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Guatemala: Increasing Yields though Improved Genetics

World population recently passed seven billion individuals and current projections are that it will reach 16 billion by 2100 (World). Given these population increases, there will be a concomitant demand on agriculture to produce food, feed, and fibers to meet the needs of this population. In addition, the new expectation of fuel production potentially adds more demands to agricultural production. Clearly world agriculture must increase productivity to meet these demands.

In the past, agricultural production has increased via of three mechanisms; increased land in production, improvements in the management of production (e.g., rotation, fertilization and irrigation) and improvements in the genetic potential of the crops being grown or produced. It is unlikely that additional land resources will be devoted to production primarily because all of the best land is already being used and there is no more to be discovered on the earth. Therefore we must maximize productivity of the land through the use of both best management practices and crop improvement technology. Therefore it is imperative that all regions of the world have access and the ability to utilize these science-based disciplines.

The specific needs and issues of each of the world's regions are unique and solutions to these regional problems must be found through research and development within the respective regions. For example, techniques to enhance yield in North American farming systems are not likely to be applicable to a developing country in Asia or Central America because they simply lack the ability to utilize much of that technology. Thus, it is important to understand the specific situation and issues that cause poverty and/or food security problems each country. The purpose of this essay is to assay the issues in the Central American of Guatemala and identify potential means to address food security and economic productivity.

Guatemala is a small Central American country with a population of 14,099,032 and a total land area of 107,159 square kilometers, resulting in a population density of 131 people per square kilometer; this density is one of the highest of any country in mainland North America (CIA). Approximately 50% of Guatemalans reside in overcrowded cities with an annual urbanization rate of 3.4 % and17.7 % of children are underweight (CIA). The remainder of Guatemalans live in rural regions of the country which remain highly underdeveloped and are composed of subsistence farming families. A typical subsistence farming family in Guatemala consists of a husband and wife with 3-5 children (Gender). The main source of food energy is from the maize (*Zea mays*) that is grown on the farms often in conjunction with beans or vegetables. In these areas, access to education is low; only 3 of 10 children complete the 6th grade and the average amount of schooling is only 4 years, which results in a literacy rate at 69.1%(CIA). Access to healthcare is also minimal, with less than one doctor and one hospital bed per 1000 people (CIA). The farm size is typically small, usually less than 1.0 hectare, often on mountainsides with slopes that limit productivity and increase soil erosion and loss (Household). All of these factors limit the subsistence farmers' ability to produce sufficient food for his family without much to market for income. For farmers lucky enough to have additional land surpluses of the staple crops maize and beans can be sold; crops such as potatoes, wheat, and vegetables are also produced (Household). Sorghum, a failsafe crop, is grown in case drought devastates the maize crop.

The major barriers against the improving agriculture productivity include the lack of education, the increasing problems of erosion, and the inability to access resources such as improved genetics or

fertilizer (Household). Introducing hybrid species to Guatemalan subsistence farms would increase the yields and quality of the grain. This would then increase the standards of living and food security and reduce the poverty level in the country.

Because maize is the most important crop in Guatemala, improvements in maize production would have the largest impact on agricultural production. Most subsistence farmers grow traditional open-pollinated maize from seed saved from the previous year's crop. As is well known in developed countries, improved maize varieties can have a dramatic impact on yield potential (Hybrid). Maize breeding has produced improved hybrids that have a significantly higher yield potential. The availability of such seeds on subsistence farms would significantly increase the yield of maize. Greater yields of foodstuff make food more available to the family; through the sale of surplus food more wealth comes to the family. This results in a higher standard of living. The heirloom species which are used on most subsistence farms have lower yields and cannot deal with stress well, resulting in more crop loss and lower yields with non-hybrid plants, leading to less food and a lower standard of living.

The ability to adopt and utilize improved genetics and management techniques has resulted in significant differences in crop yields in developed and developing countries. For example, the average corn yield in the U.S. is approximately five times as much as it is in the Central American country of Guatemala. This lower yield is due to the local farmers' inability to access (physically or financially) either fertilizers or improved genetics. Access to even one of these would likely double or triple their current yields. On average, this increase would equal the amount that a normal Guatemalan family eats a year; the money earned for work off the farm could go into improving the lifestyle of the family instead of buying extra grain.

Currently, the average corn yield of a Guatemalan subsistence farmer is 800 to 1000 kilograms/hectare (Poverty). Based on the corn consumption in Guatemala, this is half of what an average family needs for annual sustenance; they will need access to food though trade, production, or the purchase of another cereal grain source in order to meet familial needs. Almost all Guatemalan subsistence farming families must find additional work to earn money for the corn, beans and vegetables they buy to prevent malnutrition. The introduction of higher yielding varieties of plants would allow extra productivity and provide additional economic opportunities by decreasing the extra work needed for the family and allowing children to go to school instead of having to work, thus increasing the education level in Guatemala.

The impact of inputs in Central America is known, and some increases in grain yield in recent years are due to the availability of fertilizers. However, much of the land that is utilized by Guatemalan subsistence farmers is poor due to soil quality, slope, or overuse; this limits the impact of management (Guatemala). Therefore, improvement in the genetic potential of maize in this region and the availability of this improvement via hybrid seeds would further increase annual yields. Currently, most farmers do not have the economic ability to access to the hybrid seed even if it were available. While hybrid seeds are produced in the area, the cost of the seed renders investment financially infeasible. For many subsistence families, the situation is getting worse due to a decrease in land productivity. Overall, the amount of land under cultivation in Guatemala has gone down over the past eight years. If introduced, hybrid seeds could have enormous impact on the economy and standard of living in Guatemala. If hybrid seeds were planted yield would at least double. Money gained from selling the surplus food could be put into buying fertilizers to replenish the soil and increase yield further.

Systematic and scientifically-based crop improvement (specifically, maize improvement) has been ongoing for over 100 years. The impact of these programs has been substantial, resulting in higher yield, improved resistance to disease, pests and drought and improved quality. These improvements have been

accomplished using both traditional improvement techniques as well as through the use of transgenic (i.e., genetically modified), crops. Maize breeding programs use these techniques to continually improve and adapt maize for maximum yields and quality while protecting that yield potential from loss due to abiotic and biotic stresses.

Like all crop production, maize improvements are specific to regions. Currently in Guatemala, there are limited efforts to improve maize for the region. Unfortunately, most of these efforts are targeted to a small portion of commercial farmers. Efforts to produce improved genetics for subsistence farmers are even more limited to the research of small national programs or nonprofit international research centers such as CIMMYT. While these research organizations do important work, it is impossible due to limited resources to develop maize genotypes specific to Guatemalan production systems.

It would be possible, through the use of National Agriculture Research to breed improved maize for Guatemala. These programs do not have to use the newest technology; simply applying traditional approaches to both open-pollinated and simple maize hybrids could have significant impact. Furthermore, interaction with NGOs (Gates Foundation) and corporate entities such as Monsanto that can utilize their capacity to influence distribution and technology could further improve and disseminate improved genetic in maize that is specifically improved for Guatemala and Central America. Finally, if producers realize higher yields, they will have the opportunity to market that grain for cash and ultimately improve their economic situation.

Two factors that could affect Guatemalan subsistence farmers are population growth and urban sprawl. Population growth and urban sprawl affect the farming family in many ways. First, as the population grows, the demands on food supply increase and this places pressure on the land. Without plants that will yield enough to allow crop rotation, the soil quality will deteriorate to lower potential production levels. Second, urban sprawl will reduce the amount of land available for farming. This encroaches upon good farmland and forces the farmer to move to a new plot of land further away from the market, usually without payment (New).

The availability of attainable hybrid seeds in Guatemala will greatly affect the lives of subsistence farming families. I recommend subsidizing seed prices if possible or setting up facilities to cross parent lines in Guatemala. Once provided with hybrid seeds, the farmers will have the hybrids for multiple seasons without the financial burden of having to purchase new seeds.

I also recommend, if possible, a low interest loan system aimed at farming families. Using the loaned money, the families could buy their first set of seeds and proceed to pay back the loan during subsequent harvest seasons. Similar programs have been implemented with fertilizers. The repayment rate of these loans is well over 90 %, even with small amounts of interest (Poverty). This was done through the non-governmental organization HELPS, in coordination with a local fertilizer company in Guatemala, DISAGRO. Although the transportation system in Guatemala is poor in some places, overall it would not inhibit the distribution of surplus grain also, most grain would be sold to people close to the close to the field where it was grown., neighboring families for example. Those farms that are close enough to cities to sell to the people in them have transportation networks that are much better than most of the country.

All in all, the introduction of hybrid seeds in the Central American county Guatemala would greatly impact the standard of living of subsistence farmers. The introduction would lead to an increased amount of wealth coming to the family, an increased amount of education as less work is needed outside the farm freeing up the time for schooling, and a better diet for the family.

The increase in world population will place more demand on the agricultural productivity of all regions of the world. Each country must strive to maximize both productivity and efficiency of production to

enhance the food security and economic status of its citizens. Countries that fail to accomplish these goals will be limited in their ability to feed and clothe their citizens; this will have a significant negative economic impact on the country. Food security, agricultural productivity, productivity, and sustainability in Guatemala are essential. The lack of food security not only threatens stability within the country but all of the other countries in the region as well.

Guatemala is blessed with an array of production systems and citizens who work hard to accomplish a goal. To enhance maize (or other crops), research on best management practices should implemented and adopted. It must be realized that in some regions, agronomic management can be maximized. Therefore, the systematic improvement of maize for the region must be emphasized and systems to deploy these improved genotypes must be developed. Genetics is not contingent on location; it can be applied in any production system. The benefits from this system are then realized by both producer and consumer in that the producer has surplus grain to sell and the consumer realizes stable prices and a reliable supply of agricultural produce.

Works Cited

"Central Intelligence Agency." *CIA*. N.p., n.d. Web. 22 Aug. 2012. <https://www.cia.gov/library/publications/the-world-factbook/geos/gt.html>.

"Encyclopedia of the Nations." *Agriculture*. N.p., n.d. Web. 24 Aug. 2012. <http://www.nationsencyclopedia.com/Americas/Guatemala-AGRICULTURE.html>.

"Gender, Migration, and Transnational Identities: Maya and Ladino Relations in Eastern Guatemala (Massachusetts)." *(Debra Rodman)*. N.p., n.d. Web. 24 Aug. 2012. <http://rmc.academia.edu/DebraRodman/Papers/611375/Gender_migration_and_transnational_identities_Maya_and_Ladino_relations_in_Eastern_Guatemala_Massachusetts_>.

"Guatemala - Agricultural Land." *Guatemala*. N.p., n.d. Web. 24 Aug. 2012. <http://www.indexmundi.com/facts/guatemala/agricultural-land>.

"Household Food Security and Crop Diversification among Smallholder Farmers in Guatemala." *Household Food Security and Crop Diversification among Smallholder Farmers in Guatemala*. N.p., n.d. Web. 24 Aug. 2012. <http://www.fao.org/docrep/U8050t/u8050t06.htm>.

"Hybrid Seed Production in Corn. "*Http://seedbiology.osu.edu/HCS630_files/May%203/hybrid%20seed%20production%20maize%20ppt.pdf*. Mark A. Bennett, Ohio State University, n.d. Web. 1 Sept. 2012.

"Infrastructural in Latin America: Recent Evolution and Key Challenges."*Http://www.worldbank.org/transport/transportresults/regions/lac/cb-guatemala-260705.pdf*. The World Bank, 5 July 2005. Web. 31 Aug. 2012.

New Agriculturist." *: Focus On... Land Security Leading to Food Security in Guatemala*. N.p., n.d. Web. 14 Aug. 2012. <http://www.new-ag.info/en/focus/focusItem.php?a=286>.

"Poverty Alleviation through Balanced Fertilization for Corn and Integral Family Development."*Http://www.ipni.net/publication/bettercrops.nsf/0/AE734A64CF9C45828525797D00615D45/$FILE/Better%20Crops%202011-1%20p18-21.pdf*. N.p., n.d. Web. 31 Aug. 2012.

"The Impact of Non-." *The Impact of Non-*. N.p., n.d. Web. 24 Aug. 2012. <http://archive.unu.edu/unupress/food/8F154e/8F154E06.htm>.

"World Population." *Wikipedia*. Wikimedia Foundation, 29 Aug. 2012. Web. 01 Sept. 2012. <http://en.wikipedia.org/wiki/World_population>

"World Wheat Production, World Maize Production, World Rice Production." *World Wheat Production, World Maize Production, World Rice Production*. N.p., n.d. Web. 24 Aug. 2012. <http://www.nue.okstate.edu/Crop_Information/World_Wheat_Production.htm>.