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Peru, Factor 1: Plant Science

Peru: Improving and Domesticating Crops

Peru was once the home of the Incas a mighty sophisticated agricultural civilization. The Incas were able to transform their mountains into large terraces capable of feeding the growing empire. Even though the Incas didn't create a form of writing their agricultural practices were complex and had a large amount of biodiversity. The Moray is an Incan ruin which consists of three enormous circular pits encircled with terraces. Air temperature can differ between the top and bottom layers by 20 degrees. The true purpose of the Moray is unknown but researchers theorize that the agricultural site was used for crop experimentation. After the Spanish conquest the Spaniards suppressed the Incan people's culture and traditions and with that most of their agricultural crops were replaced with European species the conquistadors demanded to be grown. The traditional Andean crops were then forced to the high tops of the Andes where they became isolated from the outside world. Now as Peru is becoming wealthier gaps between the people living in cities and their rural counterparts is becoming more relevant. In order to combat issues in Peru and abroad we must improve minor crops and domesticate wild species. Peru has a rich agricultural heritage which is quickly being discarded without realizing its full potential and how it can feed the people of Peru once again. The average size of a rural poor Peruvian family is about 4.9 persons compared to the average urban Peruvian family of 5.1 persons. The difference is due to the large exodus out of the rural countryside into the city where men seek employment while women generally work the family farm. Education for rural children is usually inaccessible or the family does not have enough money to go to school. Those who have received primary education in the rural countryside find it difficult to adapt to secondary education schools especially if accustomed to a single teacher (Education System in Peru. (n.d.). Retrieved March 20, 2015). Healthcare access in Peru for the rural poor is mostly inaccessible due to lack of local governments to appropriately administer finances allocated toward social programs or because the rural poor do not know the resources available to them.

Rural farmers grow traditional minor crops such as oca, mashua, ulluco, maca, yacon, and potatoes. Farmers also raise animals such as alpaca, llama and guinea pigs. Rural farmers are raising guinea pigs more often because they require minimal amounts of food. Cuy is a popular delicacy in Peru, which consists of a guinea pig roasted on a spit. Cuy is becoming very popular to foreigners and is being exported in larger quantities. Most minor crops are not well known out of Peru and have been neglected as a potential major food crop in Peru and abroad. Rural farmers tend to grow their crops on large reconstructed terraces, which once fed their ancestors called the Incas. Other farmers use the ancient method of cultivation called Waru Waru, which are platforms of soil surrounded by ditches filled with water. During different weather patterns such as drought, flood, and extreme temperature fluctuations the Waru Waru method protects the crops. In a drought, the water in the canals slowly seep into the soil providing the crops with much needed water, while in floods the furrows drain excess runoff. During the day the water absorbs heat and radiates the heat at night protecting the crops from frost. The larger field size, the warmer the microclimate.

After many years the Waru Waru has gone into disrepair as farmers convert to more commercial agricultural methods. The Peruvian government has been promoting the reconstruction of the Waru Waru after yield trials proved that the average potato yields were greater when grown with the Waru Waru methods compared to fertilized fields. This process provides an economic advantage to return to the traditional Andean agricultural techniques, which is sustainable in the long term with very little environmental damage. An average Peruvian farm size varies from a couple of acres to hundreds of acres. Many are subsistence farmers that grow most of their own food and sell any extra crops. Any profit from

the sale of crops is typically used for tuition for their children's education. A minor crop called Quinoa has been categorized as a healthy food option. The outside world has realized its health benefits so the demand has skyrocketed, but the supply has been slow to satisfy that demand causing a paradox. With increased demand, farmers are now selling all of their Quinoa leaving the farmer's family unable to receive an important source of vitamins and minerals that are difficult to supplement in the Andean climate. Major barriers to improving agricultural are the use of variable yielding crops when non-improved plants are used. The limited use of many crops does not appropriately spread the risk of a crop failure. Minor crops have seen little selection and have largely been overlooked as a major food crop. The unique climate of Peru makes it difficult for modern agriculture to yield reliably in some parts of the country.

An un-improved crop variety hinders the farmer's ability to generate profitable yields from their land with limited outside inputs. A variable yield does not allow a farmer to predict their harvest and appropriately feed their family. As subsistence farmers who rely on what they grow, a crop failure could mean very disastrous consequences such as famine. By breeding improved crops, the risk of a crop failure is greatly diminished. Currently there are many people trying to breed crops that can cope with extreme temperature fluctuations of the Andes. Breeders are attempting to use crops that have not originated in the Andes, such as wheat or barley. These crops have been only adapted to the Andes within the last two centuries and have not experienced the climate at its most volatile temperatures that will become more frequent as climate change occurs. The improving of plants by traditional breeding is relatively constant as it takes many years for a plant to be crossed, trialed, and grown out in sufficient quantities in order to be released to farmers. Improving plant breeding in Peru will assist rural farmers to move out of poverty and feed the population who do not have access to nutritious food. Climate change is affecting Peru at a rapid speed. The glaciers are melting faster than in the past and it is predicted that the glaciers will entirely melt by 2030. In many parts of Peru, people rely on the glaciers to water crops. A future that consists of a short water supply will generate the need for crops that require less water. This should be a high priority to promote.

Peru has one of the most intact rainforests that should be protected currently and in the future. In order to leave as little impact on the environment as possible, agriculture will need to adapt to use less fossil fuel, find techniques to prevent erosion and breed crops that have little impact on the environment. This issue will only become more of a crisis as the population grows and strains the food supply. By domesticating wild edible species could potentially become a major food crop and improve minor crops so Peru is better prepared to face upcoming agricultural issues (Rosner, H. 2014, June 24). The International Potato Center located in Peru saves important tuber germplasm, such as potatoes and Andean tuber crops in order to be used in plant breeding in the future. Farmers donate a small batch of genetically distinct potatoes and in return receive a disease free stock to plant the following season. Not only does this save valuable germplasm for future use, but allows farmers to gain access to improved stock without having to spend a lot of money. If this type of exchange could be scaled up to many types of cultivated and wild edible species, it could lay the ground work for future breeders to improve and domesticate potential crops.

Domesticating edible species and using them in their native land needs to be explored. These species have been adapting to the climate for thousands of years and have found ways to survive pests and diseases (Vezina, K. 2014, July 3). We rely only on a few species to feed ourselves such as wheat, rice and potatoes. By better diversifying our food system we can then decrease the risk of a total crop failure. A community can begin the process of domestication of species to locate knowledgeable people who know what species are edible and how they have been used in the past. Some species are edible but only a few people know how to correctly prepare the food crop. A community can educate citizens how to prepare an edible plant and demonstrate the benefits of using food which that would not be utilized. The community should also begin collecting germplasm from around their local area without damaging the environment. This collection of seeds and plants could then be used by breeders. Peru only spends 0.15% of its gross

domestic product on research and development, while other countries invest additional funding. The benefits of the additional research would provide a greater opportunity for alternative growing options. With such limited spending research and development cannot efficiently address problems in Peru. The Peruvian government must raise the funds in order to support the additional research such as improving plant breeding. The government would also need to promote the newly domesticated crops allowing them to successfully enter the food marketplace. Plant breeding organizations and corporations would need to help create breeding methods for species that have little to no information on how they reproduce. The organizations and corporations would begin the domestication process by selecting individuals with wanted traits. There are many tools at their disposal that can help determine which plants have the desired traits and if they can withstand infrequent weather patterns. Rural and urban families should be well educated on the pros of domesticating new species of plants and be willing embrace different kinds of food. The power of choosing what you eat is truly underappreciated. By choosing to eat newly domesticated foods the population essentially supports newly domesticated crops.

In order to create a domesticated crop a plant breeder will use the technique of selection. Breeders will select a species which has the potential to be selected for a specific trait. Once a species has been found the breeder will begin to collect genetically diverse populations in which to select for wanted traits. The breeder will then grow out the populations and screen for important wanted traits. The breeder will cross the superior plant populations to combine the wanted traits. The F1 offspring will be grown out and self-pollinated. Once the plants are evaluated and unwanted plants are culled, the seeds of the plants which exhibit the combined traits will be collected and stored. The seeds collected are called the F2 offspring. The F2 seeds will be grown out and selected over multiple generations selecting traits important to be present in the plant. Technology is available to speed the process of domesticating. By using genetic mapping technology hidden traits and unwanted traits can be selected for and against. Government researchers will need more funding to efficiently create new domesticated crops.

Minor crops also need a boost, these crops are often neglected as a potentially major food source in the Andes because people associate the crop as a poor man's food. The crops contain significant nutritional benefits that could assist in preventing malnourishment in Peru. There is limited knowledge of flowering characteristics of many tuber crops that are traditionally planted as clones. A plant that is genetically exact each time it is planted cannot adapt to rapid changes in their environment. Most minor crops have not been selectively bred for disease resistance, yield and pest resistance which limits their full potential. Very few breeders are working on improving these crops but the materials have been obtained. The International Potato Center has collected 1,500 different varieties of minor crops collected from seven different countries (CIP, 2015). This rare germplasm can be used to improve minor crops. Breeders will have to experiment on how to successfully breed the minor crops to potentially becoming the next major crop.

Technology which is not appropriate for Peru is Genetically Modified Organisms. In 2013 Peru banned GMO's completely for 10 years. The reason Peru adopted such a ban is because Peruvian scientists believe that biotechnology is in its infancy. The ban gives time for biotechnology to mature and studies on their effectiveness is completed. Once the 10 year ban is up the Peruvian government will be able to make better decisions if biotechnology is a technology worthy of exploration and adapting to Peruvian agriculture or not to invest in biotechnology. The result of the ban is neither positive nor negative since Peru is just beginning to evolve its agricultural system.

A barrier which could inhibit the adoption of domesticating new crops and minor crops in Peru are that domesticating new crop species is relatively a new idea and not a lot of research has been conducted. This implies that Peru would have to lead the way in developing and improving new crop domestication. Advocates for this proposal would have to convince the government of Peru that more funding for scientific research and development for domesticating new plant species could benefit Peru by

diversifying their food system and opportunities for new food products. Ordinary citizens can help encourage the Peruvian government to put more funding toward scientific research and development of crop domestication by outlining the potential of domesticating new crop species.

The Incas were able to build a complex agricultural society which depended on many crops which ensured that they would have food in the worst of times. Even though Peru is only responsible for 0.1% of global CO₂ emissions the country is one of the most vulnerable to climate change. Climate change is predicted to impact South America the hardest. Actions must be taken in order for Peru can adapt to the changing environment. Using techniques which have been used in the past to solve modern problems is an ever growing idea. As a rural or urban family in Peru many are faced with poverty and have not benefited from the growing country. Men in the rural countryside travel to a large city in hopes of finding a job with a living wage but are faced with a city that has no job opportunities. The Peruvian government must encourage people to go back into the countryside with the tools they need to come out of poverty. Peru will have to spend more money on research and development to create plants with good reliable yield and disease and pest resistance. During my research on minor crops of the Andes I found a book called *The Lost Crops Of The Incas* which was very helpful to understand what these crops were used for and what is their potential as a major food crop, but I was unable to find any recent breeding projects of minor Andean tuber crops such as oca and ulluco in Peru. The International Potato Center does collect germplasm of Andean tuber crops which I had very little information to go on about domesticating new plants and only managed to find a few papers done in the United States. In order to feed our growing population focus on all potential leads is essential. A new technique of agriculture is what is needed for Peru to adapt to new problems. This new technique must have limited impact on the fragile environment and be able to help the farmer to feed their family and have money for their children to gain an education. Domesticating new crops widens the genetic diversity to our current monoculture agricultural system. These crops will be a vital addition to the future of agriculture which will feed our growing population. Cooperation with all countries is needed to begin to adapt to the changing world. Humans have overcome famine, disease, and natural disasters by innovating. Now we must reconstruct our agricultural system in a matter of a few decades.

Works Cited

- Education System in Peru. (n.d.). Retrieved March 20, 2015, from <http://www.classbase.com/countries/Peru/Education-System>
- Goldberg, R. (n.d.). MEDLIFE. Retrieved March 22, 2015.
- Home. (n.d.). Retrieved March 20, 2015, from <http://www.cgiar.org/>
- International Potato Center - Agricultural research for development. (n.d.). Retrieved March 19, 2015.
- Lost crops of the Incas little-known plants of the Andes with promise for worldwide cultivation* (1st ed.). (1989). Washington, D.C.: National Academy Press.
- Rosner, H. (2014, June 24). How We Can Tame Overlooked Wild Plants to Feed the World | WIRED. Retrieved January 18, 2015.
- Vezina, K. (2014, July 3). Global food shortage? How advanced breeding could domesticate 50,000 wild but edible plants. Retrieved March 27, 2015.