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## **Demolishing Nepal's Food Insecurity Through Soilless Farming**

The majority of Nepal's population works in agriculture, and yet this country continues to struggle to produce enough food to feed its citizens. Nepal is one of the poorest countries in the world, and it is incredibly susceptible to natural disasters, among which include drought, floods, landslides, and earthquakes. In addition, disparities in wealth, social status, education, and nutrition only add to the country's collection of issues (USAID, 2020). Despite all the determinants that lead to Nepal's underdeveloped economy, the country's lack of agricultural development is the central contributor to its terrible state.

With a population of 29.5 million people, an area of 56,956 square miles, and a diverse range of terrain, Nepalese can be found throughout all parts of the country. The majority of Nepalese live in rural areas of the country, leaving about 21% of Nepal's population in urban communities (the majority of which in Nepal's capital, Kathmandu). Nepal is considered to be a Federal Democratic Republic, which means the citizens govern themselves and vote for elected officials; however, in recent years, Nepal's government has been slowly succumbing to corruption, and its political parties have hosted unfair elections (Transparency International, 2014). Because of Nepal's unreliable government, it has been difficult for the country to determine a working solution to find an end to its poverty.

The average Nepali family contains 4-5 people, with a greater number of members (4.8) in rural areas and fewer family members (4.2) in urban communities. Though family size is often large, the typical Nepalese house is made up of basic materials - stone or mud bricks, bamboo, and reed. The house sizes can range anywhere from 2 stories to a single-story, 2 bedroom home (UNDP, 2016). Although the majority of Nepalese citizens work in agriculture, the typical family diet is quite plain. A Nepalese family can expect to consume daal blaata tarkari (lentil soup), accompanied with rice, vegetables, and the occasional pickles, chapati (unleavened Indian bread), dahi (curd or yogurt), or meat (Lonely Planet, 2021). Both men and women of typical households work in farms; however, despite the intense amount of agricultural labor invested in this country, the crops produced are not enough to meet the basic needs of a family and provide the average household with only 80,700 NPR per month (\$695.19). Due to this, Nepal has both a high rate of poverty as well as starvation (Global Hunger Index, 2021).

The Nepalese education system is also quite poor and children typically lack quality education. Even with access to school, attendance is low due to poverty and an underappreciation in the value of education (The Borgen Project, 2014). Another basic necessity, country-wide healthcare, is not available to many Nepalese. Though Nepal has taken measures to improve its healthcare system, only 61.8% of Nepalese have access to healthcare facilities within a 30-minute radius. Even when healthcare is available, Nepal suffers from a shortage of essential drugs and healthcare providers - with 0.67 doctors and nurses per every 1000 people (The Borgen Project, 2014). To add to its list of inadequacies, many Nepalese also lack access to safe drinking water, and the country's citizens often acquire disease due to this issue (The Water Project, 2021).

The majority of Nepal's population works in agriculture and the average farm size is approximately 0.7 ha (1.72974 acres), which is relatively little compared to Thailand's average of 3.4 ha and India's average of 1.15 ha. Since Nepal's crop yield is heavily influenced by its unpredictable seasons, many Nepali find themselves unemployed throughout much of the year. While food security has improved in recent years, 4.6 million people still find themselves food-insecure (DHS, 2016). This is largely due to the

geographical placement of Nepali farms. More than half of the population of Nepal lives in secluded mountain regions and agricultural developments in these areas have been neglected for many years. Not only is the location of these farms unideal, but the abundance of natural disasters also plays a part in Nepal's food insecurity. In 2009, continuous winter droughts left around 3.4 million Nepalese in starvation. Since then, Nepal has continued to suffer from inadequate farming techniques and relies on neighboring countries for imported food. Research has found that families use up to 78% of their monthly income on food, leaving only a small portion of money to pay for other basic necessities (UNWFP). Thus, Nepalese are caught up in a cycle of never-ending poverty due to their poor agriculture practices.

To combat the country's food insecurity, Nepal has begun to show support for various non-governmental organizations. One of these organizations is Mercy Corps in Nepal, an organization that implements "multi-year, resilience-focused development activities in communities with high poverty and malnutrition rates." Though this organization has benefited citizens in rural areas, food insecurity is still quite prevalent in these communities due to the country's unpredictable weather.

In other countries, people have faced similar situations. For example, in Madagascar, natural disasters have heavily impacted the economy and have hit the agricultural sector especially hard. In such cases, people have implemented modern food technologies such as drought-resistant seeds and the planting of root crops (potatoes and carrots) to ensure that food supply is always ample (Food Insight). These solutions would benefit Nepal as well; however, many of these drought-resistant crops can only be grown during certain seasons, which wouldn't provide enough food for Nepal's citizens.

The most effective and efficient solution to Nepal's food insecurity problem is the implementation of soilless farming techniques. Much like its name, soilless farming techniques include various farming methods that allow plants to grow without the use of soil. Some of these methods include hydroponic, aeroponic, and aquaponic farming. Hydroponic farming is a system in which "plants grow on a neutral, solid and inert substrate." (Foundation Louis Bonduelle). Oftentimes, these solids include materials such as clay balls or sand. In addition, a nutrient solution is typically added to provide the plants with the necessary minerals for growth. Another system, aquaponics, is similar to hydroponics; however, it doesn't incorporate the use of clay balls or sand. Instead, a solution made up of water and nutrient substrate is sprayed onto the roots of each plant at regular intervals of time. These two soilless farming methods are becoming more apparent today as people realize how effective they are. Finally, aquaponic farming is a combination of "hydroponics and aquaculture." This farming method allows one to raise both fish as well as plants. Fish in these systems thrive on the circulated, clean water filtered by the plants, and the plants use the fish feces as fertilizer.

These soilless farming methods would have tremendous effects on Nepal because they are independent of detrimental weather conditions, poor soil, and lack of land. Instead, soilless farming techniques would require less water and ground space, as well as provide a higher crop yield per square foot. The most effective farming method for the Nepalese is the hydroponic system. It would require less human labor and be a cheaper alternative to more demanding farming methods like aquaponic farming. This system would ensure food security throughout the entire country of Nepal and help citizens gain additional income.

Currently, some countries are experimenting with hydroponic farming; however, large-scale initiatives have not yet begun. Many western countries have begun to adopt this modern farming system, and in America, it is stated that by 2024, the hydroponic farming market is "projected to reach values of around \$3 billion." (Cision PR Newswire). Though many third-world countries have not yet begun such initiatives, it is likely that the future of soilless farming holds much promise.

The materials required for the success of hydroponic farming - large tanks, pipes, plastic tubing, cups, and clay balls - are quite cheap and can be locally sourced. In addition, hydroponic farming requires 80% less water than traditional farming techniques and always produces greater crop yield than soil culture. For example, when comparing beans, traditional farming methods produce only 5 tons while hydroponic farming techniques produce 21 tons of beans in an acre. Similar comparisons can be observed in other common Nepalese crops including rice, potatoes, and tomatoes (Howard M Resh). With the success of this farming technique, a single hydroponic garden would be able to provide a family with \$90-\$250 per month, which is far more than the current average income of a Nepali citizen. In addition, hydroponics would greatly benefit urban areas of this country as the population is denser, the land is scarce, and food is in short supply.

Although hydroponic farming may seem like a daunting investment, the statistics show that the initial funding pays off in the end. For a small garden that feeds approximately four people, the initial hydroponic setup and first-year costs would be \$355, but this expenditure would pay off in several ways - the crops could feed the average Nepalese family or generate a yearly revenue of up to \$1,405 (Food Navigator, 2019). On a large scale, 7.5 million hydroponic systems would need to be built to support the entire country, which would equate to approximately \$2.5 billion spent on materials and electricity costs; however, the yield value would be approximately \$10.5 billion. As Nepal currently spends approximately 25% of its wealth on agriculture, a portion of that \$1.5 billion funding could be used to produce hydroponic systems in the more populated cities. If hydroponics were to gain more popularity and economic value, the revenue from Nepali crops could be reinvested into the production of more hydroponic farming systems. In addition, if Nepal's government funding is not sufficient for the success of soilless farming, many other countries can come to Nepal's aid. Nepal currently has strong bilateral relations with various countries including France, Germany, Malaysia, South Korea, Switzerland, the United States, the United Kingdom and Japan.

To start the initiative, Nepalese citizens would need to have all the materials as well as a sufficient level of energy to support each garden. Currently, Nepalese rely mostly on biomass, human labor, imported kerosene, and traditional water-powered mills to generate electricity; however, these methods still leave approximately 12.5 million people without electricity. This would not be enough to contribute to the running of hydroponic farms, which need an average of 32 watts for every square foot of growing space. Due to this, initial hydroponic initiatives would need to begin in major cities - such as Kathmandu, Bhaktapur, and Nukawot - that have access to greater amounts of energy. Once the farmers confirm that they have adequate electricity to power their farm, they would receive the hydroponic materials and would need to drill holes into the lids of their containers. Each of these containers would include water, and the holes would provide a space barely large enough for a net pot containing a plant. Then, the air pump would be assembled. This air pump would remain outside the container and the airstone at the end of the pump would be placed within the container. This air pump would allow the water to remain in a constant state of movement, letting the roots absorb oxygen while preventing algae and disease spread. After the system has been set up, the plants will continue to grow and thrive, and freshwater would only be replaced once every 2-3 weeks (Green Our Planet, 2021).

After Nepalese citizens within high density cities begin this initiative, hydroponic farming efforts can expand to accommodate those living in the more rural parts of the country. Not only would this allow crop production to exponentially increase, but it would also help to grow a sense of connection within the people of Nepal, benefitting both individual lives, as well as the country.

After the implementation of hydroponics in large cities, the crops produced can be transported to more rural areas of the country. Although this situation isn't ideal, the transportation of food from a city within Nepal to another would be more practical than importing produce from various countries. Once

hydroponic farming techniques become more popular within the nation, Nepal would have enough produce to export its crops, which would benefit its economy.

As safe water levels continue to diminish and the climate continues to change, the hydroponic farming systems show a lot of potential for all countries, especially those like Nepal. When Nepalese can stop worrying about their food shortage, they can begin to work towards a more unified and prosperous country. By improving Nepal's agriculture situation, all other aspects of the country will progress as well.

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