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India, Spoilage & Waste

India: Honing Onto and Combating Food Loss

Forty percent of India's food is lost or wasted along the production and supply chain or at the retail and consumer levels - that's nearly six and a half-billion dollars worth of food going down the drain every year (Wageningen University, 2020)! But what exactly is food loss? Food loss is defined as the amount of edible food that is not consumed for any reason. Some of these reasons include spoilage, poor harvesting conditions, and discarding excess food after purchase (USDA, n.d.). In the case of most developing countries, food loss occurs along the production and supply chain (FAO, n.d.). India produces enough food to feed all of its citizens, but inefficient practices cause much of this food to be unable to reach the tables of many families.

India is a low-income country whose economy is highly dependent on agricultural productivity. Its population is about 1.4 billion people. About 65% of its population resides in rural areas (World Bank, 2018), the majority of them consisting of small farmers. Roughly 60.43% of the available land is currently cultivated (Trading Economics). It is the largest producer of milk and pulses and jute, the second-largest producer of rice, wheat, sugarcane, groundnut, fruits, vegetables, and cotton, as well as a leading producer of spices, fish, poultry, and livestock (FAO). As most of its rural denizens are small farmers, their farms are around 1.3 hectares (Our World in Data, 2021), or a little over three football fields (Journey North). India's climate is extremely varied; eastern India is hot and tropical with a dry winter, southern India is also hot and tropical but with monsoon rains, central and northwestern India is dry, and northern India is temperate and humid (WeatherOnline). This is because India is a peninsula surrounded by the Bay of Bengal in the southeast, the Arabian Sea in the southwest, and the Himalayas in the north (National Geographic Kids, 2015).

The well-being of a typical Indian family is affected by various social and economic factors. However, most families are about 4.8 people each (Indiatimes, 2014) and they tend to live in apartments (The Times of India, 2019). A typical diet usually consists of roti or rice, dal (a lentil stew), a combination of vegetable and/or meat dishes, and an array of condiments and garnishes (USA TODAY Travel Tips, 2019). The types of jobs family members have are usually dictated by their region of residence and caste (Asia Society, 2004). As part of the lower rungs of India's caste system, most of them are more likely to suffer from poverty-related issues than their high-caste counterparts. Consequently, education and health care are not affordable, and therefore inaccessible, to them. On the other hand, while urban families may have access to education and health care, they have limited access to clean water, proper toilets, electricity, telephones, good roads, and local markets. Other major barriers many Indian families face including earning a living and access to nutritious food include decreased opportunities for women, discrimination, a lack of economic opportunities related to caste disadvantages, and landlessness.

Food loss has had extensive and harmful effects in India. About \$15.19 billion worth of food is lost after harvest (WRI India, 2021). This trend has only been worsening with the onset of the growing COVID-19

pandemic because of the general increase in food insecurity rates (Singh, Financial Express, 2020). Another major reason for this declining trend lies in the inefficiency of existing food distribution systems. There has been less food readily available for public distribution in both rural and urban areas because due to the sudden onset of COVID-19, much of the ready-to-harvest produce was left to rot in the fields (WRI India, 2021). Vulnerable populations, particularly rural women, are more adversely affected by the consequences of food loss both culturally and economically. Traditionally, women are the first ones in their families to forgo meals when their family's food supply is limited, which leads to increased rates of hunger. Furthermore, with the social disadvantages that they already have to face, it is harder for them to recover economically from these situations than men (WRI, 2020). The environment is also adversely affected by food loss - it contributes to higher water loss, an increased carbon footprint, and more wasted land (Environment, Development and Sustainability, 2020).

Although there are few existing solutions for resolving food loss in India, several existing solutions in other countries have been proven to work well. In Sub-Saharan Africa, sequential harvesting practices have been developed to mitigate losses of cassava and yam (FAO, 2013). This method is used instead of cold storage, such as those practiced by large-scale growers elsewhere, because it is not as accessible or affordable in this region. Instead, farmers leave crops in the ground for longer periods after maturity and harvest them in batches. This reduces crop loss because crops aren't left to the surface to be exposed to sunlight, which can trigger immature greening and sprouting, therefore exacerbating loss. Furthermore, this practice can help to distribute farm labor inputs and income while maximizing crop quality for commercial sales. However, there is a risk of rot since crops are left in the ground after maturity. Overall, this is a good alternative that may also work well for India, as both countries have varied climates that have heavy impacts on crop maturity.

A viable second solution is a special plastic bag created by the IRRI, which is used by rice farmers in the Philippines for rice storage (Barona-Edra, 2015). By blocking the flow of oxygen and water vapor into the rice seeds, storage time is lengthened to a period of nine to twelve months. It discourages damage to rice seeds by protecting them from moisture, pest infestations, and fungal growth. In addition, it is also reusable - each bag is estimated to last for about five years. A few small downsides of these bags are that they are made of plastic and that so far, it has only been proven to be useful for small-scale rice farmers. These bags can only be sold if there is a recycling chain in place. Further research needs to be performed to determine if the bags can be used on a larger scale.

Another solution has been proposed by a past group of students from California Polytechnic State University - a mobile refrigeration trailer designed to preserve gleaned produce, or products obtained from the gleaning process (Bang et al., 2014). This process consists of salvaging discarded but edible produce, often from farms or local gardens. The produce is picked out, stored in corrugated cardboard boxes, and placed into the trailer to be weighed, stored, and cooled. An AC unit is present to cool and regulate the temperature in the trailer, and a PVC strip curtain at the entrance of the trailer serves to insulate the cool temperature within the trailer and prevent large amounts of dust from entering the trailer. Some advantages of this mobile refrigeration unit are that the use of an air conditioner along with thermostat hardware is cost-effective and that the use of corrugated cardboard boxes is also not only cost-effective but a sustainable way to pack food. However, some things to keep in mind are that the PVC strip curtain is somewhat costly, the digital utility-scale used for weighing produce is also expensive, the

carrying capacity of the trailer is only half a ton, and the trailer is not meant for transport over long distances. Further research could be performed to determine if the trailer design and components can be incorporated onto a larger scale of production.

While all of the above solutions have been proven to work, they do not address how to mitigate food loss on a larger scale over long periods, which the population of India needs. Therefore, one solution I would recommend is to implement a cost-friendly, environmentally friendly, and energy-efficient cold chain system. While typical cold chain systems produce a lot of harmful RAC (Refrigeration and Air Conditioning) emissions, this cold chain system would use natural, climate-friendly refrigerants such as water, ammonia, and carbon dioxide, which also happen to be relatively cheap because they are already mass-produced for a wide variety of purposes (Green Cooling Initiative, n.d.). Also, it is easier to recycle/dispose of natural refrigerants after usage compared to CFCs, HCFCs, and HFCs, which are toxic (Green Cooling Initiative, n.d.). By using these refrigerants in cold storage and transport systems, energy consumption and carbon dioxide emissions would be reduced. To put these new cold chain systems in place, India's RAC sector would be leading the efforts, which the national government can support in the form of policy-making. This project could be carried out by having the food supply chain hold trial runs with the revamped systems.

Many parts of the food supply chain could also assist with this project by testing these new refrigerants and experimenting new methods to work out the most cost-efficient and energy-efficient methods possible to minimize food loss. On the production side of the food chain, when it comes to harvesting produce, there has to be stringent regulations so workers can be more careful when operating harvesting machinery. Another method would be to keep mishapen crops that are otherwise in good condition and not throw them away. For unripe crops, instead of discarding them, they could be repurposed for many other purposes, such as animal feed, composting, and etc. As for post-harvest handling and storage, the above methods may also be applied, as well as better refrigeration during transportation from farm to processing or to storage facilities. More importantly, the government can provide infrastructure for roads, energy and markets (FAO 2011) to reduce food loss caused by spillage, which can be caused by damaged and uneven roads. On the distribution side, supermarkets should not reject edible produce that is mishapen. As for the consumption side, food waste can be donated for charity or animal feed, or given to special power plants that can convert food waste into biogas and bio fertilizer, which could be used for transportation and agriculture respectively (“Sweden Imports Waste from European Neighbors to Fuel Waste-to-Energy Program”).

To ensure that the project will have long-lasting and beneficial effects, several policies will need to be implemented. These include: passing an incentive program to motivate companies to transition to low-GWP products, banning products with high GWP (global-warming potential), labeling an appliance's energy consumption and energy efficiency, banning cooling appliances below a certain energy efficiency, requiring reports on refrigerants and operations, ensuring proper recovery of toxic refrigerants, using taxes strategically, and more (Green Cooling Initiative, n.d.). For the first policy, the government can promote a tax incentive for businesses that switch to low-GWP alternatives and show proof of their transition. This program will make it easier for the food supply chain to adapt better to the second policy in the long run. After banning high-GWP refrigerants, the government could lower import tariffs on the new refrigerants. The second policy would promote awareness among consumers, who will most likely

opt for alternatives with high energy efficiency. This would motivate the RAC market to produce more energy-efficient technologies. After the second policy is successful, the third policy would build upon the second policy by making sure that both the energy consumption and carbon footprint of these new appliances are lowered. Mandatory reports on the use of refrigerants and the operation of appliances could help the government determine if new restrictions on certain refrigerants need to be passed. Recovering toxic refrigerants can reduce the chances of them leaking into and polluting the environment. Taxing high-GWP refrigerants would discourage its usage; on the other hand, lowering taxes for those who properly dispose of those refrigerants could act as an incentive. By simultaneously using these initiatives and policies, food loss would be significantly reduced in the long run.

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