Sustainable Consumption: The Impacts of Food Wastes, Food Price and Income on Food Security

Kaimeng Song[1], Meenchee Hong[1*]

[1] Graduate School of Business, Universiti Sains Malaysia, Malaysia

*Corresponding Author: meenchee.hong@usm.my

_____

Abstract: *Food is a fundamental necessity for sustaining human life, making providing adequate food for everyone a basic human right. Therefore, meeting the food needs of the entire population at any given time becomes a primary objective of a country's food policy. Food availability is a key component of food security. In the past, food insecurity was often attributed to a lack of food supply. However, recent research has shown that food self-sufficiency does not automatically guarantee food security. Despite advancements in agriculture and the economy, approximately 735 million people globally suffer from acute malnutrition. Food waste, with one-third of food wasted annually, significantly affect food security. This study investigates the impact of food waste, national income and food prices on food security using panel data from the World Bank, FAO, Economist Impact, and United Nations. Data from 100 countries for year 2002 to 2021 will be estimated using pooled OLS, fixed and random effect regressions. Stata software will be used for data analysis. The Hausman test will determine the most suitable model, and diagnostic tests will address potential issues such as multicollinearity, heteroskedasticity, and endogeneity. The findings will inform sustainable food policies and contribute to achieving the UN Sustainable Development Goals, emphasising the importance of food security through efficient resource management.*

_____

1. Introduction

Food security is a crucial issue in the 21st century, highlighting a population's capacity to obtain adequate, safe, and nutritious food necessary for a healthy and active life (Peng & Berry, 2019). It encompasses four key dimensions: 1) Availability (on a national scale): This includes food produced locally and imported from abroad. 2) Accessibility (for households): Food must be reachable by consumers through adequate transportation infrastructure and affordable for purchase. Individuals must consume adequate amounts of nutritious and safe food to live healthy, fulfilling lives. This dimension also involves clean water, proper sanitation, and physical health to digest and utilise the food. 4) Stability (a temporal aspect influencing all levels) (Practical, 2008). This refers to the resilience of nations, communities, households, and individuals to withstand disruptions to the food supply, whether from natural disasters like climate events and earthquakes or man-made crises like wars and economic downturns.

The reverse of food security, i.e. food insecurity, refers to limited or uncertain access to nutritious food, leading to hunger, malnutrition and negative impacts on health and quality of life (Campbell, 1991). 'Undernourishment' is the main indicator used by the Food and

Agriculture Organization of the United Nations to measure the extent of food supplies and nutrition. It is often used interchangeably with 'hunger' (Ritchie & Roser, 2022). Figure 1 shows that nearly one-seventh of the global population lacks enough food to maintain a healthy and active lifestyle.
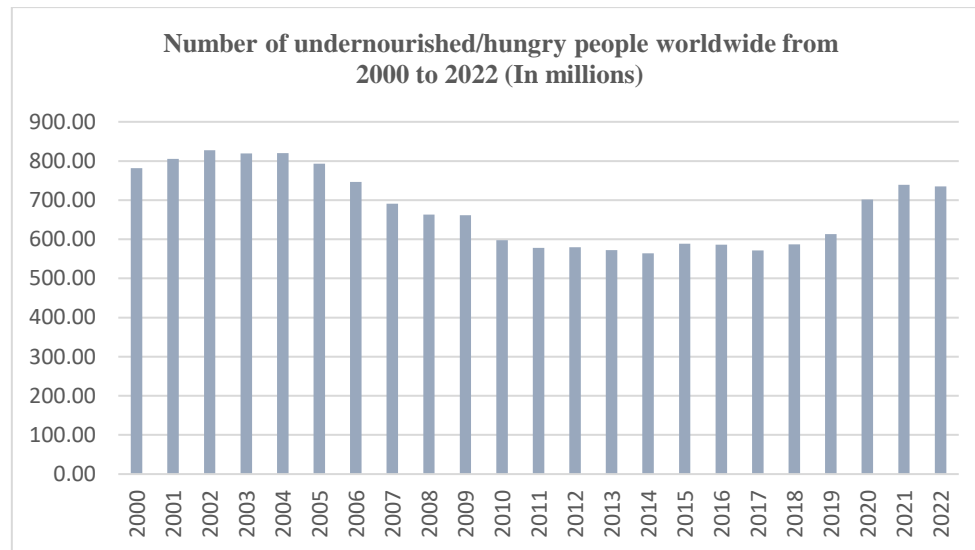

Figure 1 Number of undernourished/hungry people worldwide, 2000-2022
Source: Author's work based on data from FAOSTAT, 2023.

Food security and insecurity are interconnected, dynamic, and time sensitive. Measuring food security universally is challenging, as different indicators may be needed for varying levels of food security for different stakeholders. The overall status is determined by the interaction between food insecurity pressures, the underlying causes of food insecurity, and the strategies used to address them. Food shortages in one region and surpluses in another can occur for various reasons, including food waste in different parts of the world (Joardder et al., 2019; Tóth & Zachár, 2021).

Food availability, the first and most crucial dimension of food security, highlights the imbalance between food demand and supply in a particular market (Yamaguchi, 2022). According to the law of supply and demand, market equilibrium (price and quantity) is determined when the demand and supply intersect, meaning there are no shortages or surpluses in the market. The imbalance can be attributed to several key factors: low crop yield, inefficient distribution, improper allocation of resources, etc (Daszkiewicz, 2022). Wars disrupt supply chains, driving up global food prices and pushing millions into poverty and hunger. Conflicts such as the Russia-Ukraine war and the Israel-Palestine conflict have led to significant fluctuations in food and commodity prices which prevent 3 billion people globally from accessing healthy diets (Nasir & Lakner, 2022).

Food wastes exacerbate food insecurity. Every year, one-third of the food produced for human consumption globally (approximately 1.3 billion tons) is lost or wasted. If just one-quarter of the current global food loss or waste could be saved, it would be enough to feed 870 million hungry people worldwide (Sokołowski, 2020). Further, economic factors such as GDP and food prices are critical to food security. High food prices can reduce low-income households' access to nutritious food, exacerbating food insecurity.

While many studies have investigated the impact of climate change and poverty on food security, there is a significant gap in the literature regarding the impact of food waste on food

security. Existing research often overlooks how food waste and mismanagement of resources affect food availability (Behnassi & Yaya, 2011; Duncan, J. et al., 2016; Teeuwen et al., 2022). Moreover, there is a lack of standardised indicators to measure food wastes. Thus, the impact of food wastes on food availability remains unclear. Thus, investigating these factors not only deepens our comprehension of the fundamental causes of food security challenges but also offers crucial information for developing more efficient policies and solutions. Hence, this study aims to explore the determinants of food security, focusing specifically on the effects of food waste on national food availability and considering the role of GDP, and food prices. The insights gained will inform the development of sustainable and equitable food policies.

The remaining sections of this study are organized as follows: Section 2 provides a literature review and hypothesis development, Section 3 covers the research methodology and data, and Section 4 presents the research conclusions.

2. Literature Review

2.1 Food Security
Since the severe global food crisis erupted in 1972, food security has quickly captured the attention of policymakers and researchers worldwide, becoming a persistent research focus. Food security is an evolving concept (Liu, 2004). Its meaning has continually changed and improved with economic and social development (Liu, 2007). Over the past 50 years, through the continuous exploration of scholars, the concept of "food security" has undergone significant changes (Maxwell, 1996; Shaw, 2007; Berry et al., 2015).

In the context of significant increases in international grain prices and considerable fluctuations in food markets, FAO introduced the term "food security" at the World Food Conference in 1974. It was defined as "the availability of adequate world food supplies at all times to sustain a steady expansion of food consumption and to offset fluctuations in production and prices" (Simon, 2012). This initial concept of "food security" focused on the availability of basic foodstuffs (mainly cereals), emphasising the quantitative safety and stability of food supply, i.e., it placed more importance on the safety and stability of food production.

It was anticipated that the widespread adoption of advanced technologies associated with the "Green Revolution", including breeding, fertilisers, irrigation, pesticides, and agricultural machinery, would effectively alleviate the food crises in developing countries. However, this was not the case. Evidence showed that while these technologies significantly increased food production in developing countries, the issues of hunger and malnutrition in these regions were not effectively mitigated. In 1996, FAO incorporated nutrition and culture into the new concept, expanding the scope of food security from "access to adequate basic foodstuffs (mainly cereals)" to "access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences" (Shetty, 2009), focusing on the interests at the individual or household level.

At the national level, food security is discussed from the perspective of self-reliance (Gao, 2010). Unlike the global level, where self-sufficiency is the sole means to achieve food security, national-level food security includes imports (including international aid) as a source of food supply and self-reliance. At the household level, food security refers to the ability of a household's purchasing power to meet its members' dietary energy intake needs, which depends on the household's income level. At the individual level, food security means that an individual

can obtain nutritious food that aligns with their dietary preferences, assuming that food security at the global, national, and household levels has been achieved. This is the goal of food security.

A range of factors have been identified as determinants of food security. Food security is a complex issue influenced by a range of determinants. Louw (1991) emphasises the importance of domestic food self-sufficiency but warns that it can be counterproductive if not managed effectively. Bhuyan (2020) identifies social and economic factors as key determinants of food security in India, with caste, religion, and household structure playing significant roles. Kaur (2016) found that GDP per capita, infrastructure, food production, and access to clean water are key factors, while inflation and import levels can negatively impact food security. Pawlak (2020) emphasised the role of economic factors such as GDP, investment attractiveness, and market conditions in shaping food security. Warr (2014) underscores the importance of stimulating agricultural output without raising domestic food prices, as higher prices can exacerbate food insecurity. Zaini (2019) focused on the impact of socioeconomic status and food consumption on food insecurity, particularly in low-income populations. These studies collectively underscore the complex interplay of economic, social, and political factors in determining food security. Shebanina et al. (2023) argue that food security can be achieved by ensuring availability, quality, safety, and availability, with food availability being the foundation.

2.2 Food Wastes
Different scholars have different opinions on the concept of food waste behaviour. Buzby et al. (2002) believed that food waste behaviour refers to the behaviour in which consumers discard food that can be eaten continuously in the consumption on the table. Zhang et al. (2016) believed that food waste was caused by avoidable food loss due to individuals' lack of saving spirit, but some food waste, such as vegetable peels, bean residue and bones, were not included. Wang et al. (2018) defined the food waste behaviour as the behaviour of not packing the remaining food and eating it for a second time. Beretta et al. (2019) argued that food waste refers to food originally produced for human consumption that is later used in non-edible ways but does not include inedible parts (such as residue, skin, shells, and bone).

At present, the research is mainly divided into three aspects: the antecedents of food and beverage waste behaviour, the consequences of food and beverage waste on the environment, and the countermeasures to curb food and beverage waste. As for the research on the antecedence of food and beverage waste behaviour, Wang et al. (2018) found that the age, occupation, nature of work and income level of residents played an important role in the food and beverage waste behaviour of dining out. Sirieix et al. (2017) found that wasting food in restaurants and not packing unfinished food would lead to expected regret, guilt and other related emotions; Hamerman et al. (2018) found that environmental concerns would positively affect the possibility of people taking leftovers home; Cao (2020) took wedding banquet as an example and found that economic income, face, packing and regional factors were the main influencing factors of catering waste behaviour.

Food waste is a significant problem in the global food system, with one-third of all food produced for human consumption being lost or wasted. Both (Meacham, 2013) and (Papargyropoulou, 2016) emphasised that reducing food waste is important in ensuring food security. The study by Osner (1982) found that households had errors in food demand expectations, resulting in more food waste in summer and winter (Table 2-6). Kantor et al. (1988) found that meal waste accounted for much food waste. Kader 2003 suggests that lack of infrastructure and poor harvesting/planting techniques in many developing countries may

still be major contributors to food waste. According to Nellemann et al. (2009), reducing these losses is important to improving food security. Akram (2021) and Cao (2020) found that activity types such as Buffet-style services and wedding banquets were important causes of food waste.

Srivastava (2021) further highlighted the role of guest behaviour and party organizers' practices in driving food waste at social gatherings, including weddings. Youngs (1983) added that traditional dining methods, rich menus, and using unprocessed food in hotels also lead to significant food waste. These findings highlight the reduction of meal waste and the need for sustainable planning and balanced nutrition to address food waste and its impact on food security.

The literature extensively documents the intricate relationship between food waste and food security. Scholars have highlighted various factors contributing to food waste, ranging from individual behaviours and socio-economic factors to systemic issues within the food supply chain. Osner (1982) and Kantor et al. (1988) emphasise the role of consumer behaviour and meal waste, while Kader (2003) and Nellemann et al. (2009) point out structural deficiencies in developing countries. The implications of these findings underscore the urgent need to address food waste as a critical component of enhancing food security. From the law of supply and demand, food waste exacerbates food shortages in the market, thus reducing food availability. Understanding this relationship is essential for developing effective interventions and policies aimed at reducing waste and improving food availability and accessibility. Based on the reviewed literature, the following hypothesis is proposed:
H1 Food waste has a negative impact on food availability.

2.3 Gross Domestic Product (GDP)
Aliyeva et al. (2019) argue that higher per capita GDP is closely linked to improved food security. Dong et al. (2019) pointed out that increased per capita GDP is associated with better nutritional status, including reduced child stunting and wasting. Economic growth provides resources for investments in health, education, and food systems, collectively improving nutritional status. Duro et al. (2020) believe that while overall GDP growth can improve food security, income inequality may undermine these effects. The past literature review shows a significant relationship between GDP and food availability. Świetlik (2018) argued that an increase in GDP is usually associated with an increase in food supply. Shebanina (2023) concluded that world food security can be improved by increasing the real income level of the population and developing agricultural technologies. Aliyu et al. (2021) concluded that food security can be achieved through agricultural value added and GDP growth. However, problems such as internal displacement, population growth, food inflation and exchange rate fluctuations must be addressed. In addition, Sadowski (2019) found that economic factors were significant determinants of food security in different countries. The magnitude of dietary energy expenditure depends primarily on GDP per capita. Based on the reviewed literature, the following hypothesis is proposed:
H2 Gross Domestic Product has a positive impact on food availability.

2.4 Food price
Food price refers to the cost of purchasing food in the market. It can fluctuate due to factors such as supply and demand dynamics, production costs, and external economic conditions. Scholars have highlighted various factors influencing this relationship, from economic conditions and policy decisions to global market dynamics. The relationship between food prices and food security is highly complex and influenced by multiple factors (Hamilton et al.,

2020). Dizon et al. (2019) believe High food prices often reduce access to nutritious food for low-income households, exacerbating malnutrition and hunger. Brunelle, T., & Dumas, P. (2019) explained that Price spikes can discourage farmers from investing in production, further reducing food supply and perpetuating food insecurity. Rising food prices can limit food availability by reducing the purchasing power of consumers, particularly in low-income regions (Wibowo et al., 2023). Conversely, lower food prices can enhance food availability by making a wider range of foods accessible to more people (Benton & Bailey, 2019). Based on the reviewed literature, the following hypothesis is proposed:

H3 Food Price has a negative impact on food availability.

2.5 Conceptual Framework

A research conceptual framework, depicted in Figure 2, is developed based on a review of past literature and the underpinning theory.
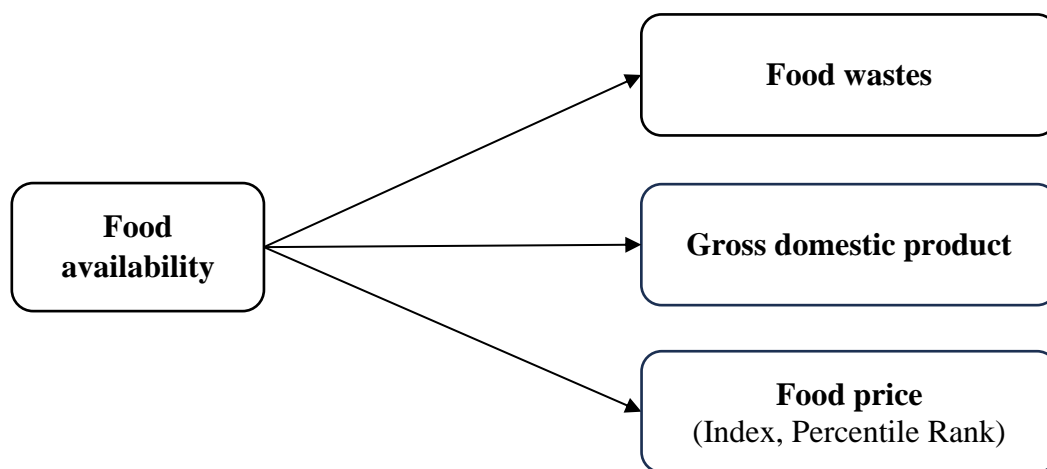

Figure 2: Research conceptual framework

3. Method and Data

This study examines the relationship between food waste, food price, GDP and food availability by employing a quantitative method. The reason for using the quantitative method in the study is to study the causal effect of the dependent variable and independent variables using a huge amount of dataset. The study begins with defining the research problem, followed by a literature review. Based on the past literature, a research framework is developed. Relationships are hypothesised and will be tested using secondary data. Data from 2012 to 2021 will be compiled for more than 100 countries to test the hypotheses. Panel regression will be carried out to estimate the relationship between independent variables and the dependent variable. Next, the result will be presented, and a conclusion will be made.

Dependent variable
Table 1 presents the description of the variables and the data source. Food availability is an indicator of food security. This variable measures the adequacy of food supply within a country or region, reflecting its capacity to meet the nutritional needs of the population. The data is measured using the latest Global Food Security Index 2022 data from Economist Impact.

Independent variables
Food waste quantifies the amount of food discarded at various stages of the supply chain, from production to consumption, indicating inefficiencies in food utilization and distribution. The data is measured using the 2023 United Nations Global SDG Indicators Database.

Gross Domestic: Product: the total monetary value of all goods and services produced within a country's borders in a specific time, typically measured annually. Using the OECD (2024), "Data warehouse". Food price refers to the cost of food products and how it fluctuates based on factors such as supply and demand, production costs, transportation, and geopolitical events. The indicators used for this study are: 1. Food price index by country and 2. Food price rank (most expensive to cheapest). The data is measured using the World Bank database.

Table 1: Description of dependent, independent and moderator variables

Variables	Abbreviations	Data Description	Data Source
Food availability	*Avail*	Index score	Economist Impact, 2022
Food wastes	*Fdwas*	Food waste per capita	United Nations, 2023
Gross Domestic Product	*GDP*	US dollars per capita	World Bank, 2023
Food price index	*Fdpri1*	Index score	World Bank, 2023
Food price rank	*Fdpri2*	Percentile Rank	World Bank, 2023

Data and model
According to Baltagi (2008), panel data constitutes a dataset featuring a cross-sectional sample of individuals, households, organisations, or countries observed over time, enabling the repeated observation of each unit within the sample. Microeconomic panels are compiled by surveying a large cohort of individuals over a relatively short timeframe, typically with N (cross-sectional dimension) exceeding T (temporal dimension). Based on the proposed research framework, food availability is a function of obesity, overnutrition, food waste, food price index, food price rank and GDP. The econometric model of the function can be written as follows:

$$Avail_{it} = \alpha_1 + \alpha_2 Fdwas_{it} + \alpha_3 GDP_{it} + \alpha_4 Fdpri1_{it} + \alpha_5 Fdpri2_{it} + e_{it} \qquad (1)$$

In Equation 1, i, t, and e_{it} represent country-specific, time-specific, and idiosyncratic errors like endogeneity, heteroskedasticity, and cross-sectional dependency (CD). The error term is assumed to be independent with zero variance. Equation 1 will be transformed into log models for estimation. The transformation of the series into quadratic logarithmic functions enables the measurement of elasticities of the coefficients of the variables and simplify the analysis by reducing the values of the variables respectively.

Initially, Pooled Ordinary Least Square (POLS) will be employed to estimate Equation 1. The partial effect of the independent variables on the dependent variable is measured via the slope coefficient. The adjusted R-squared and the F-test are used to measure the goodness-of-fit and act as a reference for comparing the performance of the proposed model. Next, a random effect regression (REM) and fixed effect regression (FEM) will be employed, followed by system panel GMM estimation and diagnostic tests.

When using fixed effects, it is assumed that the characteristics of each individual country will affect the outcomes, and control needs to be exerted on this. This type of regression is performed to avoid omitted variable bias, such as time-invariant county-specific effect. It is best used when the probability of Chi-squared is less than 0.05, which means the independent

variables correlate. The fixed effects regression is appropriate when the idiosyncratic errors are uncorrelated with the independent variables.

Random effect regression will be conducted on the unit-specific effects as the individual effect, or unobserved heterogeneity, is uncorrelated with independent variables. Dummy variables will be added to capture differences in impacts among different countries. So, random variations will be considered, and the Breusch Pagan test will be conducted to examine the random effect of the variables. The null hypothesis is that the random effects are independent of explanatory variables, while the alternative hypothesis suggests that random effects are correlated with explanatory variables.

The Breusch Pagan Lag Multiplier Test is performed to test whether the regression has unequal variance, known as heteroskedasticity. In other words, the variance of the unobserved errors might depend on the observed independent variables. It is also applied to determine whether POLS or REM is more accurate for the data.

The Hausman test will be used to detect the endogenous regressors in a regression model known as endogeneity. The null hypothesis will not correlate with the two variables, while the alternate hypothesis will be the model with fixed effects. If the p-value is small (less than 0.05), reject the hypothesis. This test also tells the study which estimate is a better fit for the model between fixed and random effects. Once an appropriate model is established, diagnostics tests such as heteroscedasticity and serial correlation will be conducted to ensure efficient and unbiased outcomes.

4. Conclusion

Understanding the relationship between food wastes and food security is crucial for addressing global hunger and malnutrition. By analysing how patterns of food wastes affect food supply, access, and stability, this study can guide for promoting more sustainable consumption practices. Additionally, examining the impact of food prices on food security is vital, as high food prices can limit access to nutritious food for low-income households, exacerbating food insecurity. Understanding the dynamics of food prices can help design policies that stabilise food markets and make food more affordable. Identifying food security factors that promote or mitigate food insecurity can enhance governance frameworks, strengthen accountability, and promote equitable access to resources. Moreover, investigating how GDP influences food security provides insights into a country's economic capacity to secure food for its population. Finally, focusing on the intersection of food wastes, food prices, GDP and food security aligns with the United Nations Sustainable Development Goals (SDGs). By addressing these interconnected issues, this study aims to guide policy interventions that seek to achieve multiple SDGs simultaneously, including the elimination of poverty, sustainable consumption and production, and climate action

References

Akram, W., & Javed, I. (2021). Food wastage and implications for food safety with special reference to marriage ceremonies. *International Journal of Agricultural Extension, 9*(2), 201–215.

Aliyu, U., Ozdeser, H., Çavuşoğlu, B., & Usman, M. (2021). Food Security Sustainability: A Synthesis of the Current Concepts and Empirical Approaches for Meeting SDGs. *Sustainability*. https://doi.org/10.3390/su132111728.

Aliyeva, L., Huseynova, S. A., Babayeva, S. J., Huseynova, V. A., Nasirova, O. A., & Hasanzade, F. (2019). Food security and optimal government intervention level in agriculture (comparative analysis). *Bulgarian Journal of Agricultural Science*, 25.

Baltagi, B. H., & Baltagi, B. H. (2008). Econometric analysis of panel data (Vol. 4). Springer.

Behnassi, M., Yaya, S. (2011). Food Crisis Mitigation: The Need for an Enhanced Global Food Governance. In: Behnassi, M., Draggan, S., Yaya, S. (eds) Global Food Insecurity. *Springer, Dordrecht*. https://doi.org/10.1007/978-94-007-0890-7_8.

Benton, T. G., & Bailey, R. (2019). The paradox of productivity: agricultural productivity promotes food system inefficiency. *Global Sustainability, 2*, e6.

Beretta, C., & Hellweg, S. (2019). Potential environmental benefits from food waste prevention in the food service sector. Resources, *Conservation and Recycling, 147*, 169-178.

Berry, E. M., Dernini, S., Burlingame, B., Meybeck, A., & Conforti, P. (2015). Food security and sustainability: Can one exist without the other? *Public Health Nutrition, 18(*13), 2293–2302. https://doi.org/10.1017/S136898001500021X.

Buzby, J. C., & Guthrie, J. F. (2002). Plate waste in school nutrition programs. *The Journal of Consumer Affairs, 36*(2), 220–238.

Bhuyan, B., Sahoo, B. K., & Suar, D. (2020). Food insecurity dynamics in India: A synthetic panel approach. *Social Sciences & Humanities Open*, *2*(1), 100029.

Brunelle, T., & Dumas, P. (2019). Risks of higher food prices on international markets. *Food systems at risk*, 103.

Campbell, C. C. (1991). Food Insecurity: A Nutritional Outcome or a Predictor Variable? *The Journal of Nutrition, 121*(3), 408–415. https://doi.org/10.1093/jn/121.3.408.

Cao, X. C., Zhang, P. P., Liu, X. J., & Cheng, S. K. (2020). Food waste and influencing factors in event-related consumptions: Taking wedding banquet as an example. *Progress in Geography, 39*(9), 1565–1575.

Daszkiewicz T. Food Production in the Context of Global Developmental Challenges. *Agriculture. 2022; 12*(6):832. https://doi.org/10.3390/agriculture12060832.

Dizon, F., Herforth, A., & Wang, Z. (2019). The cost of a nutritious diet in Afghanistan, Bangladesh, Pakistan, and Sri Lanka. *Global Food Security*. https://doi.org/10.1016/J.GFS.2019.07.003.

Dong, Y., Jan, C., Ma, Y., Dong, B., Zou, Z., Yang, Y., Xu, R., Song, Y., Ma, J., Sawyer, S., & Patton, G. (2019). Economic development and the nutritional status of Chinese school-aged children and adolescents from 1995 to 2014: an analysis of five successive national surveys. The Lancet. *Diabetes & endocrinology, p.* 7 4, 288–299. https://doi.org/10.1016/S2213-8587(19)30075–0.

Duncan, J., & Margulis, M. (2016). *Global Food Security Governance* (pp. 270–295). https://doi.org/10.4337/9781803921044.ch55.

Duro, J., Lauk, C., Kastner, T., Erb, K., & Haberl, H. (2020). Global inequalities in food consumption, cropland demand and land-use efficiency: A decomposition analysis. *Global Environmental Change-human and Policy Dimensions,* 64, 102124. https://doi.org/10.1016/j.gloenvcha.2020.102124.

Gao, S. (2010). Discussion on issues of food security based on basic domestic self-sufficiency. *Asian Social Science, 6*(11), 42.

Hamerman, E. J., Rudell, F., & Martins, C. M. (2018). Factors that predict taking restaurant leftovers: Strategies for reducing food waste. *Journal of Consumer Behaviour*, *17*(1), 94-104.

Hamilton, H., Henry, R., Rounsevell, M., Moran, D., Cossar, F., Allen, K., ... & Alexander, P. (2020). Exploring global food system shocks, scenarios and outcomes. *Futures*, *123*, 102601.

Joardder, M. U., Hasan Masud, M., Joardder, M. U., & Masud, M. H. (2019). Causes of food waste. *Food preservation in developing countries: Challenges and solutions*, 27-55.

Kader, A. A. (2003). A perspective on postharvest horticulture (1978-2003). *HortScience, 38*(5), 1004–1008.

Kantor, L. S., Lipton, K., Manchester, A., & Oliveira, V. (1988). Estimating and addressing America's food losses. *Food Review*, 20(1), 2-12.

Kaur, S., & Kaur, H. (2016). Determinants of Food Security in Sub-Saharan Africa, South Asia and Latin America. In R. Kathuria & N. K. Nagpal (Eds.), Global Economic Cooperation: Views from G20 Countries (pp. 81–102). *Springer India.* https://doi.org/10.1007/978-81-322-2698-7_6.

Liu, L. (2007). Research on the evaluation index system of food security based on AHP. *Productivity Research,* (15), pp. 58–60.

Liu, X. (2004). Discussion on the evaluation index system of food security in China. *Finance & Trade Economics, (9),* pp. 56–61.

Louw, H., & van Zyl, J. (1991). 'N Perspektief Op Voedselselfvoorsienendheid As 'N Determinant Van Voedselsekerheid / A perspective on food self-sufficiency as a determinant of food security. *Agrekon, 30*(3), 129–138. https://doi.org/10.1080/03031853.1991.9524219.

Maxwell, S. (1996). Food security: A post-modern perspective. *Food Policy, 21*(2), 155–170. https://doi.org/10.1016/0306-9192(95)00074-7

Meacham, T., Parfitt, J., Hollins, O., & Barthel, M. (2013*). Food waste within global food systems September 2013*.

Nasir, M., Nugroho, A., & Lakner, Z. (2022). Impact of the Russian–Ukrainian Conflict on Global Food Crops. *Foods*, 11. https://doi.org/10.3390/foods11192979.

Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. G., & Kaltenborn, B. P. (2009). The environmental food crisis: The environment's role in averting future food crises. *United Nations Environment Programme*.

Osner, R. (1982). Food wastage. *Nutrition & Food Science, 82*(4), 13-16.

Papargyropoulou, E., Lozano, R., Steinberger, J. K., Wright, N., & bin Ujang, Z. (2016). The food waste hierarchy as a framework for the management of food surplus and food waste. *Journal of Cleaner Production*, *126*, 155–167. https://doi.org/10.1016/j.jclepro.2016.03.090.

Pawlak, K., & Kołodziejczak, M. (2020). The Role of Agriculture in Ensuring Food Security in Developing Countries: Considerations in the Context of the Problem of Sustainable Food Production. *Sustainability*, *12*, 5488. https://doi.org/10.3390/su12135488.

Peng, W., Berry, E. M., & Goldsmith, R. (2019). Adherence to the Mediterranean diet was positively associated with micronutrient adequacy and negatively associated with dietary energy density among adolescents. *Journal of Human Nutrition and Dietetics*, *32*(1), 41-52.

Ritchie, H., & Roser, M. (2022). What is undernourishment, and how is it measured? *Our World in Data*. https://ourworldindata.org/undernourishment-definition.

Sadowski, A. (2019). Spatial and economic determinants of different food consumption patterns around the world. *Journal of Agribusiness and Rural Development*. https://doi.org/10.17306/J.JARD.2019.01109.

Shaw, D. (2007). World Food Security: A History since 1945. Springer.

Shebanina, O. (2023). Global Aspects of Food Security in the World: Economic Dimensions. *Modern Economics*. https://doi.org/10.31521/modecon.v38(2023)-27.

Shetty, P. (2009). Incorporating nutritional considerations when addressing food insecurity. *Food Security*, pp. 1, 431–440.

Simon, G. A. (2012). Food security. *University of Roma Tre: Rome, Italy*.

Sirieix, L., Lála, J., & Kocmanová, K. (2017). Understanding the antecedents of consumers' attitudes towards doggy bags in restaurants: Concern about food waste, culture, norms and emotions. *Journal of Retailing and Consumer Services*, 34, 153-158.

Sokołowski, Ł. M. (2020). The Act on Counteracting Food Waste–an attempt of its evaluation. *Przegląd Prawa Rolnego*, 2(25), 167-181. DOI: 10.14746/ppr.2019.25.2.11.

Srivastava, S. K., Singh, S., & Srivastava, M. (2021). Food Waste at Household and Social Gatherings: Drivers and Possible Remedies. Purushartha-a journal of Management, *Ethics and Spirituality, 14*(2), 117-133.

Świetlik, K. (2018). Economic growth versus the issue of food security in selected regions and countries worldwide. *Problems of Agricultural Economics, 3*(356).

Teeuwen, A.S., Meyer, M.A., Dou, Y. et al. A systematic review of the impact of food security governance measures as simulated in modelling studies. *Nat Food 3,* 619–630 (2022). https://doi.org/10.1038/s43016-022-00571-2.

Tóth G, Zachár J. Towards Food Justice – The Global-Economic Material Balance Analysis of Hunger, *Food Security and Waste. Agronomy. 2021; 11*(7), 1324. https://doi.org/10.3390/agronomy11071324.

Wang, Y., Xu, S., Li, Z., & others. (2018). An empirical study on influencing factors of urban residents' food waste from dining out. *China Agricultural Resources and Regional Planning, 39*(9), 199-204.

Warr, P. (2023). Productivity in Indonesian agriculture: Impacts of domestic and international research. *Journal of Agricultural Economics*, *74*(3), 835-856.

Wibowo, H., Novanda, R., Ifebri, R., & Fauzi, A. (2023). Overview of the Literature on the Impact of Food Price Volatility. *AGRITROPICA: Journal of Agricultural Sciences*. https://doi.org/10.31186/j.agritropica.6.1.22-32.

Yamaguchi, M., Praditsorn, P., Purnamasari, S., Sranacharoenpong, K., Arai, Y., Sundermeir, S., Gittelsohn, J., Hadi, H., & Nishi, N. (2022). Measures of Perceived Neighborhood Food Environments and Dietary Habits: A Systematic Review of Methods and Associations. *Nutrients*, 14. https://doi.org/10.3390/nu14091788.

Zaini, N. H., Hasan, W. H. W., Talib, A. N., & Ismail, D. S. (n.d.). Food insecurity: the affects of socioeconomic and food consumption | *Humanities & Social Sciences Reviews*. Retrieved 16 June 2024, from https://mgesjournals.com/hssr/article/view/hssr.2019.7520.

Zhang, D., Cheng, S. K., Gao, L. W., Liu, X., Cao, X., Liu, Y., ... & Qin, Q. (2016). The carbon footprint of catering industry food waste: A Beijing case study. *Acta Ecologica Sinica,* 36(18), 5937-5948.