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Understanding Food Cold Chain: Balance and a Sustainable Future

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Abstract: In an era marked by advancements in space exploration and artificial intelligence, it is paradoxical that hunger remains unconquered. Despite significant strides in food production, equitable distribution through an effective food supply chain remains a challenge. A pivotal component of this chain is the Food Cold Chain (FCC), essential for maintaining food quality and safety from farm to fork. The FCC, originating in the 19th century with the advent of refrigeration for cross-border food transport, has transformed food logistics by transcending climatic and seasonal barriers. This article delves into the FCC's evolution, exploring its historical context, political dynamics and its critical role in addressing food security, cultural integration, and environmental impacts. The FCC's progression from a contentious technology to a vital infrastructure underscores its complex political landscape, highlighting the need for equitable and sustainable global governance to harness its full potential.

Keywords: Cold Chain; Sustainable Development; Food Supply; Refrigeration; Food Security

1. Introduction

In an era where humans are venturing into outer space and artificial intelligence, it is ironic that we have not conquered the old specter of hunger. While we have made advancement in food production which brings food surplus, we still struggle to ensure that everyone has access to enough food. Since production shortage have its solution in mass production, automatic seeding and harvesting, chemical pesticides, breeding and genetic modification, the pressure shifts to effective and equitable distribution that depends on the function of food supply chain.

Our food supply chain has continually evolved alongside societal progress, with a significant milestone being the adoption of low-temperature technologies. Utilizing low temperatures for food storage has been essential for preserving food since ancient times. However, it was not until the 19th century that refrigeration was employed for cross-border transportation of food, marking a dramatic and fundamental shift in the global food supply chain.

The cooling infrastructure throughout the food supply chain is known as the Food Cold Chain (‘the FCC’). From initial pre-cooling processes to household refrigeration, cooling technology plays an indispensable role in maintaining food quality and safety. In comparison to the traditional local farmer markets, the modern supermarkets are featured with chilling refrigerator shelves. Refrigerated vehicles transport these goods to the stores, where consumers, accustomed to purchasing food in quantities exceeding a single day’s need, store them in home refrigerators for later consumption.

Behind the normality of such modern daily routine, there lies the transformation in food supply chain that ‘redefine geography and temporality’ . Cooling technologies enables food to be ‘transcendent of climatological, cultural, or even seasonal differences’, which has far-reaching implications for political, culture, economic and environmental aspects of our social life. This article reviews the development of the FCC to understand its transition from a dangerous and immoral food technology to a standard, even essential fixture of everyday life. It reflects the complex politics behind the FCC, which serves as an informative foundation to understand the current the FCC landscape and the direction of future development.

2. Understanding Food Cold Chain: History and Politics

The FCC, in simple terms, means keeping food fresh ‘from farm to fork’. This process covers all stages from production, aggregation, storage, processing, marketing, and distribution, right up to when it reaches our plates, using temperature-controlled supply chain of food. It is definitely a suite of technologically enabled practice, ensuring that perishable food products are kept in optimal temperature condition to ‘maintain their quality, nutritional value, and safety’. But at the same time, it transcends mere technology to be ‘the product of and players in a complex cryopolitical landscape’. To grasp how FCC is shaped by politics and will in turn reshape political landscape, it is important to understand its origin and historical context.

People in this decade might find it hard to imagine how household or supermarket refrigerators could ever be viewed with suspicion or concern. Yet, when refrigeration technologies were first applied to transporting foreign food, they faced significant skepticism and resistance .

The FCC was invented in the 1880s when Britain looked overseas for want of red meat. It was a period characterized by the concurrent processes of industrialization, urbanization, and the expansion of transportation networks, all of which were significantly altering the landscape of food supply. In response to the call for innovation, the first successful onboard refrigeration system was invented, bringing up international commerce and allowing for transnational distribution of red meat. It was celebrated in Britain as the end of the country’s commercial isolation, but despised in France, where suspicion and distrust were aroused about the quality of frozen food and transparency of marketplace .

Despite its challenging beginnings, the FCC gradually gained acceptance as its utility became evident. Throughout this process, the concept of the FCC played a fundamental role in reshaping global supply chain dynamics. It facilitated the delocalization, industrialization, and standardization of food

supply, with far-reaching implications ‘not just for how we humans feed ourselves, but also for how we relate to nature, other species and to each other in order to do so’ .

In the historical ebbs and flows, the idea of the FCC itself has also been fluid, reflecting divergent interests of those behind this technology and business. In the 19th century, the FCC is an integral part of empire politics hinging on ‘the ability to control, produce, and claim ownership over cold’; and it supports colonial economy in Australasia by supporting the export economy. In contrast, today, the main actors in this field extend beyond solely commercial groups. The FCC now serves a critical mechanism for providing sustenance to those in need serves, a guarantee for food health by preserving food in best condition and a powerful tool to boost incomes and foster economic growth in less developed areas. Given its significance to the provision of food to wider population and effective food distribution, it transcends mere business interest and enters the sphere of public policy and global governance. It becomes an integral component of the global food strategy, being incorporated into the core targets of the United Nations development plan known as the Sustainable Development Goals (‘SDGs’).

However, it is also important to acknowledge that politics surrounding the FCC in the 21st century demonstrates similar patterns of the past, with first world countries exerting dominance. This inequality is evident in the disparities between resources and the imbalanced business relations between the global North and South within the FCC framework. It leads to the suspicion that the FCC is creating new modes of colonial or quasi-colonial dependency and exploitation .

Therefore, the interwoven interests of the stakeholders behind the FCC should be untangled, and it is also critical to figure out the appropriate sphere of influence and decision-making authority for managing and regulating the FCC.

The complex in politics of the FCC offers valuable insights into its current landscape and potential future development. In the following sections, this article proceeds to discuss the various aspects of FFC with a consideration for the entangled interests lined out above, addressing the food challenges, cultural reformation and environmental impacts respectively.

3. Food Cold Chain and Food Challenges

This section analyses a pragmatic aspect of the FCC system—its significance and utility. It answers the question of why the FCC shakes off distrust and gradually integrates into everyday life—it gradually gains acceptance not because people get used to them but because they prove themselves useful .

In the eyes of Charles Tellie, who invented the first successful on-board refrigeration system, the new technology should be able to provide consumers with ‘the good life for less’ —a life abundant with fresh, affordable red meat, and to foster commerce, prosperity, and ultimately development in the resource-rich regions often overlooked by the global economy. Both ambitions remain highly relevant in today’s FCC system, telling about its two most important triumphs.

One of the critical roles of the current FCC system lies in ameliorating food security issues. First and foremost, the FCC significantly reduces food loss and waste, which is a formidable barrier to food

provision as it sets-off part of the surplus we achieved in food production. The annual total dollar value of food loss is estimated to reach 1.3 trillion. Lack of proper refrigeration itself is one of the main reasons for food waste and loss, directly resulting in the loss of 526 million tons of food production .

The most evident way that the FCC reduces food waste is how it preserves freshness and prolongs the shelf life of food. Saving food from spoilage is translated into additional food reserve to feed more people.

And it also answers to the demand for fresh products, which has implications wider than mere access to food and reducing food waste. Non-communicable diseases ('NCDs'), encompassing cardiovascular diseases, cancers, chronic respiratory diseases, and diabetes, stand as the leading cause of global mortality, accounting for a staggering 41 million deaths annually—74% of all global deaths. Unhealthy diet is an significant contributor to NCDs, and fresh fruit and vegetables are proven to have numerous health benefits including lowering NCDs risk factors (. Among all the NCDs, diabetes have the closest connection to food. Diabetes have become a global health issue, which escalates to be the notorious 'diabetes pandemic'. The ability of the FCC to provide fresh vegetables and fruits is important for fighting against unhealthy dietary structure and resulting diabetes. Moreover, the impact of fresh food on mental well-being is as significant as its influence on physical health. Research indicates that consuming raw fruits and vegetables can alleviate depressive symptoms and promote higher levels of positive mood, life satisfaction, and overall flourishing.

In addition to reducing food waste, the FCC helps to address inequalities in food resources and improves market access by connecting markets across different locations and extending the length of the food supply chain. Eventually, food waste and loss are reduced by decreasing spoilage along the supply chain and proper consumption through effective distribution. In India, where fragmented food systems and inefficient supply chains result in heavy food loss, the implementation of pre-cooling techniques for freshly picked bananas and the use of ripening chambers during banana transportation have extended the shelf life of bananas by approximately five times. This extended freshness enables Indian producers to engage in exportation and generate substantial profits from their agricultural endeavors.

However, the circumstances surrounding the FCC are somewhat contradictory because while cooling technologies are designed to preserve the freshness of food and enhance food quality and safety, they can also raise concerns about food safety in cases of malpractice like time-temperature abuse. Failure in management of the transportation process often leads to pollution, deterioration, and decay of agricultural products, resulting in food loss and compromising food safety standards. Another potential concern is that the extension of supply chain keeps adding value to the food—the storage, cooling, transportation are all indirect costs. the food wasted at the end of a supply chain extended by cooling technologies could lead to a waste of all those resources .

That being said, even after factoring in the negative influence of malpractice, the FCC should still yield a net positive effect on reducing food waste. The side effects can be mitigated through enhanced

management practices and improved refrigeration technologies. There are many innovative methods explored by the scholars to improve the FCC practice, such as adopting data analysis and mathematical modeling to achieve quantifiable reduction of loss and waste, and even the application of blockchain to the FCC management .

There are additional indirect effects that contribute to alleviating food security challenges. By minimizing food loss, the cost of food decreases, and the price decreases correspondingly, making food more affordable for everyone. It lives up to the first ideal of Charles Tellie. Simultaneously, with reduced food waste no longer cutting into business profits, there is greater room for producers to earn profits, ultimately boosting industrial performance. Those economic aspects are also critical to the food security challenges.

Another dimension of FCC utility is how improved food distribution through global the FCC can promote the equality between global North and South, which echoes the second ideal envisioned by Charles Tellie. The most evident inequality is the unequal access to food, which is attributable to unequal natural conditions and institutional distribution. It results in a disparity that the North experiencing surplus food and obesity while the South struggling with starvation. The FCC provides an answer to this problem by bridging the North and South with cold chain logistics, enabling the surplus in the North to flow to the South. Furthermore, countries in the global South bear a disproportionate burden of food loss due to limited refrigeration technologies and deployment of the FCC infrastructure . Hence, it is important to establish the FCC facilities in these regions to level the playing field and address food loss disparities.

However, while the FCC improves access to food in global South, it does not guarantee healthy diet there. While it brings healthy fresh food, it also brings processed food and frozen fast food. On the one hand, the fresh food from the FCC can relieves the problem of limited access to healthy foods in the global South, preventing the development of nutritional disorders and associated chronic disease in this vulnerable population. On the other hand, the FCC is also providing comparatively unhealthy food choices of processed food. With their affordability and convenience, these processed foods have the potential to reshape local dietary habits, leading to a transition from consuming local fresh foods to frozen and processed alternatives. This shift may have negative implications for population health.

This complexity underscores the importance of local, resilient, and sustainable food systems, which cannot be replaced by the FCC's supply of food. However, the local food system is under the threat of fierce competition brought by the global FCC. Local food producers often find themselves competing with imported foods facilitated by the FCC, which may offer lower prices and better quality, potentially nudging small-scale local producers out of market. In this vein, capitalist industrialization and the post-war international food order can ruin the rural self-provisioning and traditional way of life in Third World countries. Also, it inevitably influences consumer choice at the downstream because of price gap between cold chain food products and local fresh products. To the worst extent, if local producers are displaced from the market, consumers would lose access to the option of local fresh food.

The market impact is just part of the story about the shadow looming behind the FCC as a bridge connecting the global North and South. It is pointed out that imperialism lingers on in the current the FCC system because of trade patterns like European or Asian dominance of large-scale supply chain operations in Africa and major export destinations of the UK and France. The FCC system is inherently constrained by the existing logistical system as well as cultural and even culinary considerations. The ghost of colonial past still haunts the seemingly prosperous exporting food industry in the developing countries. This deteriorates in the context of an international order dominated by developed states. Economic dominance dictates that exporting states must adhere to the food regulations and criteria set by importing states, necessitating the adoption of corresponding technologies like proper cold chain and transportation infrastructure—resources that many developing countries may lack. In this sense, even if the FCC does build a bridge connecting global North and South, it is based on old architecture of colonial order .

In light of the considerations for health, resilience of local food economy and the wider negative implications of imbalanced power in the FFC structure, there is advocacy for alternative food economies such as the Open Food Network, which builds up local food distribution facilitating direct connections between producers, distributors, and consumers .

4. Cultural and Normative Dimension

The preceding section provides a comprehensive overview of the economic and utilitarian aspects of the FCC, laying the foundation for a deeper examination of its cultural dimensions in this subsequent section. In the following discussion, two key aspects will be addressed— cultural identity and alienation.

First, the FCC is redefining our collective identity by fostering a sense of 'international community' of food. the FCC allows food to transcend its original locality and reach foreign markets. Getting to appreciate a foreign taste is a step to embracing the culture. Therefore, imported food materializes the idea of cultural 'melting-pot' through diversified food options.

However, at times, the 'melting pot' concept does not function as ideally envisioned. The influx of foreign cultures accompanying imported food can lead to cultural invasion and the clash of cultures. Developed and developing countries often experience this cultural clash differently. For developed countries, the resurgence of local identity prompts 'buy local' campaigns. It definitely has economic roots. Targeting at supporting the local economy in response to the economic threat brought by the FCC, those campaigns promote the concepts of 'ethical trade, fair trade and economic justice'. However, beyond its economic underpinnings, 'buy local' campaigns also have their cultural dimension. There is a growing desire to preserve and promote local identity behind the marketing strategy, and those campaigns in turn reinforces local identity.

By contrast, the situation in developing countries is quite different. Tourism usually plays a significant role in developing countries. Imported food from the FCC nurtures tourists, enabling them to continue their culinary traditions from their home countries on foreign soil. However, in this practice, the local agriculture is losing the opportunity to earn foreign exchange and boost domestic agricultural

production. And the consumption habits of tourists may influence local diet habits, which is called 'demonstration effect'. Local people often adopt the culinary habits of visitors as a form of trend or fashion.

The transformation of local dietary habits can happen from deeper structural level. Cultural expressions always have its socioeconomic root. Just like how obesity 'epidemic' suggests food choices are structurally conditioned by income inequality, food producer and state intervention, food choice along the global food supply chain can be significantly shaped by the institutional influence of the FCC. Individuals may find themselves consuming what is offered rather than having genuine choices.

It is conceivable that food from developed, exporting countries—typically Western states—may assert dominance in the local markets of less developed countries due to the competitive advantage of low price based on the FCC. While the FCC indeed pumps food from food-rich countries to where food is scarce, it is questionable what food is being provided. It is more likely that the food sent by exporting countries consists of items in production surplus, often reflecting the dietary and agricultural traditions of the exporting country—just like bananas exportation from India. It is also possible that exporting countries tailor their food production to meet the demands of importing markets if a need arises. Such decisions are driven by business calculations and developing countries in the global South—largely importing countries within the global the FCC framework—may lack the economic leverage to do so. Based on this assumption, the food systems in the downstream of the FCC would inevitably succumb to 'westernization' because they have to take what the FFC has to offer.

Second, this international fusion provokes debate about the disconnection between food and its origin and resulting alienation from nature. In the past, food is nostalgia, and bears heavily on local identity. But nowadays, when food can be transported and consumed all around the world, such attachment of food to the local community pales. Moreover, as food is increasingly sourced from distant locations, we often lose sight of its connection to the soil in which it is grown. Facing frozen food pumped to the shelves by the cold chain, people may have misperceptions similar to 'milk actually comes from a cow'. It aggravates the already prominent phenomenon of consumer's alienation from natural food producing process. It is narrated that 'great and small cold storage warehouses and thousands of refrigerator cars have almost annihilated seasons and distances as our forefathers knew them' .

Such alienation profoundly impacts our self-perception, our relationships with others, and our connection to nature. It represents just one facet of a broader alienation of humanity from the natural world caused by technological advancements. In the food industry alone, we witness interventions such as genetic modification to enhance crop yields and the development of lab-grown meat. These endeavors reflect a tendency to exert more control over nature, fundamentally reshaping natural processes. In the same way that the FCC is redefining the temporality and locality of food, can we extend this redefinition further?

5. Environmental Impacts and Beyond

In addition to addressing food challenges and shaping culture, the FCC also exerts influence on society through its climate impacts. These impacts are twofold. On one hand, reducing food waste through the FCC can alleviate environmental pressure. However, on the other hand, the energy consumption associated with the FCC itself poses an environmental challenge. Addressing these environmental issues requires international collaboration to develop a comprehensive scheme that regulates the environmental impacts of the FCC, ensuring that it yields the most positive outcomes.

5.1 A Double-edged Sword

The FCC has a fundamental role to play in reducing food waste and loss. As pointed out by the UNEP, food waste poses a significant environmental burden. Green House Gas (‘GHG’) emissions are generated when food is produced, and if the food is wasted, those emissions are counted as generated from food waste. Such emissions amount to 1 gigatonne of carbon dioxide (‘CO2’) equivalent in 2017. And the methane emissions generated from wasted food is a significant climate pollutant. Besides, the conversion of agricultural land and the consumption of natural resources involved in the production of wasted food negatively bears upon the environment. Thus, saving food from spoilage can alleviate all the stressing environmental problems above.

Notwithstanding, refrigeration itself is energy-intensive, contributing to negative environmental impacts associated with the FCC, with the cold chain alone responsible for 4% of global GHG emissions. Refrigerants such as ozone-depleting substances (‘ODSs’) and hydrofluorocarbons (‘HFCs’) can lead to significant GHG emissions when leaked. Fortunately, there are available solutions, such as adopting alternative natural refrigerants like R717, which have minimal global warming potential .

Another more alarming environmental problem is the energy consumption along the FCC. This includes the direct usage of electricity for operating pe-cooling cold storage facilities and warehouses. Additionally, there is significant indirect energy consumption involved in the construction of those cold chain infrastructures. Moreover, energy consumption in transportation is substantial, considering the fossil fuels used for vehicles and the electricity required for refrigeration units onboard. Currently, the global FCC is much developed, with sea, air, and land transportation all at play. As the availability food from other locations drives the demand for such food, there is an increased use of air-freighting for the transportation of perishable products like strawberries and fresh oysters. Such demand-driven increase of transportation can intensify energy consumption issue further.

That being said, it is possible to neutralize the environmental effects of energy consumption and GHG emissions by upgrading the FCC. For example, there are proposals to establish more environmentally friendly FFC by utilizing gases with low global warming potential, prioritizing energy efficiency, and transitioning to renewable energy sources. According to a study quantitatively investigating the greenhouse gas emissions of cold chain infrastructures in China, implementing all those measures can reduce 80% of emission at most .

Therefore, the climate impacts of the FCC are complex, with both negative and positive aspects. There are research endeavors trying to understand whether the overall environmental impact of the system leans towards positiveness. According to an statistical research analyzing meat, milk and aquatic products in China and the United States, the GHG emissions from the reduced food loss exceeds those from the increased energy consumption during the expansion of the cold chain. Another study indicates that products like diaries and sheep meat exported from New Zealand to the UK were significantly more energy efficient than those produced domestically in the UK, even after counting in the energy usage in transportation. These studies are testimony to the potential of the FCC to alleviate environmental challenges.

Ultimately, what the trade-off turns out to be also depends on other external factors like diet structure, energy infrastructure and carbon footprints of food products. The logistics structure is another important factor of influence. There are continuous efforts to understand and optimize the balance between both negative and positive aspects, such as setting mathematical models to formulate optimal pathways .

5.2 Sustainable Food Cold Chains

There is a balance in the FCC framework, which should be carefully calibrated and evaluated. The balance is not solely determined by the negative and positive environmental impacts, but should take into account political, cultural and normative implications, market dynamics and food health, as outlined in previous sections.

While states should tailor policies to suit national needs, the policies need to take form of a true global compact. In this regard, the evolution of the FCC today represents an essential component of the global food strategy, as illustrated in the United Nations Sustainable Development Goals ('SDGs') No. 2—'end hunger, achieve food security and improved nutrition and promote sustainable agriculture' .

International community started to shed light upon issues related to the FCC in the 1987 Montreal Protocal, which targets at phasing out ozone-depleting substances ('ODSs'). ODSs are substances that were commonly used in refrigerators. In its Kigali Amendment, international community took a further step of adding hydrofluorocarbons ('HFCs') onto the list of target and emphasizing the improvement of energy efficiency. It was when Rome Declaration on the Contribution of the Montreal Protocol to Food Loss Reduction through Sustainable Cold Chain Development came into place that the concept of 'sustainable food cold chains' was brought to the table. This concept integrates the intricacies surrounding the FCC, from food security and economic considerations to environmental concerns, into a uniformed conceptual framework. Since then, 'sustainable food cold chains' has become a buzz word in the sphere of the FCC development.

In November 2022, under the work of United Nations Environmental Programme ('UNEP') and Food and Agriculture Organization ('FAO') a comprehensive report on the idea of 'sustainable food cold chain development' was published. It emphasizes the collaboration between governments and other cold chain stakeholders to adopt a systematical approach of development. In the vision of these

international organizations, sustainability in this context should be more than individual fix to environmental concerns, such as replacement of refrigerants or improvement of energy efficiency; instead, 'sustainable' means economically, environmentally and socially sustainable. It takes into account other social actors based on a 'comprehensive evaluation of the current and future scale' .

Another important aspect of the sustainability within the FCC is 'leaving no one behind'. The sustainable food cold chains should accommodate the inequality between global North and South, especially the everyday livelihood of people in Third World countries who suffers from heavier climate or food security tolls. It is important to bridge the gap between global South and North in terms of the FCC infrastructure building. If developing countries were to achieve the same level of food cold chain infrastructure as developed countries, it is estimated that they could save 144 million tons of food annually. Otherwise, failure to construct equity in the development of global the FCC would result in exacerbating existing inequalities .

6. Conclusion

The FCC plays a critical role in the current international society. Its role is multidimensional, hinging on social, economic and cultural aspects of life. Lack of access to refrigeration along the food chain creates a vicious cycle of food waste and income loss for farmers. And a proper institution of the FCC provides the key to feeding the constantly growing global population and boosting rural communities' resilience, while avoiding increased greenhouse gas (GHG) emissions .

Refrigeration not only extends the shelf life of food and facilitates distribution over longer distances but also operates as a complex web system linking various stakeholders within the FCC system—farmers, aggregators, processors, retailers and consumers. Their interconnected interests add layers of complexity to the FCC system, necessitating a delicate balance between factors such as dietary health, local food systems, food cultural, and environmental impacts.

After analyzing the interconnected interests, the answer to the initial question posed in this article regarding the sphere of influence and regulation of the FCC becomes clear. While the FCC impacts various sectors such as the environment and economy, it should not be governed solely by any single sector. Instead, a cross-sectoral approach is preferable. As policymakers grapple with this intricate system, it is crucial that the international community collaborates under the guiding principle of a 'sustainable food cold chain.' This principle empowers the FCC to operate in an equitable, effective, and sustainable manner. Cooling technology has the power to redefine time and space for food, but its success ultimately relies on international synergy to overcome historical constraints and unlock its true potential.

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Author Contributions

The authors confirm their contribution to the paper as follows: Xiaotong Jiao: Writing, Original draft, Conceptualization. Qian Qin: Conceptualization, Writing–review & editing, Supervision. All authors reviewed the results and approved the final version of the manuscript.

Availability of Data and Materials

The data that support the findings of this study are available from the authors upon reasonable request.

Conflicts of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

References

[1]. FAO (Director). (2023, April 6). Reducing Food Loss and Waste Through Sustainable Food Cold Chains [Video recording]. https://www.fao.org/climate-change/resources/videos/detail/reducing-food-loss-and-waste-through-sustainable-food-cold-chains/en

[2]. WHO. (2023, September 16). Noncommunicable Diseases. https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases

[3]. Dong, Y., Miller, S. A., & Keoleian, G. A. (2022). Estimating the Greenhouse Gas Emissions of Cold Chain Infrastructure in China from 2021 to 2060. Sustainable Production and Consumption, 31, 546–556. https://doi.org/10.1016/j.spc.2022.03.017

[4]. Si, Y. (2022). Agricultural Cold Chain Logistics Mode Based on Multi-Mode Blockchain Data Model. Computational Intelligence and Neuroscience, 2022, 1–12. https://doi.org/10.1155/2022/8060765

[5]. Sustainable Energy for All. (2022). Chilling Prospects: Tracking Sustainable Cooling for All 2022. Sustainable Energy for All. https://www.seforall.org/our-work/research-analysis/chilling-prospects-series/chilling-prospects-2022

[6]. UNEP & FAO. (2022). Sustainable Food Cold Chains: Opportunities, Challenges and the Way Forward. UNEP; FAO; https://doi.org/10.4060/cc0923en

[7]. UNEP. (2022, November 12). Amid Food and Climate Crises, Investing in Sustainable Food Cold Chains Crucial. https://www.unep.org/news-and-stories/press-release/amid-food-and-climate-crises-investing-sustainable-food-cold-chains

[8]. Ghantous, N. (2022, November 29). Cool Bananas: Efficient Cold Chain Technology for a Clean Agriculture Boom. Energy Monitor. https://www.energymonitor.ai/sectors/heating-cooling/cool-bananas-efficient-cold-chain-technology-for-a-clean-agriculture-boom

[9]. Gray, A. (2021). ‘Milk Actually Comes from a Cow’: Ontario Dairy Farmers’ Reactions and Interventions with Consumers’ Milk Rifts as Third‐party Alienation. Journal of Agrarian Change, 21(3), 504–521. https://doi.org/10.1111/joac.12406

[10]. Li, H., & Pan, P. (2021). Food Waste in Developed Countries and Cold Chain Logistics. E3S Web of Conferences, 251, 03001. https://doi.org/10.1051/e3sconf/202125103001

[11]. Shashi, S., Centobelli, P., Cerchione, R., & Ertz, M. (2021). Food Cold Chain Management: What We Know and What We Deserve. Supply Chain Management: An International Journal, 26(1), 102–135. https://doi.org/10.1108/SCM-12-2019-0452

[12]. Yu, Z., Liu, Y., Wang, Q., Sun, L., & Sun, S. (2021). Research on Food Safety and Security of Cold Chain Logistics. IOP Conference Series: Earth and Environmental Science, 647(1), 012176. https://doi.org/10.1088/1755-1315/647/1/012176

[13]. Darku, E. N. D., & Akpan, W. (2020). Selling Culture: A Buy Local Campaigns in the Ghanaian and South African Textile and Clothing Industries. Journal of Enterprising Communities: People and Places in the Global Economy, 14(4), 643–662. https://doi.org/10.1108/JEC-09-2019-0088

[14]. D’Odorico, P., Carr, J. A., Davis, K. F., Dell’Angelo, J., & Seekell, D. A. (2019). Food Inequality, Injustice, and Rights. BioScience, 69(3), 180–190. https://doi.org/10.1093/biosci/biz002

[15]. Hu, G., Mu, X., Xu, M., & Miller, S. A. (2019). Potentials of GHG Emission Reductions from Cold Chain Systems: Case Studies of China and the United States. Journal of Cleaner Production, 239, 118053. https://doi.org/10.1016/j.jclepro.2019.118053

[16]. Mercier, S., Mondor, M., McCarthy, U., Villeneuve, S., Alvarez, G., & Uysal, I. (2019). Optimized Cold Chain to Save Food. In Saving Food (pp. 203–226). Elsevier. https://doi.org/10.1016/B978-0-12-815357-4.00007-9

[17]. Brookie, K. L., Best, G. I., & Conner, T. S. (2018). Intake of Raw Fruits and Vegetables Is Associated With Better Mental Health Than Intake of Processed Fruits and Vegetables. Frontiers in Psychology, 9, 487. https://doi.org/10.3389/fpsyg.2018.00487

[18]. Otero, G., Gürcan, E. C., Pechlaner, G., & Liberman, G. (2018). Food Security, Obesity, and Inequality: Measuring the Risk of Exposure to the Neoliberal Diet. Journal of Agrarian Change, 18(3), 536–554. https://doi.org/10.1111/joac.12252

[19]. Mercier, S., Villeneuve, S., Mondor, M., & Uysal, I. (2017). Time–Temperature Management Along the Food Cold Chain: A Review of Recent Developments. Comprehensive Reviews in Food Science and Food Safety, 16(4), 647–667. https://doi.org/10.1111/1541-4337.12269

[20]. Woods, R. J. H. (2017). Nature and the Refrigerating Machine: The Politics and Production of Cold in the Nineteenth Century. In J. Radin & E. Kowal (Eds.), Cryopolitics (pp. 89–116). The MIT Press. https://doi.org/10.7551/mitpress/10456.003.0010

[21]. Saif, A., & Elhedhli, S. (2016). Cold Supply Chain Design with Environmental Considerations: A Simulation-optimization Approach. European Journal of Operational Research, 251(1), 274–287. https://doi.org/10.1016/j.ejor.2015.10.056

[22]. Freidberg, S. (2015). Moral Economies and the Cold Chain. Historical Research, 88(239), 125–137. https://doi.org/10.1111/1468-2281.12076

[23]. Bronwen Morgan. (2014, August 22). Crowdfunding and Ownership in the Sharing Economy. https://clmr.unsw.edu.au/article/corporate-structure/social-enterprise/crowdfunding-and-ownership-in-the-sharing-economy

[24]. Smith, D., Miles-Richardson, S., Dill, L., & Archie-Booker, E. (2013). Interventions to Improve Access to Fresh Food in Vulnerable Communities: A Review of the Literature. International Journal on Disability and Human Development, 12(4). https://doi.org/10.1515/ijdhd-2013-0203

[25]. Harvard T.H. Chan School of Public Health. (2012, September 18). Vegetables and Fruits. The Nutrition Source. https://nutritionsource.hsph.harvard.edu/what-should-you-eat/vegetables-and-fruits/

[26]. Freidberg, S. (2010). Freshness from Afar: The Colonial Roots of Contemporary Fresh Foods. Food and History, 8(1), 257–278. https://doi.org/10.1484/J.FOOD.1.100983

[27]. James, S. J., & James, C. (2010). The Food Cold-chain and Climate Change. Food Research International, 43(7), 1944–1956. https://doi.org/10.1016/j.foodres.2010.02.001

[28]. Reichman, D. (2008). Justice at a Price: Regulation and Alienation in the Global Economy. PoLAR: Political and Legal Anthropology Review, 31(1), 102–117. https://doi.org/10.1111/j.1555-2934.2008.00010.x

[29]. Likar, K., & Jevšnik, M. (2006). Cold Chain Maintaining in Food Trade. Food Control, 17(2), 108–113. https://doi.org/10.1016/j.foodcont.2004.09.009

[30]. Freidberg, S. (2004). French Beans and Food Scares: Culture and Commerce in an Anxious Age. Oxford University Press, USA.

[31]. Goodman, D., & Redclift, M. (2002). Refashioning Nature: Food, Ecology and Culture (0 ed.). Routledge. https://doi.org/10.4324/9780203414781

[32]. Wilk, R. R. (1999). 'Real Belizean Food': Building Local Identity in the Transnational Caribbean. American Anthropologist, 101(2), 244–255. https://doi.org/10.1525/aa.1999.101.2.244

[33]. Juric, B., & Worsley, A. (1998). Consumers' Attitudes Towards Imported Food Products. Food Quality and Preference, 9(6), 431–441. https://doi.org/10.1016/S0950-3293(98)00027-5

[34]. Bélisle, F. J. (1984). Tourism and Food Imports: The Case of Jamaica. Economic Development and Cultural Change, 32(4), 819–842. https://doi.org/10.1086/451428

[35]. UN. (n.d.). The 17 Goals. United Nations. Retrieved 10 June 2024, from https://sdgs.un.org/goals