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Yemen-Conflict

Eradicating War-Induced Famine with Algae-Farming

Not only facing the humiliation of being known as the country in “the world’s worst humanitarian crisis,” but staring down the worst famine the world has seen in 100 years. Yemen is a small country of 527, 920 square kilometers located on the south western edge of the Arabian Peninsula. It is bordered by Oman, Saudi Arabia, the Red Sea, the Arabian Sea, and the Gulf of Aden (Burrowes & Wenner, 2020). Yemeni people have needed urgent humanitarian aid for decades; however due to several years of political conflicts, the need has skyrocketed with only 8% of the population not needing emergent external help. Conflict heightened when Houthi rebel fighters took complete control of Sanaa in January of 2015. The war was only foreseen to last a couple of days, but six years later it is still rampant, being known as the second most lethal war yet. This civil war has negatively affected every single aspect of the economy from food security to international trade and infrastructure.

Yemen is a relatively small country with a population of 29.6 million people. The rural population consists of 70% of the people, leaving the urban population in the minority. Yemen’s quality of life is far from amazing. About 80% of the population is below the poverty line compared to being only half the population before the war (United Nations Development Program, 2019). This poverty continues to grow and negatively impact their productivity, necessity access, and income. The endless air raids, missile strikes, and fighting has caused the worst widespread poverty in decades and continues to hurt Yemenis on a daily basis (Concern Worldwide, 2020). The ongoing humanitarian assistance keeps Yemenis from famine (IPC 5). The Non-Government Organizations (NGOs) are providing 60% of the population with emergency food assistance daily (FEWS NET, 2019). Half of those people are considered “1 step away from famine”(BBC News, 2020). In addition another 30% need some form of humanitarian help. Even though one-third of people work for the agriculture sector, they can not provide enough affordable food for everyone.

Several factors play a major role in the inability to provide food for their growing population. With a population growth rate within the top 20% of the world, a more efficient way to feed the country after the conflict settles is a high priority (CIA Factbook, 2020). Being currently at the highest risk for political and economic situations creates the most difficult business environment for a country that is already struggling (Michigan State University, 2020). 44.5% of Yemen’s land is used for agriculture. However, with only 2.2 percent of their total land being arable and less than half of the land is actually cultivated, odds are stacked against the country of Yemen. This is in fact due to war, however there is still room for improvement of land use. It is time to look beyond their land and begin looking instead at their location.

The fundamental reason for the monstrous region of non-arable land is due to the climate and geography of the country. Yemen can be divided into 5 regions; Coastal Plains, Yemen Mountain Mastiff, Eastern

Plateau, desert and lastly islands. With a subtropical climate consisting of dry hot desert conditions with little to no rainfall, a tremendous difficulty for a plant's survival arises. A majority of the time they obtain so minimal rain it's impossible to measure (FAO, 2009). The climate affects the crop growth in arable regions, however the geography directly decides if the land is arable or not. Land throughout the regions is consistently sandy or loamy, has a high pH, and minimal organic matter. Despite this, there are areas where agricultural terraces are blanketing the mountains from base to peak. This is due to soil enriched with compost over a period of centuries (Burrowes & Wenner, 2020). Enriching soil can only improve the soil, it can't change the climate already present. Therefore, there will always be a struggle growing crops in an arid region.

Yemen has prominent northern and southern regions that have complicated their politics since the beginning of time, due to the "tribal, religious, and geographic divisions" between regions. South Yemen was formed in the early 1800s while North Yemen didn't come about until the early 1900s. North Yemen obtained independence since their rise, however South Yemen didn't have the same luck. A 6-year civil war in the 1960s gave the south independence from Britain, creating The Yemen Arab Republic. It wasn't until a year after the Cold War in 1990 when the two Yemens became one (UN Foundation, 2019). However, the tensions between the two continued to brew.

A republic government called the Republic of Yemen is new to the world despite the dense history the regions contain. It was created by unifying the Yemen Arab Republic and The People's Democratic Republic of Yemen in 1990. By 1991 they adopted their constitution, basing all laws off of Islamic Law (Michigan State University, 2020). Favoring one religion in the constitution would bring about a war. They were however blinded by the distress the laws would cause the opposite religion.

Beginning in the early 2000s terrorism began and foreign countries including the United States and Iran got involved. A political transition between president Ali Abdullah Saleh and his deputy Abdrabbuh Mansour Hadi in 2011 was supposed to bring stability. Instead it failed and brought about fighting (BBC News, 2020). By 2014 the National Dialogue Conference (NDC) outcome seemed to be a model of compromise and inclusive representation. However the peace again did not last long. By the summer of 2014, Houthis broke the NDC and a civil war began. Hadi fled to Saudi Arabia joining with a Saudi-led military, creating a coalition. Hourthis allied with former President Saleh. The war continues to contain a variety of distinct yet intertwining parts (UN Foundation, 2019). 6-years later the war still persists, with the only losers being the Yemeni civilians facing the world's worst humanitarian crisis. Recently, the UN was optimistic that an agreement would create a political settlement leading to the civil war's end. A hiccup occurred in January 2020 causing a "sudden escalation in hostilities" between the two groups, leading to front line fighting (BBC News, 2020). Without an end to this war Yemenis will continue to suffer and die.

Before the war, Bashir al-Sofi was a construction worker who could provide for his family, however now that life is just a distant memory. "Most needy people depend on organizations to provide them with food as the war has deprived us of our sources of income," Sofi explained. Living in a hut constructed of

stone and mud brick just south of Tiaz, Sofi struggles to provide for his family of 9. Three meals a day, meat, and fruit; basic necessities before, have become a luxury.

A normal day starts with Sofi getting up very early to travel to Tiaz. There he will register with several organizations, in hopes to get food for his starving family. Each organization will only provide a small amount of food, as a result they need several organizations' support to survive. Moreover, the aid doesn't last long because the need of assistance is high in other areas also. His family's day starts out when he returns with a breakfast of bread and tea. Then for lunch they have rice or aseed (traditional Yemeni dish made with wheat, salt, and water). Finally, for supper they have bread and tea again. As the day comes to an end, each member of the family has only eaten about 500 calories (Middle East Eye, 2019). However, several days they can only manage to eat a 40kg piece of bread or nothing at all (Tinka, 2016). Sofi's children have become the statistics with some of them suffering from malnutrition due to an insignificant amount of food.

Education and healthcare are no longer an option for Sofi's children with 2,500 schools out of service as a result of damage from attacks and being closed for shelters or military use. In addition, the journey to and from school has become dangerous with families fearing for their lives. Now that kids are home, parents are pushed to sacrifice their children to early marriages, child labor, and recruitment for fighting (UNICEF, 2018). With only half the country's 3,500 medical facilities fully functioning, the few open hospitals don't meet the standards for sanitation and medical practice. 20 million Yemenis don't have access to healthcare, resulting in the worst cholera outbreak ever recorded. Cholera is not the only disease that is eradicated and curable in other countries that is rapidly spreading throughout Yemen. Diseases like Diphtheria and Malaria are becoming deadly. The health care system has been "decimated" by the relentless war (ICRC, 2019). The need for healthcare has not lessened, but it has actually tripled since the war began. The conflict in Yemen has destroyed not only Yemen's economy but their citizens' access to education and healthcare.

Sofi, like most other Yemenis, holds out hope that the war will end allowing him to provide for his family once again. When the war ends or subsides, a plan needs to be in place to feed the rapidly growing population. Especially because all imports have been halted and 90% of their food is imported. This results in a majority of the population being pushed to starvation as a result of extreme inflation (Tinka, 2016). The agricultural land has been a frequent target for the Saudi-led coalition since the beginning of the war, causing Yemen's food supply to be in grave danger (Middle East Eye, 2019). The Yemenis are ready and willing to work, therefore a local ownership solution would be feasible.

Yemenis won't be able to accomplish stabilizing their economy without extensive international help after the conflict subsides. There will be several challenges that will need to be addressed in order to bring back normalcy. Some of the long-term challenges include high unemployment, high population growth rate, severe food scarcity, and declining water resources (CIA Factbook, 2020). International help can consist of temporary humanitarian aid. Concurrently teaching the Yemenis how to provide for themselves once again utilizing their own resources.

Two-thirds of Yemen's population cannot meet their food needs and this number will continue to rise as

the population rises (World Food Programme, 2018). Organizations have tried to help the people get the food that people need but there is such a large amount that are malnourished that it is an enormous task to help all of them. As soon as organizations start to provide food and help for the people, then they find others that need food even more and have to move on. These organizations cannot consistently feed people and give them the vital nutrients that they need. The people need to be self-reliant. If these people were able to grow their own food, then it would positively affect not only their families but the whole country.

A solution I would like to propose is algae farming. Currently Yemen farmers are only able to use 2.2% of their land for farming. However algae is a crop that can be grown where other crops can't be grown. Algae doesn't need soil or freshwater, all it needs to survive is carbon dioxide (CO₂) (Ghollpour, 2019). Algae farming could solve another problem, climate change. Algae is 400 times more efficient at taking CO₂ out of the atmosphere when compared to trees (Lamm, 2019). Instead of the CO₂ emissions being released into the air from industries, they could be directed to algae farms. The CO₂ would be used to provide essential materials required for algae to complete the photosynthesis process. One of the more popular industries in Yemen are concrete plants. Cement is the world's most used building material with 4.2 billion tons being used in 2016 alone. However, with every ton of cement produced, more than half a ton of CO₂ is produced. In addition, with countries trying to follow their Paris-agreement (climate change reduction) promises, they are increasingly looking at putting price tags on carbon emissions (Rathi, 2017). If and when Yemen gets back on their feet, their government will be looking at the same things to build their economy. However, if the industries can get ahead of it while helping to feed their citizens, the country will be better off. A sustainable way to feed the country could also help stop climate change.

Algae could solve the food security issues Yemen is experiencing. Algae has an admirable nutritional profile. It contains all of the essential amino acids, building blocks of proteins, in addition to vitamins, minerals, and essential fatty acids such as omega-3. This superfood could save trillions of dollars and lives. In addition to all of this, algae doesn't have a taste making it an ideal ingredient in traditional Yemeni dishes. Yemeni people will be more open to the ingredient because it won't collide with their cultural dishes. They could sprinkle it in or on any and all foods they eat. It would give them the nutrition they are missing and they won't even taste the difference. It could help solve the extensive malnutrition issues that Yemen is currently facing.

Algae farming can be done in regions where all other crops fail to thrive. Not only does it use carbon instead of soil and freshwater to grow, but it also thrives in saltwater. Yemen borders the Red and Arabian Seas along with the Gulf of Aden. In addition, they also can go 5 years without any measurable rain. With the minimal freshwater they do have, they need to be using it for drinking and sanitation. Therefore, being able to grow in saltwater is a major plus. This has been done before in deserts in New Mexico and Texas. The process that would be used in Yemen would be very similar because of similar geography. It would actually be simpler. Man made salt ponds would not need to be made. They could be made for areas that aren't near the coasts. However most of their algae farms can be in the seas, where they could thrive. Harvesting is also a sustainable and energy efficient process. A Zobi Harvester was created. The Zobi is a filtration based system that extracts the algae from the salt water. It then sends the clear water back into

the ocean or pond. It does this all while using low energy in addition to no chemicals. This process reduces the water footprint on top of the carbon one.

To ensure the micro-ecosystem of algae is not disturbed, harvesting comes in precise cycles. This ensures that their growth won't be halted. Once the density of the algae reaches a certain point 25% of the water is run through the filtration to remove the algae. Simoutamisy the remaining algae contines to replicate in the diluted water and the cycle repeats. Now that the algae is harvested, it is time to make the products. It can immediately be used in dishes or be eaten plain. Otherwise the oil can be extracted and be used as supplements due to its high levels of omega-3. If that is done the proteins and carbohydrates are left and can be used to make protein products (Ghollpour, 2019). There are endless possibilities for the uses of algae from food to shoes. It can be formed and used for almost any necessity at the moment. Therefore it can adapt and grow with the country. The algae could eventually be used to feed animals as well. Algae as a food source for fish, rabbits, and poultry could improve food availability while providing employment options for those raising these animals.

There are a few obstacles the Yemeni people will have to overcome. They will have to be educated in algae farming. However instead of thousands of humanitarian aid workers providing food and money to feed the Yemenis, they could send teachers to teach them how to farm. They would only be there temporarily instead of indefinitely. They could teach farmers how to build and maintain the farms. Once trained, the Yemeni natives could teach other citizens how to turn the algae into a variety of products to fulfill everyone's needs. By teaching the Yemeni people how to provide for themselves and their families, billions if not trillions of money will be saved around the world.

Being the 9th poorest country in the world, money will need to be brought in externally. In addition, they are on the verge of becoming the poorest country in the world if fighting continues (World Food Bank, 2019). The US alone gave 700 million dollars for humanitarian aid for Yemen in 2019 alone (LaForgia, 2020). The World Food Programme needs \$1.5 billion dollars for its operations in Yemen (World Food Programme, 2018). Currently the UN alone is asking for \$4 billion dollars. Building a 250 acre algae farm, including man made saltwater ponds, costs \$8,125,000. Without building the saltwater ponds that cost would be eliminated, and they would just have to pay \$1,250,000 for operational costs yearly (Briggs, 2017). International help would be needed to start the program, however once it is up and running the Yemeni people could take over the cost. Even though they would require donations, NGOs are already providing the country with billions of dollars for basic necessities. Therefore, a sliver of the money could be diverted to getting these farms up and running. So, in the future they won't be shelling out billions of dollars because they will be able to provide for themselves.

Another obstacle Yemeni people will need to overcome pertains to bugs. Algae is an extremely new crop, only being recognized as a crop in the US farm bill in 2018. As a result, there are no pesticides, insecticides, or herbicides created for algae protection, only for destroying it. Farmers in Yemen rarely use these products to prevent bugs because they can't afford them, so more natural ways to prevent bugs aren't foreign to them. Integrated pest management has been used to prevent bugs from eating the algae. A way has been discovered to grow algae in an environment that only supports algae growth. Even if microscopic rotifers grow and begin eating the algae, creating pH swings or changing the nitrogen in

ways that benefit the algae will kill pests (Ghollpour, 2019). These are all things that can be taught to the farmers of Yemen. They also can be done with little to no cost. These different options will allow for the algae to be grown in a large open environment.

In a country filled with some of the most malnourished people and on the brink of a famine, a solution needs to be found. Unfortunately, in the past, nothing has helped these people be able to provide food for their families and necessities for a healthy life. Other proposals have only helped the people temporarily but nothing lasted long-term. Algae farming could be a solution for the future of Yemen. It would not only provide Yemen with food but also help keep the environment around them cleaner. The education and application of algae farming would provide the people with the knowledge on how to grow quality crops using the resources they gave. The financial support would have to come from an outside organization initially, but once they provide them with the resources, they may be self-sufficient. Not only will the people be positively affected by being well nourished, but the country's economy will be much better because they rely heavily on the agricultural sector. In addition to people being positively affected by being well nourished, the country's economy will also improve beyond the devastation of war. The investment of algae farming would increase their agricultural production in all aspects, and subsequently lead to a positive chain reaction in their way of life. The people of Yemen are hopeful for a better future, and I believe that their hopes will be fulfilled by algae farming in the midst of the war. Helping them develop a way to grow a nutritious crop will provide the people now and future generations with the proper food for survival.

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