Corn:
Uncovering a Kernel of Truth

Written by the Biology Senior Seminar Class

The College of Idaho

Spring 2014

Chapter 4.The Builders of a Corn Plant and the Destroyers of the Environment

By Sora Klopfenstein

The corn kernel sits in a sack with every part it being touched by other corn kernels. They wait in this sack until they are suddenly moving and scattered around the dirt through rotating axles on a big truck. It is dark and the dirt is dry and there are no nutrients to start taking it. Just as he starts to wait for a better place to start my new life, he realizes that he is suddenly surrounded by all of the phosphorus, nitrogen, and silicon that he would ever need. The kernel begins taking in all the nutrients as soon as the dirt around becomes damp. There are more than enough of the nutrients than the kernel could ever uptake and shoots up quickly through the surface to be greeted by sunlight and many other shoots. Because the environment is so ideal, the kernel doesn't hesitate and gets right to work on growing tall and producing cobs covered in healthy kernels. There is no competition between the other corn plants for nutrients or water and even space. Even the weeds and pests that usually compete and attack are not bothering our little kernel. When these kernels become fully grown stalks with cobs, they are ready to be harvested. Some go straight to the table for human consumption but most of them are headed to processing plants where we will be turned into food for animals on the farm or fuel for cars.

Corn has found itself to be a huge part of the world we live in and we work on making the best environment as possible. It is dependent on the farmers to cultivate it just as much as the farming industry depends on it to function as a system. However, the strong monoculture is found to be incredibly harmful to the environment by polluting the water and damaging the homes that many species need to survive.

We now follow a little molecule of nitrogen (N_2). He's thrown out onto the dirt on the farm between the plants. All he really wants to do is become something useful. He is willing to be used by anything in any system. So he sits there in the dirt, waiting to be taken up by the corn plants around him. N_2, along with 40% of the other N_2 molecules around, ends up getting caught in the run-off water that was also meant to be taken up by our previous kernel and all his friends.[1] He finds himself caught up in the water cycle and as he and the other molecules get used and converted into all of the other ecosystems they reach.

Reliance on corn in agriculture and the environment

Our farms consist mostly of corn crops. The economic benefits of corn make the crop the most commonly grown plant. The amount of land that is being used to grow corn is as big as California.[2] The next biggest crop is soy beans and they are far from leading the farming crops and will have a hard time catching up. It took just five years to increase the amount of land used for growing corn by 13 million acres. This was talked about in chapters 1 and 3. Without getting much more in depth, we already notice that the heavy reliance on farming is narrowed down to the farming of corn and the harsh environmental impacts can point back to the corn crops.

There are numerous reasons for the large fraction of crops being corn. The huge reliance farmers have on corn in agriculture starts with the subsidies the government offers, and includes the increasing demand for corn which is talked about in depth in chapter 10.

The start of this becoming a key agricultural crop started in the late eighteenth century. It wasn't at a time when the use of corn for food dropped. People wanted this crop for its efficiency in growth. It was able to grow in the summer and whenever the cultivation of traditional cereals was out of season. Corn was used as its green manure which allowed for its decomposed material to fertilize the ground which grew a corn crop again the next year. Corn became efficient in the way it used the soil, plus it had a better use of the money and labor that went into growing this crop.[3] The recycling of the plant for fertilizer was cost effective. The crop compared to others was able to use its resources more efficiently. The work that the farmer put into growing the corn crop was less than that of another.

Farmer reliance

Farmers are the cultivators of the start of the human food chain. Trace practically any food to its source and it will end up on a farm. Even farmers raising animals for consumption use crops to feed their livestock. Humankind has a reliance on the farmer and to balance that out, we have created ways to create reliance back from the farmer to grow certain crops. This is mostly through government subsidies, but just the cost effectiveness of corn has the farmer choosing to grow that crop over another.

Corn specifically has been the most popular crop in agriculture, but most of it stays on the farm. Almost three-fourths of the production of corn stays on the farm to be used as feed for the livestock. There is a huge international demand and consumption of corn in the industry, but the grain goes back onto the farm. Corn becomes pork or beef[4]. The animal production's contribution to the corn production is talked about more in depth in chapter 5.

The Americans' need for certain crops to be grown in great amounts to quickly feed the country is clear to the government. This is where subsidies have come into play. Agricultural subsidies are created by the government as a way to supplement a farmer's income from only the crop proceeds. Corn attains the highest government agricultural subsidies with spending $41.9 billion from 1995 to 2004.[5] Money is a strong driving factor for growing corn crops as a mass production.

Corn's efficiency

Outside of the monetary incentive, farmers are drawn to grow corn over other crops because corn has one of the greatest yields. The size of the corn and the number of ears doesn't vary with the food it is supplied. The crops can also withstand differing weather conditions and has been modified to withstand pests.

Corn has been known for a very long time of its potential. In the book *Corn and Capitalism*[6], Warman talks about how corn's reputation changed in the late eighteenth century from being primarily a food to being a multi-faceted agricultural crop for uses outside of human consumption. Corn proves to be a great crop because of "its high yield and low cost, its growth in the summer which is when traditional cereals were out of season, and its intensive use of soil, capital, and labor[7]." When all other cereal grains that were brought by colonists were failing, the reliance leaned onto the corn crops of the Native Americans. The primary cultivators were the same peasants who depended on it for food. Now, the demand has become more widespread and almost all products can be traced back to corn.

Corn is a very versatile crop that is able to be used in so many different ways as talked about in following chapters. The demand for corn isn't going to change or shouldn't change because there are so many innovative uses for it and new uses coming up all the time. As the process of providing corn is evaluated the effects of the agriculture practice is noticed in the changes to the environment.

The rate of U.S. corn production sped up from 1956 of 84 million tons to 224 million tons in 1980[8]. In this time, the efficiency of growing corn was due to the huge increase in agricultural technology. Between the bigger more efficient machinery, genetically modified plants, fertilizers, insecticides and herbicides, farmers found that they couldn't pass up on producing corn. The use of machines and intense fertilization not only created more corn production but also energy consumption. The energy it takes to harvest corn and the energy the corn gives back in animal feed, fuel, and food has negative balance. It takes more energy to harvest than corn reinvests back into the energy cycle. Subsidies make the farming of corn worth it to the farmer.

Reliance from other species on added nitrogen

One of the major problems that farmers face in keeping up with the increased demand for corn is keeping the nutrient levels in the soil for the crops to grow. Because crops are planted yearly, the nutrient levels must be artificially added with fertilizer. As fertilizer is added, it affects more than just the corn plants, but the other organisms in the same environment. "Chemical fertilizer became indispensable for growing grain. The rate of nitrogen application in 1970…was seventeen times greater than what it had been in 1945[9]." The corn can't take up all of the fertilizer in the soil. As more fertilizer is added, more runs off into the rivers and streams.

One particular study looked at how increased nitrogen, a major element in the fertilizer, increased the competition between a weed and corn[10]. This weed, palmer amaranth, is a highly aggressive pigweed species. Similarly to corn, it is very responsive to nitrogen. Both corn and Palmer amaranth are C4 species. C4 species take up nitrogen more efficiently than other types of plants. These can be expected to react in similar ways when nitrogen is added to the soil. When nitrogen is added to the soil, the growth goes up greatly. When there is one palmer amaranth plant in a meter of crop row, there was an 18% corn yield loss[11]. This plant is a weed and restricts the growth of the crop. Just as the nitrogen is added to increase the yield of corn, the same fertilizer that is promoting growth in the corn also promotes growth in competitive species. This counteracts the actual purpose and shows how this crop can be inefficient to work with.

The downside to corn

There are many ways that corn is relied on because of its versatility and efficiency. This heavy reliance keeps growing and we have found many ways that this exploitation can turn around to bite us. The extra fertilizer and pesticides run off into water and cause numerous problems downstream. These start with the proliferation of life from the extra nutrients to the sudden drop in oxygen as these plants begin to decompose which creates dead zones known as eutrophication. This event streams into other ecosystems causing damage in deeper and deeper levels.

Eutrophication

A dead zone is created because of nutrients like nitrogen and phosphorus flowing through the rivers downstream collects when the flowing water meets a lake or ocean. The flood of nutrients causes a proliferation of growth of plants. The plants and phytoplankton compete for space and continue growing out of control until they begin to decompose. As the organisms begin to decompose they take up oxygen, which depletes the amounts that are found in the water. For life to continue in the water the organisms need oxygen and the lack of oxygen causes them to die or are forced out of the area. This process that depletes the oxygen in the water is called eutrophication. There are some species that proliferate off of the lack of oxygen. Species like some amphipods, flatworms, and barnacles are able to survive and even thrive. As their numbers grow, other organisms are competitively driven out due to resource availability leading to loss of biodiversity.

There are other areas where runoff has caused similar problems around the world. One of the places that were found, as another hypoxic zone, was an area off the coast of Texas near the Gulf of Mexico, discovered in 2007[12]. The areas in the Chesapeake Bay and the North Sea are smaller but are similarly traced back to fertilizer runoff from farming. They also cause collapse of fisheries and recreational fishing in the surrounding areas.

Nitrogen cascade

The result of fertilizer runoff and its effects on each ecosystem is a part of the nitrogen cascade[1]. Reactive nitrogen species run from one ecosystem to another. In each of the systems, some of the nitrogen is used and the rest moves to another system. Some of it is converted in different forms such as N_2O, which is given off in the atmosphere leading to an increase of greenhouse gases. The parts that don't convert into other forms, just travels into a different ecosystem, like how nitrogen runoff from farms enter into rivers. The cascade can travel quickly or slowly through systems depending on how much nitrogen the system stores.

In the different systems, there are varying ways that the excess nitrogen reenters the environment and has an effect on the human population. The reactive nitrogen that is converted into N_2O affects the tropospheric ozone and causes serious respiratory illness, cancer, and cardiac disease[13]. The nitrogen in grasslands, streams and coastal areas cause a loss of biodiversity and habitat destruction.

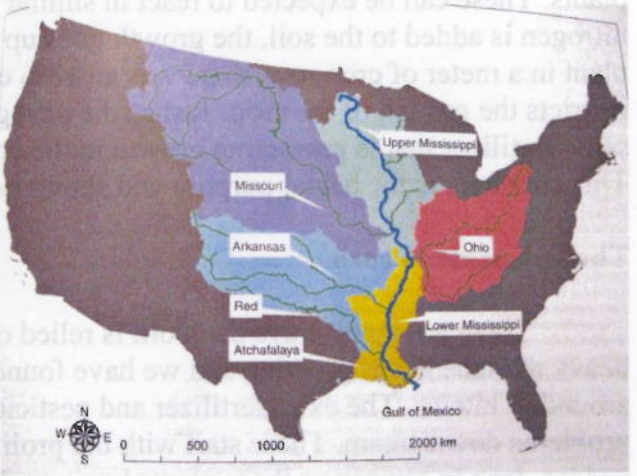

Figure 1. The image above is a picture of the main areas that are considered a part of the Corn Belt and where they flow into the Mississippi River into the Gulf of Mexico.

Fertilizer runoff

The start of the nitrogen cascade is initiated mostly from the fertilizer that runs off from farms, specifically corn fields. The biggest farming area in the US is called the Corn Belt and is found in the Midwest. The Mississippi river runs straight through this

region and is the route in which the runoff circulates down through the systems by channels like streams and rivers. The effects of the excess fertilizer can be found all along the river down to the ocean by creating dead zones.

Dead zone

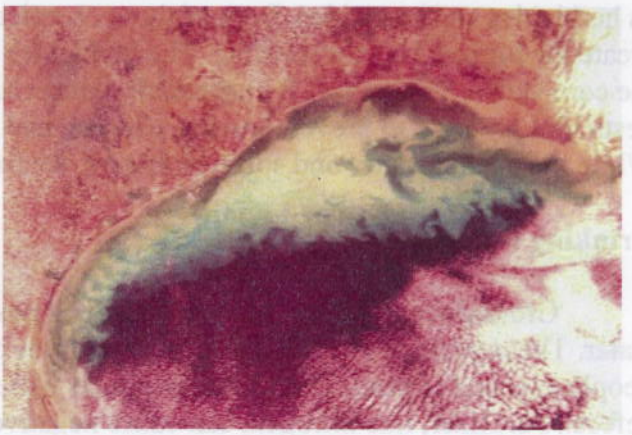

Figure 2. Picture of algae bloom from NASA when the fertilizer run-off in the Mississippi River meets the Gulf of Mexico.

The largest area of damage that the runoff from the Corn Belt causes is the dead zone in the Gulf of Mexico. In this region, the damage has caused a huge area where no life can develop. In 2002, it was measured to be more than 8,400 square miles at the biggest recording. It has decreased over the years as there is more awareness to the damaging effects of excess fertilizer. In 2012, it was the size of New Jersey. There is no life in this area, which has increased the danger for fishermen to be fishing farther from the coast to find their catch[14]. This has caused a huge economic drop as the commercial fisheries can't keep up with demand for fish. There is a huge loss in the biodiversity of water species. The actual dead zone changes because of currents and range sizes also change simultaneously as stages of framing change throughout the year as the stages of farming change.

Diminishing biodiversity

The effects on the life in the water are huge. There are many species which have become endangered and threatened due directly to the conditions the runoff from farms creates. There is a huge effect on how food production affects water life ecosystems. The change in water flow has reduced the regular water flow into the ocean. Animals that are dependent in coastal habitats and estuarine-dependent species are most affected. One example is the damming of the Colorado River. The estuarine system that this river flows into changed from a healthy estuarine system into one of high salinity and critical nursery grounds for many important species including shrimp. In the Upper Gulf of California the change in water movement has affected fish spawning and migration which caused a massive collapse in commercial fishing and a loss of species diversity in the affected areas[15].

The loss in biodiversity creates even more problems. The different species are able to provide food for other animals and demonstrate a thriving environment. This genetic diversity is important in "increasing and sustaining food production levels and nutritional diversity[16]." There is a huge contribution to the biodiversity in the soil stemming from insects and other inhabitants of the soil. This helps decomposing litter and recycling nutrients like nitrogen. When there is excess fertilizer, the flowers and plant diversity becomes strictly downsized. These are the habitats for many farmland species like insects and birds. The farmland birds depend on the diversity of insects for their first few weeks of life[17].

Herbicides/pesticides

Other damage from the runoff that isn't due to the added fertilizer includes additives such as herbicides and pesticides. Both of these chemicals are commonly used in farms to effectively create the biggest harvest possible. The herbicides are used to kill the weeds that pop up between the corn stalks. This runoff is particularly dangerous and is found to be carcinogenic[18]. The pesticides are used to prevent insects, disease, and rodents from damaging the plant structures. While the chemicals try and solve problems, we find them causing more problems downstream.

Drinking water

Groundwater is the sink or end place of pesticides and herbicides entering the drinking water. These problems to humans can come from pesticides in drinking water and in the air. People exposed to pesticides can have effects like skin irritations, nerve disorders, or birth defects. Fertilizer, like nitrogen, can cause negative effects in the human body. NO_3^- is converted to nitrite, which can cause methemoglobinemia, which changes how hemoglobin takes up oxygen and transports it around the circulatory system[19]. Infants and people with kidney problems are most prone to this type of problem. Humans are affected by the levels of NO_3^- in other ways like respiratory infection, alteration of thyroid metabolism, and cancers. While the World Health Organization monitors the drinking water, the levels can change quickly depending on the part of the farming season.

Aquatic life is an interesting problem because there is not a lot of potential for reactive nitrogen to accumulate on the surface water because the contact time is short. In streams, nitrogen is denitrified or taken up by the system by aquatic plants and is recycled by consumers and decomposers.[20] Similarly to the nitrogen being quickly taken up in the rivers and streams, coastal ecosystems are hugely impacted by the nitrogen. The process in which reactive nitrogen leads to increased growth of algae is demonstrated in the dead zone at the Gulf of Mexico. For a short time it can increase the production of harvestable fish. In the long run, the temperate zones turn into areas completely depleted of oxygen.

We go back to the little kernel that started it all. He's proud of himself. He found that he has become hugely popular. He's irreplaceable and in fact, so versatile that he is getting more and more jobs. No one can balance that much on their plate and at some time something becomes off balance. In corn's case, it has become the environment around it. Corn can't survive on its own but it created a way of adapting its way into every part of our own everyday lives with health of wildlife and the environment.

---

[1] J. Galloway (2003), pp. 341-356.
[2] J. Foley (2013).
[3] A. Warman (2003).
[4] Ibid.
[5] M. Kegans (2005).
[6] A. Warman (2003).
[7] Ibid.
[8] Ibid.
[9] Ibid.
[10] E. Ruf-Pachta (2013), pp. 249-258.

[11] K. Liphadzi (2006), pp. 156-165.
[12] T. Cox (2007).
[13] A. Wolf (2002), pp.120-125.
[14] H. Jackson (2007).
[15] M.A. (2005)
[16] AGP (2013).
[17] Ibid.
[18] L.H. Nowell (1994).
[19] J. Galloway (2003), pp. 341-356.
[20] B. Peterson (2001), pp. 86-90.