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## **Implementation of Solar- Powered Cold Storage Units to Reduce Food Spoilage in India's Food Distribution System**

The year 1943 marked the beginning of the world's worst food disaster. The setting is British controlled India, and the second World War is in full swing. While British resources are focused on fighting the war near their homeland, food supplies for the millions of Indians under British rule become a low priority. An estimated 1.5 to 3 million Indian citizens would soon die in eastern India in what would be called the Bengal Famine (Swaminathan). A collection of factors worked together to create the worst famine in the world, including natural disasters like flooding, and the Japanese occupation of Burma, leading to the devastation of the subcontinent. However, the resilient nation would make a recovery in the form of the Indian "Green Revolution". Through the expansion of farmland, the use of genetically superior seeds, and new agricultural practices, India would go from a hunger devastated country to one of the world's leading food producers.

2013 marks the 70th anniversary of the Bengal Famine, and now India is facing another agricultural disaster. While considered a beautiful nation and cultural hub, the second most populous nation is also considered the hunger capital of the world. India produces record amounts of food grains -- 252.56 million metric tonnes in 2011 and 2012 alone (Press Information Bureau, Government of India) -- yet over one fifth of the population is malnourished (Bajaj). In a nation that was reborn from the success of improved agricultural practices, the agriculture industry has now been forgotten amongst the growth of the technology and industry sectors. The base for India's economic growth is now on the verge of collapse.

The problem does not lie in food production: India grows so much food that its grain stockpile is second only to China(Bajaj). India's agricultural dilemma is due to the outdated storage practices used when grain is stockpiled or collected before being distributed to low income Indian families.. Vikas Bajaj, a reporter for the New York Times writes about the subpar logistics of the Indian food system. He describes a scene from Ranwan, India:

*"In this north Indian village, workers recently dismantled stacks of burned and mildewed rice while flies swarmed nearby over spoiled wheat. Local residents said the rice crop had been sitting along the side of a highway for several years and was now being sent to a distillery to be turned into liquor."*(*"India's Failed Food System"*).

The scene described above is not uncommon in India. More than one million tons of wheat alone are likely to go bad this year because of insufficient storage and a failure to distribute the wheat (Biman and Roy). The rotting grain, had it been properly stored, would go towards the government subsidized food programs that are meant to provide below market priced food to low income Indian families through 'fair-price shops', . However, the food system has fallen far short of its goal. A. Genesh- Kumar, a food policy analyst with the International Food Policy Research Institute in New Delhi, India estimates that "Only 10 to 20 percent of poor people actually depend on it"(Bhattacharya). This is due to the low quality of the food that is provided. Suryatapa Bhattacharya, a writer for *The National*, states that "Grain storage facilities are outdated, leading to pest infestation. Most of India's poor do not buy food at fair price shops because the quality is so poor"(Bhattacharya).

The average Indian family would have about five to seven family members to feed. Two parents and their children, usually two or three, and possibly an aging grandparent. Their basic diet would consist of rice, bread, such as naan, and other food grains, and a meat like fish and chicken when it can be obtained (Katemopoulos).

Healthcare and higher education are similar, in that the average low income family can afford neither. Both are very subjective to the income of the family, and families that spend most of their money on food simply cannot afford these simple investments. While most developed nations are able to provide one or both to a family, India lacks in that aspect. The lack of higher education specifically hinders a family's ability to gain financial standing. Without a higher education, the children of the family are bound to remain in low income slums, working low income, manual jobs as their parents had.

One urban family interviewed by reporters for *The New York Times* claim to live on about seventy- two U.S. dollars a month, yet do not rely on the fair- price shops that are supposed to distribute food grains to low- income Indian families for below market prices. According to Leela Devi, the mother of the interviewed family living in the Jagdamba Camp, all of their monthly income goes towards procuring food for her family because they are unable to obtain quality food grains at the unreliable local fair- price shop (Vikas and Bajaj).

The Devi family is not exceptional. Employment, when found, usually pays very low wages to urban workers. Such low wages are in themselves barriers in access to purchased foods, as well as the low amount of arable land in urban areas and the low production of foods grown at home by urban families. While many urban families rely on agriculture to provide food for their families, they have neither a reliable logistic process to bring rurally grown food to urban areas, nor the ability to grow their of food and food grains. Low income urban families are essentially trapped by hunger.

With so many urban families spending a majority of their income on buying food for their family, other essential expenses are being ignored amongst the poor. In a nation where education is based on financial capabilities, a household spending a majority of its money on food would not be able to afford sending the family's children to school. The government food grain subsidies were meant to lighten the burden of providing food for an entire family, and instead open doors to financial opportunities for India's poor. Because of its failure, standards used to measure the effectiveness of a nation's education system are subpar in India. For example, the illiteracy rate in 2011 was 25.96%. This may seem like a relatively small number when compared to other developing nations. However, when put into perspective, it is 25.96% of a nation of an estimated 1.2 billion people, meaning that over three hundred million Indian citizens can neither read nor write (*Literacy in India*).

Due to a the amount of money that poor families must spend on food, other expensive necessities have been disregarded amongst India's lower class. Not only is education uncommon for the poor, but so too is health care. According to The Lancet, India has experienced improvements in access to health care, but inequalities still remain due to socio economic standing (Balajaran, Selvaraj, Subramanian). While there is no study linking the expenditure on food to a lack of education or health care, it is commonsensical to believe that relieving low income families of paying full market prices for food would allow them to make investments that would otherwise

benefit their family, such as healthcare and education. If the subsidized food system were successful in supplying low income families with food grains, more income would be available to make said investments. However, due to food spoilage and infestation, this distribution system is not successful.

The state of waste and spoilage in India is hardly improving. While India has come to be realized as a world superpower due to its growth, its infrastructure and logistics are still that of a developing country. With so much attention being paid to jobs in human resources, technology, and industry, the underdevelopment of paths and storage between rural farms and low income urban areas has caused the largest current hunger crisis in the world.

The problems in the subsidized food program lie in the storage of food. If the Indian government were to implement certain measures, the food program could become successful in distributing food to low income areas and reaching certain Millenium Development Goals, such as eradicating extreme hunger and poverty, ensuring environmental sustainability, and furthering global partnership for development. A plausible step to take is the implementation of solar-powered cold storage units. These units, currently in development and testing by companies like Simplicool Technologies International, are completely solar powered and therefore environmentally sustainable. By providing a cold storage space, food grains would no longer be left in the sun to rot and become infested by vermin.

While the cold storage units would be very useful in reducing spoilage and waste, corruption also hinders the distribution process. Claims of workers in the distribution system stealing what quality food grain is left are all but uncommon. These workers feel the need due to the scarcity of quality food grain, and after stealing it, leave even less for the remainder of the poor families. This problem is a direct byproduct of the unreliability of the food system. Therefore, a resolution to the initial dilemma would also serve as a resolution to the later. Upon providing food reliability to a majority of the Indian population, the need to steal food would no longer arise as frequently. By eliminating the struggle for food, the Indian government could simultaneously lower the crime rate from within the food distribution system significantly.

Additionally, solar power is a leading contributor to clean energy production. Solar powered cold storage units would not only reduce spoilage and waste, but also cut any warehouse emissions created by the current storage processes in India. There are recent examples of cold storage warehouses reducing waste by converting to solar power. In November of 2012, Wakefern Food Corp. and NJR Clean Energy Ventures began installation of a rooftop array of solar panels to power a Wakefern distribution center in Keasbey, New Jersey. The 300,000 square foot solar array is estimated to eliminate 2,000 metric tons of carbon dioxide emissions; this equates to eliminating the carbon emissions of about 390 vehicles annually. In addition, the addition of the solar array is estimated to create 35 new jobs. The repercussions of the implementation a similar system in India would be far reaching and tremendously advantageous for those struggling with hunger and malnutrition within the nation (*Wakefern to Power Refrigeration Warehouse with Solar Power*).

The implementation of a system of solar powered cold storage units or warehouses should be facilitated by the Indian government. The current subsidized food distribution program is a government funded project, so it seems reasonable that the fix to the system should be

monetarily supported by the government. Currently, only about one percent of the Gross Domestic Product(GDP) is being used to support the distribution program. A nation that struggles so thoroughly with hunger should certainly contribute a greater amount of money to creating a not only reliable, but environmentally sustainable food distribution system. Additionally, the 300,000 square foot solar panel array used by the Wakefern Food Corp. costs only six million dollars; a more than affordable price considering that the one percent of the GDP used to support the current system amounts to slightly more than 13 billion dollars. This is more than enough to buy enough solar arrays or cold storage units to reform the current warehouse system in India.

Solar powered refrigeration units could also advance the fulfillment of certain Millenium Development Goals. One goal that the cold storage units would help achieve would be the eradication of extreme poverty and hunger. Many of India's agricultural shortfalls are due to the lack of refrigeration, which causes 30 to 40 percent of each year's harvest to be lost to spoilage (Ashton). By providing cold storage, India would retain enough edible food grains to feed most or all of its population, and conceivably enough to export to other nations, thus encouraging another Millenium Development Goal, Global Partnership and Development. In addition, the resolution could also encourage more low income Indian families to send their children to school, as less of the household budget would be spent on purchasing food. The goals of the current subsidized food program, which are to provide food for the millions of low- income families in India, as well as provide rural farmers with a greater and more regular income from crop sales, could be met if solar powered storage units are implemented.

India, as well as the world, stands to benefit from the resolution of the current food crisis. As India's population grows, so too does the worlds. Such a growing population will rely on agricultural productivity, specifically in the world's most powerful nations. Agricultural improficiency is not is not a struggle that the world's 7 billion citizens can afford if hunger is to be eradicated and the population allowed to grow. In addition, India's economy would benefit, as the 10 billion dollars of food that would normally spoil would instead be sold to low income families. This 10 billion dollars of rescued money would essentially pay for the government's spending on the storage units.

In conclusion, India is facing a major agricultural barrier. Its faulty food storage systems have been the main cause of hunger for millions of Indian citizens. In a country where technology is on the rise, food storage is far behind. However, it is not an unfixable problem. One plausible solution with a promise of longevity and environmental sustainability has been described above. I believe that with the proper steps India could become not only a food secure nation, but also a nation capable of assisting other food deprived regions. If the necessary steps are taken, India could be drastically altered into an agricultural leader. With the proper steps, India could be poised to begin a second Green Revolution.

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