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## The Philippines: Introduce Flood and Drought Resistant(SubmergenceA1 or SUBA1) Rice Plant to Ensure Production in Periods of Environmental Disaster

The Philippines is comprised of many islands, surrounded by beautiful, yet deadly water. Water that looks dazzling to the eye, but turns into monstrous waves during typhoons and other environmental disasters that in turn flood many croplands. Other times, there is a lack of water, where droughts dry out the luscious land that the country is comprised of. The main crop that is affected is the one that the Filipino people depend on the most: rice. The Philippines are the eighth largest rice producer in the world (wiki), yet they suffer from many environmental disasters each year, including five to six cyclonic storms and tsunamis (CIA) that negatively affect the production of rice crops. Drought is another thing Filipinos are constantly bracing for. In 2010, right after the typhoons that ruined 1.5 million metric tons of rice plants, the Filipino people readied themselves for a drought that would potentially destroy even more rice that would cost them even more money (New York Times). They saved what little food they had left, preparing themselves for a dangerously long dry period. The kind and traditional people of the Philippines deserve a stable life, with crops that they can depend on year round. These same crops that are the key to a stable income, diet, and lifestyle in such a dependent country.

Environmental disasters happen all over the world, destroying countless crops, homes, and families in the Philippines. These families consist of at least five people, usually holding many generations under one roof. Rice is something that is eaten by Filipinos at every meal and is a staple part of their everyday diet. Rice also plays a large cultural role in the Filipino lifestyle as it is eaten at gatherings, parties, and other major events. Because meat and other vegetables are more expensive, rice is the one food all Filipino people can surely afford to feed their families. Currently, Filipinos are depending on rice more than ever for their caloric and protein intake (newsinfo). Rice is the foundation of the daily diet, yet it is put at risk every year. The Philippines are hit with five to six cyclonic storms each year. That's five to six potential crop cycles of rice, ruined. With more children attending school because of the new K-12 education system being implemented, there should be a solution to this devastating problem. However, year after year, Filipinos are forced to brace themselves for the unexpected, never knowing if they will have enough rice to get them through the year. Education and health care are improving in this country so it only seems fit to start to develop agricultural improvement.

Despite plans to make it more industrialized, The Philippines are still considered an agricultural country. Most citizens live in rural areas and support themselves through farming. Many of the land used for agriculture is dedicated to rice (nationsencyclopedia). Although rice is the central part of the Filipino diet, other crops are major contributors as well. Corn, coconut, sugarcane, bananas, pineapple, coffee, mangoes, tobacco, and abaca, a banana-like plant, are some of the country's other important products. In order to efficiently produce these, irrigation systems were put in place. However the number of these systems are decreasing due to the governments want to become a more industrialized country. In 1993, the nation was losing irrigated rice lands at a rate of 2,300 hectares per year. According to the World Bank, the share of irrigated crop land averaged to only about 19.5 percent in the mid 1900's. The "dapog" method is an irrigation system that is effectively used throughout The Philippines. This method allows rice to be grown faster, and with less area (agropedia). However, the rice grown using this method is very delicate, making it even less tolerant of flood and drought conditions. Using this method, the seedlings are prepared on an even but slightly raised surface in an open field. The seedlings are then covered with banana leaves, and then sprinkled with water. This entire process takes at least fifteen days to complete. Although this is the shortest method used in the Philippines, it is not always practical, and many rice seeds grown using this method are destroyed in severe weather conditions.

Many Filipino people work in the agricultural sectors of their towns. The food they grow is then transferred to markets, where people purchase home grown foods from the local farmers. However, there are also supermarkets in many areas where packaged food can be bought. Because so many Filipinos are employed in the agricultural field, a stable crop is necessary for a sustainable income. The two biggest threats to rice production are flood and drought. The Philippine islands are hit by numerous cyclonic storms each year, causing major floods. The rice soaks up an abundance of water, causing it to be unsuitable for consumption. In turn, farmers who grow this rice are not able to make a product off of that damaged rice. Agricultural and rice production employ a large percentage of people in The Philippines, and when natural disasters occur, those are effected. These environmental disasters affect more than just the crops. They affect Filipino's incomes, families, and lifestyles. It also affects the country's import and export business, as they are the eighth largest rice producer in the world.

The effect of climate change, especially floods and droughts, is detrimental to the Philippine's rice production. Flooding seasons can cause annual losses of over one billion U.S dollars. When rice production is down, it affects not only local jobs and incomes, but also the local families who depend on rice for their every day meals. Just a few years ago, 1.5 metric tons of rice was lost due to typhoons. Shortly after, a major drought threatened The Philippines. Almost 400.000 acres of farmland were affected, with the damage cost estimated at about \$61 million (NY Times article). Submergence and drought are major constraints to rice crops. Production is constantly being effected, as both flood and

drought can occur within a single crop cycle. Rice production trends in The Philippines show very erratic changes. Environmental disasters are unpredictable, so the trends are understandable. Because of this unpredictability, there are currently studies being done about a gene that could potentially rid The Philippines, and other rice dependent countries, of this problem.

There is a study being done about a gene that increases rice plant's resistance to extreme submergence, as well as being able to increase its ability to recover from drought. Research has found a gene, SUB1A that shows promising results. This is an ethylene-response-factor-like gene that provides rice plants with an increased tolerance for submergence and drought. It was first identified in 2006, right after the crop's genome was completely unscrambled (BBC News). SUB1A dampens ethylene production and gibberllic acid responsiveness during submergence. This in turn significantly prolongs endurance to things like flood and drought (theplantcell). There is no genetic modification being done, because the gene is already present in certain kinds of rice. The only obstacle is actually *finding* the type of rice that it is present in.

Improving this factor using the SUB1A gene would give the Filipino people a great food and job security. People employed in the agricultural sectors of the country could not have to worry about environmental disasters ruining their crops, because they would have a plant that could withstand the harshest conditions, whether those be flood or drought. With this rice type, farmers can continue to work the fields and households will have rice with their every meal. Because the country would be saving so much more rice, they won't have to get throw away as much unused food. This then provides more for the country to consume. Because farmers aren't losing any crops, but producing more, there will be less unemployment. Quotas can be met with rice to spare. Household incomes will finally be stable, as local farmers can produce more rice to sell at their markets that so many families use to get their daily food.

Although SUB1A is a solution that will benefit not only the Philippines, but many other rice producing countries, the gene is not invincible. The rice crops may be only be able to resist up to two weeks of drought or submergence. Even though this is a significantly longer time period than that of rice plants without the gene, it may still cause farmers slight losses, depending on the severity of the disasters. However the actual gene in the rice will cause no harm to the crops or the environment around it.

Ensuring environmental sustainability is the millennium development goal that is associated with the flood and drought crisis in The Philippines that will hopefully help research and solve the problem by 2015. With its help, the rice crops with SUB1A will be used not just in The Philippines, but in every country

that struggles to grow rice effectively. Investments in research facilities for the SUB1A gene will be needed to fully determine which rice crops contain the gene. As well as using rice that contains the SUB1A gene, the “dapog” method, and method of growing rice that started in The Philippines, should be used on a larger scale. This method uses less space, and also less water, making it more economically efficient.

In order to successfully use rice with the SUB1A on a larger scale, not just in The Philippines, but in other large rice producing countries, communities have to be greatly invested in research and implementation. Because of the advancement in education in The Philippines, a lot of the research can be done there. Students who wish to peruse biological careers can take part in the research facilities that must be present in the country. Groups will have to be made to continue the search for the rice that has this gene in it. These groups will be necessary at all times, providing jobs for many people. Rural farmers will play a part in the new rice by providing maintenance, and tracking how well the rice is growing in their specific environment. They should introduce the new rice gradually to their normal crop cycle, in a natural method. By doing this, the crops can adapt naturally, and potentially provide the country with a stable rice crop.

The people of the Philippines, just like people all over the world, deserve stability. A country that is full of culture and beauty, is also struggling to maintain a crop that provides security for almost every family. Despite plans to become more industrialized, The Philippines is the eighth largest rice producer in the world and remains mainly agricultural. Typhoons, tsunamis, and other disasters cause flooding that wipes out millions of dollars of rice. Dry seasons are also devastating to the Filipino people. Drought ruins a significant amount of rice crops each year. Families suffer from hunger unemployment. Farmers markets, where people purchase a lot of local foods, aren't able to provide an adequate amount of food. The country's economy depends on the production of rice. Without a stable crop, their entire lifestyle is put at risk whenever a storm or dry season hits. Luckily, though, there is a solution. Rice with the gene SUB1A will provide people not only in the Philippines, but all over the world, with a security they've never had. They can sleep peacefully at night, knowing that if there is a flood or drought, their rice crops will be safe. The dapog method can also be re-introduces into the country, and used on a larger scale. This will save many farmers space, and time when growing their new rice crops. The Filipino people have the right to wake up each morning, knowing that they will have food on the table, and a job to come home from, just like us.

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