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Cleansing Cambodia through Development and Implementation of Sustainable Agricultural Practices

Emerging from decades of civil conflict while struggling to regain its foothold in the international arena, Cambodia appears to be headed toward a healthier and more sustainable existence. Cambodia is located south of China in the southern portion of the Indochina Peninsula. The country is bordered by Thailand to the northwest, Laos to the northeast, and Vietnam to the east. With a total land mass of 181,040 square kilometers, Cambodia is roughly the size of Oklahoma. Cambodia contains a network of waterways throughout, including the Mekong, Tonle Sap, and Tonle-Bassac Rivers. The Mekong River drains the rainfall of about 86 percent of the country. Gently rolling alluvial plains form the center of Cambodia ("Agricultural Production").

Food security issues erupted in Cambodia in 1975 when the Khmer Rouge regime ("Regime") dominated the country. Although the Regime developed a rice-based economy as the backbone of the country, millions of people died due to the genocide that occurred during the Regime's existence (The Brown Reference Group). The Regime abolished the use of money and ownership of private property, ordering city dwellers into the countryside to cultivate the fields, all in an attempt to establish classless rule. Many city dwellers had not previously performed fieldwork, and therefore, struggled to succeed ("BBC News"). After many years of struggle and strife, in 1991, the United Nations peace accord was finally signed to help support and rehabilitate Cambodia after the reign of the Regime. The main goal of the peace accord was to create economically sustainable lifestyles for the people. Cambodia struggled to rebuild its agricultural base as well as its overall economy.

Cambodia has a population of 15 million people ("BBC News"), 18 percent of which are living below the food poverty line ("Cambodia: Overview"), with over 40 percent below the official poverty line (The Brown Reference Group). One is said to live below the official poverty line in Cambodia when one is living on less than US $0.30 a day. A total of 4.8 million people, or roughly one-third, are considered poor, of which 90 percent live in rural areas and 12 percent do not own any land. Approximately 2.6 million Cambodians live in extreme poverty with food deprivation ("Agricultural Production"). About 1.6 million of 2.5 million rural households face seasonal food shortages each year ("Rural Poverty in Cambodia").

Family units in Cambodia are relatively small, usually composed of a mother, father, and children. On average, each Cambodian woman gives birth to four children throughout her life. A family forms the economic unit of the land, working together to live and cultivate the land. Agriculture is based primarily on growing rice, corn, and sugarcane, as well as raising livestock. Freshwater fish including carp, perch, and smelt caught from local waterways also provide an important role in the typical Cambodian diet. Some Cambodians consume fruits such as oranges, bananas, papayas, mangoes, and pineapples, as well as vegetables including beans and sweet potatoes with their daily meals. However, fruits and vegetables are rarely part of the diet for the poorest Cambodian population because of the limited resources accessible to this population (The Brown Reference Group).

Much of the population lives in remote villages. Many of the poorest populations live in the remote villages bordering Thailand, Laos, and Vietnam. A fast growing population, lack of education, poor infrastructure, and low productivity are taking a negative toll on the country. Transportation and healthcare are scarce in Cambodia. Cambodians must travel approximately five kilometers to the nearest road ("Rural Poverty in Cambodia"). Few hospitals exist within the Cambodian borders. On average,

there is only one doctor for every 1,700 people. Most Cambodians cannot afford to visit a doctor for treatment. At the beginning of the 21st century, the Cambodian government spent only one dollar per person per year for the health care and welfare of Cambodian citizens. The country provides no benefits to the unemployed population. Because the Regime forced Cambodians out of cities, few citizens were able to attend school. As a result, roughly 30 percent of Cambodian adults have never attended school. Today, school attendance for Cambodian children is about 65 percent, but many poor families cannot afford to pay enrollment fees (The Brown Reference Group).

The average Cambodian family lives on one hectare (2.5 acres) of land. Forty percent of rural Cambodians live off of less than one-half hectare of land. A typical farmer receives US$100 to US$200 in income per hectare per year. Most of the land is dedicated to the production of rice, making up 84 percent of the total cultivated land and providing 65-75 percent of the population's daily caloric intake. Water buffalo are often used to cultivate the land. Many Cambodians also raise livestock such as cattle, buffalo, pigs, and poultry for food. Distressingly, in 2007, five out of twenty-four provinces did not produce enough food for self-consumption. Eight provinces alone, accounted for 63 percent of the aggregate rice production ("Agricultural Production").

The Global Hunger Index score for Cambodia in 2010 was 20.9, ranking the country 58 out of 84 countries. Global hunger indices are calculated based upon the proportion of people undernourished in the population, the prevalence of underweight children under five years of age, and the under-five mortality rate (Jamann). Cambodia also currently ranks 124th out of 169 countries on the United Nations Development Programme Human Development Index ("Cambodia: Overview"). Many issues are plaguing the production of agricultural goods, most notably rice. The issues include: drastic climate and environmental changes, pesticide use, transportation of goods, composition of families, and political instability.

Environmental changes due to practices used to cultivate crops, and global warming, are having a severe and negative effect on the cultivation of rice. Only 26 percent of the land is suitable for farming. As a result, farmers must find ways to clear land that is not currently ready for cultivation ("Agricultural Production"). One method farmers use to accomplish this is the slash and burn technique. This technique requires a farmer to cut down a forested area, burn it, and use the land for production of crops. Initially the land has a high nutritional value for crops. That value is usually depleted within three years, leaving seriously depleted soil behind, thus forcing the farmer to move on to new land. Timber is a major product for export in Cambodia. Deforestation, similar to the slash and burn technique used by farmers, causes severe land erosion. Not only is the practice having a negative effect on the environment, but it is also illegal and robbing the country of millions of dollars in badly needed revenue ("BBC News"). The destruction of vital coastal mangroves from overfishing and illegal shrimp farming has destroyed the opportunity for deep-sea fishing by the population. In order to create a shrimp farm, mangrove forests are razed to create ponds for the shrimp. These ponds are highly susceptible to diseases, ultimately reducing another possible food source for the people (The Brown Reference Group). Global warming has also thrown the country into a spiraling loop of unpredictability. Rice production requires a large amount of water. With the current environmental conditions, major floods and droughts have been occurring, producing severe and devastating results in the fields. Much needed monsoons are becoming increasingly unreliable. The temperatures are climbing, and even though plants germinate better in hotter, rich carbon dioxide filled environments, plants begin to die off during pollination due to these changed environmental conditions. Research indicates that yields decline by 10 percent for every one degree Celsius increase over 30 degrees (Halweil). Cambodians are moving from the south to the unpopulated north to escape drought and floods, but these are the poorest districts ("Rural Poverty in Cambodia"). Cutting down trees is reducing the amount of carbon dioxide that can be absorbed, thus having a dramatically negative impact on the overall environment.

Another large problem with agricultural production is the use of pesticides by Cambodians. The general population does not fully understand how to properly use different treatments and the negative consequences these treatments are having on the land and their own health. Many Cambodians cannot read the information contained on the pesticide bottles in use because they are either illiterate and/or the words are written in a different language. As a result, Cambodians are mixing pesticides such as mevinphos, dichlorvos, and methyl-parathion. Mixing pesticides causes resistance to develop, so more pesticides are needed to obtain the desired results. Excess pesticides find their way into lakes and other bodies of water, affecting the fish population, which could have been used for food if not poisoned by the chemicals. Somehow, these pesticides have penetrated into the remotest of Cambodian regions. The pesticides in use are harmful and many of them have been banned in their countries and have been identified as extremely hazardous by the United Nations World Health Organization. Three billion dollars per year is being spent on such chemicals, when the money could be used more effectively and with less harmful results. For instance, that money could be used in developing more sustainable agricultural practices, such as aquaponics, altogether producing more food. The worst impact of the pesticides is the three million acute pesticide poisonings that occur worldwide per year and the 220,000 deaths annually, which are directly attributable to pesticides (Gray). Of Cambodians who use pesticides, 90 percent show some variation of abnormal health symptoms after use of the pesticides.

Inadequate methods of transportation plague Cambodia with the inability to successfully sell their products to neighboring towns, regions, and countries. This causes loss of potential income to local farmers. Waterways prove to be the main mode of transportation. However, when floods and other natural disasters occur, waterways are unavailable for use (The Brown Reference Group). The roads being used have substantial problems. Unofficial checkpoints have been set up throughout them with port fees. This decreases the already diminished value of rice. Even though a strong demand exists for cattle and buffalo in neighboring Vietnam and Thailand, weak border controls exist, preventing fair deals from being made ("Agricultural Production").

Millions of land mines were dispersed in rural areas of Cambodia during the Regime. These land mines still remain today, unexploded and extremely dangerous. As a result, eight out of ten Cambodians who live in rural areas are forced to deal with the remaining land mines. About 20,000 Cambodians have been killed due to these land mines. Not only do these mines pose an obstacle to agricultural development and life, but there are also not enough resources or funds to safely dispose of the mines ("Rural Poverty in Cambodia").

The irrigation system established by the Regime is also a disaster, as much of the system was poorly built due to lack of funds and hasty construction. As a result, Cambodians can only produce one crop each year, compared to three crops that rice is normally capable of producing. The Cambodians consume nearly all the food they can produce, so very little crop portions are available to enter the commercial market (The Brown Reference Group). Outside countries have stopped investing in agriculture because they believe the investment is unprofitable dropping investment in agriculture by two-thirds in Asia. Developed countries have taken on the role of producing cereals, leaving those farms in poverty even worse off. In the absence of government spending and policies, small landholder farmers cannot compete (Kouka).

Due to the country's turbulence during the Regime, many of the 1.4 million Cambodians who died during the Regime were males, leaving women in charge of households. The result has left tribal people and women at the largest disadvantage ("Rural Poverty in Cambodia"). Not only do women have inadequate access to reproductive health services, but women are last to eat and often do not receive adequate nutrition. The malnutrition is then passed on to children and those born malnourished are more likely to complete fewer years of schooling, earn less income, and have children with lower birth weights (Jamann). Based on this, the cycle of malnutrition continues. Some women spray hazardous pesticides

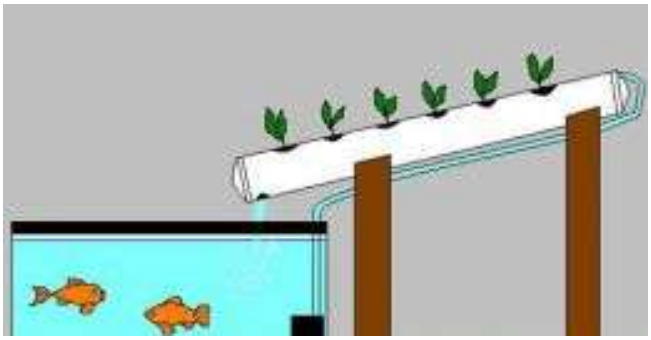
while pregnant, unaware of the dangers that can affect their pregnancy (Gray). As a result of the lack of medical attention Cambodians receive, the maternal mortality rate is 461 per 100,000 births, compared to only 17 per 100,000 births in the United States. An even larger problem of malnourishment exists for the overall population. Sadly, almost 40 percent of children in Cambodia are chronically malnourished. Living primarily off of rice presents numerous micronutrient deficiencies, especially in iron, vitamin A, and iodine ("Cambodia: Overview").

Despite Cambodia's bleak past, slow improvement has occurred. The poverty rate in Cambodia has decreased from 35 percent in 2004 to 30 percent in 2007 ("Cambodia: Overview"). The Gross Domestic Product ("GDP") of Cambodia has increased from US $2.8 billion in 1990 to US $11.3 billion, almost a four-fold increase ("Cambodia"). Cambodia is finally regaining the balance needed for a stable economy through an increase in garment exports, tourism, and infrastructure construction to help with production and transfer of goods. Rice production appears to be the benchmark to measure sustainability of agricultural practices. Wet season rice has increased from 1.87 million tons in 1992 to 4.97 million tons in 2006 ("Agricultural Production"). National irrigated acreage has increased by nearly 162 percent between 1996 and 2007 allowing for fast germinating seeds to be used so that farmers can get two to three yields per season. The Cambodian government has set high goals; by 2015, the government is striving to double rice production to 15 million tons per year (Shean).

Though food production is improving, more work needs to be done to ensure continuous progress. In order to remedy existing problems while sustaining improving trends additional measures should be considered. The first step is to disable all of the unstable and unpredictable mines in rural areas. This task may be tedious, as it requires dogs and mechanical machines to search out all areas, but must be done to ensure the safety of Cambodians, allowing them to expand into other areas and cultivate more land. Next, farmers must obtain titles to their land, through registering with the government. In the past, registration was not done due to the Regime's rule. Presently, this process is virtually impossible, however, as often the only way to obtain a title is through government connections or bribes. The World Bank and other third parties are trying to monitor the process to make sure the extremely poor have the opportunities as well ("UNHCR"). By obtaining title to land, farmers will qualify to obtain governmental assistance, and additional money from the government that can be allocated to agricultural production (Shean). Due to the variability of the weather patterns, new irrigation systems need to be implemented and existing ones must be repaired. About 4.8 million hectares of cultivatable land appears to be underlain by shallow aquifers with potential for exploitation by shallow tube wells for irrigation about five to ten meters below the surface ("Agricultural Production"). Maintenance must be performed annually on the systems to prevent any problems from occurring. Additional water for the irrigation system should be collected through rainwater drainage. By using water collected from rain, water can be stored to be used when droughts occur. Deforestation must cease and trees must be planted so that their deep roots can bring water closer to the surface for other plants, providing a more substantial product than timber alone could supply (Halweil). Finally, a new system of aquaponics should be implemented.

Aquaponics is a way of harvesting fish and produce for food production. Aquaponics works through the use of two large tubs of freshwater. In one tub, multiple fish will live and reproduce together. These fish can be taken out of natural waterways throughout the country. In the other tub, different vegetables will be grown, such as lettuce, herbs, bell peppers, cucumbers, and tomatoes, with the plants' roots dangling in the water, like a hydroponics system. Waste will build up in the fish tank, as they are fed part of the vegetables grown. Once the waste reaches a predetermined point, a pump will funnel water from the fish tank to the vegetable tank. This pump will be powered by photovoltaic cells. Gravity will allow water from the vegetable tank to enter the fish tank. The toxins of the fish produce natural bacteria, Nitrosomonas, which convert waste like ammonia into nitrates that can be used by the plants for nutrients. The plants will continue to filter the toxins out of the water, and the fish will produce the toxins in a continuous cycle. When food is needed, some of the vegetables or fish can be harvested for consumption

(Winkler). A liquid-waste aquaponics system can be used to separate the solids from the fish, so the solids can be used in the field (Nelson).



One aquaponics system can be provided to each village to share and work in collaboration together. There will be established limits for how much production each person in the village is allowed to use. Once more, money becomes available from international aid organizations and countries, aquaponics systems will be dispersed to individual families. The practice of aquaponics removes fertilizers and chemicals from the agricultural process and saves water, while also providing a wider variety of nutrition for individual consumption. By planting a variety of food, an environmental precaution is being taken so that if anything were to happen, it will be more difficult for the environment to destroy all the plants at once. Diversifying the crops will provide a hedge against loss of crops, due to its ability to resist environmental extremes and disasters. In conjunction with this new system and increased agricultural production, new measures will have to be taken to renovate roads and make policies for usage of roads. Currently, aquaponics systems are being tested in rural Kenya to assist with food production and sustainability. Aquaponics has high potential for changing the lives of Cambodians.

Clearly, the development and implementation of sustainable agricultural practices would assist in moving Cambodia from the bottom one-third in the Global Hunger Index. Working together as small and large communities will be essential to accomplish this task. Partnerships have already been made with the International Fund for Agricultural Development, Food and Agriculture Organization of the United Nations, the World Food Programme, and the World Bank. These groups have offered $33 billion to be used from 2010 to 2012 for improvement programs in the country (Kouka). Another $2 billion was received to assist with infrastructure from China and the Ministry for Water Resources and Meteorology (Shean). This money can be used to purchase the equipment for aquaponics, improve infrastructure such as roads, and educate Cambodian citizens about the sustainable systems they will use in their country.

As civil conflict in Cambodia subsides and new systems are implemented, many problems can be solved and Millennium Development Goals ("MDG") can be met. The MDG's were established in 2000 by the United Nations in an attempt to improve the livelihood of the world's poor by 2015. As a result, eight goals were developed to help solve issues in a comprehensive and coordinated fashion. Issues currently existing such as climate and environmental changes, pesticide use, transportation of goods, and political instability will be improved and eventually solved. Providing a diverse selection of vegetables and fish will assist the MDGs of improving child and maternal health, by providing access to more nutrient rich foods. A global partnership will be created, reaching another MDG, through the resources outsiders, such as the World Bank, will provide to the country. Environmental sustainability can be reached through use of aquaponics and collection of rainwater. Finally, the most important and challenging MDG of ending poverty and world hunger can be addressed through the methods proposed. Although outsiders can guide and help Cambodians, the decisions must come from Cambodians themselves. Cambodians hold the destiny of their future in their own hands and are poised to take positive, sustainable steps to eliminate poverty and hunger in their country.

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