Improving Human Health

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Humans have been fighting against malaria and the mosquitoes that cause it since the beginning of time. Most approaches have involved using heavy insecticide sprays, hoping to completely eradicate the mosquito vector. As of yet, these attempts have not produced lasting results on the African continent, a place where over 70 children die per day from malaria. When man started fighting with sprays, the mosquitoes counteracted, and produced adverse effects. The mosquitoes produced new, insecticide resistant strains and, some scientist believe, an entirely new strain of malaria.

At the International Center of Insect Physiology and Ecology [ICIPE] research institute in Nairobi, Kenya, I learned about a newer, innovative approach to fighting malaria. Researchers hope to fight against the malaria mosquito by interrupting its regular life cycle and by interrupting disease transmission. Ideas ranging from bed nets to placing fungus in mosquito breeding pools have been suggested. Many have been proven to work. Studies conducted have shown Neem can be used as a repellent and Neem oil as a larvae killer; natural plants can be used as repellents; metarizhuim can be used to kill adult mosquitoes, and all are environmentally-friendly.

Background Information

To give a brief background, I will explain more about myself. My name is Jessica Heikkila, and I have lived in Lamoni, Iowa, the past six years. When I joined a group called the World Food Prize Youth Institute in 1997, I had no idea what the organization was about. After a few months of working on writing a paper, I understood that the World Food Prize focuses on the global problem of food security. I collaborated with several students and wrote a paper for the Youth Institute, and attended the Des Moines Symposium

in 1997. Since then, I have worked on the writing of the paper every year, and learned even more about food security. The issue of world hunger is particularly intriguing to me, because I come from a highly industrial, strong economy country. As a teen, I loved reading and learning about other cultures and underdeveloped countries. I wanted to make a difference, and thought I might become an International Ambassador to a foreign country, or even volunteer for the Peace Corps for awhile. Instead of waiting until college, I wanted to travel now. Through the World Food Prize, I received a sponsorship to be an intern at a research center abroad.

I was sent to ICIPE in June of 1999, and stayed for two months. ICIPE is located in Kenya, Africa. ICIPE is a Tropical Research Institute that was founded in 1971. It maintains over five field stations located around Kenya, and a base out of Nairobi, Kenya. The Director General of ICIPE, Hans Herren, won the World Food Prize in 1995 for his work with the cassava mealybug.

While at ICIPE, I studied in the Malaria Vectors Research Program. I chose to work for Dr. Bart Knols, Head of the Program. Malaria, and human health in general, are rarely discussed issues that contribute to food security problems. I thought it would be interesting to learn more about the problems Kenya has combating malaria.

The Malaria Program, as I mentioned above, aims towards interrupting the transmission of malaria from the mosquito vector to the human host. This newer approach is something that seems to be working quite well. The approach of controlling the mosquito, rather than eradicating it, is a good one. To control a mosquito means to examine its life and its behavior, to find a way to prevent the mosquito from creating new generations, whether it be by putting a fungus in its larvae pools, using insecticide treated bed nets to sleep in, or putting repellent plants outside the house(ICIPE, 1997). These methods of controlling the mosquito population seem to be working better than trying to completely eradicate these insects. However, despite knowledge of the disease, and mosquitoes' reac-

tion to new insecticides, not much is known about this vector. Understanding the behavior of the mosquito plays an equally important role as the disease itself.

At the time of my internship, there were many studies going on. These studies focused on a variety of things, including using Neem oil as a larvae killer, sugar and blood feeding behavior, DEET's effectiveness, using metarhizium as an adult mosquito killer, and the level of attractiveness of one person over another, based on odor.

The Malaria Program is based out of Nairobi, but has a strong field station located in Mbita Point, on Lake Victoria. The head of the program, Dr. Bart Knols, works out of both stations. I spent nearly five weeks of my internship at Mbita Point. There, I worked with Dr. Knols, and three Masters Degree candidates. Kees Swaans, from the Netherlands, was working on sugar and blood feeding behavior. Patricia Descombes, from Switzerland, was doing tests with DEET versus a natural repellent. Richard Mukabana, a Kenyan, was doing attractiveness studies. In addition to helping out in their studies, and learning about malaria in general, I conducted my own research project.

Dr. Knols was looking into mating behavior of *Anopheles gambiae* mosquitoes, so my research was a part of that. I looked at the actual mating times of the mosquitoes. *An. gambiae* mosquitoes are believed to be mating only at sunset. The main goal of the experiment was to see if the mosquitoes were also mating at night, after sunset. The initial response was not positive, so the goal was changed to see the percentages of mosquitoes mating during sunset. The results in full will be discussed at a later point in this paper.

I used my time at Mbita to soak up all the information that I did not know, and expand on the information that I had. I looked at why medication is not being taken, why repellents don't work, and why children are more susceptible to death. On occasion, I helped others with their experiments. I even donated my blood to feed 50 hungry female mosquitoes one night. I value this period as a beneficial learning experience. I learned so much about problems with malaria, and how human health plays a big role in food security.

I knew before I went to Africa that I take some things for granted because I have lived in America all my life. I thought these things would be the obvious things that everyone takes for granted, such as having a television, and computers, or air conditioning. I did not expect that as an American, I take for granted that I have a decent water supply to drink from, a house made out of brick and concrete instead of cow-dung and mud, receiving three meals a day with things other than bread, and receiving decent medical care when I am urgently sick.

I saw people who cannot afford to buy medication for malaria because it is too expensive, and instead sleep on a mud floor surrounded by cows, hoping that the mosquitoes will bite the cows first. Even the so-called medical centers are filthy, and most depend on broad daylight rather than electricity to see through their microscopes for blood tests. These are factors that all underdeveloped countries have to deal with that some people are not aware of. Seeing these things first hand made a huge impression on me.

My first week in Nairobi, I was sent to Mbita Point Field Station to begin my explorations (Refer to Appendix B, Picture 1) My advisors thought I might like to see Lake Victoria, and take a look at one of the other centers. Since I had not chosen a program yet, I thought it would be interesting to look at other work. I drove to Mbita with Dr. Knols, and after the eight hour trip discussing malaria problems, and the cultural differences of this foreign country, I made my decision to work with him.

As an introduction to the world of Malaria scientists, I spent the first few days observing. I helped set up a few greenhouses to be used for experiments, watched the Insectary technician care for the mosquitoes, and monitored different larvae for awhile. I received my first experiment after a week.

Evaluation of Mating Behavior in *Anopheles gambiae* Mosquitoes

The *Anopheles gambiae* mosquito is Africa's main malaria vector. The female bites humans mainly around the ankles, because of an attraction to the odor of the feet(Pinto, 1996). In this species, the highest percentage of biting activity takes place at night(Pinto, 1996). *An. gambiae* mosquitoes are very particular in their swarming behavior. Several studies have shown that the only time at which the mosquitoes swarm, and consequently mate, is at sunset(Pinto, 1996). My study examined whether or not the mosquitoes were also mating at night.

For my experiment, I had to ensure that the females used were without a doubt virgin. I collected pupae and placed them one per test tube. When the pupae emerged, I separated males and females, and kept the females in a separate cage. Males were collected from a variety of 7 day, 6 day, 5 day, and 4 day old cages. There were twice as many males as females used, to create a higher chance of insemination. The males were immediately placed into a release cup, with a piece of wet cotton wool placed on top. Both males and females were starved from sugar water up to three hours before the experiment. The mosquitoes were released on opposite ends of a greenhouse, simultaneously (Refer to Appendix B, Picture 2)

For the first experiment, the release time was nine o'clock at night, and the recapture time was five o'clock the next morning. To validate these results, a second experiment was done, with the same release and recapture times. When the results of the first experiment did not verify the hypothesis, a third experiment was done, with a new objective. For the third experiment, the objective was to see if the mosquitoes were, in fact, mating at sunset. The mosquitoes were released at five o'clock in the afternoon, and recaptured that night at eight o'clock.

For the first experiment, an extremely low percentage of females were recaptured, as Table A shows. This may be due to too little time of sugar feeding. The females had fed and been starved for equal amounts of time. The result was that none of the recaptured females were inseminated (Refer to Appendix A, Chart 1).

For the second experiment, the females were fed on sugar water for a longer amount of time, almost 30 hours, and seemed to be in better condition. However, the re-capture rate for this experiment was considerably lower than the first experiment. There was an 18.4% recapture rate. As with the first experiment, none were inseminated.

When the approach of the first two experiments did not work, a new approach was taken. The third experiment was designed to see if the mosquitoes were mating at sunset. The recapture rate was the highest for this experiment. Insemination occurred in 54.1% of the females.

The findings of this study indicate that the *Anopheles gambiae* mosquitoes were not mating at night, but instead, swarming at sunset, as indicated by previous research. Though inconclusive, these results show that half of the female mosquitoes appear to be mating in the hours that they are supposed to be.

Cultural Observations

During my time at Mbita, I also observed the culture of the native Kenyans. Mbita Point is located in a relatively obscure place, hidden from most travelers, and definitely away from the beaten path. In all the places I went to in Kenya, I never felt more of a bond than the bond I had to Mbita.

It had a raw, untapped beauty to it. When I saw huts and villages, and beautiful, tall horizontally spread trees, I knew that they were pure. No white man had come in and placed objects and trees to make the land pretty. The land was virtually untouched. I had a fondness for Mbita, and the people who lived there. Wherever I went with a group, people hailed us, calling out friendly greetings and asking about our work at ICIPE. The children going to school at the Mbita International School inside of the ICIPE complex shouted everyday, "*Habari yako, Mzungo!*" ("How are you, white man?")

The people in the surrounding areas were very familiar with the ICIPE station. All of Suba District was aware that the scientists at Mbita were trying to help with problems with malaria and other insect carried diseases. On July 10 there was a Field Day that included a *Baraza*, or discussion, at the Mbita Point Field Station. Farmers from all of Suba District came to see the scientists' exhibits and to speak with people about their land (Refer to Appendix B, Pictures 3-8)

Baraza

Visitors saw booths from every program Mbita Point was working with. Among the exhibits were posters with information on malaria, beneficial uses of Neem, African Sleeping Sickness, problems with the fruit fly population, tick problems in the Lambwe valley, and using bees and silk moths to make honey and silk. The crowd moved around the booths, and the scientists spoke to a group at a time. Scientists explained the general purpose of their project, and how it would benefit the people of Suba District, and of Kenya. Some visitors of Luo tribe received their explanations in Luo, their tribal language. After the exhibition, the visitors were invited to the *Baraza*. The guests sat in chairs or on blankets and listened to Dr. Herren speak about ICIPE's activities, and main goals of interest. In the front of the gathering was a panel of scientists that represented ICIPE.

The audience was entertained by a local acting troupe that did a short play on diseases and sicknesses in Africa. After awhile, selected farmers spoke to the audience, and to the panel of scientists, about their farming. One farmer mentioned his problems with irrigation and poor soil. Another asked for better community involvement, and teaching children to use insect traps and know beneficial insects from harmful ones. All mentioned their gratitude to ICIPE for the help they have received.

The Field Day proved to be a success, and a date for the next Field Day was set. The farmers and visitors seemed very interested in hearing ideas and learning about what the scientists were hoping to accomplish.

Shortly after the Field Day, I returned to Nairobi for the rest of my internship. Leaving Mbita was like saying good-bye to a chapter of my life. I would love to visit Mbita again, as a tourist, and revisit the places I went, but something would be missing.

My experiences in Kenya have changed me as a person, and helped me to grow into an adult a bit sooner than I expected. I saw many things that I cannot describe. The best explanation that I can give is that I absorbed so much in a little period of time. My surroundings were surreal to what I had been used to. Even though I saw many trees, birds, houses, and people, those familiar things were anything but. There were trees spread out horizontally. There were birds with bright purple chests, houses made of mud, or sometimes incomplete brick apartment buildings would be rented out as flats, and all the facial characteristics of the people were much different. I know that these things have helped me establish a new, renovated me. Before I traveled to Africa, I was almost afraid that I would return completely different and view everything seriously. Instead, I returned, having learned two important things. To open my mind to what I have not seen, and to know that there are so many more things to see.

When I returned to Nairobi, I was assigned to work with a Kenyan named Sarah Waweru. Ms. Waweru was studying the larvicidal effects of Neem powder on *Anopheles gambiae* larvae. My assignment was to assist her in her experiments.

Evaluation of Neemcake Powder as a Larvicide on all Stages of Larval Development

Neem is a compound that can be used for many different purposes. In India, it has been prescribed for a wide variety of ailments, from stomach upsets to contraceptive

uses(ICIPE, 1997). Neem bark and leaf extracts have traditionally been used as malaria remedies in Asia and Africa. Recent studies conducted in India have demonstrated that neem oil is an effective mosquito repellent(ICIPE, 1997). Neem oil has been shown to be an effective *Anopheles gambiae* larvicidal killer. In a number of tests done, a 0.1% concentration of neem oil produced a 100% mortality rate after four hours. The larvae used in the tests were from the four stages, L1, L2, L3, and L4. A 100% mortality rate was shown in all stages(Waweru, 1999).

Although neem oil has been proven effective, it was thought that neemcake powder might work just as well. The neem powder would be cheaper and more available than the oil. The main objective of this study looked at 1) Finding out if neemcake powder has any killing or repellence effects on *Anopheles gambiae* larvae and 2) Finding the lowest effective concentration of this substance.

The Neemcake powder samples were weighed and wrapped in aluminum foil. Four samples, each weighing 0.5mg, were used in the experiment. 50 larvae from each stage, L1, L2, L3, and L4, were used for test. 50 larvae for control were also used. Each group of 50 larvae was placed into a tray, labeled Test or Control. The Test trays were exposed to a neem sample and a pinch of larval food. The Control trays were only exposed to a pinch of larval food. All trays were labeled with the proper larval stage. The trays were monitored for deaths three times a day, i.e. at 8:oo am, 12:oo pm, and 4:oo pm. The trays were exposed for 24 hours.

The larvae, after being monitored for 24 hours, showed no significant mortality. Deaths were recorded for every stage of larvae, but were attributed to natural factors. The raw data obtained from the experiment suggests that the concentration of the Neemcake powder is not high enough to be effective. Looking at the Mortality Chart in Appendix A, Chart 2, one can see that the powder was only effective after 32 days. The powder delayed the pupae from emerging, and eventually killed the pupae. However, a higher concentration may have larvicidal effects in a much shorter period of time.

The findings of this study, although only preliminary, indicate that Neemcake powder at the concentration utilized, is not as effective as neem oil. Since higher concentrations of the powder have not been tested, it seems that the lowest effective concentration has not been found. Neemcake powder should not be ruled out as an effective larvicide. After more conclusive studies, we can ascertain whether or not Neemcake powder is effective. Until then, the use of neem oil would be beneficial.

Conclusion

Human health, in terms of food security, is one of the most important factors we can work to improve. A sick person is less able, and therefore, cannot work nearly as much in the field.

If a family had five children, they might divide up their land seven ways: five separate areas for the children, and two for the parents. So after the crops have all been planted, the children will work in the fields to maintain the crops. If, annually, three out of five children come down with malaria, the possibility of cultivating all the land reduces. It places more work on the other family members, in a shorter amount of time. If one of the children died from the malaria, it would mean devastation to the family and the crops.

While at Mbita Point, a group of approximately ninety girls from a neighboring high school came to visit the center. On a tour of the complex, Dr. Knols asked if any one of them had contracted malaria in the past year. Every single girl raised her hand.

To the people of Lake Victoria, the water hyacinth has invaded their fishing area. Their animals are dying from possibly African sleeping sickness or famine. Their land is all they have. If they cannot harvest all of it, their life becomes that much harder. They do not have much to fall back on.

The Researchers at ICIPE are working their hardest to improve the quality of life for the Kenyans. From teaching them to use bed nets to prevent malaria, to giving them traps to catch the deadly Tsetse flies, the scientists are working to improve the health of the people. The more healthy these people are, the better chance they have of surviving, and being able to cultivate their land fully. Improving the quality of life improves their health, and their food security.

Although many things are being done at the moment, there are still things to improve upon. The centers around the world are working their best to solve the problems of food security, and we can only hope that ICIPE continue to do so in Kenya.

The World Food Prize is a wonderful orgainzation that I am proud to have worked with. They have provided me with a life changing experience to better myself, and improve the knowledge of my fellow peers about Africa. They have given me the opportunity to expand my horizions, and make my dreams about traveling come true. Now that I have returned home, I plan on speaking to peer groups in my area, in hopes that they will understand that improving human health is one of the best ways to improve food security.

References

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Chart 1

Experiment A June 16, 1999
Experiment B June 24, 1999
Experiment C July 4, 1999

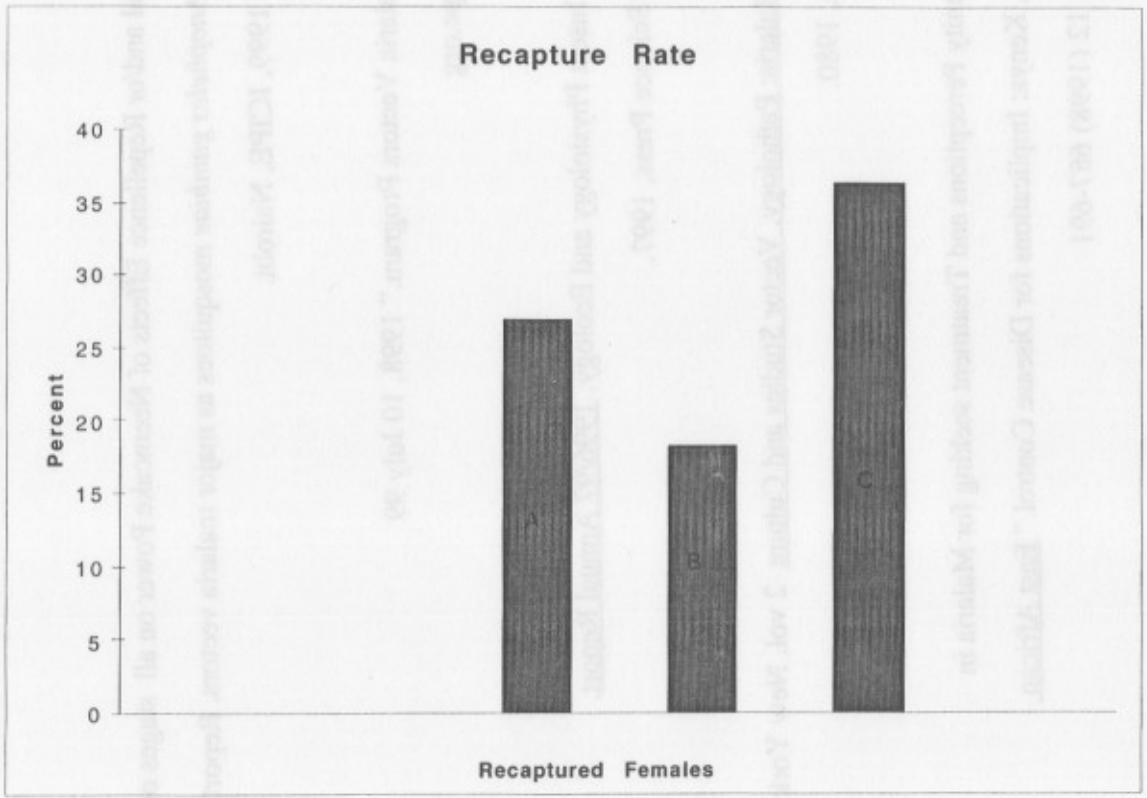
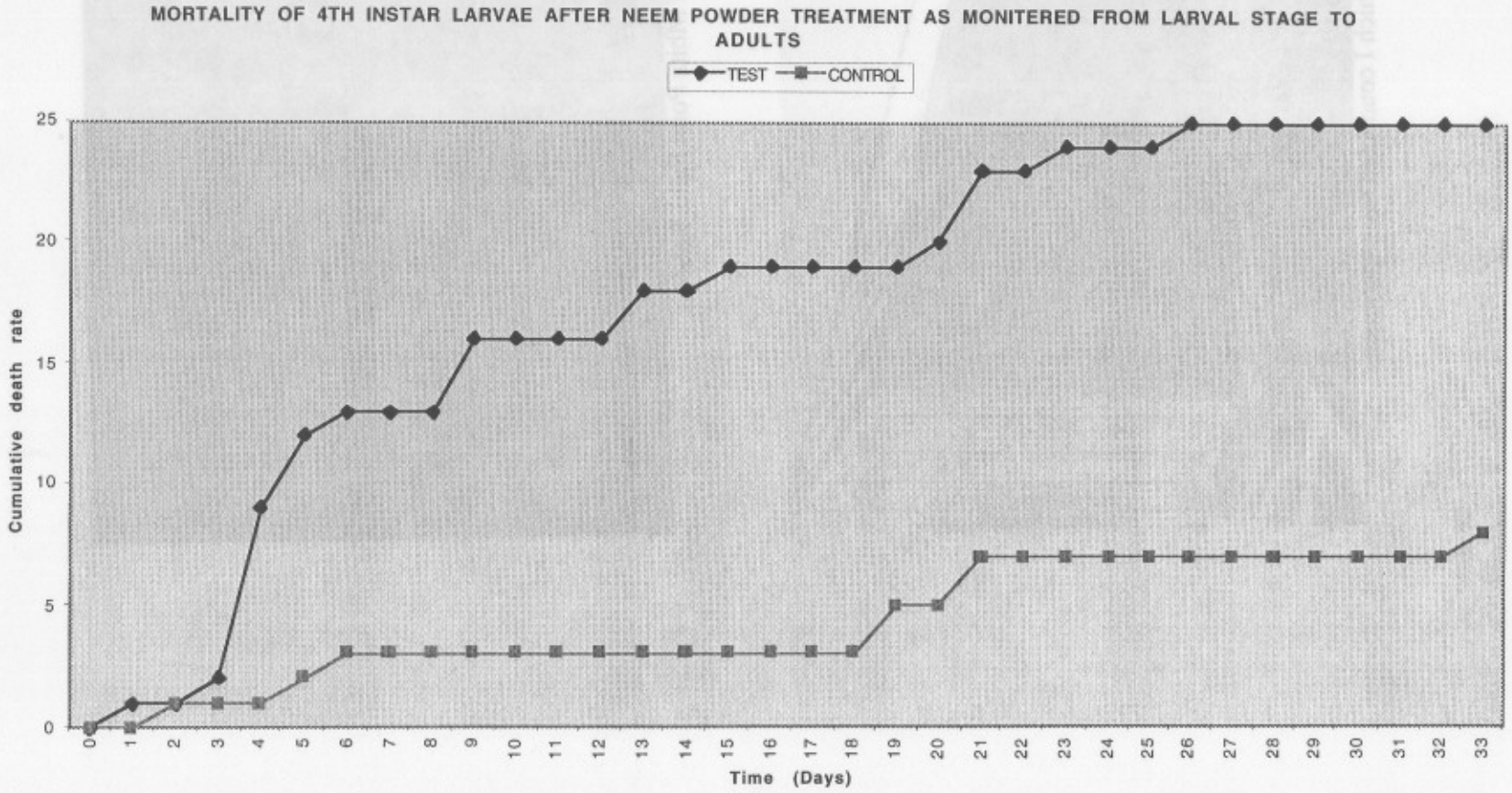


Chart 2
After 32 days, the Neemcake powder killed all pupae.

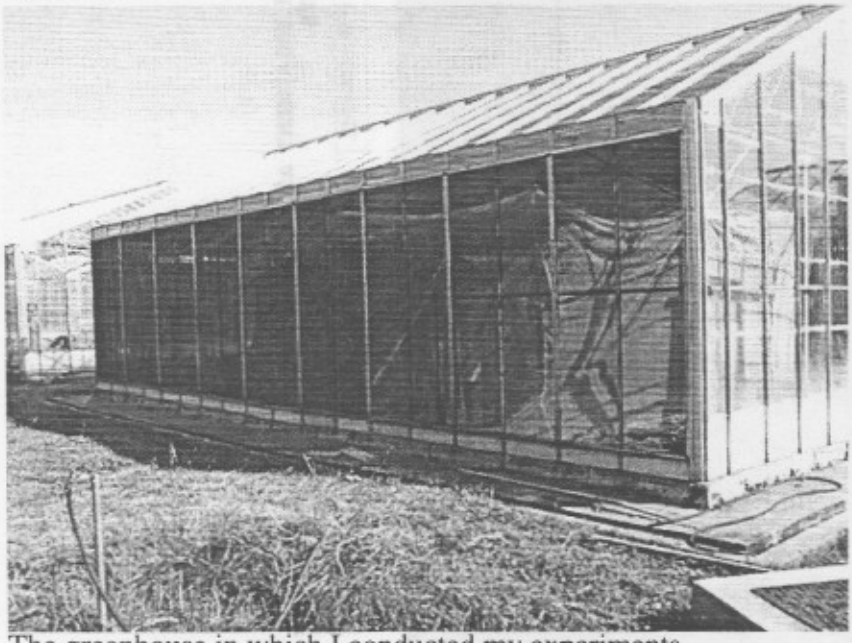


Appendix B

Picture 1

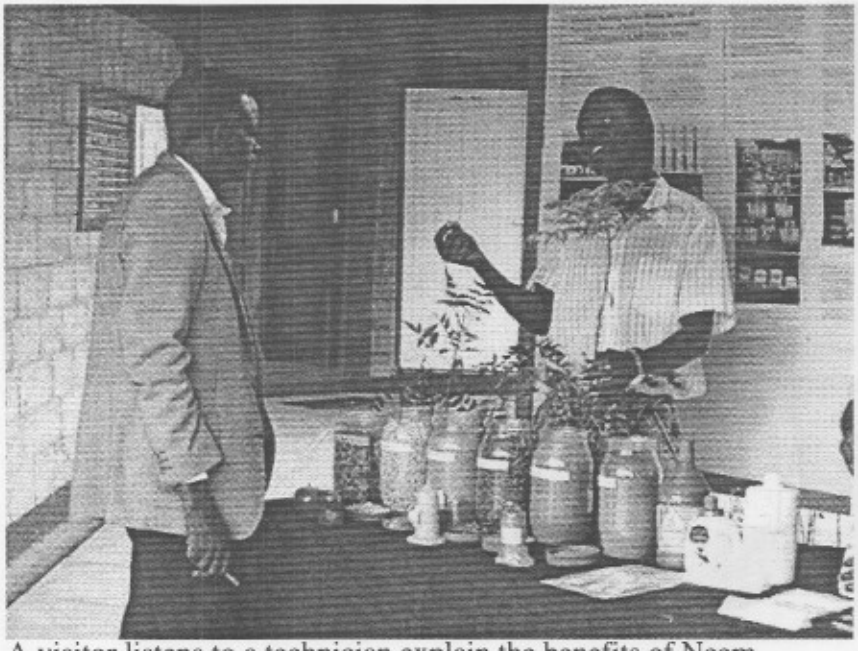
An overhead view of Mbita Point Field Station.

Picture 2



The greenhouse in which I conducted my experiments.

Picture 3

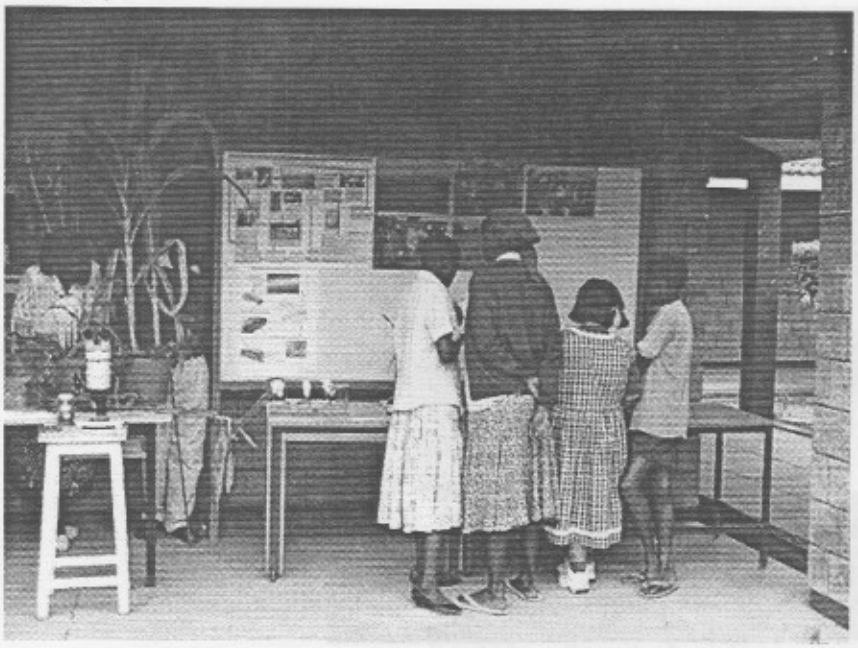


A visitor listens to a technician explain the benefits of Neem.

Picture 4

A crowd awaits tours and explanations of programs at Mbita Point Field Station, at the beginning of the Field Day.

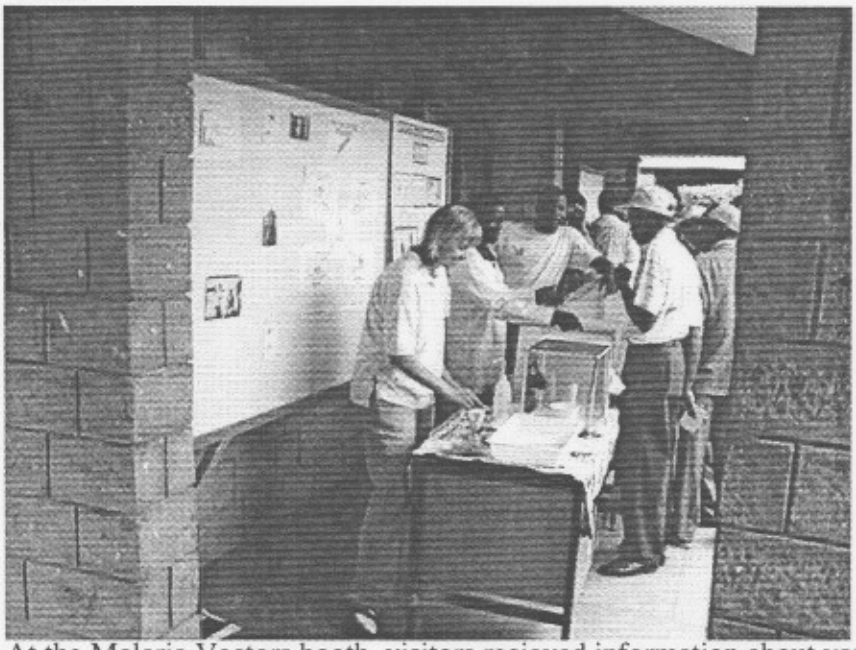
Picture 5



Picture 6

Visitors at the *Baraza* see exampls of crops improved by neem.

Picture 7



At the Malaria Vectors booth, visitors recieved information about various repellents, and were given the option of donating blood to cages of mosquitoes.

Picture 8