

Brandon Arbuckle
Academy of Science and Entrepreneurship
Bloomington, Indiana
Sudan, Factor 6

Sudan: Desert Locust Plague and Possible Semiochemical Solutions

Sudan has had a history with desert locusts; located on the coast of the Red Sea, a common breeding ground for the desert locusts, the pests quickly sweep across the region, consuming crops and vegetation along the way and leaving behind a trail of destruction. Swarms of desert locusts have been recorded for centuries; they are even mentioned in the Bible and Quran. There are additional problems that threaten crops inside Sudan, but the desert locust is the most well-known and destructive. The fact that the locusts thrive at the same time as the crops, during times of rain, is a curse in itself.

Sudan has a very culturally rich society composed of over 550 different tribes, and speaking in nearly 150 different languages (Bechtold). Many of these tribes have their own indigenous religions and languages, passing down their knowledge verbally from one generation to the next. Villages also have their own styles of music which have been used for intercommunications between tribes of different languages and dialects. The cultural melting pot that makes up Sudan is one of an abundance of things that make it an amazing country.

The history of Sudan has been shadowed with conflict. Civil war affected much of Sudan during the 20th century, and in 2011 South Sudan seceded. Nearly 99% of the voters in Sudan approved of this separation, and South Sudan contains the oil that has fueled most of the country's growth (*Sudan Embassy.org*). Due to the recent occurring of this event and lack of individualized information, we will consider the Northern and Southern regions of Sudan as a single entity. Despite the separation of the two countries, it is essential that humanitarian aid be provided to each.

Families are a very large part of Sudanese society, and the behavior of an individual reflects how a family is looked upon in the community. This pushes each individual family member to try and make a good name for their relatives (these relatives may include aunts and uncles, cousins and siblings, etc.). Families may be through blood, marriage, or even honor. Due to these high expectations of each individual, family values are very high, and customs are important (*Resettlement Inter-Agency Partnership*).

Patriarchy is quite common in Sudan, and men are considered the primary breadwinners for both their immediate and extended families. Although the views and attitudes are changing, a majority of Sudanese men do not regard women as their equals. These views are changing faster in urban areas rather than in rural, where many older traditions take place. Domestic violence is on a decline, but it is frowned upon less in the more traditional and isolated villages compared to the cities and towns (*Resettlement Inter-Agency Partnership*).

Education is more readily available for men than women, and illiteracy among women is nearly 49 percent. This statistic changes from the Northern regions to the South, where it is more difficult to find employment and education for both men and women. The civil wars and relocation of civilians have made for very tough conditions to get an education. Many of these displaced refugees have little to no chance of receiving an education. The overall illiteracy rate of adults in the country is approximately 40 percent. The government provides free education for children between the ages of six and thirteen years of age, but educational situations in Southern Sudan are far worse than they are in the more urbanized North, with inadequate facilities and very few qualified teachers. A large amount of these educational facilities lack clean water and have poor sanitation facilities (*Resettlement Inter-Agency Partnership*).

Sudanese health care is almost nonexistent, but improving according to studies conducted in the past seven years. A study by the World Health Organization in 2006 determined that there are only 1.4 doctors per 100,000 people in Sudan (International Committee of the Red Cross). But in a study two years later for the CIA World Factbook, it was determined that there were nearly 28 doctors per 100,000 people (CIA World Factbook). It is nearly impossible to get any sort of a health care infrastructure established in Sudan. Years of poverty, war, drought, and famine have all contributed to this problem. When people fall ill they seek medical attention locally, if at all. Fortunately, the medical field in Sudan is one that both women and men can work together in, side by side with the same level of respect (Resettlement Inter-Agency Partnership).

Although the agricultural system in Sudan is frequently disrupted by pests, drought, and disease, when it is going through an undisturbed period, the Sudanese diet is fairly diverse and healthy. The rural diet is slightly less diverse, but for the purpose of this essay it will be the primary focus. Most farmers grow their own produce and are likely to find pre-packaged food a foreign concept. Goats, sheep, chickens, and sometimes cows are common livestock herds in the Southern regions of Sudan. In a combination with these meats, Sudanese families may eat maize, rice, beans, sweet potatoes, yams, groundnuts, or even onions (Resettlement Inter-Agency Partnership).

Sudan's agricultural sector makes up about 45 percent of the country's economy. It also makes up for two-thirds of all employment, and is supposed to provide for three-quarters of the population's food. One of the main problems with the Sudanese agricultural system is the lack of land that is able to be grown on. Drought, desertification, and pest infested areas all contribute to this no-man's land. Some of the more common crops that are grown in the fertile areas consist of maize, sorghum, peanuts, wheat, and sugarcane (US Library of Congress). In addition to these exports, Sudanese livestock includes camels, sheep, goats, and cattle. In 2004, about half of Sudan's 251 million hectares is suitable for farming. Only about 13 percent of that fertile land is actually used for sustenance farming (US Library of Congress).

Some of the major barriers preventing the Sudanese people from producing and selling large amounts of produce and harvest include periodic droughts, desertification, pests such as the desert locust, witch weed, and soil erosion. Many farmers don't have access to education centers that can help them better establish themselves in markets, if the markets are at all accessible (US Library of Congress).

The desert locust is one of the largest hostilities to Sudanese agriculture. This locust is part of a vicious cycle that causes billions in damage annually to Northern Africa and surrounding regions. Sudan is one of the countries that have been most heavily hit by this infestation. The locusts breed in moist and rainy environments, and then congregate when the rain provides sufficient vegetation. When these pests congregate, their behavior changes and they begin to swarm. After swarming, and after the vegetation is depleted in one area, the swarms migrate to surrounding areas and begin relentlessly consuming crops. This happens multiple times annually and affects areas the size of continents. With Sudanese farming families lacking the equipment and knowledge to effectively handle these outbreaks by themselves, entire crops can be destroyed in anywhere from hours to days (Food and Agriculture Organization of the United Nations). This is especially harmful when most of the families rely on their own crops.

In current times, swarms of desert locusts are still consuming crops in Sudan and all across the northern half of Africa. As of the 24th of January, 2013, Sudan is considered to be one of the countries with the most threatened crops due to the desert locust. And as of the 15th of May, 2013, several swarms have been detected (Food and Agriculture Organization of the United Nations). After the locusts consume crops, environmental damage may sustain. After a crop is eaten, the farmers have to replant it. This constant loss of soil nutrients can lead to desertification and other related problems such as lower crop nutritional value. The consumption of vegetation can lead to the lack of food for livestock as well (Showler).

Furthermore on environmental issues, some of the control methods for the desert locust cause problems. Insecticides can cause damage to the soil and wildlife aside from the locust. Infected water pools can cause harm to migratory avian species, or untargeted arthropods (Showler). These insecticides and pesticides can also cause harm to humans who may consume locusts for their nutrients. An affected locust can carry these chemicals before they die, and after a human ingests them they are at risk of becoming ill, especially pregnant women, the elderly, or children. Governments in developing countries like Sudan may not be concerned about the environmental effects of these pesticides and insecticides, making the potential harm in the future harder, if not impossible, to undo (Showler).

So far there is no evidence suggesting that the desert locust swarms occur with any regularity. The times when desert locusts are unable to reproduce is both a blessing and a curse. Locusts breed and lay their eggs in moist areas, frequently after rains. This means that when there is a drought crops will suffer from a lack of water, but not as much from locusts. Measuring and gathering swarm and breeding information on locusts is somewhat challenging, due to how spread out they are over such a large amount of land. Most populate in areas that are inaccessible by conventional methods, breeding in mountainous terrain. The UN's FAO Desert Locust organization gathers information on swarms and posts it on their website. They also provide an early warning system for farmers in the areas that will be affected (FAOUN).

There are control methods, but they are unable to control locusts on a large scale. Desert locust control teams are sent out to collect data and detect breeding grounds so that they can provide an early-warning system to local farmers when a swarm may be imminent. Due to a lack of situational change many farmers in Sudan and surrounding countries will experience the same amount of crop loss as they have before. The constant swarms of biblical proportions are bound to be in our future as well, as they have happened in the past (Food and Agriculture Organization of the United Nations). In countries such as Sudan, the loss of crops means the loss of lives.

The long term effects of fewer or no desert locusts swarms could prove to be very profitable to both the government of Sudan, as well as the smallholder farmers. It is a commonly known and accepted fact that when the availability of crops decreases, the prices increase. So by diminishing the threat of desert locusts on crops, the chance for farmers to get their crops to the markets increase, and money in the farmer's pockets means one of several things: a) they can buy more seed and expand their farms, b) they can give their families a more diverse and nutritional diet, c) they may be able to buy better equipment to protect their crops.

In addition to the farmer's benefit, the environmental benefits may be substantial as well. Vegetation eaten by the young hopper locusts will have a larger chance of surviving, which can help prevent desertification, and provide more food for various other kinds of wildlife such as birds and bees. The popularity of beekeeping is increasing in Sudan, but is largely threatened by the use of pesticides against the desert locusts. A majority of beekeepers in Sudan are women. They are able to maintain the bees during any down time that they may have in order to provide for their families if the husbands are not present. If the locust population wasn't so threatening, the amount of pesticides used to combat the swarms wouldn't be so massive. In turn, the fear of losing hives to this abundance of pesticides could diminish as well (Showler and Global Giving).

Not only are the financial benefits helpful to farmers and communities in Sudan, but to the government as well. In 2004 and 2005, desert locust swarms cost the Sudanese government and FAO over \$500 million. This would have cost more if it were not for favorable conditions granted by Mother Nature (FAOUN). The money that could be saved if the locust problem were under control could be put towards other things Sudan desperately needs, such as a more structured educational system, better roads, or towards strengthening food security in the country.

Pesticides currently in use can have severe backlash to the environment, with the possibility of hitting non-target insects or animals such as bees, freshwater arthropods, or even other insects that are natural predators of the desert locust such as the *Speius nigricornis*, a parasitic locust-killing wasp species native to Africa (Encyclopedia of Life). Common methods in spreading these pesticides include planes, hand sprayers and sprayer trucks. The most commonly used pesticides include Biopesticides, which have a shorter shelf life and are harder to produce in larger quantities cheaply, Phenylpyrazoles, which affect a large amount of life aside from the locusts, and IGRs (Insect Growth Regulators) which can affect freshwater arthropods in addition to the locusts (FAO Control Guidelines).

A lesser-known control method that shows a promising future is the use of semiochemicals. Desert locusts emit pheromones that alter the way they interact with one another. Males are capable of secreting a volatile substance to promote faster-maturing of young locusts, allowing swarms to last longer and form faster (W. Loher). These pheromones can encourage everything from mating to marching, swarming to scattering. The research going into desert locust semiochemical possibilities is promising as well. Studies have shown that semiochemicals can even cause effects such as increase in cannibalism and predation, and increased susceptibility to other forms of pesticides, pathogens, and natural diseases (FAO Control Guidelines). It is common sense that if given the opportunity to eliminate a problem with minimal backlash or harm, it is the most logical route to take. So if presented with a way to eliminate locusts without even having to use pesticides, semiochemicals are the most sensible and logical way to go about it.

Implementation of the semiochemical control method would be similar to the actions that are being taken now. The primary methods of control currently consist of spraying pesticides on swarms, breeding grounds, and locust spawning areas. The pesticides are sprayed by hand from hazmat-suited personnel, by planes equipped with equipment similar to that of crop-dusters, and from trucks outfitted with sprayers (FAO). On a more localized scale, a method of “drop and go” semiochemical containers would be fairly easy to develop. This would be a great way to get farmers and families involved with the control efforts. The containers would be filled with either the semiochemical powder or liquids. Small holes or mesh along the sides of the containers would be opened to the air, and the wind would do the rest. Since locusts primarily utilize the wind to mobilize, so would the chemicals (FAO). They could easily be placed near breeding grounds to prevent the locusts from reproducing, or near spawning areas to prevent the locusts from maturing and eventually growing to their swarming state. Stopping the problem at the source is certainly the most efficient way of containing the locusts.

The low setup time and benefits provided to threatened crops and areas by the drop-and-go units would be substantial to farmers and their families. A national awareness campaign which could be sponsored by the government for semiochemicals and their distribution method could easily spread the word. FAO would be in charge of distributing these containers, and collecting them after their use, similar to how they do today (Locust Watch). GPS trackers could be attached to the vessels in order for easy retrieval in remote areas. In addition to retrieval, the pods would only be placed near breeding sites, so data could be collected. Shipping from the production facility to the distribution centers would be exactly like it is now with the currently used pesticides. Year-round administration of the semiochemicals would be required due to the spikes in locust population during most seasons; and the most common breeding and swarming grounds would be the primary target areas (*Locust Watch FAQ's*).

The Sudanese constitution includes several areas that encourage the advancement of their Millennium Development Goals. Several of these include creating a workforce that demands employees and encourages economic growth in areas such as oil and agriculture, targeting support for the agricultural sector including crop sustainability, livestock, and promote growth and productivity change, and increasing education in the agricultural sector to promote food security (United Nations Development Programme).

According to the United Nations Development Programme website, unless significant financial and humanitarian aid is provided to Sudan, the goal of targeting and supporting the agricultural sector will be difficult (UNDP). However, the suggested solution does not only affect Sudan. Developing semiochemicals that are able to untie the binds that hold swarms together would aid Africa's entirety. FAO and the World Bank provide grants and large amounts of pesticide use and research for Northern Africa. They also have investments in several new locust-management projects, some in the semiochemical area. On a more local level the Pesticide Action Network (PAN) in Africa influences which actions are taken regarding pesticide use. Currently they are able to encourage the use of certain pesticides through radio spots, meetings with farmers and gardeners, and conferences. If spreading the word of a new pesticide is a concern, contacting PAN would certainly be a first thought.

Although semiochemicals would take a season to show their effects, the results would be astronomically visible. The time period required for the effects would be a perfect time for agencies to get involved. The Sudanese government would have plenty of time to monitor the environment of their country during the initial deployment of semiochemicals, FAO could track their effectiveness, and research agencies could fine-tune the product itself. In addition to this, the Pesticide Action Network would be able to lobby and encourage the use of these. Education for how to effectively use this control method would be required for the handlers and sprayers. FAO currently has publications and training classes regarding desert locusts and effective control. Local and governmental level classes are available. Farmers are among the most common sprayers, and so long as they're willing to try something new, the use of semiochemicals can be implemented.

In reflection, organizations involved in the research would be part of a significant leap towards conquering the threat of the locusts, and saving millions of lives. The desert locust affects nearly 60 countries, 32 million square kilometers, and 20% of the Earth's landmass, far too much (Showler). Poverty stricken villages will finally have the chance to gain their footing and make a difference for themselves in Sudan, the government will have millions of more dollars devoted to other projects, such as establishing an educational system, a healthcare system, or creating more employment opportunities.

Semiochemicals utilize a natural loophole in the makeup of desert locusts that can be exploited to help solve food insecurity in Sudan, as well as surrounding African countries. Although there is plenty more research to be done and a bit more funding that needs devoted towards the aforementioned research, the product can be perfected. A commercially available semiochemical control agent for other species is already available, and can be altered to come into the playing field for desert locust control.

The Millennium Development Goals established in the Sudanese Constitution have a greater chance of being met with a stable agricultural system. Employment created from pest-control positions would be substantial, creating thousands of new jobs. The money which farm-owners could make from surplus crops could be taken to the market to provide a more diverse diet for the Sudanese family, put towards better farming equipment, buying more land, more seeds, the list of possibilities goes on and on. Someday, the desert locust will be just another problem that the world solved in an effort for humanity to move forward.

Works Cited

- “A Country Study: Sudan.” *Library of Congress: Country Studies*. Library of Congress, March 22, 2011. Web. March 1, 2013.
- “About Sudan.” *Embassy of the Republic of Sudan, Washington D.C.* Sudan Embassy, n.d. Web. March 1, 2013.
- Bechtold, Peter R. *Sudan: State and Society in Crisis*. Bloomington, Indiana: Indiana University Press, 1991. Book.
- Cloyd, Raymond A. “Chloronicotinyl Insecticides.” *Home, Yard, Garden and Pest Newsletter*. University of Illinois, Nov. 26, 2003. Web Newsletter. March 1, 2013.
- “Combat Malnutrition with Beekeeping in South Sudan.” *Globalgiving.org*. GlobalGiving Foundation, n.d. Web. March 1, 2013.
- “Combating Climate Change in Africa.” *The World Bank*. The World Bank Group, 2013. Web. Feb. 28, 2013.
- Cressmen. “Desert Locust Management.” *Slideshare.net*. Food and Agricultural Organization of the United Nations, Aug. 27, 2012. Slideshow. Feb. 25, 2013.
- Dillon, Vennard, Charnley. “Pheromones: Exploitation of Gut Bacteria in the Locust.” *Nature.com*. Nature Publishing Group, Feb. 24, 2000. PDF. Feb. 25, 2013.
- Emana, Bezabih. “Socio-economics of Desert Locust Control in Sudan – a Micro Level Case Study.” *Prevention Web*. Food and Agricultural Organization of the United Nations, 2002. PDF. February 25, 2013.
- “Fighting the Locusts... Safely: Pesticides in Desert Locust Control: Balancing Risks Against Benefits.” *Food and Agricultural Organization of the United Nations*. Emergency Center for Locust Operations, n.d. PDF. Feb. 22, 2013.
- Locust Watch – Desert Locust*. Food and Agricultural Organization of the United Nations, 2009. Web. February 20, 2013 to March 4, 2013.

Loher, W. "The Chemical Acceleration of the Maturation Process and its Hormonal Control in the Male of the Desert Locust." *Proceedings of the Royal Society of Biological Sciences*. The Royal Society, n.d. Web. March 1, 2013.

"PAN Africa Report: Workshop on Management of Locust Control and Participation of Civil Society." *PAN-Afrique.org*. Pesticide Action Network: Africa, Feb. 2010. PDF. March 1, 2013.

"Republic of South Sudan." *IMA World Health*. Blue Water Media, 2010. Web. Feb. 22, 2013.

Showler. "The Desert Locust in Africa and Western Asia: Complexities of War, Politics, Perilous Terrain and Development." *Radcliffe's IPM World Textbook*. University of Minnesota, Nov. 20, 2009. Web. Feb. 22, 2013.

Symmons, Cressmen. "Desert Locust Guidelines: Biology and Behaviour." *Locust Watch – Desert Locust*. Version 2. Food and Agricultural Organization of the United Nations, 2001. PDF. Feb. 28, 2013.

"Sphecius Nigricornis." *Encyclopedia of Life*. Encyclopedia of Life, n.d. Web. March 1, 2013.

"The American Colony in Jerusalem." *Loc.gov*. Library of Congress, July 23, 2010. Web. Feb. 28, 2013.

"The UN Millennium Development Goals in Sudan." *UNDP Sudan*. The United Nations Development Programme, 2011. Web. Feb. 28, 2013.

Watson. "South Sudan: Desperate Struggle For Health Care in World's Newest Nation." *International Committee of the Red Cross*. International Committee of the Red Cross. June 6, 2012. Web. Feb. 22, 2013.