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Yemen, Climate Volatility

## **Climate Volatility in Yemen is Affecting Food Security**

Driving cars. Burning fuel. Cutting down trees. These things may seem harmless, but in reality they are causing a much greater problem. Everyday actions emit greenhouse gases into the atmosphere slowly causing the temperature to heat up. As the water levels rise, and severe weather conditions grow more problematic, many underdeveloped countries are beginning to feel the effects of climate change. Shorter growing seasons and severe droughts are just some of the many factors of climate change that lead to food shortages. If these trends continue, what seems to be a basic human necessity, will be out of reach for many.

Yemen is an underdeveloped country located in the Middle East just south of Iraq. With a total of 203,850 square miles, only 2.2% is arable land meant to feed the growing population of 30,399,243 people (Central Intelligence Agency [CIA], 2021). Out of this, a mere 37.9% live in urbanized Yemen and have access to safe drinking water and electricity. Maeen Abdulmalik Saeed, the Prime Minister, and Incumbent Abdrabbuh Mansur Hadi, the President, work hand in hand to govern Yemen, which previously was a Republic, but is currently in transition. The unstable government is just one of the factors that led to the ongoing civil war being fought. Furthermore, the countries struggling from war and conflict are also the same countries who are struggling from the effects of climate change. The climate of Yemen is mostly desert, hot, and humid (Britannica, 2021). The inadequate farming conditions will just continue to get worse as temperatures rise and weather conditions become more severe. This will cause growing seasons to shorten and leave Yemen residents unable to provide for their family's hungry mouths.

Yemeni families are typically large and close knit. With an average of 7.4 members per family, everyone needs to work in order to provide for themselves. Generally, Yemeni people work in agriculture, trade, and services, earning an average of 2,213 USD (Human Development Reports, 2021). This limited wage does not allow them to purchase a sufficient amount of food. Yemeni people depend on farming and imports to feed their growing population. Elevated levels of carbon dioxide in the atmosphere reduce the nutrients in food and livestock (Concern Worldwide, 2020). Compared to other countries, Yemen comes in at number one for undernourished children with 47.5% of children under the age of five being underweight (World Food Programme, 2021). Additionally, the people of Yemen are at high risk of catching infectious diseases. Although free health care is promised to all, just 25% of people living in rural areas obtain it. With only 0.53 physicians per 1,000 people catching a disease may be lethal. If these obstacles continue, the effects of climate change will be staggering.

Yemen's hot, dry climate, in addition to the mountainous and desert-like geography, severely limits agricultural options. The country is located between two main weather patterns: the regular northerly winds and the southwest monsoon winds (Britannica, 2021). The northerly winds bring winter temperatures and the monsoon winds bring the primary rains. Rainfall increases with elevation, so while in the southern coastal belt, annual rainfall is only five inches, but in the highlands, annual rainfall can be up to 30 inches (CIA, 2021). Throughout Yemen, precipitation is sporadic from year to year. Although, the recent droughts and lack of rainfall during the rainy season can be directly correlated with climate change and the increase of global temperatures, these dry patches can create vast amounts of issues in maintaining crop growth and being able to provide enough food for their large families.

Additionally, the soil throughout the country varies from sandy to loamy, both of which do not allow growth in many areas (Britannica, 2021). These types of soil are low in organic matter, which is a component of soil which holds minerals. Along with reduced minerals in the soil, plants are also taking in an excess amount of carbon dioxide. The elevated carbon dioxide concentrations are caused by burning fossil fuels such as coal and oil (NOAA, 2020). Throughout the process of photosynthesis, plants take in carbon dioxide. If a plant absorbs too much, it reduces the nutritional value of the food, for instance micronutrients (Nature Education, 2010). The lack of micronutrients, such as iron, folic acid, vitamin A, and iodine, are among the key reasons for birth defects and developmental issues.

Nutrients are necessary for a healthy diet. There are five essential nutrients to keep the body functioning normally. Protein is a fundamental nutrient because it is the building blocks of the body. It not only makes up muscle, but it also makes up every cell, from bones to skin to hair. Proteins are made from amino acids, and while some can be made on their own, many essential amino acids can only be found in food. This macronutrient is used primarily for growth, health, and body maintenance. Carbohydrates are another crucial macronutrient needed for a balanced diet. According to the Dietary Guidelines for Americans, carbohydrates should make up 45 to 65 percent of the total daily calories. They are used to fuel the human body, especially the central nervous system and brain. Additionally, carbs protect the body against disease. The third and final macronutrient is fats. Although fats normally get a bad reputation, research has shown that healthy fats are an important part of a person's diet. Under 30 percent of a person's daily calories should come from them (World Health Organization, 2018). According to Harvard Medical School, fat supports many of the body's functions such as vitamin and mineral absorption, blood clotting, building cells, and muscle movement. Implementing healthy fats in a diet can help balance a person's blood sugar, decrease the risk of heart disease and type two diabetes, and improve the brain function. They are also powerful anti-inflammatories, and will lower the risk of arthritis, cancer, and Alzheimer's disease.

Vitamins are an imperative nutrient because they are important for healthy vision, skin, and bones. Each vitamin plays an important role, and not getting enough of them can cause health problems. This micronutrient is vital for fighting off diseases. Also, vitamins may lower the risk of lung and prostate cancer, and they are powerful antioxidants. Much like vitamins, minerals help support the body. They're essential for many body functions, including building strong bones and teeth, regulating metabolism, and staying properly hydrated. Some of the most common minerals are calcium, iron, and zinc. In addition to strengthening bones, calcium helps with nerve signal transmission, maintaining healthy blood pressure, and muscle contraction and relaxation. Iron supports the red blood cells and hormone creation, while zinc boosts the immune system and wound healing. However, food is not the only crucial part of a diet. While humans can go weeks without food, it can't last more than a few days without water. Water is essential for every system in the human body. It improves the brain function and mood. It acts as a shock absorber and a lubricant in the body. It also helps flush out toxins, carry nutrients to cells, hydrate the body, and prevent constipation. Even mild dehydration can make a person feel tired and impair the concentration and physical performance.

In Yemen these macro and micronutrients are not always easily available. Whether it is the crops themselves losing nutrients or not being able to provide enough food for their families, Yemeni people struggle with getting enough to support their bodies. Not consuming enough of these nutrients leads to malnutrition. Malnutrition can have a number of adverse effects on the body. If a person is malnourished, the body will slow down and it will not work as well as usual. Typical adverse effects of malnutrition include reduced muscle and tissue mass, decreased mobility and stamina, breathing difficulties, an increased risk of chest infection and respiratory failure, wounds take longer to heal and illnesses take longer to recover from, slower immune response which increases the risk of getting infections, and increases the length of time that it takes to recover from infection, difficulty staying warm as a result of having less muscle and tissue mass, and increasing the risk of hypothermia.

These obstacles that Yemen face impact both the quality and quantity of food available to the people. The unsatisfactory land and climate causes them to depend on imports to supply their food. When outside countries can not provide an adequate supply of food, Yemen is left suffering. Currently, 13.3 million people in Yemen consume an insufficient amount of food (WFP, 2021). This is nearly half of the entire population. Along with having a scarcity of food, the quality of food is in danger. With less nutrients in the plants, the people of Yemen are severely undernourished. If this food insecurity continues, it will continue to establish more health problems, leaving Yemen in distress.

One way to improve the status of undernourishment, is to add the lost nutrients back into the food. This is done by a process called food fortification. Food fortification is a proven, sustainable, cost-efficient, and high-impact solution to address micronutrient deficiencies (Nutrition International, 2021). Nutrients could be added back through commercial and industrial fortification, biofortification, and home fortification. Groups such as the Food Fortification Initiative (FFI), have implemented food fortification in areas across Latin America and the United States of America (GiveWell, 2017). These programs have obtained immense success in the battle against malnutrition. If used in Yemen, workers would inject some of their staple foods, like maize, wheat, and barley, with the missing micronutrients. Through this, the fear of undernourishment and health issues would begin to diminish.

Although this would be a solution for the quality of food, there is still a high demand for the quantity of food. A way to solve this problem is by finding a way to grow food in the hot, dry climate of the desert, and a group of young scientists from Southern Australia did just that. Pulling off the ultimate agricultural feat, they found a way to use the sun to desalinate sea water for irrigation, as well as using the sun to heat and cool greenhouses when necessary, called the Sundrop system (Sundrop Farms, 2020). Taking no fresh water and emitting close to zero fossil fuels, they developed a system to cheaply grow high quality, pesticide-free crops year round in commercial quantities.

To begin the process, a line of motorised parabolic mirrors that follow the sun all day focuses its heat on a pipe containing a sealed-in supply of oil. The hot oil heats up nearby tanks of seawater that is pumped up from a few meters below the surface. The oil brings the seawater up to 160 degrees celsius and the steam from this drives turbines providing electricity. Some of the hot water from this process is used to heat the greenhouse through the cold desert nights, while the rest is fed into a desalination plant that produces 10,000 liters of fresh water a day. The air in the greenhouse is kept humid and cool by trickling water over a wall of honeycombed cardboard evaporative pads through which air is driven by wind and fans. The system is hi-tech, and the growing conditions can be controlled from anywhere by an app on a phone (Guardian, 2017).

This would be a way of growing a surplus amount of food, while avoiding the risks of extreme weather conditions, such as floods, frost, hail, and lack of water. Additionally, it is economically and infinitely scalable since there is no shortage of sunshine or seawater. Salty seawater, it hardly needs explaining, is free in every way and abundant – rather too abundant these days, as the ice caps melt away due to rising global temperatures. An unexpected bonus of the Sundrop system is that crops are produced year-round and wholly pesticide-free (Modern Farmer, 2016). The Sundrop system would be an outstanding fit for Yemen since it is bordering the ocean. This way they have easy access to seawater to begin the process of desalination. By using this system, Yemen would be able to produce a substantial amount of food throughout the whole year.

Also, scientists all around the world are working on new innovative ways to grow food. One way is areoponics. Aeroponic systems nourish plants with nothing more than nutrient-laden mist. The concept builds off that of hydroponic systems, in which the roots are held in a soilless growing medium, such as coco coir, over which nutrient-laden water is periodically pumped. Aeroponics simply dispenses with the

growing medium, leaving the roots to dangle in the air, where they are periodically puffed by specially-designed misting devices. In aeroponics systems, seeds are “planted” in pieces of foam stuffed into tiny pots, which are exposed to light on one end and nutrient mist on the other. The foam also holds the stem and root mass in place as the plants grow.

It turns out that eliminating the growing medium is very freeing for a plants’ roots: the extra oxygen they are exposed to results in faster growth. Aeroponic systems are also extremely water-efficient. These closed-loop systems use 95 percent less irrigation than plants grown in soil. And since the nutrients are held in the water, they get recycled, too. In addition to these efficiencies, aeroponics’ eco-friendly reputation is bolstered by the ability to grow large quantities of food in small spaces. The approach is mainly employed in indoor vertical farms, which are increasingly common in cities – cutting down on the environmental costs of getting food from field to plate. Also, because aeroponics systems are fully enclosed, there is no nutrient runoff to foul nearby waterways. Rather than treating pests and diseases with harsh chemicals, the growing equipment can simply be sterilized as needed.

However there are also some drawbacks to the areoponics system. Aeroponics systems require a bit of finesse to operate effectively. The nutrient concentration of the water must be maintained within precise parameters and even a slight malfunction of your equipment can cause the loss of a crop. If the misters don’t spray every few minutes – maybe because the power goes out, for example – those dangling roots will quickly desiccate. Also, the misters need regular cleaning to keep them from becoming clogged by mineral deposits in the water. There is also one major drawback, environmentally-speaking: aeroponic systems rely on electrical power to pump water through the tiny misting devices. While they can be employed in the natural light of a greenhouse, they are more often used with energy-intensive grow lights. Solar power or other alternative energy sources can be harnessed to eliminate this drawback, however.

The areoponics system can be cost-efficient to the people of Yemen. DIY models can be made for less than \$100, but good quality professional systems with automated nutrient monitoring and a backup power supply start in the four-figure range. However, you can grow practically anything with this system. In practice, aeroponics systems are primarily used for the same applications as hydroponics systems, including leafy greens, culinary herbs, marijuana, strawberries, tomatoes, and cucumbers. One exception is root crops, which are impractical in a hydroponic system, but well-suited to aeroponics, as the roots have plenty of room to grow and are easily accessible for harvesting. Other vegetable crops are possible but have more complex nutrient requirements. Fruiting shrubs and trees are impractical in aeroponics systems due to their size. This system could fit well in Yemen because it would be a way of growing crops in the hot and dry climate.

Though climate change is a serious complication in Yemen, they did not cause the issue. Global warming and climate change is caused by many developed countries burning fossil fuels, but it is the underdeveloped countries that feel the consequences. These countries, that are already struggling, now have the added pressure of extreme weather conditions and lack of food. The constant droughts, ongoing civil war, and unsuitable land in Yemen all contribute to their food insecurity. These concerns lead Yemeni people to be undernourished and underweight. Improving the quality and quantity of food will not only improve the health of Yemen, but the economy as well. Implementing programs such as food fortification and the Sundrop system will help Yemen turn from one of the most underdeveloped countries, to a prosperous and thriving nation.

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