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India, Water Scarcity

India: Alleviating Extreme Water Stress and Improving Food Security

India is currently the second most populous nation on the planet, with a population of just under 1.4 billion. The country's population is also projected to reach over 1.6 billion by the year 2050 (United Nations, 2019). It comes at a surprise that India is currently in a huge water crisis, ranking number 13 in the world for water stress (Aqueduct). With this lack of water also comes a lack of food, as water is desperately needed to irrigate India's many farms necessary to feed the country's vast population (Dhawan, 2017). If India does not find a sustainable way to acquire water to hydrate their people and irrigate their farms, they may be facing a grave humanitarian crisis on an enormous scale.

Households in India have an average of 4.6 people, with rural households averaging 5.0 people and 1.8 children per household (Business Standard, 2020; International Data, 2020). These numbers may be obsolete as the last census of India was in 2011, hopefully the upcoming national census in 2021 will provide better data. The gross national income per capita of India is only about 3,000 dollars annually, an already extremely low number which we can assume to be even lower for the average rural household (World bank, 2020). These poor rural families are often living in houses made of clay or mud that have very limited to no access to fresh water, with some families having to walk miles away from their houses to acquire water. With these harsh conditions, rural Indian villages develop a sense of community and family, as they all often look to help each other (Merlin, 2017). These farming communities make up the majority of India's population, with only 35% of the population living in cities (International Data, 2020). 58% of India's population relies on agriculture for their primary source of livelihood, and it is safe to say that life in rural India is heavily based around agriculture (Agriculture, 2020). These family farms which so many people rely on average only over 1 hectare in size. Large-scale farms are rare in India, but those that exist average 37 hectares in size. The degree of mechanization on these farms is poor, not even reaching 50%. India is dependent on these farms to feed itself. With 140 million hectares of arable land, India has the second largest agriculture sector in the world (Dhawan, 2017). It is the largest producer of spices, milk, tea, and fruits in the world, and is the second largest producer of the two most important crops, wheat and rice. A large portion of this crop productivity is heavily reliant on monsoons for its irrigation, with 88 million hectares being sown with monsoon crops in 2020 (Agriculture, 2020).

Most of these farms are not well irrigated, with two thirds of them reliant on the seasonal monsoons for their water. These monsoons typically come between the months of June to September, making them incredibly vulnerable to droughts and water shortages (Dhawan, 2017). However, between the years of 2000 and 2018, 13 of the 18 monsoons experienced by India were deficits (Akshay, 2018). These deficit monsoons in the last two decades can be largely attributed to climate change and have caused droughts and increased food insecurity in rural India. Monsoons are becoming increasingly unpredictable for Indian farmers, both in their schedule and intensity (Dhawan, 2017). It is crucial for Indian farmers to predict when the monsoons will arrive, as they need to know when to plant their crops, lest they risk lower yield or even crop failure. Furthermore, the intensity of the monsoons has become irregular, there

has been an increase in extreme rainfall over the past couple decades, causing massive floods that have directly killed thousands of people, not mentioning the damage to infrastructure and agriculture. For example, the 2019 monsoon caused floods that displaced over 2.5 million people (Earth Observatory).

Even with this increase in heavy rainfall, the overall amount of rain has been steadily decreasing, around 6% between 1951 and 2015. Changes in India's climate extend beyond the monsoon season, there have been an increase in both the frequency and intensity of heatwaves, putting even more stress on India's water supply (ODI).

The increasing irregularity of the monsoons have forced many find other ways to irrigate their crops. Many often turn to groundwater wells, which do supply water for a period, but these wells are not sustainable and are quickly being run dry. Signs of this extreme groundwater depletion are already appearing. In some villages even wells of 244 meters have run dry (Dhawan, 2017). The use of groundwater for agriculture has had a massive contribution to India's agricultural output. Using groundwater farmers can plant crops outside of the normal monsoon season. These winter crops have been the main source of India's agricultural growth over the past 50 years. Groundwater depletion threatens not only the necessary growth of India's agricultural sector, but also India's ability to even maintain its current agricultural output. The restoration of groundwater is a slow process, rendering it unsuitable as a long-term source of water. Despite this, many communities have run out of options, and are forced into rapidly depleting their groundwater reserves, effectively putting an expiration date on their livelihood. (Groundwater Depletion).

With the onset of COVID-19, the human society has ground to a halt, with many nations implementing strict social distancing and lockdown guidelines during the outbreak. India was initially praised for its response to the new threat as it was one of the first to implement strict social distancing policies for its population. Despite these efforts, the nation was forced into lockdown in a failed attempt to flatten the curve. The lockdown in India was far more obstructive than those in other nations. India heavily relies on migrants from its rural provinces to work in its urban cities, and the lockdown stranded those workers miles away from their hometowns without support. As a result, millions of migrant workers were forced to travel hundreds of miles on foot without proper food and water. (NCBI). The second wave proved to be far more disastrous for India however, with a peak of over 400,000 daily cases and 4000 deaths (Kapoor, Ravi). Thankfully the number of cases has dropped recently, but this should not distract from the emergence of the Delta variant, a more contagious variant of the coronavirus. This Delta variant has not caused as stark of an increase in cases within India compared to other countries such as the United States or Great Britain, but it is not something that can be ignored (CNBC).

These recent outbreaks in India deal two major blows to rural households. One, millions of migrant workers are forced out of their jobs in the cities due to national lockdowns. Two, rural villages are ill-equipped with proper testing and treatment facilities. The lack of these facilities means that if one member of a community were to be infected, it would be difficult to both diagnose and to treat them. This inability to detect the virus means that it is imperative that villagers take every measure to ensure that they do not bring the virus back home. A known way to do this is to wash your hands with clean water. Clean water, that many rural villages do not have access to. COVID-19 and themore contagious delta variant have made clear the necessity of expanding sanitation in India. Clean water for drinking and washing is

necessary for a population to stay healthy. How could a person living in rural India wash their hands if the water needed to do so was already contaminated? Such a plight is not uncommon, and its abatement is key to a healthy future for India (Associated Press). The subject of the cleanliness of the water cannot be ignored. The step after the procurement of water is its sanitation. What good is having water if you cannot use it? It is necessary to recognize that the treatment of both natural and grey water is a core factor in the equation of a healthy water supply. Especially in times like these, where clean water is a crucial line of defense between the people of India and COVID-19.

The key concern for India's water supply is its scarcity and lack of seasonal consistency. To help solve the water crisis in rural India, increasing the efficiency of irrigation and improved rainwater harvesting could be two feasible solutions.

80% of India's water is used for agriculture and irrigation, and most of it is going to waste. Currently India's irrigation systems are incredibly inefficient, over 88% of farmers who use groundwater for irrigation use a flooding or open channel system (Dhawan, 2017). This is incredibly inefficient as much of the water is lost to evaporation and provides an uneven distribution of water to the crops, many of which receive either too much or too little water. However, if a drip or sprinkler system were to be implemented it would drastically increase the efficiency of irrigation in India and help alleviate water stress. Less water would be used for the same crop yield, allowing for higher average yields and the potential to grow even more crops. Despite their potential, both sprinkler and drip irrigation systems have their advantages and disadvantages. Sprinkler systems are expensive, with high costs to install and operate these systems, but do provide consistent, efficient, and effective irrigation. Drip irrigation on the other hand, despite being incredibly cheap and highly precise at delivering water to crops, is unreliable and difficult to install properly. Drip irrigation is also highly prone to clogging and other malfunctions, it requires constant attention and maintenance to function properly. The issue of cost could be shouldered at least partly by the Indian government through subsidiaries. They have proposed to establish a subsidiary in October 2020 to provide guarantees for agricultural loans (Agriculture, 2020). With this, farmers can overcome some of the financial burden necessary to invest in modern irrigation methods, reducing the strain on both water and food in India.

Another promising system to alleviate some of rural India's water stress could be the establishment of an expansive rainwater capture program. Some solutions do already exist, but they are far more focused on providing water for the daily use of individual families, not for large scale operations like irrigation (Directorate). A possible solution would be the establishment of temporary reservoirs solely for agricultural use. Although crude, a system of tarps may be a viable solution for creating such temporary reservoirs. They could be connected and fixed to the ground to prevent water from seeping into the ground, and have their sides folded up to create a barrier to prevent runoff. Such a solution would have some major benefits, it would be cheap, portable, and simple. The storage of water would also be easy, as these tarps could be easily covered to prevent evaporation in the time necessary for it to be either used or transported to a permanent facility. The issue of transportation is a key point in any rainwater capture program, having water without the ability to use it means you have no water at all. A solution to this issue could be the use of large, foldable containers around the size of an oil drum. It would be easy to transport large amounts of these containers, as folded they would take up far less space inside a vehicle. Their small size would also make it easier to transport them without the use of heavy machinery. These portable

containers will be far more expensive to produce and distribute than common tarps, and government support is key to the establishment of such a product. A further benefit of such capture operations could be the slow replenishment of groundwater. Instead of excess water simply becoming runoff as the top layers of dirt become saturated, the water could be slowly released from collection areas. This would quicken the replenishment of groundwater wells in India and allow for stable food production even outside of the monsoon season.

The treatment of water is crucial during a pandemic, the safety of the water is a necessity. Large water treatment plants are almost entirely out of the question. Such facilities can only service a small region in the absence of long pipelines. Increasing the capacity of current facilities or building entirely new ones would take far too long in the current situation and would most likely prove to be far too expensive to justify. Thus, a small-scale solution is necessary. Portable sand filters are relatively cheap and portable, making them an excellent solution. They can be gravity fed, eliminating the need for complex machinery or moving parts. The size of these devices can range from a small bucket to a large silo, so they can fit a large range of needs, from an isolated rural family to a village community. The technology is there, but their use needs to be expanded upon. It would be advisable to start mass production of small to mid sizes, perhaps from a 30 cm in diameter to around a meter or two. This size would emphasize the portability, allowing for them to be transported to even isolated communities without the need for developed infrastructure. If these devices were to become widespread, their use would help to slow to spread of COVID-19 and provide an interim solution until it become viable to construct centralized water treatment plants.

The Indian government has implemented programs for rainwater harvesting, on both a regional and national level, and as much good as these initiatives have done, it is not enough. Those residing in rural areas are still facing acute water stress despite such government initiatives. It is imperative that the Indian government step up its support of national initiatives for both water acquisition and water treatment.

In addition to government programs and support, volunteer work could play a crucial role in helping rural communities and educating people on water conservation and enhanced rainwater collection methods. Volunteers and nonprofit foundations could travel out to rural Indian villages to educate rural Indians on best practices. Programs spreading the information of how to best irrigate crops and how to gather and purify water for daily use. If farmers are shown cheap and effective ways to boost their crop yield, most if not all of them would at least be willing to try out that method. Sand filters are also relatively simple, so the construction could be done on site with the help of locals, reducing the need for infrastructure to transport such devices. The people in rural India are looking for anything to help them in these times, whether that be more effective ways of combating COVID-19, or simply how to gather more water in a way that is sustainable. If this is done, India's food security would be less threatened by water shortages, and the overall living standard of rural communities can be improved.

As the world's second most populous nation and second largest agricultural power, India faces significant food insecurity and severe water stress due to improper practices in irrigation, water management, and water treatment. The increased adoption of more efficient irrigation systems would help to produce more crops for the same amount of water. Rainwater capture systems could help supply India with more water than they can currently acquire and could help to gradually replenish the rapidly depleting ground water.

Support from the Indian government and various grassroots programs is essential for these projects to succeed. The Indian government must put more resources in the development of better water systems and the promotion of best practices. Volunteer programs are crucial in serving areas of the nation that would be otherwise maligned by a broader program and could help to better the water situation on a case-by-case basis. The issues of water stress and food insecurity will only increase in coming years for India, possibly turning into a humanitarian crisis as the population in India rapidly grows, adding more demand to an already stressed water supply.

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