per capita with a moderate standard deviation of 9.334 kg, highlighting variation in retail-level food waste due to differing levels of efficiency, infrastructure, and consumer demand across countries.

Food wastage from out of home consumption (fw_oohc) exhibits a mean of 30.771 per capita and a moderate standard deviation of 8.833 kg, reflecting difference in food service sector practices, ranging from 8.43 kg to 47.55 kg per capita. Household food wastage (fw_household) averaged 72.647 kg per capita, with high variability (SD of 30.154 kg) indicating substantial differences in household consumption behavior and food management, from as low as 33.37 kg to as high as 162.95 kg per capita. Food access (food_access) averages 7.375%, representing the portion of the population experiencing insufficient food consumption, with a standard deviation of 5.784% showcasing moderate disparities in food security across the BRICS countries. Food availability (food_avail), measured by average daily protein supply per capita, has a mean of 92.04 grams with a moderate standard deviation of 17.78 grams,

indicating nutritional difference and unequal access to protein-rich foods across countries, ranging from 67.2 g to 125.6 g. These statistics underscore significant disparities in food-related and economic conditions among the BRICS countries, suggesting uneven development and challenges in achieving sustainable food systems.

The analysis in Table 5 provides the regression analysis for Model 1, which examines the impact of total food wastage, food access, and availability on economic growth using a random effects panel data regression. The model yields a Chi-square value of 568.345 with a p-value of 0.000, confirming strong overall model significance. Furthermore, the R² value of 0.662 for this model suggests that the independent variables account for approximately 66 per cent of the variation in the dependent variable.

Table 5. Results of panel data regression using random effects model (Model 1)

	Coefficient	P-value	
Constant	-8.91	0.078	
total fw	0.143	0.000***	
food access	0.322	0.000***	
food avail	0.017	0.609	
inflation	-0.092	0.000***	
population	0.521	0.018**	
unemployment	-0.055	0.058*	
R²	0.662	No. of Obs	20
Chi-Square	568.345	Prob > Chi²	0.000

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: STATA Output

The analysis in Table 6 presents the statistical test for Model 2, which disaggregates total food wastage into retail, out of home consumption (OOHC), and household sections to examine their individual impacts on economic growth using a random effects panel data regression. The model produces a Chi-square value of 1023.027 with a p-value of 0.000, indicating strong overall model significance. Additionally, the R² value of 0.666 suggests that the explanatory variables account for approximately 66.6% of the variation in the GDP growth rate across the BRICS countries in the observed years.

Table 6. Results of panel data regression using random effects model (Model 2)

	Coefficient	P-value	
Constant	-8.883	0.461	
fw retail	0.064	0.42	
fw oohc	0.057	0.398	
fw household	0.045	0.003***	
food access	0.339	0.000***	
food avail	0.019	0.696	
inflation	-0.088	0.001***	
population	0.442	0.576	
unemployment	-0.055	0.37	
R²	0.666	No. of Obs	20
Chi-Square	1023.027	Prob > Chi²	0.000

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: STATA Output

Previous studies have found contradictory effects of this study, a negative relationship between food wastage and economic growth. One such study, previously discussed, examining 165 countries between 2014 and 2018 found that food wastage hinders GDP growth, especially in middle-income countries with high undernourishment levels (Cm, 2022). However, in the context of this study, this counterintuitive, suggesting improved economic growth, may be explained by the following factors.

The regression analysis (see Table 5) reveals a significant positive impact of total food wastage on GDP growth in BRICS countries ($\beta = 0.143$, $p < 0.01$). Hence, H_{01} stands rejected. This finding suggests that higher food wastage actually leads to an increase in economic growth. At first glance, this result may seem counterintuitive, as food wastage is widely recognized as an economic, social, and environmental concern with negative implications. However, in the context of fast-growing economies such as the BRICS nations, this positive association can be explained by the fact that food waste often reflects increased economic activity and rising consumption. Beyond consumption, food wastage does generate economic activity through its management. The disposing, processing, and repurposing of food waste creates demand for waste collection, composting, sanitation services, and even energy recovery industries (PIB Delhi, 2024).

Furthermore, this sector provides significant employment opportunities. The existence of food wastage ensures new jobs across numerous layers of the economy, from collection and transportation to composting and energy recovery. While precise statistics on the number of people employed in BRICS countries are limited, research indicates that recycling, composting, and energy recovery generate substantially more jobs per ton of waste than landfill or incineration (Eco-Cycle, 2024). City-level studies, such as in Brazil, suggest that tens of thousands of people are employed in municipal waste management, with food waste representing a significant portion of these activities (Franz & Da Silva, 2024).

As these countries experience industrialization and urbanization, inefficiencies such as food wastage frequently emerge as unintended byproducts of rapid economic expansion rather than a driver of growth. One may also see surges in food waste often linked to gaps in storage, transport, and supply chain management, particularly in countries with underdeveloped infrastructure. As GDP, these inefficiencies become more evident, leading to increased food losses. While these losses reflect inability of certain sectors to meet the demands of a growing economy, they do not actively generate real economic value themselves. All in all, food wastage is primarily a byproduct of surging consumption and production, not an engine of growth (Rahman et al., 2024).

The model also finds that food access—measured as the prevalence of undernourishment—has a strong positive and statistically significant relationship with GDP growth ($\beta_{Model1} = 0.322$, $\beta_{Model2} = 0.339$, $p < 0.01$). Hence, H_{02} has been rejected. This finding is also unexpected and appears counterintuitive, as higher values of undernourishment implies worse access to adequate nutrition. One would expect that improved food access (i.e., lower undernourishment) would support economic growth by enhancing public health and labor productivity, thereby contributing to long-term economic expansion. However, the results suggest the opposite: that developing countries experiencing rapid growth may still struggle with chronic undernourishment.

One possible explanation is that BRICS countries—such as India and Sub-Saharan Africa nations—are experiencing GDP growth due to industrialization or non-agricultural sectors, rather than by improvements in agriculture or rural development. Hence, economic growth may occur in parallel with, rather than in response to, improvements in food security. GDP growth may reflect increases in sectors that do not directly impact undernourished populations, especially those in rural and low-income communities (Chaudhary, 2024). Economic expansion is often export-oriented and not rooted in agricultural development. As a result, domestic systems failing to meet nutritional needs contribute to high prevalence of undernourishment, despite strong GDP performance. Food access plays a pivotal role in building human capital and supporting economic development.

On the contrary, food availability—proxied by the average daily protein supply per capita (in grams)—does not have a statistically significant effect on economic growth ($\beta_{Model1} = 0.017$, $\beta_{Model2} = 0.019$, $p = 0.696$). Hence, H_{03} has been accepted. This suggests that simply increasing the overall supply of food does not translate to economic productivity. In countries with high inequality, food may be available but not equally distributed to vulnerable or rural populations due to infrastructure gaps, inefficiencies, or income inequality. Large portions of the population remaining food insecure does not result in positive effects of the availability.

To further understand the relationship between food wastage and GDP, Model 2 (Table 6) breaks down total food waste into its three components: retail, out of home consumption (OOHC), and household waste. The results indicate that household food waste is the only component that is statistically significant ($p < 0.01$), and it also has a positive impact on GDP growth. This finding reinforces the idea that household-level consumption and economic activity are closely linked. Household-level food waste's positive and significant association with GDP growth may seem counterintuitive at first.

However, it suggests that increased food consumption and wastage at the household level may reflect rising affluence. As households gain more purchasing power and access to a wider variety of foods, waste tends to increase—particularly when storage or refrigeration infrastructure is lacking. This, in turn, stimulates economic activity through higher demand across multiple sectors, including agriculture, retail, and processing (Parfitt et al., 2010). While such waste is undesirable, it reflects higher levels of consumption and income, which are drivers of GDP growth in emerging economies. Food wastage at the retail and OOHC levels is not statistically significant, suggesting that these sectors do not play a direct role in influencing economic performance. Inefficiencies may exist in both but do not translate directly into national-level economic growth.

4. Conclusion

The objective of this paper was to explore and understand the impact of food wastage, access, availability on economic growth in BRICS countries during the years 2019 and 2022. The analysis revealed that food wastage, primarily by households and food access significantly impact economic growth, while food wastage in retail, OOHC, and food availability do not. The positive correlation between total food wastage and GDP growth highlights the complexities of early-stage development. In this context, increased household food wastage serves as a reflection of more purchasing power and consumption, particularly in economies undergoing rapid industrialization and urbanization.

These findings carry important implications for policymakers in BRICS nations. To effectively combat food insecurity and promote sustainable economic development, policies must address both unequal access to nutrition and ensure that economic growth is inclusive. One key area for reform is the way GDP is calculated. Current GDP metrics in many BRICS countries typically measure economic output without accounting for environmental costs, like losses from food waste or the resources in managing it. Some examples of alternative measures are green GDP or adjusted economic welfare indicators.

Policymakers should prioritize targeted initiatives, such as awareness campaigns using nudges, labelling, and portion planning, which can reduce waste without compromising consumption, helping to strike a balance between economic growth and environmental sustainability. Moreover, encouraging composting, waste-to-energy conversion, and food redistribution programs through partnerships with apps or NGOs are crucial for recovering economic value from waste and boosting green innovation sectors. Policymakers can also begin to factor in

environmental inefficiencies such as food wastage when redefining traditional growth metrics to include sustainability. Regarding food access, the findings underscore the importance of integrating nutrition indicators, such as tracking undernourishment alongside GDP to evaluate the quality of development. By emphasizing domestic food production, reinforcing social safety nets, and building resilient supply chains are critical to ensuring that economic growth is both food-secure and inclusive.

This study, however, is not without limitations. Firstly, due to data availability constraints, the analysis is restricted to two key time points (2019 and 2022) which limits the ability to assess long-term dynamics in food-related variables and economic growth. Secondly, the inclusion of the COVID-19 period introduces possible distortions in consumption patterns and economic activity. The year 2022, in particular, reflects a recovery phase, where many economies were still adjusting from the shocks and disruptions of the global pandemic. Lastly, while the sample of ten countries provides meaningful insights, it does not fully capture the broader diversity of advanced, emerging, and developing economies. Despite these limitations, the study offers timely and valuable contributions by highlighting nuanced associations between food waste, access, and macroeconomic performance during a period of global disruption. The findings provide a strong foundation for future research that can build on this work using larger, multi-year datasets and wider country samples. As data availability improves, future studies can further expand and refine these insights to inform more inclusive and sustainable growth strategies across regions.

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