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Tackling the interlinked problems of Food Wastage and achieving Zero Hunger

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Abstract: *This study analyses the connected economic hardships of food waste and world hunger. Using economic theories and models, this research paper evaluates how reducing food wastage can help achieve zero hunger, one of the United Nations Sustainable Development Goals (SDG 2). The focus of this analysis is on economic inefficiencies resulting from food wastage. It also looks at the effects on food security, market mechanisms, policy instruments, and technological innovations used to address these problems. In conclusion, addressing food waste through economic incentives, regulatory frameworks, and improved market coordination will significantly boost and facilitate agricultural production in a country, promoting food safety policies leading to zero hunger.*

Keywords: Food Wastage, Zero Hunger

Introduction

Despite advancements in food production, many people still suffer from hunger. Ironically, one-third of the total food produced is lost each year. This loss amounts to $1 trillion of economic output and consumes water and land resources. Moreover, it leads to climate change. This predicament calls for an examination of how food waste affects the security status of nutrition, which means that all people have enough access to safe and nutritious food. Food wastage decreases food availability and affordability, worsening hunger, and price instability. Current market failures and externalities indicate that they are not charging the complete cost of food waste. Supply and demand models show how waste reduction can enhance access to food and bring down prices. Additionally, behavioral economics provides insight into consumer behavior and household waste prevention interventions. This study investigates the economic facets of wasted food and malnutrition, examining its causes, effects, and potential

alternatives. It delves into policy interventions, market mechanisms, and technological innovations to explore how economic instruments may fight food waste while promoting nutritional safety, indicating the need for collaborative efforts alongside innovative approaches.

Literature Review

Food waste represents a considerable economic inefficiency in the global food system. All resources put into it, such as labor, capital, land, and water, are also lost. The Food and Agriculture Organization (FAO) estimates that about one-third of all food produced for human consumption is either lost or wasted, translating to 1.3 billion tons yearly. Consequently, nearly $1 trillion is drained from the economy through this wastage. Market failure occurs when the allocation of goods and services by a free market is inefficient. Regarding food wastage, the costs associated with waste disposal, environmental degradation, and loss in nutritional value are not included in market prices, leading to suboptimal outcomes. Externalities can be positive or negative, depending on whether they arise from the production or consumption of goods and services affecting third parties not directly involved in the transaction but affected in some way. For instance, negative externalities like greenhouse gas emissions, arising from decomposing waste, make wasted food more expensive than their monetary value, because these gases are not factored in when calculating cost impacts on our environmental systems.

The concept of food security, which refers to a situation where every individual has access to adequate, safe, and nutritious food at all times, as per the FAO, is directly influenced by food wastage. This can shift the supply curve and increase the quantum of food while possibly reducing its price. This, in turn, enhances food accessibility and affordability, which are important elements of food security. From an economic point of view, reducing food wastage could boost allocative efficiency within the food system. It means that resources are allocated to satisfy human needs (and this implies maximized social welfare). Through waste reduction, more resources could be directed towards producing consumable foods, leading to improved social welfare. Hence, contributing towards zero hunger.

Government interventions, economic policies, and market strategies are vital components in the fight against food wastage. Governments can employ various methods to minimize food wastage at various points in the food chain or supply chain. For instance, goals such as waste reduction, employing fines for creating excessive waste or requiring business owners to donate

food create economic motivations for reducing waste. Policy instruments like tradable waste permits and waste taxes can enhance effective cost-shifting to internalize the external costs of food waste issues and ensure the congruency of private and social benefits. The availability of technology in food preservation, better storage and transportation facilities, and techniques of food processing may also help in this aspect. Technological developments in production processes are argued in economic theory to bring about a shift in the PPF, showing that output is possible with the improvement of existing tools or techniques. Community outreach programs are also important; people should be given information about the importance of avoiding wasting food by being made aware of the financial repercussions as well as the environmental impact of food wastage. Here, another cornerstone of behavioral economics, namely, information and nudges, comes into play – consumers move from one state to another in the presence of relevant information as experienced consumers who are better aware of the consequences of their actions are more likely to engage in pro-environmental behavior and avoid food waste. Additionally, multifaceted approaches and the involvement of public and private institutions would help encourage appropriate management of food resources for sustainability.

Post-harvest losses are partly a function of the technology available in a country, and the extent to which markets have developed for agricultural produce. Three interrelated global drivers provide an overall structure for characterizing supply chains and future trends in developing and transitional countries.

Urbanization and the contraction of the agricultural sector.

The proportion of the world's population employed in agriculture has declined in recent decades and 50 percent of the world's population now lives in urban environments. This proportion is expected to rise to 70 percent by 2050 (United Nations 2008). Rapid urbanization has created the need for extended FSCs to feed urban populations. For these to be efficient, countries need to develop roads, transportation, and marketing infrastructure to keep food affordable for low-income groups. How these extended supply chains develop has implications for food waste globally, now and in the future.

Dietary transition.

Growth of household incomes, particularly in BRIC countries, is associated with declining consumption of starchy food staples and diversification of diet into FFVs, dairy, meat, and fish. This transition conforms to Bennett's Law (Bennett 1941), where the food share of starchy staples declines as income increases. The shift toward vulnerable, shorter shelf-life commodities is associated with greater food waste and a greater draw on land and other resources (Lundqvist et al. 2008). The transition varies by country and culture, e.g. in India, there is less pressure on resources compared with China, where the demand for meat is increasing rapidly.

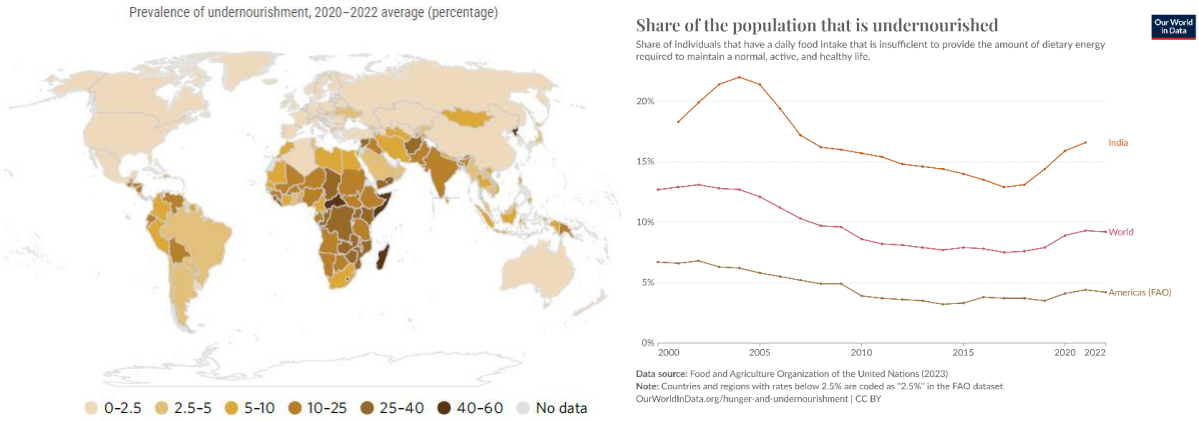
Increased globalization of trade.

International trade in processed foods accounts for 10 percent of processed food sold (United Nations 2002). Globalization may open up opportunities for agricultural exports while representing a threat to the development of internal markets through competition from inexpensive imports of higher quality that can be produced locally. Linked to trade liberalization, multinational chains have become a driving force in the rapid growth of supermarkets in many transitional economies.

In 2022, the prevalence of undernourishment remained unchanged compared to 2021, following a significant increase in 2020 due to the pandemic and a slower rise in 2021. The global population facing chronic hunger stood at 9.2 percent in 2022, up from 7.9 percent in 2019, affecting around 735 million people, which is a rise of 122 million since 2019. Moreover, an estimated 2.4 billion individuals, equivalent to 29.6 percent of the world's population, experienced moderate to severe food insecurity, meaning they did not have regular access to adequate food. While Africa has a higher proportion of its population facing hunger compared to other regions, Asia is home to the majority of people facing hunger. It is projected that more than 600 million people worldwide will be facing hunger in 2030, highlighting the immense challenge of achieving the zero-hunger target.

Global trends in the prevalence of hunger and food security reflect the interplay of two opposing forces. On one hand, the resumption of economic activity has led to increased incomes and improved access to food. On the other hand, food price inflation has eroded income gains and hindered access to food. However, these forces have manifested differently

across different regions. Hunger continues to increase in Western Asia, the Caribbean, and all subregions of Africa. Conversely, most subregions in Asia and Latin America have experienced improvements in food security.



Strategies for Addressing Food Wastage and Achieving Zero Hunger

Achieving zero hunger requires a multi-faceted approach that integrates efforts to reduce food wastage with initiatives to enhance food access, affordability, and nutritional quality. Key strategies include:

Promoting Sustainable Consumption.

Promoting sustainable consumption is essential in the fight against food wastage and achieving zero hunger. Sustainable consumption involves making mindful choices that reduce the environmental impact, promote social equity, and ensure economic viability. This section delves into the strategies for promoting sustainable consumption, emphasizing the role of consumer education, behavioral change, and the influence of policies and practices in reducing food wastage.

Consumer Education: Educating consumers about the importance of sustainable consumption is the first step towards reducing food wastage. Awareness campaigns, workshops, and educational programs can inform the public about the environmental and social impacts of their food choices. Key areas of focus include:

1. Portion Control: Educating individuals on appropriate portion sizes can prevent over-preparation and reduce leftovers that often go to waste.

2. Meal Planning: Encouraging consumers to plan meals ahead of time can help them purchase only what they need, reducing the likelihood of food spoilage and waste.
3. Understanding Expiry Dates: Clarifying the meaning of "best before," "use by," and "sell by" dates can prevent consumers from discarding food that is still safe to eat.
4. Storing Food Properly: Providing information on proper storage techniques can extend the shelf life of food, reducing spoilage.

Behavioral Change: Behavioral change is critical in promoting sustainable consumption. This involves shifting consumer habits and attitudes towards food. Strategies to encourage behavioral change include:

1. Nudging: Subtle interventions, such as positioning healthier and more sustainable food options at eye level in stores, can influence consumer choices.
2. Incentives: Offering discounts or rewards for purchasing 'imperfect' produce or buying in bulk can motivate consumers to make sustainable choices.
3. Community Initiatives: Engaging communities in food-sharing programs, local food co-operatives, and urban gardening projects can foster a culture of sustainability and reduce individual food waste.

Policy and Practice Influence: Governments, businesses, and organizations play a crucial role in promoting sustainable consumption through policies and practices that support food waste reduction. Key initiatives include:

1. Food Labelling Regulations: Implementing clear and consistent food labelling standards can help consumers make informed decisions about food safety and storage.
2. Incentives for Sustainable Practices: Offering tax incentives or grants to businesses that adopt sustainable practices, such as donating surplus food or investing in food waste reduction technologies.
3. Legislation Against Food Waste: Enacting laws that require supermarkets and food producers to donate surplus food to food banks or other charitable organizations can significantly reduce food waste.

4. Public Awareness Campaigns: Governments and NGOs can collaborate to launch nationwide campaigns that raise awareness about food wastage and promote sustainable consumption habits.

Case Studies: Examining successful case studies can provide valuable insights and inspire similar initiatives globally. Examples include:

1. France's Food Waste Law: In 2016, France became the first country to prohibit supermarkets from throwing away or destroying unsold food. Instead, they must donate it to charities and food banks. This legislation has significantly reduced food waste and helped feed those in need.
2. Denmark's WeFood Supermarkets: WeFood is a chain of supermarkets in Denmark that sells surplus food at reduced prices. This initiative not only reduces food waste but also provides affordable food options to low-income individuals and families.
3. Love Food Hate Waste Campaign: Launched in the UK, this campaign provides practical advice and resources to help consumers reduce food waste at home. It has successfully raised awareness and changed consumer behaviors towards food waste.

Technological Innovations: Leveraging technology can enhance sustainable consumption practices. Innovations include:

1. Food Waste Apps: Apps like Too Good To Go and Olio connect consumers with surplus food from restaurants, cafes, and neighbors, helping to redistribute food that would otherwise go to waste.
2. Smart Refrigerators: Modern refrigerators with inventory management systems can alert users when food is nearing its expiry date, helping to reduce spoilage.
3. Blockchain for Traceability: Blockchain technology can enhance transparency in the food supply chain, allowing consumers to make more informed choices about the sustainability and provenance of their food.

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Enhancing Supply Chain Efficiency

Enhancing supply chain efficiency is critical for reducing food wastage and ensuring a more sustainable food system. Food loss and waste can occur at various stages of the supply chain, from production and post-harvest handling to processing, distribution, retail, and consumption. By improving efficiency at each stage, we can minimize losses, maximize resource use, and enhance food security. This section explores strategies and technologies for optimizing supply chain efficiency, highlighting best practices and successful case studies.

Production and Harvesting: Efficient production and harvesting practices are fundamental to minimizing food losses. Key strategies include:

1. Precision Agriculture: Utilizing advanced technologies such as GPS, sensors, and drones can optimize planting, irrigation, and harvesting processes. Precision agriculture reduces resource use and increases crop yields by providing real-time data on soil conditions, weather, and crop health.
2. Training and Support for Farmers: Providing smallholder farmers with access to training, financial services, and modern agricultural tools can enhance productivity and reduce post-harvest losses. Extension services and cooperatives can play a vital role in disseminating knowledge and resources.
3. Improved Harvesting Techniques: Implementing efficient harvesting techniques and equipment can reduce crop damage and losses. For example, mechanical harvesters with adjustable settings can minimize damage to delicate crops.

Post-Harvest Handling and Storage: Post-harvest losses are significant, especially in developing countries with inadequate infrastructure. Strategies to improve post-harvest handling and storage include:

1. Cold Chain Logistics: Developing and maintaining a cold chain (temperature-controlled supply chain) from farm to market can significantly reduce spoilage, particularly for perishable goods such as fruits, vegetables, dairy, and meat.
2. Proper Storage Facilities: Investing in modern storage facilities such as silos, warehouses, and refrigeration units can extend the shelf life of produce. Hermetic storage bags and improved packaging materials also help in preserving food quality.

3. Transportation Infrastructure: Improving transportation infrastructure, including roads and vehicles, ensures timely and efficient delivery of goods to markets. Reducing transit time minimizes the risk of spoilage.

Processing and Packaging: Efficient processing and packaging practices are crucial for maintaining food quality and reducing waste. Strategies include:

1. Efficient Processing Techniques: Adopting efficient processing techniques that maximize yield and minimize waste can reduce food losses. For example, using the entire fruit or vegetable in processing can produce multiple products (e.g., juice, pulp, and peels for animal feed).
2. Innovative Packaging Solutions: Utilizing packaging solutions that extend shelf life, such as vacuum sealing, modified atmosphere packaging, and edible coatings, can reduce spoilage. Biodegradable and recyclable packaging options also promote sustainability.
3. Byproduct Utilization: Identifying and utilizing byproducts from food processing (e.g., peels, seeds, and pulp) for other purposes, such as animal feed, bioenergy, or secondary food products, can reduce waste.

Distribution and Retail: Efficient distribution and retail practices ensure that food reaches consumers in optimal condition. Strategies include:

1. Inventory Management Systems: Implementing advanced inventory management systems that track stock levels, expiration dates, and demand patterns can reduce overstocking and understocking, minimizing waste.
2. Demand Forecasting: Utilizing data analytics and machine learning to predict consumer demand accurately can help retailers manage inventory more effectively and reduce the likelihood of unsold goods.
3. Food Recovery Programs: Establishing food recovery programs that redistribute surplus food from retailers to food banks and charities can prevent food from going to waste while addressing hunger.

Consumer Engagement: Engaging consumers in the supply chain is essential for reducing food wastage. Strategies include:

1. Consumer Education: Educating consumers about the environmental and social impacts of food waste, as well as proper storage and usage techniques, can influence their purchasing and consumption behaviors.
2. Transparency and Traceability: Providing consumers with information about the origin and journey of their food through traceability systems can build trust and encourage responsible consumption.
3. Collaboration with Consumers: Encouraging consumers to participate in feedback mechanisms and community initiatives, such as food-sharing platforms and local markets, can enhance supply chain efficiency.

Case Studies: Examining successful case studies can provide valuable insights into enhancing supply chain efficiency. Examples include:

1. ColdHubs in Nigeria: ColdHubs is a social enterprise in Nigeria that provides solar-powered cold storage units to smallholder farmers. This initiative has significantly reduced post-harvest losses and increased farmers' incomes by extending the shelf life of perishable produce.
2. Walmart's Food Waste Reduction: Walmart has implemented several initiatives to reduce food waste, including improved inventory management, optimized supply chain logistics, and partnerships with food recovery organizations. These efforts have resulted in significant reductions in food waste across its supply chain.
3. The Rockefeller Foundation's YieldWise Initiative: The YieldWise Initiative aims to reduce post-harvest losses in sub-Saharan Africa by providing farmers with training, technology, and market access. The initiative has successfully reduced food losses and increased incomes for smallholder farmers.

Supporting Smallholder Farmers

Smallholder farmers play a crucial role in global food production, contributing significantly to food security and rural livelihoods. However, they often face numerous challenges, including limited access to resources, markets, and technologies. Supporting smallholder farmers is

essential for reducing food wastage and achieving zero hunger. This section explores strategies to empower smallholder farmers through access to markets, financial services, agricultural training, and technological innovations.

Access to Markets: Access to markets is vital for smallholder farmers to sell their produce, obtain fair prices, and reduce post-harvest losses. Strategies to enhance market access include:

1. Market Information Systems: Providing smallholder farmers with real-time market information on prices, demand, and supply trends helps them make informed decisions about when and where to sell their produce. Mobile applications and digital platforms can facilitate the dissemination of market information.
2. Aggregation and Cooperatives: Encouraging the formation of farmer cooperatives or producer organizations can enhance smallholder farmers' bargaining power and enable them to access larger markets. Aggregation of produce reduces transaction costs and improves market access.
3. Infrastructure Development: Investing in rural infrastructure, such as roads, storage facilities, and transportation networks, can improve farmers' access to markets and reduce post-harvest losses. Better infrastructure facilitates the timely and efficient delivery of produce to markets.

Access to Financial Services: Financial services are essential for smallholder farmers to invest in productive assets, technologies, and inputs. Strategies to improve access to financial services include:

1. Microfinance and Credit: Providing microfinance services and credit facilities tailored to the needs of smallholder farmers can enable them to purchase seeds, fertilizers, equipment, and other inputs. Flexible repayment terms and low-interest rates can make credit more accessible.
2. Insurance Schemes: Implementing agricultural insurance schemes can protect smallholder farmers from risks associated with climate variability, pests, and diseases. Insurance can provide financial stability and encourage investment in productive activities.

3. Digital Financial Services: Leveraging digital financial services, such as mobile banking and digital wallets, can enhance financial inclusion for smallholder farmers. Digital platforms can facilitate access to savings, credit, and insurance services, even in remote areas.

Agricultural Training and Extension Services: Providing agricultural training and extension services is crucial for enhancing the productivity and sustainability of smallholder farming. Strategies include:

1. Capacity Building Programs: Organizing training programs on modern agricultural practices, sustainable farming techniques, and post-harvest management can improve smallholder farmers' skills and knowledge. Training can cover areas such as crop diversification, soil health, pest management, and climate-smart agriculture.
2. Extension Services: Strengthening agricultural extension services to provide on-the-ground support and advice to smallholder farmers can improve their productivity and reduce losses. Extension agents can disseminate information on best practices, new technologies, and market opportunities.
3. Farmer Field Schools: Establishing farmer field schools where farmers can learn by doing and share experiences with peers can promote knowledge exchange and innovation. Field schools can focus on practical training and problem-solving in real-world settings.

Technological Innovations: Adopting technological innovations can significantly enhance the productivity and efficiency of smallholder farming. Strategies include:

1. Mobile Technologies: Mobile applications and platforms can provide smallholder farmers with access to weather forecasts, pest and disease alerts, and market information. Mobile technologies can also facilitate access to financial services and training resources.
2. Improved Seed Varieties: Distributing high-yielding, disease-resistant, and climate-resilient seed varieties can boost crop productivity and reduce losses. Research and development efforts should focus on developing seeds suited to local conditions.

3. Mechanization: Introducing affordable and appropriate mechanization solutions, such as small-scale tractors, planters, and harvesters, can enhance the efficiency of smallholder farming operations. Mechanization reduces labor intensity and minimizes post-harvest losses.

Case Studies: Examining successful case studies can provide valuable insights into supporting smallholder farmers. Examples include:

1. One Acre Fund: One Acre Fund is a social enterprise that provides smallholder farmers in East Africa with access to credit, high-quality inputs, training, and market support. The organization has significantly increased farmers' yields and incomes while reducing food wastage.
2. Digital Green: Digital Green is an initiative that uses video-based training to disseminate agricultural knowledge to smallholder farmers. By leveraging community-based videos, the program has improved farmers' adoption of best practices and increased productivity.
3. India's E-Choupal: E-Choupal is an initiative by ITC Limited that provides smallholder farmers in India with access to market information, agricultural advice, and e-commerce platforms. The initiative has enhanced market access, reduced intermediaries, and improved farmers' incomes.

Implementing Policy Reforms

Policy reforms are critical in addressing the systemic issues that lead to food wastage and hinder progress towards achieving zero hunger. Effective policy frameworks can create enabling environments for reducing food loss and waste, supporting sustainable agricultural practices, and enhancing food security. This section explores the necessary policy reforms at local, national, and international levels, highlighting their potential impacts and the roles of various stakeholders in their implementation.

Food Recovery and Redistribution Policies: Policies that facilitate food recovery and redistribution can significantly reduce food wastage and address hunger simultaneously. Key measures include:

1. Good Samaritan Laws: Enacting laws that protect food donors from liability can encourage businesses and individuals to donate surplus food to charities and food banks. These laws reassure donors that they will not face legal repercussions for donating food in good faith.
2. Tax Incentives: Providing tax deductions or credits for businesses that donate surplus food can motivate more companies to participate in food recovery programs. These incentives can offset the costs associated with food donation.
3. Mandatory Food Donation Policies: Implementing regulations that require supermarkets, restaurants, and other food businesses to donate unsold yet safe-to-eat food can ensure a consistent supply of food to those in need.

Food Waste Reduction Targets: Governments can set national or regional targets for food waste reduction, driving collective action towards this goal. Strategies include:

1. National Action Plans: Developing comprehensive national action plans that outline specific goals, timelines, and responsibilities for reducing food waste across the supply chain. These plans should involve all relevant stakeholders, including government agencies, private sector actors, and civil society organizations.
2. Monitoring and Reporting: Establishing systems for monitoring and reporting food waste at various stages of the supply chain can provide valuable data for tracking progress and identifying areas for improvement. Regular reporting can also hold stakeholders accountable for their commitments.
3. Public Awareness Campaigns: Launching public awareness campaigns to educate citizens about the importance of reducing food waste and how they can contribute to national targets. These campaigns can utilize media, schools, and community organizations to reach a broad audience.

Support for Sustainable Agricultural Practices: Policies that promote sustainable agricultural practices can reduce food losses at the production and post-harvest stages. Key measures include:

1. Subsidies and Incentives: Providing subsidies and incentives for farmers to adopt sustainable practices, such as organic farming, conservation agriculture, and

agroforestry. These incentives can help offset the initial costs of transitioning to more sustainable methods.

2. Research and Development: Investing in agricultural research and development to innovate new techniques and technologies that improve crop yields, reduce losses, and enhance resilience to climate change. Governments can support public research institutions and collaborate with private sector companies.
3. Extension Services: Strengthening agricultural extension services to provide farmers with the latest knowledge and skills in sustainable farming practices. Extension agents can offer on-the-ground support and training, particularly in remote and underserved areas.

Regulations on Food Quality and Standards: Revising food quality and standards regulations can prevent unnecessary food wastage due to cosmetic imperfections and stringent quality requirements. Key measures include:

1. Relaxing Aesthetic Standards: Encouraging retailers and consumers to accept cosmetically imperfect but otherwise safe and nutritious produce. Policies can include revising grade standards and promoting the sale of “ugly” fruits and vegetables.
2. Standardizing Date Labeling: Implementing clear and consistent date labeling standards (e.g., "best before," "use by," and "sell by" dates) to reduce confusion among consumers and prevent premature disposal of food. Standardizing these labels across the food industry can improve clarity.
3. Food Safety Regulations: Ensuring that food safety regulations focus on actual health risks rather than aesthetic qualities. This can prevent the rejection and wastage of safe food due to minor imperfections.

Support for Circular Economy Initiatives: Promoting a circular economy approach in the food system can minimize waste and maximize resource use. Key measures include:

1. Food Waste-to-Energy Programs: Supporting initiatives that convert food waste into renewable energy through anaerobic digestion or other technologies.

Governments can provide funding, technical assistance, and regulatory support for these programs.

2. Composting Incentives: Encouraging the composting of organic waste by providing subsidies for composting facilities and equipment, as well as promoting household and community composting programs.
3. Resource Recovery: Facilitating the recovery and repurposing of by-products and waste materials from food processing industries. Policies can include grants for research into innovative uses of food waste and support for pilot projects.

International Cooperation and Trade Policies: International cooperation and trade policies play a crucial role in addressing food wastage and achieving zero hunger. Key measures include:

1. Harmonizing Standards: Collaborating with international bodies to harmonize food safety and quality standards, reducing trade barriers and facilitating the movement of surplus food to regions in need.
2. International Aid Programs: Integrating food waste reduction and food security goals into international aid programs. Providing technical assistance and funding to developing countries can help them build capacity for reducing food losses and enhancing food security.
3. Trade Agreements: Including provisions in trade agreements that promote sustainable agricultural practices, reduce food wastage, and ensure fair trade conditions for smallholder farmers.

Case Studies: Examining successful policy reforms can provide valuable insights and best practices. Examples include:

1. France's Food Waste Law: France has implemented comprehensive legislation to reduce food waste, including banning supermarkets from destroying unsold food, requiring food donation, and promoting public awareness campaigns. This has led to significant reductions in food waste and increased food recovery.
2. South Korea's Waste Management Policies: South Korea has established a robust waste management system that includes mandatory food waste recycling, pay-as-

you-throw programs, and incentives for reducing food waste. These policies have resulted in high rates of food waste recycling and reduced landfill use.

3. European Union's Farm to Fork Strategy: The EU's Farm to Fork Strategy aims to create a sustainable food system by addressing food waste, promoting sustainable farming practices, and enhancing food security. The strategy includes specific targets for reducing food waste and implementing circular economy principles.

Fostering Collaborative Partnerships

Collaboration among various stakeholders is critical to tackling the interlinked problems of food wastage and achieving zero hunger. By fostering partnerships between governments, private sector entities, non-governmental organizations (NGOs), research institutions, and local communities, comprehensive and effective solutions can be developed and implemented. This section explores the importance of collaborative partnerships, the roles of different stakeholders, and strategies to facilitate successful collaboration.

Importance of Collaborative Partnerships: Collaborative partnerships enable the pooling of resources, expertise, and networks to address complex issues such as food wastage and hunger. Key benefits include:

1. Resource Sharing: Partnerships allow for the sharing of financial, technical, and human resources, making it possible to undertake larger and more impactful initiatives.
2. Knowledge and Expertise: Different stakeholders bring unique knowledge and expertise to the table, fostering innovation and the development of best practices.
3. Scaling Solutions: Collaborative efforts can scale successful pilot projects and initiatives, extending their reach and impact.
4. Policy Influence: Partnerships can create a stronger advocacy voice to influence policy changes and drive systemic reform.

Roles of Different Stakeholders:

1. Governments:
   a. Policy and Regulation: Governments can create an enabling environment through policies and regulations that support food waste reduction and sustainable practices.
   b. Funding and Resources: Governments can allocate funding and resources to support collaborative initiatives and pilot projects.
   c. Infrastructure Development: Investing in infrastructure such as storage facilities, transportation networks, and market access can support collaborative efforts.
2. Private Sector:
   a. Innovation and Technology: Private companies can drive innovation by developing new technologies and practices to reduce food waste and improve efficiency.
   b. Supply Chain Management: Businesses can implement sustainable practices across their supply chains and collaborate with other stakeholders to optimize resource use.
   c. Corporate Social Responsibility (CSR): Companies can support community initiatives, food banks, and other programs through their CSR activities.
3. Non-Governmental Organizations (NGOs):
   a. Advocacy and Awareness: NGOs can raise awareness about food waste and hunger issues and advocate for policy changes.
   b. Program Implementation: NGOs can design and implement programs that directly address food wastage and hunger at the community level.
   c. Capacity Building: NGOs can provide training and support to smallholder farmers, local communities, and other stakeholders.
4. Research Institutions:
   a. Data and Analysis: Research institutions can conduct studies and provide data to inform policy decisions and program design.
   b. Innovation and Development: Academic and research institutions can develop new technologies and methods for reducing food wastage and enhancing food security.
   c. Knowledge Dissemination: Researchers can share findings and best practices with stakeholders through publications, conferences, and workshops.

5. Local Communities:
    a. Grassroots Initiatives: Local communities can drive grassroots initiatives that address food waste and hunger in culturally appropriate ways.
    b. Community Engagement: Engaging community members in planning and implementing initiatives ensures that solutions are locally relevant and sustainable.
    c. Feedback and Adaptation: Community input can help adapt and improve programs to meet local needs effectively.

Strategies for Successful Collaboration:

1. Building Trust and Relationships:
    a. Regular Communication: Establishing open lines of communication and regular meetings fosters trust and transparency among partners.
    b. Shared Goals: Defining clear, shared goals and objectives ensures all partners are aligned and committed to the same outcomes.
    c. Mutual Respect: Recognizing and valuing each partner's contributions and expertise builds mutual respect and strengthens collaboration.
2. Formalizing Partnerships:
    a. Memorandums of Understanding (MOUs): MOUs and agreements can formalize partnerships, outlining roles, responsibilities, and expectations.
    b. Joint Committees and Task Forces: Creating joint committees and task forces can facilitate coordinated action and decision-making.
    c. Funding Mechanisms: Establishing joint funding mechanisms or pooled funds can support collaborative projects and initiatives.
3. Leveraging Technology and Innovation:
    a. Digital Platforms: Using digital platforms for communication, coordination, and data sharing can enhance collaboration.
    b. Innovation Hubs: Creating innovation hubs or incubators can foster collaboration between startups, researchers, and other stakeholders to develop new solutions.
    c. Data Sharing: Sharing data and research findings through collaborative platforms can inform decision-making and improve program design.

4. Engaging Stakeholders:
    a. Stakeholder Mapping: Identifying and mapping relevant stakeholders ensures all key players are engaged in the collaboration.
    b. Inclusive Participation: Ensuring inclusive participation of marginalized and vulnerable groups in planning and decision-making processes.
    c. Public-Private Partnerships: Encouraging public-private partnerships to leverage the strengths of both sectors in addressing food wastage and hunger.

Case Studies: Examining successful case studies provides valuable insights into fostering collaborative partnerships. Examples include:

1. The Global FoodBanking Network (GFN): GFN connects food banks across the world, facilitating the exchange of best practices, resources, and support. This network has successfully reduced food waste and provided food assistance to millions of people.
2. The Champions 12.3 Coalition: This coalition of governments, businesses, international organizations, and NGOs is dedicated to achieving the UN Sustainable Development Goal Target 12.3, which aims to halve per capita global food waste. The coalition promotes collaboration and shares strategies for reducing food loss and waste.
3. Feed the Future: The U.S. Government's global hunger and food security initiative works with multiple stakeholders, including governments, private sector partners, and NGOs, to address the root causes of hunger and poverty. Collaborative projects under this initiative have improved agricultural productivity and reduced food wastage in several countries.

Case Studies

United States: The country spends $218 billion a year, or 1.3% of GDP, growing, processing, and transporting food that is never eaten. That adds up to 52.4 million tons of food sent to landfill annually. Add to that another 10.1 million tons estimated to be discarded or left unharvested on farms and in packinghouses, and you have a 63-million-ton mountain of wasted calories, resources, and energy. This waste grows up to two times if added in other food fit for

people that ends up being composted, converted into animal feed, or discarded in other ways, leading to up to 40% of all food grown being wasted. Put another way, if all of our country's wasted food was grown in one place, this mega-farm would cover roughly 80 million acres, over three-quarters of the state of California. Growing the food on this wasteful farm would consume all the water used in California, Texas, and Ohio combined. The farm would harvest enough food to fill a 40-ton tractor every 20 seconds. Many of those trailers would travel thousands of miles, distributing food to be kept cold in refrigerators and grocery stores for weeks. But instead of being purchased, prepared, and eaten, this perfectly good food would be loaded onto another line of trucks and hauled to a landfill, where it would emit a harmful stream of greenhouse gases as it decomposes. Meanwhile, the biggest tragedy is that one in seven Americans, many of them children, are food insecure without reliable access to sufficient, affordable, nutritious food.

Nearly 80% of food waste comes from perishable foods, which include prepared fresh deli items, meats, fruits and vegetables, seafood, milk and dairy, and some grain products such as bread and bakery items. In contrast, non-perishable foods — kinds of pasta, canned goods, and highly processed, shelf-stable products — are generally wasted less because they don't spoil as easily. Perishables often get discarded because they are inexpensive and quickly go bad. Pound per pound, fruits, and vegetables are among the least expensive and fastest spoiling foods, constituting over 40% of total food waste. Conversely, seafood and meats are the two least wasted and most expensive food types.

According to ReFED, a collaboration of over 30 business, nonprofit, foundation, and government leaders committed to reducing food waste in the United States, four actions are needed to quickly cut 20% of waste and put the U.S. on track to achieve a broader 50% food waste reduction goal by 2030.

Financing **–** To overcome the bottlenecks to unlocking $18 billion in financing, $100-$200 million annually is needed in catalytic grants, innovation investments, and low-cost project finance. Today, few investors or foundations focus explicitly on food waste.

Policy **–** Commonsense policy adjustments are needed to scale federal food donation tax incentives, standardize safe handling regulations, and boost recycling infrastructure by expanding state and local incentives and reducing permitting barriers. The biggest lever to accelerate change is comprehensive federal legislation.

Innovation – Key technology and business-model innovations are needed around packaging and labeling, IT-enabled transportation and storage, logistics software, value-added compost products, and distributed recycling. These could be accelerated through a national network of food waste innovation incubators.

Education – Launching a widespread training effort to change the behavior of food business employees is critical. In addition, campaigns to raise food waste awareness among consumers need to attract additional funding and support to expand the scale of antilittering and anti-smoking efforts.

SDG2 – Zero Hunger				
Prevalence of undernourishment (%)	2.5	2021	●	↑
Prevalence of stunting in children under 5 years of age (%)	3.4	2018	●	●
Prevalence of wasting in children under 5 years of age (%)	0.1	2018	●	●
Prevalence of obesity, BMI ≥ 30 (% of adult population)	42.0	2022	●	↓
Human Trophic Level (best 2–3 worst)	2.5	2021	●	↓
Cereal yield (tonnes per hectare of harvested land)	8.1	2022	●	↑
Sustainable Nitrogen Management Index (best 0–1.41 worst)	0.5	2018	●	↑
Yield gap closure (% of potential yield)	68.5	2022	●	●
Exports of hazardous pesticides (tonnes per million population)	12.1	2021	●	●

India: The Indian Constitution guarantees its citizens the Right to Health under Article 21 and requires the State to improve the level of nutrition among the people. India has made significant progress in human development over the past 70 years. However, as per the Global Hunger Index 2022, India ranks 107th out of 121 countries, and the level of hunger and undernutrition in the country is now at "serious" levels. A staggering 214 million people suffer from chronic food insecurity, representing 17% of the country's total population. One in three malnourished children in the world lives in India. around 68.76 million tonnes of food is wasted annually in Indian homes, which translates to 7% of the global total and around 50 kg of household food waste per capita. Reasons include inappropriate purchasing, bad storage conditions, over-preparation, socio-demographic factors, consumption behavior and patterns in the face of increased income and more food choices, etc.

The Indian government has undertaken several initiatives to reduce food waste and combat hunger. Here are three key initiatives:

National Food Security Act (NFSA): The NFSA aims to provide subsidized food grains to approximately two-thirds of India's population through the Public Distribution System (PDS). This ensures that vulnerable populations have access to essential food items at affordable prices, thus reducing food insecurity and wastage.

Pradhan Mantri Kisan Sampada Yojana (PMKSY): This scheme focuses on creating modern infrastructure facilities for food processing along the supply chain to minimize food wastage and enhance farmer incomes. By investing in cold storage, food processing units, and transportation facilities, the government aims to reduce post-harvest losses and increase farmers' access to markets.

Mid-Day Meal Scheme: Implemented in schools across India, the Mid-Day Meal Scheme provides nutritious meals to students to improve their nutritional intake and attendance. By utilizing surplus food grain stocks and promoting local sourcing of produce, the program tackles food wastage while also addressing malnutrition among children.

SDG2 – Zero Hunger				
Prevalence of undernourishment (%)	16.6	2021	●	↓
Prevalence of stunting in children under 5 years of age (%)	35.5	2020	●	→
Prevalence of wasting in children under 5 years of age (%)	18.7	2020	●	→
Prevalence of obesity, BMI ≥ 30 (% of adult population)	7.3	2022	●	→
Human Trophic Level (best 2–3 worst)	2.3	2021	●	→
Cereal yield (tonnes per hectare of harvested land)	3.6	2022	●	↑
Sustainable Nitrogen Management Index (best 0–1.41 worst)	0.8	2018	●	↗
Exports of hazardous pesticides (tonnes per million population)	0.9	2021	●	●

Analysis

Food waste is a significant challenge that impacts both the United States and India. According to a recent survey undertaken in the US, as much as 63 million tons of food gets wasted every year. The negative aspects of this are depletion of resources, increased energy consumption, and greenhouse emissions fueled by fruits and vegetables that contribute over 40% towards food waste. Unlike this, India alone makes an annual loss of 68.76 million tonnes. Globally, an estimated 76 million tonnes of food goes to waste, with a majority of food waste coming from households primarily because of inadequate storage and extra procurement. However, a significant proportion of the global population is experiencing hunger chronically. Lack of proper transportation and storage in the US leads to food spoilage. Excessive focus on cosmetic

appearance in food influences its quality and how much consumers eat, contributing to food waste. In India, widespread misunderstandings about food storage and shopping habits further exacerbate these issues. The strategic initiatives by the government of the US are financing innovations and awareness creation to the customers. Corresponding initiatives by the Indian government are distribution schemes like the NFSA and investments in infrastructures like the PMKSY. Even if the US throws more waste every year in terms of quantity, the relatively lower per capita waste and hunger rates in India make its context even worse. Supply chain intervention is the focus of the US strategy, whereas India has focused on behavior modification and upgrading physical infrastructure. An integrated approach to tackling these challenges is essential, necessitating collaboration across sectors, the adoption of technological advancements, and a shift in consumer behavior, which will enable the promotion of Public-Private Partnerships (PPPs) in the realm of food and contribute to the development of a fairer and sustainable global food system.

Conclusion and the way forward

The US and India face a paradoxical situation of massive food waste coexisting with hunger. While the US struggles with inefficiencies throughout the supply chain (wasting 63 million tons annually), India grapples with household-level waste (68.76 million tons) despite adequate food production. To achieve zero hunger and to reduce waste, both nations need a multi-pronged approach encompassing five ideal approaches:

Politico-legal measures: Implementing stricter regulations on cosmetic standards for produce, promoting easy-to-read food labeling (including "best before" and "use by" dates), and enacting tax breaks for food donations are some potential legal levers.

Market incentives: Creating financial incentives for farmers to adopt better storage practices, encouraging supermarkets to reduce price markups on approaching-expiry items, and fostering the growth of food rescue organizations can incentivize less waste and more efficient distribution.

Technology: Investing in modern and advanced packaging material and methodologies that ensure longer shelf life, developing apps that connect consumers with discounted surplus food, and utilizing data analytics to optimize food transportation and storage can significantly reduce waste.

Publicity: Launching national awareness campaigns focused on responsible food purchasing, storage techniques, and the environmental consequences of food waste can empower consumers to make informed choices.

Partnership: Building public-private partnerships between governments, businesses, NGOs, and research institutions can facilitate knowledge sharing, resource allocation, and the development of innovative solutions to tackle food waste across the entire supply chain.

While obstacles like political complexities and changing consumer habits persist, prioritizing these approaches and fostering collaboration between nations like the US and India promises significant improvements. Ultimately, achieving zero hunger requires a delicate balancing act within the Food Balanced System – minimizing food waste throughout the supply chain while ensuring food availability and accessibility.

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