A Path for Sustainable Agriculture in Bolivia

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As the world's population approaches seven billion, food production is of great importance. Technological innovations in the past 60 years, such as plant breeding and Genetically Modified Organisms, have allowed us to increase food production. But current agricultural practices in many countries cannot sustainably support large populations. Because of this, new agricultural methods must be adopted to increase food production and maintain environmental health.

South America is rich in biodiversity and agriculture potential; however it experiences some of the worst resource degradation in the world. The Republic Bolivia is less publicized than many developing countries, but has all of the same problems. Bolivia is a landlocked country that is located in Central South America with a population of almost ten million. Almost two-thirds of the population are indigenous people. Bolivia is rich in tin, natural gas, and silver. With a history of political instability, Bolivia's government is now defined as a republic with Evo Morales serving as president.

Ineffective agricultural practices, lack of education, and lack of government support are serious problems in this country, and must be resolved now. Each of these problems has prevented agricultural and economic growth. By focusing on these three issues, smaller problems such as deforestation and desertification will in turn be resolved.

Family is very important. In rural parts of the country, it is common for several generations to live in one home. An extended family is viewed as a strong support system. The roles of family members are very traditional. Men are responsible for the family's income, and women are left in charge of child rearing and maintenance of the household. The average size of the immediate family is about five, with two parents and three children.

The Bolivian diet relies on a few staple items including corn and potatoes, and a small amount of beef. A Bolivian diet is based generally on carbohydrates, and lacking in other food groups, resulting in malnutrition.

Children in Bolivia are only required to attend school from the ages of six to thirteen, but enforcement is difficult. While public school is free, the quality of the education differs. Secondary education is an additional four years, but only one-fourth of adolescents continue after age thirteen. Bolivia's literacy rates fall about 10% below the South American average with a rate of 81%.

The dropout rates are very high in Bolivia. Only one-third of first graders complete the fifth grade because most children must drop out to contribute to the family's income. Because of the low status of women, attendance rates among women are much lower than those of men. Women are expected to help with household chores instead of going to school. The dropout rates of girls are also much higher than those of boys. The lack of bilingual schools also contributes to the increased dropout rates. Some children only speak native languages such as Quechua and Aymara, and schools often teach only in Spanish.

Bolivia is South America's poorest country. The unequal division of wealth as well as corruption in the government contributes to the country's economic problems. The World Food Programme reported the 80% of Bolivia's population is below the poverty line, a large portion of the population is unable to

afford basic needs such as food and water. The average income of a Bolivian household is only $732 U.S. according to the World Food Bank. However, most Bolivian farmers survive on only $200 a year. Of the income, 37% spent on food, 11% on fuel, 9% on health care, and 14% on education.

The jobs most common to the people of Bolivia include mining, smelting, clothing, agriculture, and professions in the natural gas industry. The majority of people living in Bolivia are employed in agriculture, however, this accounts for the lowest contributor to the gross domestic product due to the inefficient methods. The farm land in Bolivia is divided into three types. The Andes Mountain range splits into two separate ranges, the Cordillera Oriental and the Cordillera Occidental. These ranges run parallel, north to south. Between the ranges lies the Altiplano plateau, which stretches 500 miles wide. The soil on this plateau is extremely dry due to the very little rain this area receives, making the soil the least fertile in the country. This plateau is farmed by 60% of the country's farmers. The main crops grown in this region include vegetables, potatoes, maize, beans, and quinoa. The farmers rely on trucks to move their produce to sell in mining camps and farmers markets in local cities. The average size of a subsistence farm in this location is less than ten acres.

The land east of the Andes has a completely different climate. The Yungas region borders the numerous river basins. About 20% of the country's farmers cultivate this land. Because of the moist soil, the crops grown here include sugarcane, tropical fruits, coffee, and cacao. Corn, wheat, rye, and oats for feed companies as well as domestic consumption are also grown here. Due to the suitable climate, the Yungas region is capable of offering two crops a year. An average farm in this region is less than thirty acres. Farmers in this region are also isolated and rely on trucks to move their products for sale.

Farmers in these two regions use traditional farming methods, which include terracing. Terracing is used on land with a steep grade. Earth is removed to create benches in the land, preventing the topsoil from eroding. Many of the farmers on the plateau still do not use mechanical machines, and wield more traditional machines such as the foot plow, used for cultivation.

The lowlands in the eastern and northern parts of the country are the source for almost all of Bolivia's agricultural exports. Most of the farms in the lowlands are large commercial farms that practice modern farming techniques. These farms are about 220 acres in size. In the northern part of this region, the main products include rice, cattle, and timber. Soybeans, coffee, rice, and corn are more popular products in the southern region around Santa Cruz. The agriculture industry in the Santa Cruz area is more profitable than any other area in the country. The other two regions of the country have very little involvement in the marketing of their produce. In the lowland region, however, the farmers play an important role in all parts of the agricultural industry, including marketing. Because of the larger commercial farms in this region, small subsistence farmers have trouble selling their products. The current government contributes to the problem by giving large corporations tax breaks, while failing to support the subsistence farmers with a similar advantage.

The potential agricultural development in Bolivia is astounding, but many barriers inhibit productivity. One of the main factors preventing agricultural development is lack of adequate infrastructure. Many of the roads are unpaved, making them dangerous to use after rain. The road to the capital, La Paz, from the Yungas region is known as the "Road of Death" and is considered the most dangerous road in the world as a result of the many fatalities. Small farms are isolated because of poor roads that make it difficult for their product to be transported to markets for sale and ports for shipping. If infrastructure was improved, marketing for the subsistence farmers would be much easier, allowing them to compete in the world market. However, the poor economy of Bolivia leaves few funds for infrastructure development.

The lack of political support has made it difficult for the industry to flourish. Certain government policies make it almost impossible to obtain a loan, hindering development. The farmers are unable to afford the high cost of modern resources such as machinery and fertilizers. This limits productivity and contributes to unsustainable farming methods by making it more expensive for farmers to invest in more sustainable agriculture. Also, certain government policies favor commercial farming companies, keeping the price of food low. These low prices discourage farmers from planting more crops. The Bolivian government fails to grant subsidies to farmers using sustainable methods. If subsidies were issued, this would create more of an incentive for agricultural productivity.

Lack of modern methods limits agricultural productivity. Bolivia has the worst agricultural technology in Latin America. Many small farmers in the plateau and valley region still rely on obsolete machinery and out of date farming methods. Many farmers do not use fertilizer or tractors because of the cost. Bolivian fields often lack irrigation systems as well. In place of tractors, the power of animals is employed. The use of small scale production methods prevents subsistence farmers from competing with the commercial farming in the lowlands.

Bolivia experiences some of the worst resource degradation as a result of the farming and timber industries. Severe resource degradation can negatively affect the agricultural productivity. Soil quality is a determining factor in productivity. Degradation of the soil in Bolivia occurs mostly from either poor farming methods or overgrazing, resulting in erosion.

Overgrazing can result from allowing too many animals to feed on one area of land, or by not controlling their grazing habits. Without the root system of the plants to prevent soil erosion, the land loses valuable topsoil that contains nutrients, minerals, and organic matter. The quality of soil is measured by it’s permeability. Soil that allows rainwater to flow quickly through is generally of poor quality because it increases run-off, further eroding the soil. Measurements of the soil in Bolivia show that the topsoil is being eroded, harming agricultural productivity. Topsoil is vital to the growth of crops, and without it, agricultural productivity suffers. Preserving the soil would increase yields immensely. By controlling grazing patterns, the quality of farmland can be maintained, preventing more resource degradation and increasing agricultural productivity.

The slash and burn agricultural practice has also increased soil erosion and resource degradation. The method of cutting down the forests of Bolivia for farmland is becoming more common. This not only destroys the forests and its vegetation but also puts Bolivia’s rich biodiversity at risk. The soil of Bolivia’s rainforest lacks nutrients, most of the supply being used in the already existing life. Cutting and burning the biomass of the forests releases the vegetation’s nutrients into the soil. However the land is only good for a few years before the nutrients are leached from the soil. The farmer must abandoned the land and find new farmland, most likely using the slash and burn method, further perpetuating the unsustainable process and its ill effects. Not only is Bolivia's biodiversity at risk, but the soil quality is as well. The nutrients in the soil are washed away without the vegetation to retain them. This unsustainable method cannot continue forever. As the countries population increases, more people will need their own farmland. If more sustainable methods are not adopted, the population will not only kill off thousands of species, but run out of farmland and resources as well.

Lack of information is one of the biggest barriers in agriculture production. The smaller farmers have very little knowledge of not only modern farming methods, but successful marketing techniques as well. This makes it difficult for farmers to move their product, discouraging agricultural development. Bolivia also lacks the research facilities to better improve farming methods. Without adequate research facilities, modernized farming techniques will be difficult to implement. Because of such poor farming methods, farmers of Bolivia are more vulnerable to droughts and floods. These natural disasters have devastating

effects on the crops, resulting in even lower agricultural productivity. Education may provide subsistence farmers with more control over marketing, better production techniques, and more negotiating power.

Climate change has created weather extremes which have had a negative effect on agricultural production, ruining the crops of Bolivian farmers. In the last century, the temperature in Bolivia has risen by one degree centigrade and rainfall has decreased to about five inches. Climate change has resulted in an increase of intensity of natural disasters such as El Niño. El Niño is a cyclic weather pattern that creates warm winds from the Pacific Ocean. The change in climate has increased the severity of El Niño's precipitation, resulting in an increase of flooding and drought. Both of these results are devastating to crops and livestock.

Water scarcity has also become an issue in Bolivia. Many subsistence farmers receive their irrigation and drinking water from the Chacaltaya glacier. However, due to climate change, the glacier has been receding 30 meters a year. This measurement indicates that the problem will get worse as time progresses. This will leave many Bolivians without water, both for drinking as well as for their crops, which many depend on for their livelihood. Without this vital reservoir of water, farmers will be unable to provide food for the growing population. The problem will only worsen in the years ahead because Bolivia lacks the resources to adapt to changing weather patterns.

In the coming years, water scarcity will continue to be an issue. The best way to manage this problem is to focus on conservation methods. Based on the current economic situations in Bolivia, surge flow irrigation would be the most beneficial to the terrain. This method works by applying periodic surges of water using irrigation lines, instead of a continuous flow. This provides a more equal distribution of water to the plants. Surge irrigation differs immensely based on the type of soil, but it can be customized and will adjust to provide maximum efficiency. Meters measure the water to determine the correct cycle. This process of surge irrigation will increase the efficiency of fertilizer and decreasing salinization of the soil.

Although an excellent alternative, the start-up cost is preventing its use. However, the benefits this system provides, such as a decrease in water use and long life span, outweigh the initial cost. Educating subsistence farmers on this technology and its benefits will increase its popularity, and allow them to move forward in the sustainable direction. Government subsidies would also encourage its use.

Genetically modified foods could significantly increase yields; however there is opposition for their use. In 2001, Bolivia had banned the use of Genetically Modified Organisms, but repealed their ban to test the plants in 2005. GMOs are not only more resistant to disease, making their growth easier and less intensive, but they can also be modified to be more nutritious. By implementing traits of successful crops in Bolivia to other plants, productivity will be increased. In a country where one in every three children under the age of three is malnourished, GMOs can make a big difference. Not only can GMOs provide improved nourishment and increased yields, but they can be created to adapt to changing ecosystems. As reported by *American Scientist,* "High soil salinity is believed to hinder crop yields in 100 countries, including Bolivia." Currently, scientists are working to develop plants with a better salt tolerance. These GMO's would allow countries to adapt to lower quality soil. Research should be done on what makes Bolivia's native crops thrive. Taking genes from plants that grow well naturally in Bolivia and genetically implanting them into other crops will increase productivity.

The practice of unsustainable slash and burn agriculture should be abandoned, and the land that has already been converted should be treated with more care. Practices such as low or no tillage protect the soil by not exposing loose soil to wind or water, preventing erosion. This will also reduce pollution and enrich the soil for future planting seasons. Crop rotation will also benefit subsistence farmers by reducing

erosion, preventing soil depletion, controlling pests, and reducing pesticide use. Crop rotation is a simple process which will bring great benefit to small farmers. By rotating the types of crops planted, soil depletion and build-up of pests will be prevented. Cover crops and compost will also prevent erosion. They protect the soil from erosion as well as pests and weeds. Cover crops also add organic matter to the soil by biodegrading into hummus, a material that provides great benefit to crops. Bolivia should also specialize in crops native to the region. These crops will be better suited for the growing environment, increasing productivity.

The best way to encourage sustainable agriculture is strong government policies. Implementing more efficient technology can be expensive for most subsistence farmers. By providing subsidies and tax exemptions to farmers who employ sustainable agriculture, more farmers will be willing to convert to these methods. The loan process should also be made easier for Bolivian farmers. Many people do not have the funds to convert to sustainable agriculture. Loans would not only encourage sustainability, but also strengthen Bolivia's economy. The Bolivian government should also be working on developing more research facilities. Research facilities will produce more efficient technology based on the climate and terrain of Bolivia. It will also improve GMOs which will make their use more accepted in Bolivia. A program to spread information to small subsistence farmers should be adopted. Information goes a long way, and a better informed farming community will make better decisions both for the welfare of the Earth as well as their own. Efforts should be made to reduce climate change. Although Bolivia has a relatively small ecological footprint in comparison to other countries, deforestation and slash and burn agriculture are not working. By creating government policies to reduce or to prohibit these practices, biodiversity and healthy soil will be protected.

There are many ways world organizations can aid Bolivia. The U.S. currently assists Bolivia in food scarcity, health, and environmental issues among others, but the government cannot do it alone. Private organizations can make a greater impact. The United Nations can play a big role by creating a suitable climate bill that drastically cuts carbon emissions. Although there has been recent progress to cut emissions such as the Energy Bill, more has to be done. Major countries can lead by example, and cut emissions to at least 350 ppm, the recommended maximum to sustain our current lifestyle, hoping others will follow suit. This would decrease climate change, slowing the melting of Bolivia's glacier and decrease the severity of natural disasters. The International Committee of the Red Cross could help by setting up small clinics that teach subsistence farmers how to farm more sustainably using practices such as surge flow and low tillage. Such programs could be funded by the World Bank. The funding should be seen as an investment; it is cheaper to prevent an environmental problem, such as deforestation, then to fix it later. World Wildlife Fund could also assist Bolivia in protecting its rich biodiversity. By setting up nature reserves, both land and animal would be protected. The Union of Concerned Scientists could have a major affect in Bolivia. Their goal is to use science to solve environmental and social problems. This organization includes scientists, economists, and engineers. By allowing this group to conduct political, social, and economical research in Bolivia, better ways to increase agricultural productivity will be found, allowing the other organizations focus on Bolivia's main problems.

The biggest way to have an impact in Bolivia is by spreading information. Getting information to the poorly informed farmers will allow them to see that converting to modern practices will prove beneficial in the long run. By developing strong government policies that encourage sustainable agriculture, the plans will come to fruition. With the commitment of private agencies dedicated to assisting the country of Bolivia both economically and politically, the transition to sustainability will be made easier. By focusing on ineffective agricultural practices, lack of information, and government instability, both problems of food scarcity and resource degradation will be resolved.

We know what must be done. By taking the initiative to act on this knowledge not only people, but the environment can be saved. Although this plan may take time to effectively be instated, once running this plan will maintain itself. Each generation will benefit from this plan, and the rewards will belong to more than just the people of Bolivia. We have the means with which to help, and though there are some who may ask, why must I help, there are many more who realize that it is our duty to humanity to do so. We live in a world plagued by problems of all varieties and all magnitudes. We live in war, we live in famine; we live in disease, we live in poverty. But we also live in a time of great progress with which to challenge these problems. And because of our knowledge, which grows each day, those committed to making a difference cannot fail.

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