

## Natural Resource Conservation in Mexico

Derek Koebrick

Charles City High School

Forty percent of Mexico's population is below the official poverty line. Many families live in total poverty, and are farmers out of necessity. Many families hold other occupations alongside the supplemented subsistence farming which is needed to grow food for their family, not necessarily to make a profit as with developed agriculture. The minimum wage is approximately four US dollars per day, not per hour.

Mexican farm sizes vary greatly, as with any other country. The major difference is that most of the larger farms in Mexico couldn't ever compete with even the smallest of farmers in the United States. Over sixty-five percent of Mexican farmers utilize five acres or less per family. Five acres to use as farm land, not five acres to live on like many American farms. To make matters worse, this land is generally poor quality, condemned by eroded, infertile soils or low annual rainfall.

Mexican subsistence farming is mostly intensive with few acres of land per farmer to raise crops on. Principal crops include corn, soybeans, coffee, sugar, tobacco, and cocoa with dwindling production of cotton. Distribution of the above stated crops varies, depending on factors such as rainfall, temperature, and demand. One-third of Mexico's land is designated as grazing land, due to high soil erosion and dry lands. Animal husbandry, or raising of livestock, contributes about one percent on the annual GDP. Weak productivity is likely due to high feed costs, low prices which are fixed by the government, poor weather, and climate conditions. Mexicans raise mainly grazing-compatible animals, such as cattle, goats, and sheep. Pigs and chickens are also raised.

The main crop for farmers is corn, which is grown on forty percent of viable land. During the 1980's, forty percent of all governmental agricultural support went to corn, mostly in the form of subsidizing the purchase of tortillas, the primary manner of corn consumption in Mexico. Although the plan helped some people, few of the subsistence farmers the program was supposed to help actually benefited from the program.

Additional agriculture programs were implemented, including the North American Free Trade Agreement, or NAFTA. This made Mexico a viable venue for American farmers, and in turn, food prices dropped in Mexico due to the fact that corn could be purchased from America cheaper than Mexican farmers could produce it. Although this benefited the non-agriculture population of Mexico, subsistence farmers struggled to sell their crop.

Mexico faces many environmental challenges. Many of the tropical forests of the southern regions have been cleared for pasture land. Tabasco, a state in the south has seen the results of these actions. In 1940, half of the state was covered in tropical forests. By the late 1980's, only ten percent was tropical forest. In that same time period, pasture land increased from 20 percent to sixty percent of the total area. Deforestation is one of the main causes of erosion, perhaps the most serious environmental issue affecting Mexican agriculture.

The Mexican government categorized eighty-six percent of all Mexican land into three erosion divisions. Thirty-eight percent of Mexican land is in initial erosion stages. Thirty-one percent is in an advanced state of erosion, and seventeen percent is completely eroded. Soil erosion is pronounced in the north/northwest, as sixty percent of this land is considered either completely eroded or in an advanced state of erosion. This region is irrigated, due to its dry nature, but the salinity of the water aids in the

destruction of the local soil. Irresponsible irrigation leads to desertification, the degradation of soils of arid and semi-arid regions.

One of the biggest factors of erosion is caused by overgrazing. Between pastoral actions, such as clearing trees and grazing animals, erosion has been accelerated in northern Mexico. There is little rain penetration, so the runoff water, pushed by gravity, trickles on top of the soil surface to the bottom of the terrain, where it deposits the soil particles. In the south, the soil water capacity is much greater than that of the north, but according to research, overgrazing could substantially reduce the water storage capacity of the soil, which would lead to similar difficulties as stated above.

Soils in the northern part of the country are losing several millimeters of soil every year. These soils are located on steep slopes, plus the area is heavily grazed. When the heavy animals, which are usually cattle, trample the vegetation, they pack the ground. The livestock eat only grassy and herbaceous plants, so only thorn scrub and pine remain. These types of plants are less effective for holding the fine layers of soil in place. These factors combine, along with the sheer intensity of the rain produce erosion. The valley bottoms where the least amount of rain falls has intense erosion, too. These types of sites which are horribly degraded pasture lands were heavily overgrazed. This area also handles the majority of the rainfall, due to runoff. This type of erosion is called flooding-induced gully erosion, which is only a mere two percent of total erosion. Sheet erosion, which is surface-type erosion, applies to all surfaces considered. The first example above is a prime example of sheet erosion.

Aside from erosion, water conservation is a major environmental issue affecting Mexico. Aquifers, which are underground water deposits, have been getting tapped increasingly over the years. As the pump water out, especially in the arid parts of the country, they aren't getting replenished. Decreased water output is happening currently, due to over-tapping.

The importance of water conservation to Mexican agriculture is tremendous. Mexico is classified as an arid and semi-arid country, with parts of the country receiving a mere twelve inches of rain per year. While this is true, most regions of the country get more, between twenty-four and forty inches, while the wettest areas can receive as much as seventy-eight inches of rain.

Mexico has pronounced wet and dry seasons, with the rainy season between June and October, and July being the wettest month. In the center of the country near Mexico City, over six inches of rain fall during the wettest month. On the contrary, February is the driest month with rainfall being a dismal quarter of an inch near the capital city.

Water is used for irrigation, as much of Mexico is covered by hot and dry terrain. The water being pumped from underground aquifers has high salinity concentrations, which when used for irrigation purposes, usually does more harm than good. The salinity can harm the plants directly by decreasing water utilization in the plant. This can then kill the plant. Water that is being sprayed on fields for irrigation purposes then turns into runoff water. This happens because as the saline-water solution percolates through the soil, the water evaporates, leaving only the ionized salt particles. The dominate  $\text{Na}^+$  ions create highly concentrated sodic soils. It is difficult for water to penetrate and drain through sodic soils due to poor soil structure. The resulting excess water turns into runoff water.

The other front of the battle begins with the dead plant. After the water evaporates out of the plant, the plant shrivels up and shrinks. This deems the roots worthless to hold the soil. The runoff caused by the sodic soils then picks up the soil particles and carries them to the bottom of a valley where they are finally deposited. This is how salinity creates erosion.

The National Institute for Forestry, Agriculture and Animal Husbandry Research of Mexico has created an effort to prioritize water resource research on watersheds. A watershed is a drainage basin, which is an extent of land where water drains downhill into a body of water. Currently, they are analyzing many of the watersheds that have a local impact. Eighty-five percent of the water availability comes from highlands. The water then flows to irrigation districts where water reserves are consumed. Places like these are where seventy percent of the GDP of agriculture is grown. Many of these watersheds accumulate water from the highlands, and then accumulate in central Mexico.

Global climate change is the final issue that will be discussed in this paper. Climate change is expected to have one of the biggest impacts on subsistence farming in Mexico of the modern era. As northern Mexico has experienced a series of droughts in recent years, crop farming is almost becoming non-existent. With dramatic fluctuations in precipitation output, varying directly with location, agriculture could become even more uncertain, a risk many Mexican subsistence farmers can not afford. To make matters worse, corn prices are on the rise in Mexico, due mostly to European and American producers selling corn for corn-based ethanol production. If output prices increase, input prices will climb also. Taking this into factor, if a crop fails, perhaps due to weather or climate change, it can break any subsistence farmer. Even with the improved production, Mexico has to import white corn from the US, South Africa, and Mozambique to ensure an ample stock and stable prices. White corn is being promoted in Mexico, rather than yellow corn. White corn is the preferred corn to use in the tortilla making process.

While Mexican subsistence farmers shift to increased corn production, part of Mexico may not be able to produce corn. Northern Mexico and part of the American Southwest may not be able to produce corn due to permanent drought forecasts as a result of global climate change. According to a study, annual rainfall in the stated region will have decreased by almost twenty percent by the end of this century if predictions are true. Northern Mexico has bared several droughts in the past twenty years, which has caused significant reduction in agricultural production in the region.

One alternative to battle reduced crop productivity could be in the seed. Agronomy geneticists have designed corn seed varieties that are more resilient to diseases such as blight, and weather extremities, such as drought and high rainfall. These varieties could increase potential productivity by fifteen percent.

Another factor, while not necessarily a major issue, is that as corn prices go up, acres of corn planted go up. This means fewer acres of other crops including coffee, cocoa, soybeans, and agave. This could have a negative effect on the tequila industry, as tequila is produced from fermented agave. As agave plants are moved west, the maturity rate increases. This means that the tequila industry would be over-producing tequila. A simple solution to the tequila issue and the under-production of corn would be to plant corn where some agave plants are located.

One of the positive outcomes of global climate change that can affect Mexican agriculture would be the carbon fertilization effect. Carbon fertilization can increase crop growth by the atmospheric carbon interacting with the sunlight through photosynthesis. Some studies have concluded that with a doubling of carbon dioxide, average yields of crops increase approximately thirty-three percent. Increased carbon dioxide levels amplify maturity rates in plants.

In southern Mexico, climate change has actually been making farmers money. Approximately two thousand farmers are fighting global climate change and making a profit from climate change. *Scolec Té*, which is translated from ancient Mayan languages to “the tree that grows”, is the name of the project that enables farmers to profit from global climate change. The farmers taking part in this project are paid for conserving their dry forests, protecting wildlife, and farming in a way that creates minimal environmental damage. Credits of tons of carbon dioxide transformed into oxygen through photosynthesis

sell for five to fifteen US dollars per ton. Scolel Té is the Mexican division of the global project Plan Vivo, which includes programs in Uganda, Mozambique, and southern India. Together, Plan Vivo sells approximately 90,000 tons of credits per year, with that number on the rise.

In conclusion, the main environmental issues regarding Mexico subsistence agriculture are soil conservation, water conservation, and adapting to global climate change. Soil has been eroding at increasing rates over the past several years.

Although water may be scarce in arid areas, water conservation is not a major factor affecting Mexican agriculture. Because the terrain of northern Mexico is mountainous and hilly, much of the rain water falls on slopes, and then becomes runoff, which isn't effective for watering purposes. So while creating terraces or steppes would correct the problem, this is impractical. This is why northern Mexico's agriculture is very animal based, especially extensive breeds such as cattle, sheep and goats. The livestock don't need rain, just water to drink, which can be easily arranged. So while water scarcity affects crop farming, livestock farming is a suitable alternative.

Erosion is one of the biggest conservation issues with Mexican subsistence agriculture. Not only does erosion affect crop farming, but it affects livestock farming, too. Families in northern Mexico are more disadvantaged than farmers to the south, mostly due to the majority of erosion taking place in northern Mexico.

Water salinity affects livestock as well as crop farming. The salt can cause desertification which can and will leave nothing for the animals to eat. This would mean that the subsistence farmers would have to decide on giving their high price corn to their animals as feed, or save it for themselves.

Finally, one of the more controversial issues is global climate change. Although there are some benefits about it, such as carbon fertilization and selling of carbon credits, many long term effects are depressing, including the drastic fluctuations in temperature and rainfall. These effects could make much of Mexico completely useless when trying to grow crops.

To prevent this from happening, something drastic needs to be done now. Advanced research needs to be done to find alternative corn varieties, efficient methods of turning greenhouse gasses into harmless gasses, and anti-erosion techniques. With the coalition of Mexican farmers and groups such as the United Nations or the World Bank, subsistence farmers of Mexico can be a thing of the past, and a period of agricultural prosperity can be achieved.

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