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"Looking Ahead: Sustainable Paths toward Food and Nutrition Security"

The Green Revolution was a change in agriculture in many developing countries that led to an impacting increase in cereal production. The Green Revolution began in 1945 when the Rockefeller Foundation, Ford Foundation, and the Mexican government agreed to increase the production of the countries' farms. In doing this the Rockefeller Foundation and the Mexican government created the Cooperative Wheat Research and Production Program. After seeing their astonishing outcome, Mexico went from having imported half its wheat to exporting half a million tons of wheat. A man by the name of J. George Harrar, who later became president of the Rockefeller Foundation, sought out the Office of Special Studies, which formally became The International Maize and Wheat Improvement Center (CIMMYT) in 1963. One of the main scientists from the Office of Special Studies was Dr. Norman E. Borlaug, and several other scientists. They all took part in helping develop what the Green Revolution is known for today. The main objective of the Office of Special Studies was the development of various types of high yielding maize and wheat. Because of the significant numbers that Mexico was producing, other countries started to look upon Mexico as a leader in helping aid malnutrition. The second country that received the Green Revolution was India. The Indian government and the Ford Foundation decided to import wheat seeds from The International Maize and Wheat Improvement Center in Mexico, thus India began it's own Green Revolution by plant breeding, irrigation development, and financing of agrochemicals. In 1961 the Ford Foundation and the Rockefeller Foundation created The International Rice Institute (IRRI) in the Phillipeans. The high yielding varieties also became known to countries such as Pakistan, Sri Lanka, Indonesia, and other countries in North Africa, Latin America, and Asia. From 1961 and thereafter the Green Revolution exploded in many countries. All of the outstanding production in wheat, maize, and rice brought along with it two major technologies. One of those technologies was the use of irrigation, pesticides, herbicides, and synthetic nitrogen fertilizer. The other major technology was the creation of higher yielding varites of maize, wheat, and rice. This is done by selecting the best qualities from a certain type of crop and breeding it to another plant in the same crop family, or also known as crossbreeding, and the prodcut of that crossbreed is called a hybrid. A hybrid crop has all of the best characteristics from different plants in the same crop family. The hybrid crop that the Green Revolution developed was a F1 hybrid. There are many advantages and disadvantages to using this type of hybrid. Some advantages are that because the breeding lines are so closley related, it is easy to predict the outcome. There is hardly any genetic variation. Once the genes are known, it makes it easier to produce. Also, because the Green Revolution does use F1 hybrids, these types of hybrids need to be produced seasonally. If it was more difficult to find the genetic make-up for the plant, then it would take longer, and because the hybrid needs to be produced seasonally, this type of hybrid saves a lot time. Another advantage would be that they have a higher performance. By this I mean that they have two different versions of their allels, causing two different versions of the enzyme. This will increase the chances of having the best version of the enzyme and also reduces the chances of a genetic defect. Some disadvantages to using the F1 hybrid would be that when F1 cultivars are used for breeding a new generation, their offspring, which is called F2 generation, will be high in homozygous genes. This is found in the weaker parental generation, and will then have a depression in yield and lack the hybrid strenght. Another disadvantage to using the F1 hybrid would be that because of the inbreed with parental lines, there is no diversity in the crop. Crossbreeding and inbreeding both require a lot of work, so the cost of the seed is much higher. This is a huge disadvantage for small family farms because their income is not high, so they can't afford to pay high amounts for seeds. Also, the F1 hybrid relies fully on fertilizers, pesticides, and herbicides. This is a major disadvantage for any farmer. This requies more money to buy these necessitieis, which only does more damage to other crops that do not require as much

fertilziers, pesticides and herbicides. This also extremely hurts the water quality. All of these necessities get into the water supply and can do damage to the human body. In review, these are the two technologies the Green Revolution ushered in. I will be focussing my paper on the country of Costa Rica with an emphasis on sustaining natural resources and water quality. I chose Costa Rica because I have been there previously. I have some knowledge of the country itself from personal experience. I also chose to focus this paper of water quality because a friend and I have been testing well waters for four years. I have done a lot of research on water quality, treatment, and various contaminates.

A typical family farm in Costa Rica is not the small family farm that we might think of here in Iowa. Costa Rica has come a long way from growing crops as a family production. Costa Rica contains 130,000 small and large farms. Because there are not as many small family farms, there are more mills and plantations. Costa Rica seems to be more advanced, in some senses, than what we are. They are now what we are coming to be. By this I mean that the small family farms cannot survive farming on their own. There are too many expenses, and there are too many barriers that prohibit them from overexceeding. It is hardly possible to farm in a small family farm anymore. That is why most family farms have turned into larger coorporations, where families have joined together, or are part of a large family farm already. The larger families are the ones that have the money to continue to farming, and can afford to pay for the necessities of farming. Like I said earlier, the Green Revolution brought in the F1 hybrid crop. This is a more expensive way to farm because the hybrid needs to be produced seasonally. This increases the cost of produciton for farmers. Also, with the Green Revoluiton bringing in the F1 hybrid crop, this crop is a monocultural. This means that the same crop is grown in the same area every planting season. This can also hurt family farmers because they may not be producing as high of yields as they could if the F1 hybrid was a polyculture. A polyculture is what is most commonly used here in Iowa. This is more commonly known as crop rotation. Polyculture crops contain different crops grown in the same region or area. This can be a disadvantage to many small family farmers because the whole purpose of crop rotating is to put back into the soil the nutients that the previous crop took out. Also, Costa Rica is a mountainous country. The topography of the country is not flat, causing erosion. That can be a major barrior for any farmer. Say there happens to be a smaller family farm just barely making it by, they are not going to be able to withstand the expenses of have to fix the erosion problem. Also with it being a mountainous area, if a farmer is at a lower altitude than another farmer, the farmer at the lower altitude is going to be receiving all of the other farmer's fertilzers, pesticides and herbicdes. That is another expense that many small family farms cannot afford to pay. The main exports from Costa Rica are coffee, bananas, cocoa, sugar, meats and cattle. The two greatest of these would be coffee and bananas. Although the bananas that we eat are not hybrid bananas, some bananas grown in Latin America are hybrid bananas. This is a recent discovery performed by scientists at the Honduran Foundation for Agricultural Research. These scientists believe they have created the first hybrid bananas and are ready to test them in the market. This would not have been possible if it was not for the Cavindish. The Cavindish is a natural variety of banana that oustood the disease called Panama disease. This disease just about wiped out all bananas in the 1950's. After the Panama disease traveled through the eastern coast of Costa Rica, plantations were moved to the Pacific lowlands. Costa Rica is famous for its coffee. Most Costa Rican coffee comes from the hyrbid "caturra." The coffee in Costa Rica is wet-pocessed coffee. This is a pocess done by removing the skin and pulp from the bean while the coffee fruit is still moist. The coffee skins are removed, which is called pulping, the skinned beans are allowed to sit in tanks where enzymes loosen the sticky fruit pulp or mucilage, which is called fermentation, after which the loosened fruit is washed off the beans, this is called washing. This method also intensifies the acidity. Some of the greatest coffees in the world are wet-processed. Costa Rica markets their coffee off as brands. There are two major brands exported from Costa Rica, they are "Costa Rica La Minita" and "Bella Vista." A typical diet in Costa Rica is made up of rice, beans, bread, tortillas and fruit. Another typical dish is "gallo pinto" which is a mixture of black beans and rice. This dish can either be served as a breakfast or dinner dish. It is usually a side dish, but can be a majority of the meal. This dish can benefit many small family farmers. It is obvious that the small family farms are dying out, and a main cause for

that is income. There is not much of an income, and more of an output. This meal is very popular in Costa Rica mainly because it is cheap and tasty. Their diet does not make up much of, if any, sweets, which is very different than here in the United States. Fruit is a main part of every meal in Costa Rica. The fruit is the way you imagine it in a paradise dream: juicy, rich color, and very flavorful.

Like I said earlier, Costa Rica is a mountainous country. This causes erosion, which does much damage to the water quality. Erosion is a problem in many countries and is something that is hard to fight off. Erosion can do major damage to crops. Erosion is the process by which the surface of the earth is worn away by several actions. These actions include water, glaciers, winds or waves. If water carries soil, and there are fertilizers, pesticides and herbicides required for the process that the Green Revolution carries out, then one field may obtain too much of these substances. Too much of any of these substances can kill the plant. Erosion can also hurt the water quality by carrying different contaminates in the soil, which then gets into the water supply. There are some contaminates that could be close to harmless, but most can cause illnesses and disease if the amount in the water reaches a certain point. One major contaminate is nitrates. If there gains to be more than 10 mg/liter, such high levels in drinking water can cause methemoglobinemia, or blue baby syndrome. This is where the digestive systems in infants converts nitrates to nitrites, which then blocks the ability of a baby's blood to carry oxygen, and than can lead to suffocation and death. This syndrome can also occur in cattle and sheep. Blue baby syndrome can be a huge problem for Costa Rica because one of their main exports is cattle and meats. This could really hurt the countries economy if they could not provide the meat to export based on their water quality. Another factor that could harm Costa Rica's economy would be the fact that the government does not do a lot to treat the country's water supply. In the capital of Costa Rica, San Jose, the government does add chlorine to the water supply. Chlorine is a common additive to water to help kill bacteria. The government in many countries does not take the time or money to clean the entire country's water. This is the case in Costa Rica. Now, think if the country does not clean most of the country's water, and many small farmers are also obtaining other farmers fertilizers, pesticides and herbicides, then they are also taking all of that in. They are in no way having their water cleaned, so they are also consuming all of the ingredients that are carried through their soil. These contaminates can cause much damage to the human body, possibly even death. The F1 hybrid requires more pesticides, fertilizers, and herbicides, which also lowers the water quality.

Today in Costa Rica the water quality has not changed drastically. The government has provided with some form of water treatment, but only in the larger cities. This does not do many small family farmers much good. Especially with all of the herbicides, pesticides, and fertilizers that they have to add to their crops, which because of erosion, ends up in their water supply. Rural family farms are at such a disadvantage. They are only hurting themselves, but there is nothing they can do about it.

There are many different tests that can be done to prove or disprove if there are contaminates in water. Many farmers in Costa Rica could have their water tested. There are many home kits, which are not always as accurate as what can be done professionally. If a small family farm has the ability to do their own testing, then should pursue that, but if they do not have that ability, then there are also professional tests that can be done. Also, there are many different tests that can be done on soil. In this situation, topsoil would be most ideal to test. If these tests were repeated every year then the farmers would be able to tell if the situations are progressing or if they are decreasing. By having tests done it can also tell how serious the situation really is. Some areas may only contain several, fixable contaminates, while other areas may not. One way to tell if the situation is changing for the better would be if the crops were producing better yields than they were the previous year.

Sustainability is a major factor in any crop production. To be able to keep close the same yield as the previous year is ideal. It is hard to predict the outcome when variables may change. The F1 hybrid is a predictable crop, but other factors play a huge role in the final yield. Farmers have to take into account

the weather, topography, the amount of fertilizers, pesticides, and herbicides used, the water quality, and the amount of water to use for irrigation. These factors all play a huge role in the final yields. To achieve a sustainable goal, there needs to be a way to move away from relying on pesticides, herbicides, and fertilizers so much.

My recommendation to the Costa Rican government would be to provide better treatment to increase water quality. Although they are providing this treatment in several larger cities, that does not mean the government needs to exclude those that don't live in cities. These farmers that live in rural areas are the ones that are providing the major exports for their country. They are the ones providing for the economy. They deserve better health treatment, especially when it may cost them their lives. I think that the Global Water Partnership could help out more in Costa Rica. The Global Water Partnership has already established a partnership with Costa Rica, but it seems as though they aren't fully doing their job. The Global Water Partnership's main objectives are "1. To clearly establish the principles of sustainable water resource management. 2. Identify gaps and stimulate partners to meet critical needs within their available human and financial resources. 3. Support action at the local, national, regional, or river basin level that follows principles of sustainable water resource management. 4. Help match needs to available resources." Those four points were taken directly from the Global Water Partnership website. When I was in Costa Rica the first thing they told us as we exited the plane was to not drink the water. This was in San Jose, and that is not a good sign if we were not allowed to drink the water in the urban areas. Although the government is making a small effort to clean the urban area's water, more still needs to be done. The water still is not clean enough to meet healthy standards. Also, another idea would be that other businesses or colleges get involved. There are many programs that other people can get involved. This may be done by volunteer work also. One example would be going on a mission trip. This is what I have done previously. Although I did not actually conduct labor in physically helping the country or people, I know of many people who have gone to Mexico or other countries with that goal in mind. Also when I was in Costa Rica I saw many, what looked to be trash bins, outside various people's houses. These trash bins were made of metal, and looked like an open basket. There was hardly anything holding in their garbage. This can have a huge affect on water quality as well. Debris will get into the water systems and clog up the water flow. The biggest risk of having trash everywhere, especially in the water system, would be that the garbage carries so much bacteria and germs with it. That all gets into the water system. This debris is another factor for many illnesses. If the government would provide better waste disposals, then the people would have a place to put their garbage, so it would not end up in their own water supply. There again, farmers and citizens are only hurting themselves, but there is nothing they can do about it. It is the government's responsibility to take care of their people. All of these recommendations require money, and the government may not have the amount desired to carry out these recommendations. There are many other programs or organizations that are designed specifically for this purpose, to provide money to countries in need. Through donations and other offerings, these organizations can make this possible. Organizations can really work together in this area. There are many objectives for one organization that another organization cannot meet because they have their own. Though they have different ideas and goals, together they can meet the needs of a country.

In conclusion, the Green Revolution has provided in many ways for less fortunate countries. They have saved many lives and will continue to produce the good in this world. The Green Revolution produced the F1 hybrid of maize, wheat, and rice. These crops are grown throughout the entire world, and they are producing food for many malnourished people. The intentions of the Green Revolution are high quality, and I believe they have set their standards for a very high goal. Their goal can be achieved. Although the population of the world is continuing to increase, humans are also increasing their knowledge in technology. There is still time to find better ways to produce more efficiently and with better quality. The quality of the F1 hybrid plant is outstanding, but it causes much damage to everything around it. There needs to be a crop that will produce high yields, better the environment, have high stability, and will just be a better crop all around. That is something we can only dream about right now.

Although, I do believe we are on that road to coming to a hybrid crop of that kind. There will be a day when the government from every nation will want to better their entire country, organizations will work together to provide for those less fortunate, and those that cannot afford to buy food will be provided for. I see the better for this country happening in a short time. However, there are things that need to be done to make this dream possible. We cannot just sit back and hope that others step up to do the work. To make a dream possible takes effort from all those able.

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