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Bolivia, Factor 5- Climate Volatility

Bolivia: Using Hydroponics to Protect Agriculture from Erratic Weather

When asked to name the single greatest challenge in human history, people jump to name the world wars, searches for cures for diseases like cancer and AIDS and landing a man on the moon. However, with a world population that is predicted to reach 9 billion people by 2050, humanitarian organizations and scientists worry about the world's food supply. Today, countries can't feed all of their populations and an estimated 870 million people suffer from chronic undernourishment. Unless farming and consumption tactics change drastically, millions more people will go hungry. However, as new technologies are discovered, scientists come closer to finding a way to help end world hunger, the single greatest challenge facing humanity now and possibly for the rest of time. This worldwide epidemic is especially evident in many areas of Latin America, where poverty and hunger statistics have skyrocketed and where much of the region is plagued by adverse weather conditions. One such example is Bolivia, located in Latin America, a country plagued with widespread droughts and subsequent flooding.

Rampant flooding occurs primarily in large residential areas, where large population densities and copious amounts of standing water breed diseases such as bacterial diarrhea and Hepatitis A. Malnutrition makes individuals susceptible to insect-borne diseases like malaria and yellow fever that are also prevalent in the region. Mortality statistics are alarming; infant mortality rates measure 51 deaths in 1000 live births and adult life expectancy is only 66 years. Deforestation compounds the effects of flooding. But despite periods of excessive flooding, there is not enough water to sustain a profitable agricultural industry in Bolivia throughout the country's long periods of drought. As most of the country's precipitation is isolated to a few large showers a year, periods of drought are long and numerous. In fact a total of three months of Bolivian rain make up over half of the total rainfall for the entire year. As a result of the dreadful combination of flooding and droughts, 60% of the population is living in poverty and 14% of the country does not have access to water (*Bolivia*).

A lack of health care opportunities exacerbates dismal living conditions. The Ministry of Health (MoH) regulates and executes national health policies and strategies at the national level. At the regional level, prefectures are responsible for human resources administration. Municipal governments are in charge of administering health care facilities at the local level, aiming to provide health services to the low-income population. Despite these efforts, coverage is still low; only about 30% of the population has reliable sources of health care and social protection for health is still developing. Most of the labor forces in urban areas belong to the informal sector; which means that people aren't employed in a job with benefits. An estimated 80 percent of the population works outside the formal labor sector in the cities; this statistic rises to 100 percent in rural areas. Poor health conditions of the region mean very little access to emergency facilities with an average of only 1.1 hospital beds per 1,000 persons. For those who have the ability to reach a hospital, they don't have health insurance, or the funds to cover health insurance (*Aguilar-Rivera*).

The average family in Bolivia consists of a married couple, their children, and often, their extended family. Bolivia has a dominantly patriarchal society, with men making most of the income for the entire family. The average yearly income for the 10.5 million people that live in Bolivia is about 1,620 dollars a year. But when factoring in income inequalities, this number would actually be much lower if the upper 5% of the population were removed from the equation. This is displayed by the fact that 52% of the country, about 5.3 million individuals, is living in poverty. A majority of the jobs are found in the service industry, specifically 48% of the total jobs in Bolivia. Due to gender norms, women are often left at home

with the children. Even the children are often employed in the country, with 26%, although probably closer to 35% percent of people between the ages of 5 and 13 employed, typically in agriculture and illegal or hidden economic activities (*Bolivia*). Women who would choose to work outside the home cannot find employment due to a national job-shortage. They need resources to help out their families financially. One huge possibility is the utilization of Bolivia's women in the agrarian work force, producing small community or household gardens to produce food for themselves, and their families.

The conditions in Bolivia are especially harmful to Bolivian children; one-quarter of the nation's children suffer from stunting, a condition caused by a deficiency in the micronutrients that accompany the consumption of a balanced diet. This syndrome leads to unhealthy children who are more susceptible to deadly diseases. Bolivian adults have small statures because as children, they did not have the nutrients required to grow at a healthy rate. Malnutrition affects Bolivian education opportunities as well. Only 94% of Bolivian children enroll in school and Bolivia's literacy rate is only 86%. And while this doesn't seem alarming, public education is of poor quality and educational opportunities are among the most unevenly distributed of Latin America. Girls and indigenous and rural children are less likely to be literate or even to complete primary school. Also, there is a large child labor force, with some figures saying the total number of employed children totaling somewhere around 850,000 (*Branca*).

Indigenous people comprise the majority of agrarian families. Farming in Bolivia is isolated to only 23% of the nation's land. Two-thirds of available agricultural land lay fallow every year leaving very little land to produce successful crops. And with widespread droughts affecting a majority of Bolivia's farm land around Lake Titicaca, production in that region is limited. The average income for an agricultural family in Bolivia is 500 bolivianos or approximately 73 dollars a year. And while Bolivian production of the camelids (llamas and alpacas) by Bolivian farms is the second highest in South America, many of these animals and crops are being exported, and with the recent droughts many of the rancher's herds, which total around 19.8 million head of livestock, are dying of starvation.

The average diet of a Bolivian is very high in carbohydrates, but deficient in protein and fats. The primary food crop of Bolivia is the potato and the primary proteins consumed are jerky-like products made of both beef and the native camelids, although beef is much less common. The population of Bolivia as a whole has very few food taboos, and has a low waste attitude towards consumption, presumably due to the low amount of total food (*Anabria*).

Several factors hinder the growth of Bolivia's economy. With very little or no money to their names, most families are unqualified to take out much needed loans that could help them get a step ahead. Furthering this problem is countless Bolivians lack basic job skills, and are therefore unemployable. For Bolivians living below the poverty line, not having a reliable source of income also prevents them from receiving important health care services and blocks access to education. The combination of these factors creates a vicious cycle of poverty in which the family and future generations are permanently stuck. While there is limited access to healthy, affordable carbohydrates, most Bolivians have poor diets based mostly on cheap carbohydrates such as rice and other starchy foods like the potato as access to other produce is isolated to more affluent areas. This diet leads to not only a high prevalence of stunting but also to increasing obesity rates which increases the susceptibility to any number of diseases. However due to a lack of education, many of the Bolivian people are unable to make healthy food choices. (*Bolivia: Climate Change, Poverty and Adaptation*).

Bolivia can be divided into four groups by climate; Chacos, Valleys, Amazonian Flatlands, and the Altiplanos. All four of these groups have been affected differently by the changing weather patterns. Countrywide, storms that occur over a handful of days cause rapid flooding. These storms are often accompanied by hail in the higher regions. After these brief periods of rain, areas suffer long droughts. Unfortunately for most farmers, rain mainly falls during seasons not optimal for growing crops. Dry

growing seasons inhibit agricultural production because farmers do not have irrigation systems. Heavy rains also damage the country's infrastructure, cause problems with electricity generation, damage winter crops, and cause an overall lack of biodiversity. Flood waters wash away much of the fertile soil. Due to rapid deforestation and the slash-and-burn agricultural technique currently preferred by Bolivian farmers, the country is losing all of its fertile soil. The issue to be addressed is how Bolivia can use the water during periods of heavy rain and conserve water for periods of drought.

There is an emerging technology which can aim to solve Bolivia's poverty, malnutrition, and uneven supply of rainfall. Hydroponics is a technology that involves growing produce in standing water. By growing plants in this method, uncontrolled runoff water is eliminated, water usage is much more efficient and yields are much higher due to the constant presence of mineral enriched water. By utilizing hydroponics, agricultural yields will increase and water use will be cut by 80% when compared to the water use needed to grow the same amount of produce in a normal ground- farm (*Simply Hydro*).

The sand/stone culture method of hydroponics can be utilized widely and with great success. This technique involves filling a plastic-lined bed with a mixture of sand, peat stone and trap rock and arranging the material so that there is a clear run off point on one side of the bed. Then, fertilizer materials such as corn fodder, animal wastes and other organic materials are added to the sand/ stone mixture to provide nutrients for the plants. Seedlings are planted directly into the medium, and watered multiple times a day. However much of the water is recycled as the sand and stone absorb almost no water. This constant use of the same water creates a very nutrient rich solution with which your plants are being watered. This method not only greatly reduces water loss due to evaporation, but also systems can be created with almost no work, and require a small amount of plastic sheeting initially and nothing more. Additionally, the systems require no weeding or tilling, making the growth an easier alternative to traditional methods. This system can also be used in the rural areas on a much larger scale, thus improving yields and ultimately, a family's income and way of life (*Hydroponics*).

Hydroponic systems on any scale can more than pay for themselves in a very short period of time. Between 20,000 and 25,000 hectares of land are currently under hydroponic development globally, supplying 6 to 8 billion dollars' worth of produce. If this general production to acre is applied to farming areas in Bolivia, a quarter of the current land for agriculture could be used and it would produce 290 billion dollars annually. When you compare this to the total 53.4 billion GDP produced by Bolivia every year, this number seems even bigger. While this figure is only theoretical, and most likely far fewer acres of land would be set aside for hydroponics use, the increased production would still produce more crops than the land that was previously a traditional farm.

Little space is required for hydroponics gardening. Because so little of Bolivia's agriculture land actually receives sufficient water needed to produce a viable crop, hydroponics systems could also be set up in the large urban areas which receive more water than the agriculture lands. Water could be diverted from the flood areas of the lakes and rivers to prevent the erosion that this water excess causes. Because the technology doesn't take much space and can be stacked vertically for the desired compactness, the systems would be perfect for the small areas available in urban area.

Another benefit to the hydroponics system is that potatoes, both the main staple and the main crop of Bolivia, are able to grow in the sand/ stone mixture and in fact have been shown to increase yields when grown by this method. So the typical diets of the Bolivian people would not have to change drastically. This would help integration of the technology. On the other hand people will find that other crops are easier to plant and raise, and will venture to try new things. If the people of Bolivia begin to work for their own food, and have the opportunity to watch it grow, perhaps most would be swayed to venture towards a healthier lifestyle (*Finding Ways to Change Eating Habits in Bolivia*).

While the systems are relatively easy to produce, the main problem that the implementation of the technology would face is a general lack of interest by the local farming class; attempts to start hydroponics in the past have failed due to a strong sense of family traditions. To overcome the cultural stumbling block, education would have to be provided to help spread public awareness of not only the new technology, but also of its practicality and benefits. Because most of the people utilizing the systems would be inside of the city limits, even basic agriculture techniques would need to be taught. While at first tedious to deliver, this new knowledge would in the long run be beneficial to the country as it would breed a generation that has the know how to be self-sustainable. Gardens would also have to be implemented with crops that are both familiar to the area, but also more nutritious than the typical potato and rice diet. Luckily, the crops that would be the most successfully planted would be crops like lettuce, tomatoes, peppers, carrots, etc. - all of which contain greater nutritional value than potatoes.

The government would have to play a small part in the production and implementation of these gardens and would not only have to make access to supplies more wide-spread, but would also have to offer temporary loans to even the poorest citizens so that they start farms. With the sand/ stone culture method, very little money is required; but funding will be needed to cover the initial start-up cost. Large farms would need irrigation canals or water pipes to store the rain during times of excess for later use. One advantage is that much less of this stored water would actually be used by the gardens, and the water would be able to last long throughout the drought seasons, and produce enough excess crops to be able to last even in the times of need (*Vera*).

By utilizing hydroponics, less space would need to be devoted to agriculture and nobody would need to constantly move around in search of more fertile lands. Farming would be more compact and large amounts of it would be in the city. When farmers plow their fields, they leave soil exposed to the elements. Wind and rain sweep away soil as a result. Reducing the amount of land farmed would help reduce erosion. Also, by limiting space given to agriculture much of the land that has become deforested would be allowed to gradually turn back into the rainforests. A change that is needed if we need to slowly reverse the weather changes that result from global warming worldwide (*Glass*).

Organizations are already invested in hydroponic implementation in more developed South American and Latin American countries such as Brazil and Nicaragua. This interest will continue to spread, especially if the government of Bolivia passes new reforms to help fund the growing hydroponic movement. Auburn University is among those taking the initiative in the third world countries and has developed a method to implement the technologies. With continued financial support from organizations like the UN or smaller, anti-hunger non-profits entities like the Global Hunger Foundation (GHF), large scale and commercial farms can be produced. These enterprises will not only generate income for Bolivia but will also provide much needed employment opportunities both in manual labor field, but also in the high-tech sector, allowing all Bolivians the chance to have a better living.

Steps need to be taken to help improve the lives of the millions of people living in poverty within Bolivia. Implementation of just one hydroponic system will improve the standard of living for the family that tends it as well as that of anyone with whom they come in contact. A healthier population will be less of a strain on a struggling health care framework. Children will be able to attend schools instead of working in menial jobs. Bolivian success will bolster the economy of Latin America and will lead to greater personal autonomy, especially for Bolivian women. Implementing existing technology and promoting its use are relatively easy cures to a problem that affects the millions of people living in poverty in Bolivia.

Works Cited

- Aguilar-Rivera, Ana M., Ke Xu, and Guy Carrin. "The Bolivian Health System and Its Impact on Health Care Use and Financial Risk Protection." *World Health Organization*. World Health Organization, 2006. Web. 28 Feb. 2014.
- Anabria, Harry S. "Countries and Their Cultures." *Culture of Bolivia*. Advameg Inc, 2014. Web. 16 Mar. 2014.
- "Basic Hydroponic Systems and How They Work." Simply Hydroponics. Simply Hydro, 2008. Web. 16 Mar. 2014.
- "Bolivia: A Development Overview." *Bolivia: A Development Overview*. Inter-American Development Bank, 2014. Web. 13 Mar. 2014.
- "Bolivia: Climate Change, Poverty, and Adaption." *Oxfam.com*. Ed. Simon Ticehurst and Sagrario Urgel. Oxfam International, Oct. 2009. Web. 27 Feb. 2014.
- "Bolivia." The World Fact Book. Central Intelligence Agency, 2013. Web. 6 Mar. 2014
- "Bolivia." *World Vision*. World Vision Inc, 2014. Web. 16 Mar. 2014.
- Branca, F., and M. Ferrari. "Impact of Micronutrient Deficiencies on Growth: The Stunting Syndrome." *Annals of Nutrition and Metabolism*. National Institute for Food Nutrition Research, 22 Aug. 2002. Web. 13 Mar. 2014.
- "Finding Ways to Change Eating Habits in Bolivia." *Inter-American Development Bank*. Finding Ways to Change Eating Habits in Bolivia, 14 Mar. 2013. Web. 8 Mar. 2014.
- Glass, Don. "Disappearing Soil." Moment of Science, 2007. Web. July 1, 2014.
- "Hydroponics." Mission 2015: Hydroponic Agriculture. MIT, 2011. Web. 09 Mar. 2014.
- Vera, Raul R., Dr. "Bolivia." *Bolivia*. Food and Agriculture Organizations of the United Nations, 2000. Web. 14 Mar. 2014.