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Bangladesh, Climate Volatility

Bangladesh: Solving Food Insecurity through Climate Change Adaptations

Abstract

A small yet overpopulated developing country bordering India, Bangladesh's economy and the livelihoods of over half of the 160 million Bangladeshis depend on agriculture. For centuries Bangladesh has been enduring the impacts of extreme weather patterns such as flooding, cyclones, and droughts. In the future, climate change will further exacerbate this situation with rising sea levels and increased salinity and droughts, ultimately destroying more fertile lands and reducing crop productivity. Approximately 25% of the current population is food insecure. As an attempt to mitigate ramifications of climate volatility, this literature review presents two sustainable solutions: dissemination of stress-resistant seeds and the employment of hermetic storage bags. Large-scale distribution of salt, flood, drought-tolerant crop varieties can potentially increase crop yield by 20%. Reducing post-harvest loss by using hermetic storage bags such as PICS and SuperGrain can increase food availability without using more energy or land. Up to 40-60% of rice, wheat, and maize that are lost due to insufficient storage will not go to waste. Overall, with the help from the government agencies and international organizations such as the World Bank, USAID, and Feed the Future, these long term solutions have the potential to transform Bangladesh into a more food-secure nation.

Background

Bangladesh is located between India and Myanmar and borders China in the North. It sits at the bottom Ganges River Delta, which empties into the Bay of Bengal. Because of its low, flat terrain and numerous rivers, two-thirds of Bangladesh is less than five meters above sea level (*Bangladesh*, 2016).

Due to geography, Bangladesh has extreme weather conditions and annual monsoon seasons, which makes the country especially prone to flooding, droughts, and tropical cyclones. The summer (March to June) is hot and humid with little rainfall and common droughts. The monsoon season (June to September) has heavy rainfall, causing flooding. The winter (October to February) is dry and cool ("Climate Change Profile Bangladesh 2018," 2018). For centuries, cyclones (e.g. the 1970 "Bhola Cyclone" / the 1991 cyclone) have been a detriment to the country, killing hundreds of thousands of people and leaving millions homeless or displaced. Moreover, Bangladesh also sits on the juncture of three tectonic plates, meaning there is the possibility of major earthquakes. The complex geography and extreme weather have aggravated the country's insufficient infrastructures, making transportation and communication inefficient. On the more beneficial side, this land is extremely fertile due to the Bay of Bengal, and 164 million people depend on it for food and agriculture. However, 164 million people live in 147,570 km², meaning Bangladesh is considered one of the most densely populated countries in the world. Comparing Bangladesh to Illinois (12.7 million of people living in 150,000 km²), its area is smaller but has 13 times the population.

Bangladesh has a parliamentary government system led by a president and prime minister elected by a National Assembly. The president serves as the head of state, and the prime minister serves as the head of government. In Bangladesh, corruption is found in almost all areas of government and some private organizations (Rahman, 2019). There is a high risk of corruption in developing countries because "public administration in developing countries is often bureaucratic and inefficient" (*Fighting Corruption in the Developing Countries - OECD Observer*, n.d.). The underdevelopment in countries also encourages corruption because low wages in civil services, imbalance of supply and demand in public services, and low level of education restrict people from understanding their rights and being politically active (*Fighting Corruption in the Developing Countries - OECD Observer*, n.d.). Bangladesh is ranked 146 out of 180 countries in Transparency International's 2019 Corruption Perceptions Index (CPI). Examples of corruption allegations include the "Padma Bridge project, the Railway Scandal, the HallMark Group scam, Destiny Group" (Mehta, 2012). However, corruption is difficult to measure accurately because it is kept hidden from the mass of the Nation. Developing countries are especially vulnerable to corruption because a larger portion of their populations is in poverty and "corruption has disproportionate impacts on the poor, increasing costs and reducing access to services, including health, education, and justice" (*Combating Corruption*, n.d.). Corruption hurts developing countries the most because it impedes investment thus economic growth and perpetuates the ongoing inequalities (*Combating Corruption*, n.d.).

Though the education and the healthcare system have improved substantially over the century, much still remains to be done. According to USAID, "Approximately 98 percent of children of primary school age are enrolled in school." However, having more access to education does not guarantee a higher quality of education. The poor literacy outcomes and the 20% dropout rate before completing fifth grade implies a need for a better teaching program in their educational system (USAID). Bangladesh's healthcare has made progress in child and maternal health. According to the World Bank, "84 percent of children under 23 months received basic vaccination in 2014," and there is a "40 percent reduction in maternal mortality from 2000 to 2010." However, the overall healthcare system still struggles to provide accessible and affordable services. In 2016, Bangladesh spent 0.8% of its GDP, less than $10 per capita on health (*Bangladesh*, 2016b). Further, healthcare is unaffordable since patients pay 63% of total health expenditures from the pocket, which drives "an estimated 3.5% percent of the population into poverty (*Bangladesh*, 2016b)."

The average household size is 4.5 people, with an annual household income per capita of 602.549 USD in 2016 (CEIC Data). The urban population primarily lives in apartments, and people in the slum sector of cities live in crammed shacks, such as 80-square-ft units with 6 people (Next Billion, 2017). In rural areas, people live in villages with houses made of mud, wood, and/or bamboo. Bangladesh has been improving its poverty rate for the last century, decreasing from 24.3% in 2016 to 21.8 % in 2018 (*Bangladesh: Poverty | Asian Development Bank*, n.d.). The international poverty line is defined as $1.90 per person per day according to the World Bank. Despite its tangible progress, Bangladesh is still considered the "largest least developed country in terms of population and economic size" (*Leaving the LDCs Category*, 2018).

The economy is mainly based on agriculture, which contributes to 20% of the GDP. According to the World Bank, "Nearly half of all of Bangladesh's workers and two-thirds in rural areas are directly employed by agriculture." Most of the agriculture in rural Bangladesh consists of small farmers (owning less than 1.5 acres), which make up 80.9% of the farming community (Ahmed et al., 2013). Out of the crop distribution, rice covers about 61% of the farmland (Majumder et al., 2016) and accounts for more than 90% of agricultural yield (Abedin, 2012). Rice is the staple food in Bangladesh, accommodating for

more than 70% of people's diets (Abedin, 2012). The other major crops are wheat and maize. The rest of the consumer diet include pulses (dry peas and lentils), vegetables, and occasionally fish (*Food-Based Nutrition Strategies in Bangladesh*, n.d.). Because families in rural areas mainly eat and produce rice, they lack micronutrients such as vitamin A, zinc, folate, and B12 in a diversified diet ("Bangladesh: Nutrition Profile," 2018), leading to malnutrition.

Climate Volatility and Food Insecurity

Food insecurity means "household-level economic and social condition of limited or uncertain access to adequate food " (USDA). In other words, people lack access to sufficient food to live a healthy lifestyle. According to the UN World Food Programme, approximately 40 million people (25% of the population) are food insecure. Climate change effects, such as droughts, flooding, salinity, will continually exacerbate food insecurity by destroying coastal homes and impeding agricultural progress.

The northwestern region is prone to severe drought because of little rainfall and dry rivers. Drought is estimated to increase and could cause a 40% reduction in crop productivity by 2050 ("Climate Change Profile Bangladesh 2018," 2018). In the coastal region, cyclones are more common and flooding is more intense. The floodwater can stay for months, completely engulfing the farming land and filling it with river sediments. The salty water from the Bay of Bengal travels up ever further into coastal lands through rivers, and according to the Environmental Justice Foundation, "by 2050, with a projected 50 cm rise in sea level, Bangladesh may lose approximately 11% of its land, affecting an estimated 15 million people living in its low-lying coastal region." The inundation of saltwater precipitates an increase in soil salinity. According to the Soil Resource Development Institute, "a comparative study of the salt-affected area between 1973 to 2009 showed that about 0.223 million hectares (26.7%) of new land are affected by salinity." Kalapara Coastal Belt is one of the nearest areas to the Bay of Bengal, where flooding is causing major salinity problems. The people in the Kalapara region "have been suffering from a scarcity of safe water for the production of crops, fish, and livestock" (Alam et al., 2017), which their livelihoods are dependent on. The soil salinity increases every year, making it harder for farming as time goes by.
With the rising sea level submerging the land and stripping away local establishments, rural Bangladeshis are forced to migrate to the densely populated cities, such as Dhaka, to search for economic opportunities according to the Internal Displacement Monitoring Centre. IDMC expects that an average of 1,214,715 people will be displaced per year from natural hazards. In the cities, the migrants often do not have access to basic necessities and live in slum sectors. The shanty houses of 3x3 meters are familiar to more than two million people and counting. With the fast rate of climate change causing coastal villagers to move inland, the future will only create more slum sectors in the densely populated Dhaka and the cities. The rural population is decreasing from 76.41% in 2000 to 63.37% of the population living in rural Bangladesh in 2018 according to the World Bank Data.

Because the effects of climate change directly affect the coastal rural area, the area of arable land has decreased largely and will continue to do so. A simulation conducted and led by Winston H. Yu estimates that climate variability will reduce rice production by 7.4% each year over the period 2005-2050 (Yu, 2010). According to the findings from "Climate Change Impact and Agriculture of Bangladesh" by Sikder et al. 2014, "The agricultural sector is most likely to face significant yield reduction in the future due to climate variability." Granted that 12 million people live in poverty in the coastal regions of Bangladesh (*Climate Change Poses Urgent Threat to the Poor of Coastal Bangladesh*, 2016), improving the agricultural economy is an urgent problem. Agriculture also plays a significant role in reducing poverty, accounting for 90% of the poverty reduction between 2005 and 2010 (*Bangladesh*, 2016a). In the face of climate change's destruction on rural coastal areas, improvements in agriculture are crucial to increase food production so that the rural economy will prosper and lessen burden on urban poverty.

Solving Hunger with Agricultural Prosperity

Even though developing countries such as Bangladesh have contributed little to the pollution-induced climate change by only emitting 0.3 percent of the emissions producing climate change (Glennon, 2017), they suffer most from the consequences. Because climate change is a global challenge and Bangladesh cannot change its consequences alone, adapting to the dynamic climate is crucial to the economic prosperity of rural Bangladesh.

Submitting to Nature: Adaptations of the Locals

The full impact of climate change can be witnessed in the villages of coastal regions, where cyclones and flooding are frequent. The natural cyclones have inundated the coastal regions of Bangladesh with salty water, destroying the fertile fields that once supported agriculture. With the benefit of fertile soil now demolished, locals are not only challenged to find housing but also forced to change their source of food production. Many villagers have invested money to raise their plinth (foundation platform) of the houses by several feet to combat flooding (Dixit, 2011). In Ranpur, villagers have learned a new technique to dig holes in the sandbars (eroded soil) and fill it with compost to plant pumpkins. The pumpkins are preserved to be sold during the rainy season to help provide a source of income (*How Bangladesh Has Adapted to Climate Change | The Economist*, 2015). Others have adapted to frequent flooding by farming on compacted water hyacinths called baira. These floating gardens can adjust to the floodwater, making planting vegetables more sustainable (*Moveable Feast*, 2008). Taking fate into their own hands, locals are following such measures to tackle climate change. However, Bangladeshis need outside assistance to secure their livelihoods and economic stability.

Stressed-Resistant Seeds

Expanding the availability of stress-resistant seeds is crucial to alleviate food insecurity and combat the threats of climate change (i.e. increased levels of salinity, droughts, and flooding). Cereal crops are staple foods in Bangladesh, and these new varieties of cereal crops such as rice and wheat could potentially increase the crop yield up to 20% ("Climate Change and Agriculture in Bangladesh," n.d.). Research institutes in Bangladesh such as the Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA) have been researching and developing many cereal crops that are resistant to climate change. Using genetic engineering, BARI has developed many salt-tolerant rice varieties such as BRRI rice -47, BRRI rice -53, and BRRI rice -54 (Ahmed et al., 2016; "Climate Change and Agriculture in Bangladesh," n.d.). BINA has researched many genes of lentils and found that the LG-208 gene in lentils has the highest yielding drought-tolerant qualities. This lentil is named Binamasur-10 lentil and was released in 2016 (Roy et al., 2019). The international community is also researching new stress-resistant genes. For example, the International Rice Research Institute (IRRI) has engineered rice that contains the Sub-1 gene, which is found to be flood and drought tolerant. Compared to the popular Swarna rice, this Swarna Sub-1 rice is able to withstand floods, and produce a 45% higher yield (Emerick & Ronald, 2019). Through this, farmers can gain 1-3 tons per hectare compared with farmers growing the intolerant varieties (Emerick & Ronald, 2019).

Implementation of Stress-Resistant Seeds

If made available to climate-impacted regions, these new seed varieties will bring game-changing potentials for economic prosperity. The seeds must be quickly disseminated by the Bangladeshi government to the farmers in these challenging times. Studies suggest that the government should make these seeds locally available for purchase to ensure wide-spread adoption (Emerick & Ronald, 2019) and provide agricultural training to facilitate crop production. These seeds can be multiplied by the

Bangladesh Agricultural Development Corporation (BADC) and disseminated by the government-based Department of Agriculture Extension (DAE) to the farmers ("Climate Change and Agriculture in Bangladesh," n.d.). The government and NGOs can introduce and distribute new seeds as mini kits for free, as well as educate and train farmers. Research shows that "the farmers who received training by the extension department (DAE) are more efficient in the production of the rice crops" (Majumder et al., 2016).

Post-Harvest Loss Problem

Because of rising sea levels and increasing population, arable cropland in Bangladesh is becoming a limited resource. One way to maximize food production in limited cropland is to reduce post-harvest loss. Post-harvest loss is the loss of food between harvest and consumption. This can happen because of transportation, storage, and/or handling (Md. Latiful Bari, 2015). Reducing post-harvest loss will maximize the conservation of food that is available without growing more. This will improve the rural economy because higher yield means more money for the farmers. Reducing food losses will also positively impact the environment because the land, water, and energy used to produce the crops will not go to waste (Kumar & Kalita, 2017). The main crops in Bangladesh are rice, wheat, and maize (corn). Studies have found that the main reason for these post-harvest losses of these crops is storage loss, meaning the reduction of stored edible crops. Factors that affect storage losses include insect, rodent, and fungal infestation as well as humidity and temperature fluctuations. This is because increased moisture content and temperature will lead to rapid mold growth. There is also around an 11% loss in rice value from the producer to the retailer (Kumar & Kalita, 2017), and about 40% of the total loss is due to insufficient storage (Alavi et al.). In the case of wheat, storage loss accounts for the highest percentage (41.7%) (Kumar & Kalita, 2017). There is up to 60.4% of maize losses during storage (Kumar & Kalita, 2017). Overall, the post-harvest loss can be effectively minimized through better storage.

Post-Harvest Loss Storage Solution: Hermetic Storage

Hermetic storage is a sealed, airtight, waterproof structure. It is one effective way to reduce post-harvest losses of grains. Without using any chemicals or pesticides, hermetic storage will effectively kill pests and insects and reduce mold by cutting off the oxygen circulation. One notable type of hermetic storage is the Purdue Improved Crop Storage (PICS), funded by the Bill and Melinda Gates Foundation. The bag consists of three layers: a double layer of high HDPE (high-density polyethylene) and a third woven nylon bag. This low-cost technology was initially developed for cowpea grain and widely used in Africa. From the studies conducted in countries in West Africa, the PICS maintained "100 seed grain weight, seed viability, and seed germination along with 95%–100% insect mortality at all localities (...) moisture content was also observed to be unchanged during storage for most of the PICS bags," (Kumar & Kalita, 2017). This highly-efficient storage bag has since disseminated in South Asia. Another widely used and commercialized hermetic bag is "SuperGrain." This bag is made of a single layer of HDPE and a normal polypropylene bag. In an investigation on rice in Bangladesh, the SuperGrain maintained the moisture content and had a total of 1% damage compared to 6% in traditional storage (Kumar & Kalita, 2017). NGOs and government agencies can make these hermetic storages more available and affordable to Bangladeshi farmers and provide training instructions. Doing so will greatly minimize post-harvest loss, thereby inflating profits and increasing the chances of prosperity without sacrificing extra natural resources.

Conclusion

Overall, with the inevitable obstacles such as overpopulation and devastating yet frequent climate catastrophes and political corruption, Bangladesh is still considered the largest least developed country (LDC) in the world when measuring population and economic size. However, Bangladesh is on its way to leave the LDC category in 2024 because of the estimated average GDP growth of 6.5 percent in the last decade according to the World Bank. In the face of devastating climate effects, popularizing new seeds and reducing post-harvest loss will maximize food production, reduce hunger, and increase financial support for rural Bangladeshis in the long run. According to the world bank, agriculture was a major factor that reduced 90% of the poverty between 2005 and 2010. It still has the potential to revolutionize hunger and poverty now. Because smallholding farmers contribute to a majority of the agricultural profit, equipping farmers with new technological advancements and proper training will advance economic progress and stabilize food security. Bangladesh government organizations such as the BADC, BINA, and DAE can help with new seed distribution and development. Many international organizations have initiated help and made tremendous progress. For example, according to USAID, USAID interventions help the adoption of post-harvest practices and invest technological innovations to support agricultural research. According to the US government initiative Feed The Future, “In 2018, Feed the Future activities helped more than 700,000 farmers to increase their production of food, commercial crops, fish, and livestock, gain access to markets, and improve the nutrition of their families.” Lastly, the World Bank has founded the Integrated Agriculture Productivity Project (IAPP) to “improve the resilience of agriculture production (*Bangladesh*, 2016)” and the Modern Food Storage Facilities Project (MFSFP) to “improve grain storage infrastructure (*Bangladesh*, 2016).” With help from these international organizations in addition to its government agencies, Bangladesh will continue to make immense and sustainable progress to food security.

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