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India, Spoilage and Waste

Food Waste in India: The Preventable Problem

With a population of over 1.3 billion people, India is the second most populous country in the world (“The World Factbook”). While 34% of the population resides in urban areas, the majority of Indians live in rural villages, ranging in size from 1,000 to 5,000 people (“The World Factbook”; Garcha). These small agrarian communities produce the food that supports the entire nation (Garcha). The combination of enormous cities and small villages makes India the largest democracy in the world (“India Data”). India’s republic government consists of a legislative, judicial and executive branch, similar to the United States (“The World Factbook”). However, India’s executive branch contains both a prime minister, who has legal responsibilities, and a president, who acts as a social figure (Pariona; Judge). Under the federal government, India is split into 29 states and seven territories, each containing a local government (Pariona; Judge).

India’s diverse climate and geography enable the country to support its massive population. Stretching from the Arabian Sea to the Himalayan Mountains and covering nearly 3 million square kilometers, India experiences both tropical and temperate climates (“The World Factbook”). Near the coast, temperatures are cooler compared to inland areas, and humidity is higher in the south compared to the north (“India”; Appel). Overall, temperatures typically fall between 75 and 84 degrees Fahrenheit (“India”). Temperatures above 86 degrees Fahrenheit, which cause fresh produce to spoil, are also prevalent throughout the country (Appel). Monsoons are another defining feature of India’s climate that determine agricultural success. While precipitation throughout the rest of the year is sparse, monsoon winds bring immense amounts of rainfall from July to September (“India”). Since 55% of India’s farmable land is reliant on precipitation, monsoon rains have a direct impact on crop yield by providing inadequate, sufficient or excessive rain (Lee). Delayed monsoons have also further accelerated water shortages throughout the country, most recently in Chennai (Pathak). With the exception of monsoons, India’s tame climate makes year-long crop production possible in most regions, placing India as one of the top three nations for global fruit and vegetable production (Rathore 9 ; Garcha). India grows a variety of crops, such as rice, onions, mangoes, wheat, and sugarcane, on 60.5% of its land (“The World Factbook”; Garcha). Additionally, dairy products and pharmaceuticals are vital parts of India’s economy and provide employment opportunities (“The World Factbook”; North 15). However, since approximately half of Indians hold agricultural jobs, food production continues to dominate India’s economy (“The World Factbook”).

Family lifestyles differ in urban and rural areas. In cities, families typically live in apartments or condos and utilize public transportation (Judge). In rural communities, families are multigenerational and reside in smaller shelters (Jacobson; Judge). Larger families are an advantage to agricultural communities because additional laborers increase crop yield. In 2017, an average of 4.8 people lived in Indian households, compared to 2.53 people in the United States, making Indian families, on average, twice the size of American families (United Nations; “Average number of people...”).

Diets throughout India vary depending on crop availability. In northern regions, meals are wheat-based, while southern regions consume more rice (Judge). All families eat produce that is grown near their homes and bought in local markets, including oranges, mangoes, peaches, zucchini, and carrots (“Kinnow Cold Chain Study” 5; Judge). Since 23-37% of Indians are vegetarian, access to fresh produce is necessary for their food preferences (Biswas). While some Indians choose not to incorporate meat into their diets, most citizens are not given the opportunity to make this choice. Due to a lack of proper

refrigeration, meat can only travel short distances before spoiling, restricting meat availability to certain regions within India (Herbst). In the event that communities are able to access meat, proper storage would be difficult due to the electrical scarcities that 18% of the country faces (“The World Factbook”). This problem is worse in rural areas, where approximately 30% of the population goes without power (“The World Factbook”; Appel). If rural communities have electricity, it is often unreliable, leading families to depend on fires for food preparation (North 7; Herbst). In cities, where electricity is more dependable, gas ovens and stoves are used for cooking (Judge).

Poverty exists throughout India in rural and urban areas. In 2018, the average net salary in India was US \$1600, placing 22% of Indians in poverty (“Highlights of Provisional Estimates...”; “India Data”). Some of these citizens are found in slums stretching between cities, but 80% of poverty-stricken Indians reside in rural, agricultural communities (Judge; “India Data”). While these citizens dedicate their lives to producing food for their country, they often can not afford nutritious meals for themselves. One third of Indians survive each day on only US \$1.25 (North 7). Since these Indians lack the financial means to purchase quality food, they are considered food insecure. The lives of Indians are further degraded as 163 million cannot access clean water and 552 million citizens are without toilets. These issues facilitate the spread of illnesses and diseases, lowering their quality of life (“India's Water Crisis...”).

Food loss is a major issue within India caused by poor transportation. India actually produces enough food to feed its massive population, but large amounts of this produce rot before being consumed for nutritional value (“Hunger in India”). In fact, 30-40% of all fruits and vegetables spoil before reaching the consumer (“Hunger in India”; Garcha; Rathore 9). This equates to 40-65 million tons of lost food, totaling US \$13 billion of waste (Rathore 9; Reyes). The majority of this waste occurs due to food packaging and storing techniques that are unsuitable for India’s climate. Currently, harvested produce is placed in plastic crates and stacked onto the back of open-air trucks (Negi 17; Appel). This method exposes the food to sun and rain during transport, facilitating spoilage (Appel). A lack of vehicle refrigeration is another cause of food loss (Appel). In addition to this, insects and rodents have the opportunity to devour 25-30% of produce due to poor storage methods (Reddy; Bundhun). These produce losses have significantly impacted India’s ability to compete in a global market. Even though India is the second largest producer of fresh fruits and vegetables in the world, the country is only accountable for 1.5% of global shipments due to spoilage (Appel). Decreasing India’s food loss will lead to the improvement of the country’s economy and standard of living.

Currently, food loss harms India’s economy, people and natural environment. Spoilage reduces the amount of food and nutritional value available to India’s population, causing severe hunger in both rural and urban areas. In 2018, 196 million Indians were malnourished and physically unable to lead constructive lives (“Hunger in India”; Reddy). The health effects of hunger are even more apparent in Indian children, as 35-43% of children younger than five are underweight (“The World Factbook”; North 8). This lack of nutrition causes slower mental and physical development, filling their lives with difficulties (Appel).

Food waste not only lessens the amount of nutrients available to India’s population, it also damages the economy. With less edible food available and consistent demand for fresh produce, inflation occurs. In extreme cases, fruit and vegetable prices have doubled (Reddy). Indians living in poverty cannot afford to pay these higher prices. Since there is less product to sell, farmers’ incomes have decreased (Reyes). As a result of smaller salaries and debt, more than 10,000 farmers have committed suicide over the past 20 years (Hunnicut 83). These rural deaths prove that food loss has severe physical and emotional effects.

Along with damaging the economy and population, food loss also wastes natural resources. Water, energy and soil nutrients are used to grow food that is never eaten (Blackstone). Trucks are used to deliver rotten food to markets, emitting unnecessary greenhouse gases (Blackstone). Combined with methane given off

by uneaten decomposing produce, food loss is responsible for 3.3 billion tons of carbon emissions globally (North 4). Due to its effect on the environment, economy and citizens, food loss in India is an issue that needs to be solved.

Individuals have tried to lessen food spoilage throughout the country. In 2013, a group of graduate students devised a solar-powered conduction dryer to help tackle food waste in rural areas (Reyes). The invention enables farmers to independently preserve their crops, effectively extending their edible lifetime (Reyes). Since roughly 30% of the rural population lives without electricity, a solar powered device is a suitable solution for India (“The World Factbook”). While the device is fitting for India’s rural areas, the technology comes at a high price. Costing US \$57, the invention is expensive for poverty-stricken farmers (Reyes). The students claim that the financial investment in their technology will raise farmer incomes because dried produce can be sold year-round at a higher price (Reyes). Even if farmers experience an increase in salary from using the dehydrator, these funds will not be available to cover the initial cost of the invention. If farmers can afford the dehydrator, there is still a lack of transportation of produce from the field to the market. While the dried produce no longer needs refrigeration during transit, it needs to be properly packaged to avoid contamination. This sanitation requirement is an additional obstacle for farmers trying to make a living off their crops. Mainly due to its unreasonable price, solar-powered dehydrators are not a completely valid solution for India’s food spoilage.

Radiation processing has the potential to prevent food loss. According to the Bhabha Atomic Research Center (BARC), “radiation processing of food involves exposure of food to short wave radiation energy to achieve a specific purpose such as extension of shelf-life, insect disinfestation and elimination of foodborne pathogens” (“Food Preservation...”). By killing bugs and harmful microorganisms, gamma radiation effectively stops produce from ripening (“Food Preservation...”; Nuclear Energy). Additionally, this process does not alter the physical appearance of the produce, making it a preferred method from the consumer standpoint (“Food Preservation...”). While radiation processing has many benefits, public skepticism has prevented the technique from becoming widespread. Citizens worry about consuming radioactive elements in radiation processed food despite reassurances from the Department of Atomic Energy (DAE) that the method is “clean and very safe” (Nuclear Energy). Even with this verification, few processing plants exist across the massive country. In 2008, India had only 12 gamma radiation processing facilities, most of which were dedicated to the sterilization of medical tools instead of produce preservation (Tikku 6). These facilities are not adequate to process India’s immense food production rates. Building additional radiation processing plants would be a financial burden for the government or corporations since each facility costs approximately US \$1.4 billion (Radiation Processing of Food 50). With these plants scattered across the country, transportation is still needed to deliver the produce from the field to the processing plant and later to markets. Additionally, only a handful of foods have been approved for radiation preservation, including onions, potatoes, mangoes, and rice (“Food Preservation...”). Multiple other crops are grown throughout the country, so radiation processing is not an applicable solution for all of India’s produce.

India’s federal government and other organizations have attempted to limit food loss in a variety of ways. The government’s main focus has been increasing overall food production and farmer incomes by improving irrigation systems and road accessibility (“Nutrition and Food Security”). In addition to government efforts, the World Bank has assisted India with road expansion. In 2004, the World Bank spent US \$2 billion to build an additional 40,000 kilometers of roads in rural India (“India Data”). Recently, the World Bank also committed to constructing an additional 2,500 kilometers of roads within the state of Bihar by 2022 (“Bihar Rural Roads Project”). In theory, building more roads will increase farmable land and therefore crop yield (Hunnicut 18). However, this plan will only succeed if farmers have vehicles to utilize the new roads for produce transportation. Currently, this is not the case in India because only 3.5% of the population owns a vehicle (“India”). On the rare occasion that farmers do own a vehicle, it is likely a two-wheeled vehicle, such as a moped or scooter, which is the most popular vehicle

in India (“Two-Wheeler Sales...”). These small vehicles do not have the carrying capacity to transport current crop production, let alone additional food grown as a result of new roads. Instead of alleviating the problem, building more roads worsens the situation by making more food susceptible to spoilage. Unless vehicles with proper carrying capacities are part of the solution, efforts to improve rural roads are ineffective for reducing food loss in India.

While governmental actions may have slightly reduced food loss, they have not directly addressed the source of the problem. Food spoilage does not occur because farmers do not have roads to use to transport produce, but because their vehicles lack proper cold chain carrying capacities (Garcha). By definition, a cold chain is “the uninterrupted temperature controlled transport and storage system of perishable goods between producers and consumers” (Appel). This means that fresh produce must be refrigerated once it is harvested until it is purchased. A typical cold chain system includes refrigerated packing centers, trucks, storage facilities, and distribution centers (Smith). Implementing a proper cold chain in India will have a considerable impact on the country’s economy. By transferring fruits and vegetables in refrigerated vehicles, 25-35% of current food losses will be prevented (Appel; Smith). In a 2016 study, a cold chain system was used to transfer kinnows, a citrus fruit, from the state of Punjab in northern India to Bangalore (“Kinnow Cold Chain Study” 5). The study found that kinnow spoilage dropped from 28% to only 9% as a result of implementing a cold chain (“Kinnow Cold Chain Study” 7, 18). Additionally, since more produce arrived at markets in edible condition, profit for farmers rose significantly (“Kinnow Cold Chain Study” 4). Cold chain technology will also enable food to be stored for many months and sold in the off-season at a higher price, further increasing farmer incomes (India 21). This study proves that establishing a refrigerated transport system will successfully reduce food spoilage and boost India’s economy.

Despite their proven benefits, cold chains are extremely uncommon in India. Currently, there are only 6,300 cold storage centers in India (Reddy). Of these centers, 52% are located in northern India, while temperatures that cause produce spoilage mainly occur in the southern part of the country (Negi 16). Not only are cold storage centers ineffectively placed, they are also lacking in quantity. India’s cold storage facilities are only able to house 10-15% of its fruit and vegetable production, leaving 85-90% of produce susceptible to spoilage (Negi 12; Rathore 9). In addition to refrigerated storage, refrigerated vehicles are essential to forming a complete cold chain. Presently, India has only 10,000 trucks equipped with coolers for produce transportation while it is estimated that the country needs 62,000 trucks (“Kinnow Cold Chain Study” 5). The absence of refrigerated trucks and cold storage facilities allows only 4% of India’s fresh produce to be properly refrigerated for its entire journey from field to market (Appel). To put this statistic into perspective, the United States transports 70% of food in refrigerated vehicles (Appel). This amount is even higher in the United Kingdom, where 90% of produce travels in a cold chain (North 6). Clearly, India is extremely under-equipped to properly transport its produce, causing unnecessary food loss.

To reduce food spoilage, cold chain technology needs to be implemented throughout India. Outside entities are financially backing India in this endeavor. In partnership with the Global Cold Chain Alliance (GCCA), the United States Department of Agriculture (USDA) recently announced a plan to assist developing countries in establishing their own cold chain systems (Rathore 12; Jorgensen). As a developed country, the United States is experienced in operating cold chains and will be able to support India in its quest to do the same. According to Symantha Holben, the International Program Manager for GCCA, “the ultimate goal of this program is to increase U.S. agricultural exports” (Jorgensen). By helping establish a more complete cold chain in India, the country will be able to accept more perishable goods from the United States, thus boosting the economies of both countries (Jorgensen). However, foreign financial aid is not a long term solution for funding India’s cold chain. Since the purpose of the project is to expand the economy of the United States, funding is likely to cease once the expansion of India’s cold chain is no longer benefiting the United States. The funds are being invested to build a design that favors American interests, not Indian interests. This may leave India with a partially complete cold

chain that enables them to accept food from other countries, but not use its own crops to feed its population. Additionally, projects focused on helping other countries may face criticism from Americans. As in any country, nationalistic beliefs are present in the United States. Citizens with these values may find it unacceptable to assist other countries before focusing on American problems. These issues make foreign aid an unsustainable and unpopular solution for constructing India's cold chain.

A cold chain needs to be implemented by Indians in order to be successful. To do this, the federal government is encouraging farmers to utilize cold chain technology. The National Skill Development Agency was created to teach Indians how to properly complete jobs that will be created as a result of cold chains (North 7). Pamphlets and classes have also been offered to farmers, educating them on available cold chain technology and its benefits (India). These actions hope to motivate and empower Indian farmers to change their current produce transportation methods. The government has also offered incentives to boost cold chain implementation. Farmers and businesses that start to use this technology will not have to pay certain transportation taxes (India 28; North 9). The government will even provide grants to cover 35-50% of cold chain technology costs (India 6). This is an effort to assist farmers who may be struggling to afford cold chain components.

Unfortunately, these incentives have not been very successful. In order to obtain grants, farmers must complete a report and turn it into the federal government, along with proof that they can pay for the complete project without government assistance (India 29). For farmers in debt, it is nearly impossible to have enough collateral to cover the costs of cold chain technology. Even if farmers are able to apply for governmental financial support, initial costs are still daunting. A complete cold chain system includes refrigerated packing centers, trucks, storage facilities, and distribution centers (Smith). Prices for these elements vary depending size, but all four components cost approximately US \$1.4 million (India 4). This immense sum of money provides temperature-controlled storage for produce from harvest to consumption. Individual farmers would only be responsible for the cost of the refrigerated truck, while other parts of the cold chain would be communal. A single refrigerated vehicle costs around US \$37,000 (India 4). While a single truck has a significantly lower price, it is still unaffordable for most farmers. Due to extreme prices, few farmers have invested in cold chains. Therefore, this technology is not widespread in India.

Cost is the main factor preventing cold chain technology from expanding into India. Cold chains are expensive, so struggling farmers do not invest in this solution. While global organizations, such as the World Bank, are able to provide funding for this project, the Indian government needs to assume financial responsibility. As a democracy, India's government is responsible for the well-being of its people. This includes access to affordable and sufficient amounts of food, which is obtainable through the use of cold chain technology. A portion of India's annual budget should be set aside to purchase and maintain this technology. If additional funds are needed, the government should tax its citizens. While this action may be viewed negatively by the public, it will force India to invest in its agricultural capabilities, improving the lives of all its citizens.

However, implementation of cold chain technology will be difficult considering the current political climate in India. In May of 2019, Prime Minister Narendra Modi was re-elected (Ingber). Modi is a part of the Bharatiya Janata Party (BJP), the major political party currently controlling the federal government (Ingber; Hume). Recently, Modi's administration has heightened religious tensions. For his entire political career, Modi has been a member of the Rashtriya Swayamsevak Sangh (RSS) organization, which is "an all-male Hindu volunteer corps that... aims to promote Hinduism in civic life" (Hume; Frayer). The RSS wishes to mold India into a Hindu based nation. However, this vision does not align with India's current demographics. While approximately 80% of Indians are Hindu, over 14% of the population is Muslim ("The World Factbook"; Khan). Considering India's large population, this means there are nearly 200 million Muslims in the country ("The World Factbook"). This religious group has

been the victim of recent crimes. According to the Human Rights Watch, riots and religious-based lynchings have killed 36 Muslims from May of 2015 to December of 2018 (Frayer). These outbreaks and the lack of government response have caused religious minorities to think negatively of their leaders. In addition to Muslims, farmers have expressed distrust of the government. Indian farmers and other citizens have participated in marches to express their discontent with the government's policies regarding agriculture ("India Farmers..."). Along with marches, agricultural workers have protested by leaving produce to rot in the streets (Artiuch). These instances clearly illustrate the tensions that exist between government leaders and farmers. With these political and religious tensions dividing India, a plan to raise taxes to fund cold chain technology may not be welcomed by the public.

Despite its potential unpopularity, having the federal government fund its own cold chains is the best solution for India. With first-hand knowledge about India's climate and culture, its government is capable of effectively enforcing this plan. This is also an opportunity for the government to display its dedication to Indians and the future of their country. By keeping produce properly refrigerated, spoilage will decrease, making more edible food available for purchase (Appel; Smith). This will lower the prices for fruits and vegetables, giving more Indians access to affordable food. With more people buying their produce, farmers will be making an adequate income ("Kinnow Cold Chain Study" 4). Cold chains will also raise employment rates, as drivers will be necessary for the system to function (North 7). Higher employment rates will give more citizens a livable salary, which will boost spending and India's economy. Additional fresh produce can be exported, which will also improve the economic state of the nation (Appel). With a successful refrigerated transit system, India will become an example of success for other developing countries, empowering them to implement similar practices to benefit their citizens.

Cold chain technology will grant India the opportunity not only to support itself, but to feed millions of people around the world.

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