ADOPTING NATURAL PESTICIDES IN RURAL AGRICULTURAL PRACTICES: A CASE STUDY IN KONZA, MALI

A Report

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By

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Figure 1 Dramane Kone, my Malian counterpart, shaving a tree root to test its potential pesticide abilities.

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Abstract

While the developing world only contributes to 25% of total pesticide use, it accounts for 99% of pesticide related deaths (FAO, 2004). Due to small farmers' limited pesticide knowledge and no governmental presence or regulation of the matter, using chemical pesticides for crop protection in the developing world can be dangerous to the farmer's health and to the environment. Moreover, the introduction of this and many other western agricultural technologies promoted by aid organizations ignore and break down the long-standing traditional and inherited systems (Stoll, 1998, pg. 8).

An alternative to chemical pesticides can be implemented to prevent dangerous residues from contaminating food and water. Introducing natural methods return to these traditional systems, and can help achieve the economic, social, and food security of small farmers. Natural pesticides, made from substances such as neem, garlic, and hot pepper, are used instead of or in addition to chemicals to control pests. With more preparation and application work involved, natural pesticides are not necessarily an easier alternative, but rather a lifestyle choice.

This project was conducted in Konza, a rural village in the Sub-Saharan country of Mali, with several subsistence farmers participating. Incorporating both experimental and educational components, farmers were able to see and learn about the differences between chemical and natural pesticides. 87.5% of the participating farmers had previously used commercial pesticides, with 25% reporting no adequate training in the use of such chemicals. 75% of the farmers had previous familiarity of natural methods, although only 50% had working knowledge of making the physical pesticide treatments. By the end of the project, all farmers had learned how to make and apply the natural treatments, properly use and care for chemical pesticides, and could explain the environmental and health effects of the commercial products. When asked which method they would prefer to use in the future, 37.5% of the farmers answered only natural methods, 25% for only chemical pesticides, and the remaining 37.5% would combine both methods for pest control. This division shows how the decision to protect farmers' crops and ultimately, their livelihoods, relies heavily on varying factors, including social and economic security, and other established agricultural practices, that cannot or should not necessarily be changed. In general, this project gave the farmers the education and experience necessary to be able to make an informed decision to improve or maintain their crop protection practices.

Prologue

The following document is the project paper prepared to fulfill the requirements of my Masters of Engineering and Masters International program in the Biological and Environmental Engineering department at Cornell University. The unique Masters International program combines interdisciplinary academic course work with Peace Corps field experience. After conducting one year of focused course work in Ithaca, the student serves two years in a related field as a volunteer, and works on an applied project while overseas.

The United States Peace Corps is a volunteer organization started in 1961. It has three goals within its mission: helping the people of interested countries in meeting their need for trained men and women, helping promote a better understanding of Americans on the part of the peoples served, and helping promote a better understanding of other peoples on the part of Americans. Since its beginning, the Peace Corps has sent over 200,000 volunteers to 139 countries to provide skills in areas such as education, agriculture, youth and community development, health, environment, and business and information and communications development.

After completing the required coursework for a Masters of Engineering in environmental engineering, I was sent to the Republic of Mali in West Africa on July 7, 2008. I entered training on July 10, 2008, participating in a 9 week program and then a subsequent 3 week program early in 2009 in Bamako, Mali. Language training consisted of 133 hours of French (official language of Mali) and Bambara (a local language of Mali). Technical training included 122 hours of classroom lessons and hands-on learning about wells, latrines, soak pits, pumps, irrigation, hygiene, sanitation, and water-related diseases. Cross-cultural training included 22 hours of intensive study of local customs and traditions.

After successfully completing training, I was sworn in as a volunteer on September 12, 2008. I was assigned to live and work in the rural community of Konza, a small-sized (population 2,000) village in the southern region of Sikasso. My primary role in Konza was to work with the community on water and sanitation projects.

In Konza, I accomplished several projects. In the first few months, I conducted a community – wide baseline survey of basic water and sanitation conditions in the community. Information was gathered from over 100 households, comprising the entire population on such topics as drinking water source, water use and treatment, water-related disease occurrences, and latrine and soak pit use. Additionally, Participatory Approach Community Assessment (PACA) was performed with separate men's and women's groups as a needs assessment to determine appropriate water and sanitation related projects in the community. For two months, I met with the groups to discuss appropriate individual and communal sanitary hygiene behaviors, and to identify what community members can do to improve their sanitation situation, starting with small scale washing hands with soap to large scale construction of a combination enclosed pump house and soak pit. From these PACA sessions, and with my homologue's advice, a Water and Sanitation

committee was initiated, including seven men and women who would meet regularly to discuss improving Konza's water and sanitation situation.

The most apparent problem identified by the baseline survey and the PACA sessions was the need to construct soak pits to control domestic wastewater at the household and communal levels. Dirty, standing water from household latrines and pumps made Konza aesthetically displeasing and a breeding ground for malaria-carrying mosquitoes. With the help of the Water and Sanitation Committee, I constructed 200 soaks pits at individual households, constructed soak pits at three communal pumps, and constructed washing areas next to two pumps and one at the medical center. Additional funds built concrete walls around the school pump to keep trash and animals entering and dirtying the area. Community contribution included labor and the provision of rocks, sand, and gravel. The remainder materials were financed by USAID Small Project Assistance (SPA). After project completion, the majority of standing water was eliminated, greatly reducing the amount of mosquitoes, and making Konza community members proud of their cleaner village.

My largest project in Konza was a 2 million FCFA (approximately $3899) project to improve and protect the pump water resources. During the dry season of 2010, pump water was severely strained as all the wells dried up early. A single working pump was serving the community's water needs after the only other functioning pump broke. People were misusing water, taking more than what is needed for drinking purposes to water cows and gardens. I had mentioned instating a water tax to cover pump maintenance costs in 2009, but was dismissed by the village elders. During the 2010 water shortage, a water tax was implemented and money was collected to repair one pump and save for pump formation project. After it was clear a sustainable tax procedure was in place, I agreed to organize a project that was three fold, to replace one Vergnet model pump to an India/Mali pump, to purchase both model pump keys to be kept in Konza and used for pump repair, and to hold a 10 day formation to educate seven Konza community members in pump repair and maintenance. This project secured reliable pump water for Konza, as all the necessary tools for pump repair can be found within the community. Konza continues to collect a water tax to pay for future pump costs.

I conducted a series of hygiene and sanitation classes for the sixth and ninth grade classes in Konza. Topics included identification and prevention of malaria, identification of non-sanitary conditions in Konza, the importance of washing hands with soap, and the fecal chart diarrhea prevention tool. The seminar ended with a hand-washing station construction project, in which the school obtained a cemented hand-washing station to place outside their latrines. This project was replicated in the nearby village of Kouale.

During my two years of service, I also participated in various secondary projects. I was able to spread sanitary messages to a wider public through local radio broadcasts acted by myself and Malians in Bambara. I organized sexual health classes to dispel myths surrounding HIV/AIDS, sexual diseases, prostitution, and methods of protection. I educated several farmers on urine

fertilization techniques to enhance their crop yield. Additionally, I worked with women's groups to create income generating activities, including organizing an improved shea butter and soap formation, and educating women in beaded jewelry creations. Through producing and selling soap, the participants are empowered while generating an income for themselves.

One of the most important and satisfying projects that I completed while in Konza was working with a group of farmers on utilizing a new technique for crop protection. This paper addresses this particular project, as it was used for my applied project for the requirements of the Masters of Engineering and Masters International program.

Introduction

With about 10,000 classified pests worldwide, agricultural pest management is required in order to support our expanding global population (Grodner, 1996). People have been using chemicals to control pests for thousands of years; even Odyssesus was described by Homer as burning sulfur in his court and hall to control pests (Edwards, 1993, p. 13). Today, farms are still using chemicals, but the problem lies in that these are much more lethal chemicals from those first implemented.

Pesticides can pose risks long after being applied to crops because they can find their way into groundwater, surface water, and aquatic ecosystems (e.g., fish), and pesticide residuals may remain on or in our food. Many people including farmers, environmentalists, and consumers ask if the risks posed by pesticides are warranted in growing food for our populations. With the amount of people living in this world, and the number expected to increase, and with the lack of space available to grow the food required to feed this population, it has never been more crucial to protect our crops from disease and destructive pests. An estimated $4 billion dollar investment in chemical pesticide use yields approximately $16 billion dollars in savings in United States crops, where the total environmental and social costs of pesticide use are $8 billion dollars each year (Pimentel et al., 1993, p. 72). These numbers fuel an ongoing debate as to whether pesticides should continue to be used at their current levels or should be eliminated altogether, or can we find a balance that will address the social and economic costs surrounding this established technology.

It may not be feasible to completely eradicate chemical pesticides. Having been sprayed on our crops since the 1940s, the consequences of suddenly stopping this practice should be analyzed before pulling all the pesticides off the market. Some plants that naturally produce and release chemicals that combat pest problems have adjusted to the chemicals that farmers have been spraying, producing less of their natural chemical (Grodner, 1996). Pests have also adapted, evolving to become more resistant to the chemical pesticides, consequently, stronger and "smarter" chemicals have to be manufactured to combat these continually evolving super pests (Pimentl et al., 1993, pg. 226). Removing pesticides would allow pests to prevail with no natural repellent to control their impacts on crops. The economic aspects of this debate are also complicated; specifically our food is cheap and abundant in-part because of the chemicals used to protect and produce it. Eliminating pesticides would raise food prices, especially nutritious food; consequently, people worldwide would not be able to access nutritious and adequate amounts of food required to maintain sufficient levels of health, ultimately resulting in increased levels of disease and death (Lehman, 1993, pg. 6).

On the opposite side of the pesticide-elimination argument, maintaining the amount of pesticides used has adverse effects on our environment and health risks. The introduction of chemical pesticides resulted in the "Godly" ability to control our surroundings. Environmentalists ask, when does the cost of the negative impact to fisheries, groundwater, and wildlife exceed the

benefit of cheap, abundant food? Acute toxicity of most pesticides has been documented; the chronic human illness associated with pesticide exposure has yet to be completely evaluated (Pimentel et al., 1993, pg. 48). Consumers are concerned that we are introducing more pesticides and widely using existing chemicals without knowing the full extent of the health effects to humans. The situation is even grimmer when recognizing that the current trajectory is towards expanded and more intense pesticide use. Note that even with pesticide treatment, pests still destroy approximately 37% of all potential food crops. This would increase by an average of 10% if pesticides were not used, with specific crop losses ranging from zero to 100% (Pimentel et al., 1993, pg. 47). Total crop losses have increased even with the use of pesticides because of changes in agricultural practices, such as reduced crop rotation. Spraying crops with chemical pesticides has disrupted natural predators and parasites of the crop pests, resulting in fierce pest outbreaks that were previously held at bay with the assistance of these natural pest-predictors. When this happens, more chemical treatments have to be applied in order to protect the crop yields (Pimentel et al., 1993, pg. 55). Thus, we have already substantially changed our environment. Rightfully so, scientists are questioning if these changes are reversible and what other changes should occur if we continue with pesticide use.

Thus, eliminating pesticides altogether would have devastating effects, probably most notably on the poorest people, but it is essential that we find ways to maintain pesticides at a level that does not risk contaminating water, ecosystems, and people. This enduring pesticides debate is complicated and highly charged with ethics and morals; many factors need to be addressed when reaching a viable solution including public health, animal poisoning, pesticide resistance in pests, crop losses, ground and surface water contamination, fishery losses, and government regulations.

One stable approach that may help balance our dependence on pesticides with the risks they pose is integrated pest management, which is a program that incorporates a balance of chemical pesticides, natural alternatives, and agricultural practices to combat a pest problem. Reintroducing sound agricultural practices such as crop rotation and diversification, and understanding how pest life cycles could be used to develop more targeted pest management practices would help deter pests more naturally.

Although it will not be completely resolved in the near future, in the United States, we are fortunate to be able to foster this educated debate, incorporating both science and ethics to reach a practicable resolution for everyone involved. In developing countries, however, where the majority of the population is illiterate, no regulatory agencies exist, and information is not disseminated properly, the people have no option for discussion and little opportunity to make decisions that affect their lives. We, as informed individuals, consumers, and manufactures have forgotten that every individual has the right to information and education along with the freedom to access safe, affordable, and abundant food.

Project Idea

I began my Peace Corps (PC) service with a set of personal requirements for my Masters project. The project could be very different from those that I would facilitate for my Peace Corps service. Ideally, there would be more planning involved, support from my Cornell community, and the potential of more future implications than a typical PC project. However, I hoped that this project would, first, have a meaningful impact on my community and for the overall development of Mali. It had to address a desired need in the community, to be accepted by the community, and be sustainable for the future. Second, I wanted this project to contribute knowledge and awareness of Mali to the academic world.

While brainstorming project ideas (Appendix A), it became evident that those ideas I had suggested pre-departure or in the early months of service would not meet all of my criteria. After this realization, I decided to proactively wait until the idea discovered me. During my service, I positioned myself into various activities and small groups in order to get a full exposure to my community. I would often tag along with my host country counterpart, Dramane, as he ploughed or planted his fields and garden. He thoroughly taught me his farming techniques, including planting schemes, diversification, crop rotation, using compost, and growing a tree nursery. One day, he complained to me about experiencing adverse health effects after spraying chemical pesticide Calfus 500 EC on his cotton crop. He recounted that a powerful smell, sore throat, irritated skin, and headaches occur with every application of the chemical. He told me he does not know much more about using pesticides except that he should use protective clothing during application. I asked Dramane if he knew of any available natural alternatives to the Calfus 500 EC. He replied that he knew little of this topic, but would like to learn more and knew other farmers would be interested as well. Thus, this project fell into my hands; a project that would meet a desired need and had the potential to be sustainable, improving farming techniques in my community and elsewhere in Mali.

When researching more into chemical pesticide use in Mali, I found that there was little to no information was being transferred to farmers actually applying the product to the crop. I assumed that Dramane is a good example of a typical subsistence farmer in the developing world. His lack of knowledge but persistent use of chemical pesticides are likewise typical and, considering the large population of such farmers in the developing world, attest to the severity of this problem.

Country Background

The Republic of Mali (Figure 2) is a landlocked country located in West Africa with a population of approximately 14.1 million, the majority of whom are living in the capital of Bamako. It gained independence from France in 1960 (CIA, 2011). Largely considered one of the poorest countries in the world, Mali is rich in music, tradition, and unique cultures that make it a very interesting place to live, visit and work.

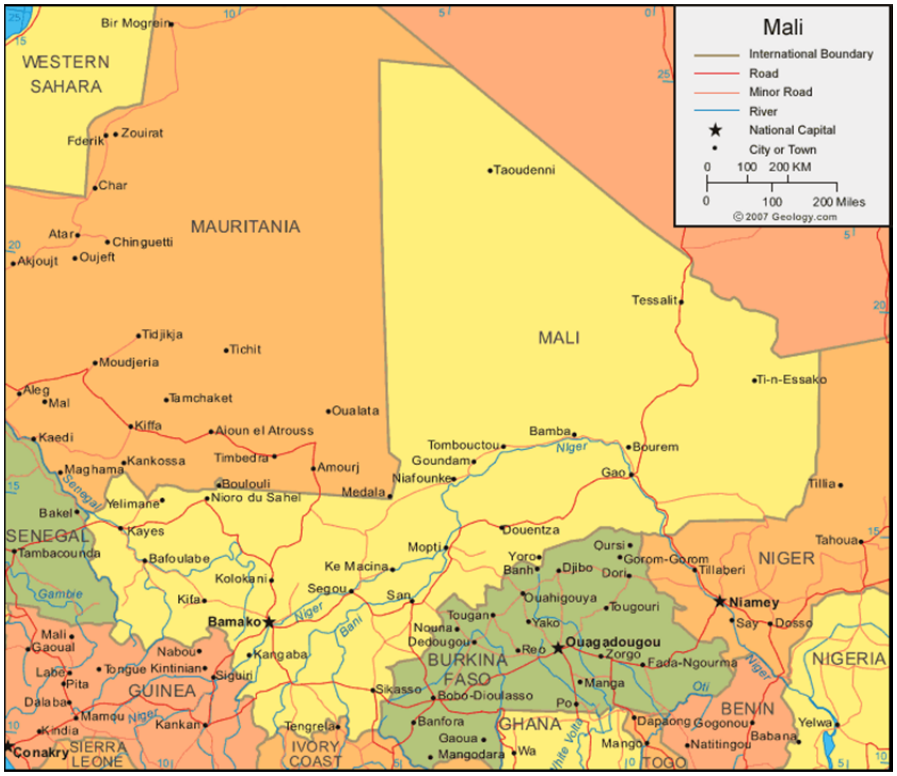

Figure 2: Map of the Republic of Mali (http://geology.com/world/mali-satellite-image.shtml)

There are five distinguishable ethnic groups in Mali. 90% of the population practice Muslim, while the other 1% identifies as Christian, and the remaining 9% of indigenous beliefs. Less than half (46.4%) of the total population is literate, i.e., a literate person is a person aged 15 years or above that can read and write. The school life expectancy, the average number of years a child is expected to stay in school, is only 8 years (CIA, 2011). The infant mortality rate is 11.1% and the average life expectancy is 52 years. Diseases plague Malians including hepatitis A, typhoid fever, malaria, schistosomiasis, meningitis, and a presence of HIV with 1% prevalence rate in adults (CIA, 2011). Lack of sanitation infrastructure, potable water, hygiene education and small household incomes, mixed with cultural beliefs (e.g., believing that washing hands with soap washes away a person's luck) provides many routes of exposure to diseases, most of which are preventable.

An estimated 80% of the labor force is in agriculture, the main crops being cotton, corn, millet, rice, and vegetables. The majority of the agricultural culture is subsistence farming. Gold mining is an important industry and accounts for one of the three main exports also including cotton and livestock (CIA, 2011). The agricultural industry has little access to machinery or large-scale production infrastructure and the success or failure depends on several unpredictable factors (e.g., weather, health, pest infestations), leading to an estimated 36.1% of the population living below the poverty line (CIA, 2011). As it has been for hundreds of years, farming is life in Mali; it is the driving force of the rural peoples because it is all they have ever known. Recently,

younger generations have sought other, more lucrative work in the urban areas, as shown through the 36% of the total population living in urban areas and the rate of urbanization that grows 4.4% annually (CIA, 2011).

Mali has a three-season-climate. From February to June it is subtropical to arid, dry and hot. It is rainy, humid, and mild during the June to November rainy season, followed by a cool and dry season from November to January. The area is mostly flat terrain, with savannah in southern Mali and rugged hills in the north leading into the Sahara desert (CIA, 2011). Only 3.76% of the land is identified as arable; 65% of the land is desert or semi desert. In 2003, it was reported that 2,360 km^2 was irrigated; only .19% of available land. Environmental problems include deforestation, soil erosion, desertification, and insufficient supplies of potable water (CIA, 2011). Of all the chronic environmental and health issues that plague Mali, hunger, malnutrition, and food security are the most prevalent and are physically visible in distended bellies and sunken faces. It is also what the majority of Malians identify as the issue that most prominently affects and shapes their daily lives.

Konza is a rural village located in the southern region of Sikasso in the Koumantou commune. The approximate population is 2,000 people. There are three schools in Konza: primary (grades 1-6), secondary (grades 7-9), and an alternative Arabic school. Other community resources include a mosque, protestant church, maternity, several traditional healers, and a weekly market. A larger, more diverse market is located in Koumantou once a week to provide for all the villages in the commune. Konza is serviced by five pumps located throughout the community, and a number of unprotected wells. The majority ethnic group in Konza is Bambara. All households sustain themselves on farming and animal husbandry livelihoods, while few members, mostly men, venture into small business opportunities such as tailoring, managing a store, and selling gasoline. A council of elders, led by the village chief, is responsible for making community wide decisions, collecting taxes for paying the mayor in Koumantou and the matron, and for upholding justice during small disputes. A women's savings group, a farming society, and a school council are some of the additional organizations supported by the community that help Konza residents to conduct civic duties and maintain involvement with governmental and aid organizations.

Food Security

Food security is "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life" (WHO, 2010). There are three components to food security: food availability, food access, and food use. Availability is defined as "sufficient quantities of food available on a consistent basis," access as "having sufficient resources to obtain appropriate foods for a nutritious diet," and use as "appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation" (WHO, 2010).

For Mali, food access and use are both severely lacking (CIA, 2011). Insufficient rain, large animal and pest damage, and farmers' health are some of the unpredictable components that can affect the amount of harvestable crop form year-to-year. Most years the farmers that I lived with harvested just enough to feed their families and, perhaps, have a bag to trade or sell with other farmers. In some cases, if certain challenges arose, they would not have enough grain for the year and would have to find other work or sell animals to make up the difference. Even when sufficient grain is harvested, it is not always prepared in the most nutritious ways. Most of the women do not understand how to properly prepare a meal for maximum nutrition and boil the grains until there is little nutritional value left. Additionally, I found that farmers would often rather sell their fresh vegetables for a profit than give them to their families to boost the nutritional value of their meals.

Food security is plaguing all developing countries. Since agriculture is the majority of Mali's employment sector, food security is a major issue that is being addressed by several organizations. It seems that each organization, including Peace Corps, has its individual approach to addressing food security. A three-step approach is most common among organizations, which includes adopting short-term relief, capacity building, and system change strategies (WHO, 2010). Short-term strategies focus on emergency type situations by addressing the immediate problem of a lack of safe, nutritious food; e.g. providing soup kitchens or food banks. Capacity building strategies are aimed at the individual and community levels and include activities such as teaching vegetable gardening and composting, setting up a community garden, establishing farmers markets, campaigning to "buy local," and building seed banks. System change strategies are policy changes that will affect how food is traded and bought. As a Peace Corps volunteer for two years, I could adequately work on the first two goals towards improving farmers' food security in Konza. Since there was no emergency type situation in my community, I decided capacity building strategies would be the best way to address food security issues.

Pesticides pose a variety of risks in Mali, and more specifically in my community of Konza. Pesticide label directions are often not followed and vegetables are commonly harvested early, resulting in ingestion of pesticide residues. Farmers work with pesticides in their fields with no safety equipment, followed by eating, drinking, or socializing with their family, resulting in possible poisoning routes to him or his family. Using pesticides haphazardly leads to contamination that can leave residues on consumed food, rendering their food security, as having safe food, ineffective. Organizing a project to introduce natural pesticides was one way to combat food security issues at the local, capacity building level, because using natural methods is completely safe with respect to consumption.

Agricultural Practices in Mali

Like their ancestors, Malians still hand till and plant their fields. Slight changes in using cattle driven plows have made preparing the fields easier. Part of the reason for no dramatic changes in the farming culture is the lack of money and technology available to these farmers. The few

tractors or large farming equipment in Mali was shipped in from another country and usually arrived old and worn out, i.e., not wanted anymore by its previous owner. In addition, these large machines are expensive to run and maintain and, assuming replacement parts could be found, very few people in Mali have the relevant training required to use and fix this equipment. The average Malian subsistence farmer makes just enough to support his family with little to no extra savings to put towards modern farming equipment. Chemical pesticides, on the other hand, are a much cheaper technology to purchase and use, and the benefits are very visual and immediate. Thus, farmers will decide to save some money to invest in pesticides.

Commercial pesticides

Each year, there is an estimated three million cases of pesticide poisoning worldwide, causing over 250,000 deaths (WHO, 2004). Some of these cases are intentional poisoning by farmers who want to commit suicide because of their desperate economic situations surrounding their fields (WHO, 2004). Of those who attempt but do not succeed, chemical pesticides can cause temporary or permanent disability (WHO, 2004). Most of these poisonings are caused by inadequate knowledge surrounding the use of pesticides, and some are reported as accidental child poisoning. Chemical pesticides were introduced for use in the United States in the 1940s and increased rapidly until the 1980s (Lehman, 1993, pg. 3). While chemicals were changing the way people grow crops and control the environment in the United States, less developed countries like Mali were still relying on traditional agricultural practices until pesticides were introduced later.

Use of Chemical Pesticides in Mali

Because of a lack of attainable information about chemical pesticides from Mali, I have decided to take the subsequent pesticide data available from US records, such as those from the Environmental Protection Agency (EPA), the National Pesticides Telecommunication Network (NPTN), and the Pesticide Action Network (PAN). Additionally, with no guidelines set by the Malian government, I used those created by the US to discuss the two common pesticides in Mali. Pesticide poisonings or large environmental events resulting from pesticide use in Mali are not recorded; therefore, incidents reported in the US are used to validate the severity of this issue.

Currently, the most common commercial pesticide found in Mali is Calfus 500 EC, which contains 500 g/L of profenofos. This chemical is listed as an insecticide under the class of organophosphorus. It is widely used to combat pests of cotton. According to the PAN database, symptoms of poisoning with this chemical include excess sweating and salivation, muscle weakness, tremors, twitching, headaches, nausea, vomiting, dizziness, respiratory depression, wheezing, productive cough, fluid in lungs, blurred or dark vision. In severe poisoning cases, symptoms include seizures, loss of consciousness, and cholinesterase inhibition. A properly functioning nervous system requires the enzyme cholinesterase. Cholinesterase inhibiting

pesticides, such as Calfus 500 EC, will disengage this enzyme, causing nervous system breakdown with weakness and tremors to seizures, paralysis, and death in serious poisoning. Young children have increased sensitivity to cholinesterase inhibitor pesticides (Moser, V.C., EPA).

Profenofos was first approved for use in 1982 (EPA, 2008, pg. 9), however, it was not introduced in Mali until circa 2000 through the Compagnie Malienne pour le Developpement des Textiles (CMDT) (Balamouru Diarra, personal communication). CMDT coordinates the cotton industry in Mali, instructing farmers on successful cotton farming techniques, orchestrating pick up and transportation of cotton from rural communities to their offices, and preparing the crop for exportation. Part of CMDT's tactic in producing quality cotton is to distribute Calfus 500 EC to manage cotton pests. This is accomplished with little to no education on safe handling and application of the pesticide, a result of a lack of resources and interest. CMDT handed out the pesticide "for free," recovering the cost of the chemical at the end of harvest from the pay-out to the farmers for their cotton. Consequently, farmers take advantage of having this effective pest control method and use it for other crops and vegetable (e.g., rice). Coincidentally, in September 2007, the US EPA investigated a petition to use profenofos on rice in Texas, and found that this could result in acute and chronic risks to terrestrial and aquatic biota (EPA, 2008, pg. 10). Farmers in Mali are unaware of such petitions and more importantly, the effects of using Calfus on other crops, because of a lack of governmental regulation and education

As well as being toxic to young children, the US EPA reports that profenofos can bioconcentrate in fish, and may bioaccumulate in terrestrial and aquatic food chains (EPA, 2008, pg. 10). Profenofos has moderate acute toxicity to humans through the oral and dermal routes, minimally toxic via the acute inhalation exposure, and is classified as not likely to be carcinogenic to humans. The EPA found through the IRED assessment that exposures from eating foods treated with profenofos are below the level of concern (EPA, 2008, pg. 11). No known human poisonings from profenofos have been reported in the US, but an ecological incident occurred in Louisiana, Mississippi, Georgia, and Alabama from 1989 to 1999 involving aquatic animal mortality (EPA, 2008, pg. 13). The average water solubility of profenofos is 28 mg/L, making it a likely groundwater contaminant (PAN). All of this information attests to Calfus 500 EC being an environmental and human health threat, especially when not as heavily regulated and held to such standards as in the US.

The other common pesticide found in Mali is 2.5 EC, which contains 25 g/L of Lambda-cyhalothrin. In the United States, this chemical is listed as a restricted use pesticide, which only certified applicators can purchase and use (EXTOXNET, 2008). It was registered with the EPA in 1988. The chemical works by disrupting the nervous system in organisms that can cause paralysis and death (NPTN, 2001). It is applied to a range of crops, but advertised in Mali specifically for vegetable use. In Mali, 2.5 EC can be bought at any local market where other garden supplies are sold. The pesticide comes in concentrated liquid form in a small 250 mL canister or 1 L bottle.

Lambda-cyhalothrin is moderately toxic via if ingested orally (EXTOXNET, 2008) and moderately toxic when inhaled (NPTN, 2001). Contact with the substance causes irritation to the skin and eyes. A more serious poisoning will cause damage to the nervous system with symptoms such as tingling, burning or numbing sensations, incoordination, tremors, paralysis, loss of consciousness, seizures and coma (NPTN, 2001). Humans working with the concentrated substance reported face and skin irritation that started within 30 minutes of exposure and lasted anywhere from 6 hours to 2 days (NPTN, 2001). Effects are reversible as the compound degrades in the body (EXTOXNET, 2008). There are known reproductive effects, such as low birth weights. The EPA classifies the chemical as a Class D carcinogen, meaning not enough data has been collected to determine if it is actually carcinogenic (NPTN, 2001).

The chemical is highly toxic to fish and can bioconcentrate in aquatic species. The water solubility is 0.005 mg/L along with high potential to bind to soil make it an unlikely groundwater contaminant. Also, the reported half-life of lambda-cyhalothrin is between four and twelve weeks which makes it moderately persistent in the environment (EXTOXNET, 2008).

While the developing world only contributes to 25% of total pesticide use, it accounts for 99% of pesticide related deaths (FAO, 2004). There are many risk factors that contribute to pesticide poisonings, most of which can be prevented by a responsible government or organization controlling the use of such dangerous chemicals. In the United States, we are fortunate to have the Food and Drug Administration, and the EPA among a long list of federal agencies that regulate and approve chemicals, and set standards to which they can be used and applied, along with providing the education for safe storage and application. Additionally, the EPA provides consumers and citizens with comprehendible educational material as well as an open status for all their documentation surrounding pesticides. As users of chemicals, we have certain standards that we have to know and abide by, which makes protecting the environment and ourselves easier and safer. There exist no regulatory or informational agencies in Mali where farmers, consumers, and the general public can rely on for their personal and community safety.

Environmentalists, consumers, and users alike will argue that there are safer alternatives to chemical pesticides. By introducing substitutes into an integrated pest management program, it is arguable that farmers could see similar results as with using pesticides. The Bambara people of Mali, like many African peoples, have a culture of using traditional medicines to treat a variety of problems (Imperato, 1977, pg. 22). This traditional practice can easily translate to other uses, such as protecting crops against pests.

History of Traditional Alternatives in Mali

Mali has a rich history of practicing traditional medicine. Countless scholars have travelled extensively throughout Mali to record and understand the various ceremonies, beliefs, and practices that make up traditional medicine. The custom of learning about different plants' and herbs' healing properties continues today. Naturally caused illness and maladies are treated at

home, as Malians have a pharmacopeia of known remedies for minor ailments (Imperato, 1977, pg. 55). An herbalist is usually consulted if the home remedy is not successful. Along with herbalists, there exist midwives, bonesetters, and divine healers who offer a variety of unique services. Malians will usually look to traditional medical practitioners before being advised to see a westernized hospital if the illness is serious.

Even with the introduction of Western medicine, Malians are still very interested in maintaining their beliefs with traditional medical practitioners. It is a practice deeply rooted in the culture, which has remained unchanged for hundreds of years.

Use of locally available herbs, roots, barks, and seeds, is not restricted to human medicines, but also extends to healing of ailments in livestock, and plants, including as pest repellents. For example, Malians noticed the strong odor emitted from an abundant weed, cut it down every night, and surrounded their beds or sleeping mats with this weed to ward off mosquitoes during the rainy season. This was the traditional form of mosquito repellent before the introduction of the mosquito coils, liquid repellent, and mosquito nets.

Other plants have been used to naturally ward off other pests. Although there is a history of using natural methods for pest control, the specific methods could not be recollected by the participating farmers. The introduction of technology, improved techniques, and chemicals probably resulted in a decrease or elimination of historic natural pesticide use. Due to this unfortunate lack of indigenous knowledge, I used Natural Crop Protection in the Tropics (Stoll, 1998) as a guide for choosing natural treatments that could be produced locally in Mali, and that were effective against pests for the specific crops grown by farmers in Konza.

When introducing a new concept, it is important to express them in the context of practices that are used daily and trusted by the locals to solve problem, whether it be treating a medical ailment or resolving a community dispute, is an acceptable model to use for projects organized by an outsider. A slow, people-focused approach to implementing a project will warrant a sustainable outcome, as outlined by the Roland Bunch (1982).

People-Centered Agricultural Improvement

Two Ears of Corn, written by Roland Bunch in 1982, is a very comprehendible and direct guide to people-centered agricultural improvement. During our Peace Corps in-country training, I was introduced to this book to use as a standard for implementing sustainable, accepted agricultural and economic development projects. The book leads its readers through an easy step-by-step process to overcoming common errors in development work to direct the project in a people-centered movement.

I used Bunch's (1982) recommendations as guidelines for organizing and managing my project. First, Bunch argues that small programs are often the best option for a community, as they "meet the specific needs of specific cultures, markets, and microclimates and can build upon existing

local resources, such as traditional knowledge, exceptional leadership, or indigenous forms of organization" (Bunch, 1982, pg. iv). Understanding that including many factors could complicate the project, I decided to keep my project small by not collaborating with other organizations and only studying a few members of my community. Small-size projects encourage more village participation in which involved members are more likely to understand and contribute. Additionally, small projects have the ability to change or adapt with feedback, which is important when first starting a new project. Little to no funding for a project means that the project is more likely to run on participants' passion. Limiting the technology requires less funding and is more likely that the practice will be understand and become permanent and continue to other communities (Bunch, 1982, pg. 83).

Second, project leaders should be engaged in the community, understand the local political and culture influences, and be motivated by the genuine desire to see the community develop (Bunch, 1982, pg. vi). This is difficult to achieve if the project leader does not live in the community with the beneficiaries, which is why Peace Corps volunteers have an advantage of completing quality, people-centered development work.

For organizing small scale agricultural projects, four criteria are used to establish the project (Bunch, 1982, pg. 10):

1. Project introduces a technology that responds to a community need
2. All supplies and equipment to carry out the project are readily attainable and affordable
3. Local markets can absorb expected increase in production at a reasonable price
4. Project participants have sincere desire to improve their livelihoods

I recognized that, as the leader of this project, I had to generate enthusiasm among the community so that the participants will eventually take on the responsibilities of managing the project (see discussion of paternalism in Bunch 1982, pg. 18). Enthusiasm can be defined as "the desire or willingness to work and make sacrifices to reach a goal" (Bunch, 1982, pg. 24). In order to move towards participant owned, the members should be involved in project planning and be free to be creative in shaping the project as it progresses, which enables them to make decisions, form a sense of community, and receive and give positive feedback to other villagers (Bunch, 1982, pg. 24). Additionally, the villagers need to believe that the leader is working for their benefit and that the program can help solve a specific community need. Achievements will help motivate participants as they move from easier goals to increasingly more advanced and complicated objectives, where recognizable successes will generate enthusiasm. If enough participant enthusiasm is created, the project will be able to move ownership from the leader to the people who the project is serving so that, in return, they can manage the continuation of the project for other participants, thus, initiating a sustainable cycle.

Both experimentation and education components are encouraged in agricultural improvement projects (Bunch, 1982, pg. 138). When using a technology, most farmers will attempt to try it on

their entire crop. The advantages for the farmer of having small experimentation plots in the project include there is little to no financial risk, a large learning curve exists for getting their hands active in an experiment, and results can be compared with other plots, if small and numerous. It is recommended that village training always accompany the introduction of the technology, where there is an advantage to holding short, frequent lessons, teaching in a manner the participants can understand, and using many visual aids. Thoroughly addressing both of these components in his book reinforced my decision to have these two parts as a top priority in the project.

Project Scope

I organized the project around four attainable goals:

1. Improve farmers' food security

As previously mentioned, food security is a main concern for most households throughout Mali and the developing world. I identified it as a prevalent and visual problem in Konza, with most households' farms not yielding enough grain to feed the family for the entire year. Therefore, the over-arching goal of this project was to assist my fellow community members on an essential and basic level. By addressing Konza's need for access to a safe, nutritional, and adequate amount of food, this project would inevitably contribute, albeit slightly, to improving their food security problems.

2. Evaluate effectiveness of natural pesticides relative to commercial pesticides

Some people are skeptical about how effective natural alternatives can be to keep pests from destroying a crop. Before launching a full out pro-natural campaign, I wanted to test the pest repellent abilities of natural pesticides in comparison to the chemical pesticide competitors. The focus question was: "are natural alternatives a viable alternative to chemical pesticides." Instead of assessing the various chemical and natural products in test plots in a controlled environment, I decided it was best to engage local farmers to plan and conduct experiments in their fields and gardens, so that they were more directly involved in the process. Also, the farmers are knowledgeable about farming techniques and conditions, making them more qualified to manage the test plots than I. Additionally, the farmers ultimately need to be convinced of the technology if they are to adopt it after I have finished my involvement in the project. By managing the experiment on their own properties, they are invested in achieving a successful crop yield, can easily track changes or differences between test plots, and determine, for themselves, whether the natural pesticides are effective at protecting crops.

3. Introducing or enhancing on previous knowledge of natural pesticides as a method of crop protection

Few farmers in Konza knew about the natural ability of certain plants to repel pests. Capitalizing on this natural pest-repellant ability can help improve their crop yields inexpensively. An important part of this project was to announce this as a viable agricultural practice to the community, by using experimental plots and education to teach a select few, who would then be encouraged to continue to educate others.

4. Educating farmers in the health and environmental effects of commercial pesticides.

As previously mentioned, rural farmers have limited or no knowledge of safety precautions or the health and environmental effects of chemical pesticides. The participants will be educated on these related pesticide issues through a series of organized classes. It is the goal of these classes to provide the necessary background information so that the farmers can make informed decisions regarding their agricultural techniques and pesticides.

Methods

Project Organization

There are five methodological components to this project: introduction surveys, experimentation, field visits, classroom education, and conclusion surveys. Each part is to be included in order for their combined efforts to achieve the intended project goals.

I chose eight male and three female participants for my project. Dramane helped to find farmers that were interested in learning about various techniques that could improve their crop. It was important for Dramane to be involved in this step, because he knew others in the farming community and has previously worked with many of them on a variety of projects. When a farmer told me they were interested in participating, I asked them a few background questions to gauge their dedication and interest in pesticides. I informed them of both project components and how they would be required to be active in the classroom and experiment.

The female participants were recruited by me based on knowledge of women in the community who had interest and good work ethics. I worked with the female farmers only in their rice fields, as most of the females in the community did not own a garden. All the participants were told that they would be a part of an important project that required their participation through to the end.

When conducting this project, I chose a group of farmers manageable in size because this component can be time consuming. I used farmers that I knew would conduct consistently good work and who were motivated to undertake this project. Eleven participants was a good number to work with and took up a generous amount of my time, but still small enough to create a working community. All activities conducted with the participants was reviewed and approved by Cornell University to include human subjects in research (Appendix K).

Introduction Surveys

I used introduction surveys to familiarize myself with the farmers participating in the project and their farming practices, especially with respect to previous natural and commercial pesticide usage. These surveys were also used to evaluate their previous knowledge of the health and environmental effects of pesticides. Surveys were conducted during a one-on-one meeting between the farmer and myself between April 2010 and May 2010 and they were completed before initiating any other project activities.

The surveys began with questions about the farmer's biographical information such as age, level of education, birthplace, and number of spouses and children. The bulk of the survey contained questions regarding previous knowledge, use, and observations of commercial and natural pesticides in their gardens or fields (Appendix B). Since all the farmers were illiterate, I read the survey questions and wrote the answers in the project notebook. I used the survey answers to develop my classroom lessons to address notable knowledge gaps within the group of farmers.

Experimentation

Convincing farmers that natural alternatives to chemical pesticides are effective as a form of crop protection was the most important goal in this project. Bunch (1982) recommends using small experiments to get participants enthusiastic about the project while simultaneously showcasing the effectiveness of the technology. The experimental objective of this project was to compare the effectiveness of natural and commercial pesticides.

Each farmer managed his/her own experimental plot, choose what crops to treat and which natural pesticide to make/mix and apply (Table 1). The chosen crops included: tomatoes, eggplant, Malian eggplant (goyo), squash, cucumber, rice, beans, orange trees, guava trees, and jatropha tree nursery. In general, most farmers did choose crops that are most susceptible to pest problems. While each farmer ran his/her own experiment, the collective of all the participating farmers allowed me to analyze the variability among same crop-pesticide combinations.

Table 1: Farmer treatment and crop matrix

Farmer Name	Crop	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Karim	Tomato, goyo	Control	2.5 EC	Neem leaves	Neem leaves & hot pepper	Hot pepper
Dramane	Orange trees	Control	2.5 EC	Neem seed	Hot pepper	Neem leaves
Alou	Tomato, eggplant	Control	2.5 EC	Neem seed	Hot pepper	
Shaiga	Tomato, eggplant	Control	2.5 EC	Neem leaves	Hot pepper	Neem leaves & Hot pepper
Saliya	Tomoato, goyo	Control	2.5 EC	Neem leaves & Hot peper	Garlic	Neem leaves
Yuba	Guava, beans	Control	2.5 EC	Neem leaves	Garlic	Neem leaves & Hot pepper
Mousa	Goyo	Control	2.5 EC	Neem leaves	Garlic	Hot pepper
Daouda	Tomato	Control	2.5 EC	Neem leaves		
Rokia	Rice	Neem leaves				
Haia	Rice	Neem leaves	Neem seed			
Mama	Rice	Neem leaves	Neem seed			

Treating different crops with various pesticides allows for the farmers to share observations and recommendations. In general, the participants were interested to see the wide range of applications for natural pesticides.

Farmers set up their experimental plots by marking-off a small portion in the field or garden for each pesticide used. A control plot, which received no pesticides, and a plot for commercial pesticide (2.5 EC) were also delineated. Old fabric was tied on long sticks to mark off the various plots. Colored fabrics help distinguish the types of pesticide; red fabric for hot pepper, white for garlic, green for neem, and a neutral color for commercial. Each plot was approximately same area, $1m^2$. Each farmer tested the same crop on the experimental plots. If he wanted to test more crops, he used a different plot for each plant so it would be easy to see any visual differences when comparing the plots of the same crop between farmers.

Figure 3: Daouda pounds the neem leaves during preparation of the neem leaves solution.

I instructed each individual farmer on how to make or prepare the various natural pesticides. Each participant learned to make and apply three different natural pesticides (Figure 3). I physically made the initial solutions with the farmers to disseminate the information easier. Since the participants were illiterate, I created a visual diagram (Figure 4) of how to make the different natural pesticides to give to each farmer to use as a reference for the subsequent preparations.

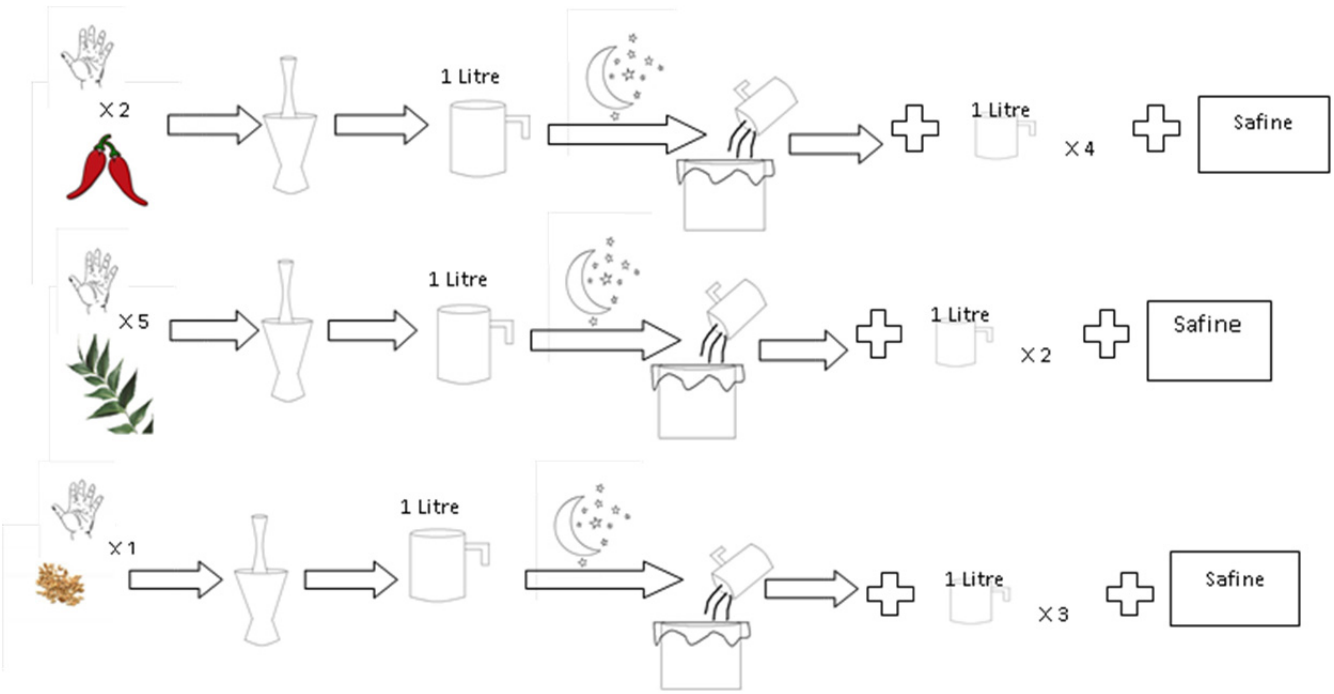

Figure 4: Schematic of natural pesticide solution preparation (neem leaves, neem seed, and hot pepper)

To prepare the natural pesticides, the pesticide property was extracted from the plant using a mortar and pestle. The extracted substance was allowed to sit in water overnight. After soaking for 8 or 10 hours, the water was sieved and mixed with more water and soap powder.

The neem tree will produce seeds two or three times during the rainy season depending on the age of the tree and the amount of water received. The seeds will turn yellow and drop when ripe. After the seeds are collected, the outer skin is peeled off revealing a stubborn fruit. If the fruit is hard to remove by washing, the fruit covered seeds can be dried in the sun. Depending on weather, the seeds take about two or three days to fully dry out, after which, the dried fruit can be peeled off exposing the dried seed. This seed needs to be cracked open to get to the greenish pulp of the seed, which contains the pesticide properties and what is used in making the solutions. Upon being dried, many seeds can be pounded together to crack them open. If some of the dried seed shell is accidentally left among the seed pulp, it will not greatly affect the solution, but care should be taken to remove anything but the seed pulp.

The neem tree leaves have pesticide abilities, although arguably not as strong as the seeds based on the potent smell. The leaves can be harvested at any time of the year, and should be picked fresh before making the solutions. The hot pepper, grown by many farmers in Konza, is readily available during the harvest season, and other times if the farmer maintains a stock throughout the rest of the year. The solutions can either use dried or just-harvested hot peppers. The garlic was not grown in Konza but easily bought in the market town. Newly bought garlic was used for this experiment, although dried garlic flakes would probably work just as well.

All of the natural pesticide recipes were adopted from the "Natural Crop Protection" handbook. Note, since most of the recipes had no specific published quantities for various ingredients and reported methods varied, the ratios used in the recipes here are somewhat of my own devising:

Neem seed-shell dried neem tree seeds (Figure 6) and crush one handful, sit overnight in one liter of water, sieve out the seeds and add three liters of soapy water.

Neem leaves-crush five handfuls of neem tree leaves (Figure 5), sit overnight in one liter of water, sieve out the leaves and add two liters of soapy water.

Hot pepper-crush two handfuls of hot pepper, sit overnight in one liter of water, sieve out the pepper and add four liters of soapy water.

Garlic-crush one bulb of garlic, sit overnight in one liter of water, sieve out garlic and add two liters of soapy water.

Neem seed and hot pepper- crush one handful of dried peeled neem seed and one handful of hot pepper, sit overnight in one liter of water, sieve out hot pepper and seeds and add four liters of soapy water.

Neem leaves and hot pepper- crush four handfuls of neem leaves and one handful of hot pepper, sit overnight in one liter of water, sieve out hot pepper and leaves and add three liters of soapy water.

Figure 5: The neem tree when the seeds are ripe and can be used for making pesticide solutions.

Figure 6: Ripened neem seeds fall to the ground and can be gathered to produce the solution.

Adding soap to the solution allows the natural pesticide to stick to the plants during application. The soap used was a multi-purpose powdered soap found in every local store and very affordable. It is the same soap that Malians use to wash their clothes and dishes. The soap was added in small amounts as the water is stirred; only a small amount is needed and should not be wasted. The water was sieved through a large, old cloth provided by the farmer. Containers, cloths, and any other objects that come into contact with the natural pesticide solutions should be

washed before reusing. Each batch is large enough for several applications. Therefore, the remaining solutions were stored in closed containers away from the reach of children and animals, while a small amount was brought out to the application area. The solutions can last a long time; they will actually get stronger over time.

Each farmer received one recycled soda bottle (35 cl) to use as a pesticide applicator. Discarded bottles were collected from the street or shops that sell soda. The farmer poked small holes in the bottle cap so it could be used as a sprayer (Figure 7). This proved to be a cheap and easy alternative to a hand pump, and somewhat unified the method of application among the participants.

Figure 7: Alou using his recycled bottle to apply the pesticide solutions to tomato plants.

The three female participants only used neem solutions in their rice plots. Natural Crop Protection in the Tropics stated that neem would be a good treatment for rice (Stoll, 1998, pg. 43). The rice farmers set up their plots in the same manner, and applied treatments the same way. Because applying any solution to a rice field requires stepping through the plants, care was taken to apply as the farmer was walking backwards away from the treated area (Figure 8). Additionally, the rice sits in a good amount of water, making it easier for the solution to wash

away earlier, so I instructed the farmer to aim for the top of the rice plant when applying the treatments. No commercial pesticides were used in the rice fields, as they are positioned in a vulnerable area, where water contamination is more likely to happen. Also, women and children walk through this water when tending to their rice plots and could be affected by the pesticides in the water.

Figure 8: Mama applies neem solution to her rice plot

The commercial pesticide used for this experiment was 2.5 EC because it was readily available at most markets in Mali, fairly inexpensive, and specifically produced to be used on vegetables gardens. It comes packaged in either small containers (approx. 1,000 CFA) or by 1 liter bottles (approx. 5,000 CFA). The pesticide lasts a long time and is typically stored in an air-tight container.

The natural pesticide solutions are made in volumes between 3 and 5 L. Farmers transferred about 1 L into another bottle for transport to the garden plots. The farmers sprayed each pesticide solution in the appropriately marked plot at a dosage of approximately 1 bottle per square meter. For the commercial pesticide, 2.5 EC, one full bottle cap (approximately 2 ml) is mixed with 1 L of water to spray. If the plot was small or sparse, the pesticide dosages were decreased to the farmers' discretion. I encouraged farmers to begin application of pesticides at the first signs of damage or pest, and/or before the pests appear if he/she has enough knowledge of the pest cycle. The natural pesticides were sprayed until the end of harvest. The commercial pesticide was stopped 10 days before harvest due to its potency.

The commercial pesticide was sprayed every 10 to 14 days, as per the directions on the packaging. Natural pesticides required more frequent spraying; typically. Two to three times a

week is recommended, which will increase due to any big rainstorm. For the experiment the farmers were as consistent in their methods as was practical.

Some modifications were made during the experiments that were not controllable. For example, farmers may have diluted the natural pesticide solution if they noticed burns on the plant leaves. Conversely, they may have made more concentrated solutions if the pests had not receded.

Field Visits

As the experiments progressed, I visited the farmers' plots once every two weeks so I could record observations in a field journal, discuss any observations with the farmers, address problems with the experiment, answer questions, and learn from the participants. During each field visit, I conducted a visual inspection of any pests or damage done by pests. I watched the farmer apply the pesticides (Figure 9). Frequent field visits ensured the farmer that I was committed to this project and interested in his opinions and individual experience. I documented some important observations with digital images.

Figure 9: During a site visit, Shaiga prepares his solutions to treat his garden.

At harvest time, I planned to conduct a biomass survey. Each time they picked crops from a plot, the farmer was to weigh the amount of edible (sellable) produce or crop harvested. These were to be my primary quantifiable data for analyzing the effectiveness of the natural pesticides.

Farmers' School

The Farmers School was developed so that the participants could gather together to discuss their experimental plots and to learn about various farming topics within the scope of the project. The School also was meant to generate a sense of a community among the project participants. I adopted an informal teaching style to educate farmers about the health and environmental effects of both natural and commercial pesticides, holding class at my house or under a shady tree (Figure 10). One objective of the school was to educate participants about farming techniques, crop protection techniques, and various options, so they can make better decisions based on their economic, social, and personal preference. Options give farmers flexibility.

Figure 10: Gemma Kite teaching the farmers about the human health effects of chemical pesticides.

I named it "Farmers School" because it is closely modeled after the similar classroom component under the same name as part of a project organized by SOTUBA, the Malian Ministry of Agriculture. Additionally, as most of these farmers have limited education, putting a formal name on the group instills a sense of pride among the members. The School was active during the same time as the experiment. Seminar topics I facilitated included an introduction to food security, environmental effects of pesticides, health effects of pesticides, commercial pesticide use and storage, the organic movement, and a compare/contrast of natural vs. commercial. Regardless of whether there was a prepared seminar, the participants met to update each other on their experimental plots in a roundtable type manner. The lessons were written up in English (Appendix D) and in Bambara (Appendix E) for future use.

Conclusion Surveys

Surveys were also conducted at the close of this project to be able to receive feedback on the project in order to assess what the farmers learned during this project, especially pertaining to natural pesticides and the health and environmental effects of pesticides. The conclusion surveys also evaluated whether this project is likely to influence future farming practices. Like the introductory surveys, all conclusion surveys were conducted on an individual basis. Some plot experiments had not yet been completed by the time I was interviewing because my Peace Corps service was ending.

The conclusion survey focused on asking questions about the farmers' opinions on the availability, application, health and environmental risks associated with pesticides and experimental results of both the commercial and natural pesticides used by the farmer (Appendix B). Additionally, each farmer was asked what he would prefer to use in the future and to state the reasons.

During the conclusion survey, I asked the farmer to list each pesticide used in their experimentation in a grid like the example below (Table 2). They would then indicate relative preferences for each pesticide pair. In the example grid below, this farmer preferred pesticide Type 1 better than Type 2 or 3 but preferred Type 4 over Type 1. These data were used to evaluate any consensus regarding specific pesticides.

Table 2: Example of Preference table completed by the farmer during the conclusion survey

Preference of Pesticide Type				
	Type 1	**Type 2**	**Type 3**	**Type 4**
Type 1	X	Type 1	Type 1	Type 4
Type 2	X	X	Type 2	Type 4
Type 3	X	X	X	Type 4
Type 4	X	X	X	X

Culturally, Malians like to please their peers, work partners, and employers so I developed a similar survey tool with the thought that having a variety of questions that get similar information I might be able to detect instances where the participants may have been anticipating answers they believed I thought were correct. I asked each farmer to choose natural or commercial pesticide based on a variety of categories including: cost, application, health effects, environmental effects, and experimental results as seen in the below example (Table 3).

Table 3: Example of comparison chart completed by the farmer during conclusion survey

Commercial and natural pesticide comparison					
	Cost	Application	Health	Environment	Experiment
Natural	X		X	X	
Commercial		X			X

Informational Deliverables

In order to ensure that information is not lost or accidentally changed through or after the project timeline, I created pamphlets and fact sheets. Fact sheets written in English (Appendix F) and Bambara (Appendix G) are written for the farmer, whereas pamphlets written in both English (Appendix H) and Bambara (Appendix I) are organized into a more professional product that can be given to organizations. Both have the same content: background information on pesticides, methods to make natural pesticides, instructions on how to apply and care for the pesticides, and helpful visual aids. The deliverables will help to remind the participants of project information, and an easy way to share the concept with potential farmers. The diagrams and pictures help to convey the information to farmers who are illiterate. Also, the printed tangibles give the project legitimacy, as it provides a paper trail that validates the information supplied in the project. Like the Farmers School, owning such deliverables gives the participants a source of pride. Malians like to show off their paperwork, whether it is informational or diplomas for education, possessing these documents gives them a documented history. The fact sheets and pamphlets were handed out to all participants, other interested individuals, the Peace Corps, and to other organizations.

Results

Evaluating the Effectiveness of the Pesticides

Viewed as the most important factor in this project by a more technical person, proving the effectiveness of natural pesticides compared to commercial pesticides is a necessary step for farmers to accept this technology. According to Bunch's methodology, the technology has to respond to the farmers' required needs, of which can only be trusted upon personally seeing experimental results in their own fields and gardens. No measurable data was extracted from the test plots comparing natural pesticides to commercial pesticides, as there was no visual difference between plots treated with varying natural pesticides and plots treated with commercial pesticides. In two cases, however, there existed a measureable difference between the natural pesticides plot and the control plot, proving to the participants that using natural pesticides is more beneficial than not using any treatment at all.

While not all farmers saw dramatic results in their test plots, two participants were able to see quantifiable results proving the effectiveness of natural pesticides as a form of crop protection. Dramane applied neem seed solution, hot pepper solution, and 2.5 EC to three different plots alongside a control plot in a small orange tree nursery.

Figure 11: Dramane applying pesticides to his plot

Dramane applied his first treatments to the orange tree nursery on August 19, 2010 (Figure 11). The plots are marked with colored flags. The plot to the left of the blue flag was treated with 2.5 EC. The plot in-between the blue and red flags was treated with hot pepper solution. The plot in-

between the red and the white flags was treated with the neem seed solution. To the right of the white flag is the control plot. A schematic representing Dramane's plot is easier to show how the plot was divided (Figure 12). Following the proper treatment dosage and application methods, after one month he was able to see visual results between the control plot and the treated plots, as seen in photos recorded during our September 12, 2010 field meeting (Figure 13). Note that the photo view is backwards from the previous photo, so the control plot is closest to the viewer.

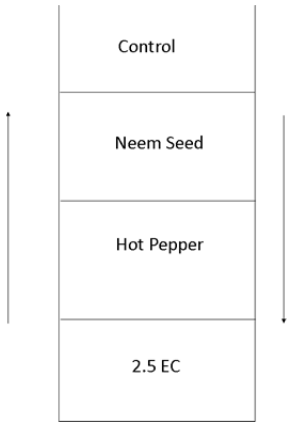

Figure 12: Schematic of Dramane's plot

Figure 13: Visual differences between the marked plots taken on September 12, 2010

The photo clearly reveals that the orange trees in the control plot have not grown as tall or as thick as the other plots treated with pesticides. The control plot trees are significantly smaller with less leaves. No visual difference can be seen in the trees between the 2.5 EC treatment plot and the hot pepper and neem seed solution treatment plots.

In another case, Saliya was using neem leaves solution, mixed neem leaves and hot pepper solution, garlic solution, and 2.5 EC solution to treat the Malian bitter eggplant. Before treatments, he would describe his plants has having dried, curled up leaves, and producing little to no fruit. When Saliya first applied pesticide treatments to his eggplant plots, the plants were in poor quality (Figure 14). Both Saliya and I assumed it was a pest causing this problem with his bitter eggplants, yet there is no concrete evidence that this was the most contributing factor compared to other potential factors such as disease or lack of soil nutrients.

Figure 14: Saliya's crop before treatment showing the shriveled leaves on the eggplant

After several treatments of his natural and commercial pesticides, the plots developed into producing healthy plants with harvestable fruit (Figure 15). The same plot above is represented in the figure below, one month after starting treatment.

Figure 15: The same plot as Figure 4 one month after starting treatment.

Using one of his children as a measuring stick, he first stands in the control plot in the photo on the left (Figure 16). Then, he stands in the plot where there was natural pesticide treatment application, where the plants are clearly at a taller height. It is not specified which natural pesticide treatment this picture was taken in, but either represents the neem leaves treatment or mixed neem leaves and hot pepper treatment plots. Both plots were planted at the same time.

In a separate category, the three women rice growers also experimented with control and neem treatment plots. No quantifiable data was collected. All three women attested to the neem solution treatments, saying that they noticed a visual decrease in the amount of pests in the treated fields after applying the solutions. Two of the women experimented both neem seed and neem leaves solutions, and both stated that they believe the neem seed was a more potent solution.

Figure 16: Comparing the heights of the eggplant from a control plot (left) and a treated plot (right)

Other uncontrollable factors prevented getting measurable data. Many farmers had planted early during the 2010 growing season. Unexpected strong and frequent rains drowned their newly planted crops, destroying them so they would have to replant mid-way through our project. The second round of plants was not able to produce fruit before my project closure date.

I encouraged farmers to take bio-mass measurements of their crops as they harvested the gardens. By taking the mass of edible or sellable vegetables from each individual plot as they were picked, and by comparing the masses between the various test plots, any difference would be able to give valuable information on the effectiveness of natural pesticides compared to commercial pesticides. The majority of farmers complained they did not have enough time, or the proper equipment to carry out such method. Additionally, I could not be in their gardens every time they harvested a plot to enforce mass measurements. In the future, I would advise to take mass measurements to use as quantifiable data.

Managing this project with eight garden farmer and three rice farmer participants stretched my time thin. Rotating through the farmers, spending a few hours each day dedicated to field visits did not give me enough time to monitor each and every experiment. The farmers' observations were the most valuable part of this experiment, as they were present in their gardens and fields on a day to day basis, noting minor changes as they occurred. I compiled comments that farmers made during their conclusion surveys. During the survey, we completed an activity, which made every possible pair combination for each pesticide and asked the farmer to choose which pesticide out of the two he thought was the best for his crops. The result of this activity gives a

neat list of pesticides starting with the most chosen pesticide to the least chosen pesticide (Table 4).

Table 4: Farmers preference choices based on answers from the conclusion surveys

Name	Dramane	Ali	Daouda	Shaiga	Youba	Karim	Saliya	Mousa
First choice	Neem seed	2.5 EC	Neem seed	2.5 EC/Neem leaves	Neem leaves & Hot Pepper	2.5 EC	Neem leaves	Neem leaves
Second choice	Hot Pepper	Neem seed	Neem leaves	Hot Pepper/ Neem leaves & Hot pepper	2.5 EC	Neem leaves	Hot Pepper	Hot pepper
Third choice	Neem Leaves	Neem leaves	2.5 EC		Neem leaves	Neem leaves & Hot pepper	Garlic	Garlic
Fourth choice	2.5 EC	Hot pepper			Garlic	Hot Pepper	2.5 EC	2.5 EC

The conclusion surveys were completed after both the experimental and classroom components of the project (Appendix C). The results of this table do not reflect views of just the experimental component, and may have been influenced by lessons taught in the classroom. Not all farmers used every natural pesticide, which explains why some pesticides are listed with a farmer and others are not.

For four farmers, using the 2.5 EC is their last option when applying a pesticide. They would prefer to use natural methods than use commercial pesticide. Three farmers chose 2.5 EC as their first option in crop protection, putting commercial pesticide ahead of natural pesticides. Overall, neem leaves solution was chosen as the best natural pesticide to use in their gardens. Neem seed and hot pepper followed closely behind. Garlic was the least favored natural pesticide, showing it as the least effective pesticide. This is supported with many farmers' comments throughout the experiment of garlic being too weak to have a real effect on deterring pests.

The objective of the experiment component of this project was to convince the participants that using natural pesticides is a practical method to protecting their crops against pests. In order to measure that analytically during the conclusion survey, I asked all participants to explain what they would use in the future to protect their crops and the reasons behind this decision. I received a variety of results.

Three out of the eight farmers (37.5%) answered they will use both natural and commercial pesticides in the future. The reasoning behind these answers was because both worked well to protect crops against pests. One farmer answered that he will use 2.5 EC on his tree nursery because the fruit will not be eaten, and use natural pesticides on garden vegetables because the harvest will be consumed. Three out of the eight farmers (37.5%) answered they will use natural pesticides to protect their crops, stating that it is an easy, affordable, effective method, and there are no harmful effects to the user or the environment. Two farmers (25%) answered they will only use commercial pesticide. One farmer explained that the 2.5 EC is more potent, less effort involved because it lasts 10-15 days before reapplying, and it upholds stronger against rains and does not wash away prematurely. He stated even though he knows it has harmful effects, the benefits of using commercial pesticide outweigh the negatives. The second farmer stated he would only use commercial pesticide if he had the money to purchase the supplies.

Another survey question asked the farmers to compare the natural and commercial pesticides use in the following categories: cost, application feasibility, health effects, environment effects, and experiment results. Each farmer answered by deciding which pesticide type was better in the specific category (Table 5). The natural pesticides were overwhelmingly preferred in all categories. The experimental results category was the only area without a large difference between the pesticide types, which is supported by farmers' comments that the commercial pesticide is more effective, long-lasting, and durable.

Table 5: Farmers' comparison of natural and commercial pesticides in various categories

	Cost	Application	Health	Environment	Experiment
Natural	XXXXXXXX	XXXXXXX	XXXXXXXX	XXXXXXXX	XXXXX
Commercial		X			XXX

Introducing or enhancing previous knowledge on Natural Pesticides

Before the project began, introductory survey answers revealed that six farmers (75%) had knowledge of using natural alternatives to commercial pesticides for crop protection (Appendix C). When the farmers answered that they had previous knowledge of natural pesticides, in most cases it referred to their limited understanding that plants exist that can be used naturally for crop protection. Farmers would know of this through communicating with other farmers. Only four farmers (50%) of the farmers had ever experimented with making and using natural pesticides in their gardens or fields. Two farmers (25%) offered a recipe for the neem solution that they have used in the past, including mixing the leaves or seeds, petrol or water, and soap together before spraying. Dosage and plant soaking times were not mentioned and based rather on experience.

By the end of the project, all participating farmers had an increased awareness of natural pesticides. Farmers were able to make their own natural pesticide solutions, whether it is from hot pepper, garlic, neem seeds or leaves, or a combination solution. During the experiment, I emphasized making the solutions together with the farmer, and then repeating the process having the farmer make it from memory. Additionally, I made diagrams to easily show the steps in making the various natural pesticides, as all the farmers were illiterate. After the first two visits to make the solutions and with the handouts, the farmers were able to produce their own solutions, and teach other non-participants as well. Furthermore, participating farmers were so encouraged by the plants' natural pesticide abilities that they were interested in finding other plants with similar properties that could be even more potent, or repel other pests. During one of the classroom sessions, the farmers discussed finding a variety of successful natural pesticide solutions, producing them in mass quantities, and selling the product to other farmers as a small-business activity.

In comparison, seven farmers (87.5%) answered that they had previously used commercial pesticide in their fields or gardens and thought it was a successful method to protecting their crops. Four of the seven farmers admitted that the cost and availability of the commercial product was an issue, so using commercial pesticides was not sustainable. Two farmers admitted that improperly applying the commercial product with an incorrect dosage could destroy their crops and scared them to not use the pesticide freely. Three farmers mentioned that using commercial pesticides has given them health concerns, such as a tingling sensation in the hands, cold-like symptoms, or the bad smell and taste that settles in the mouth. At the close of the project, all farmers had gained knowledge in proper care and handling of commercial pesticides.

Educating farmers in health and environmental effects of commercial pesticides

The introduction surveys gave shocking insight into the limited knowledge farmers have of commercial pesticides, even though they are rampantly spraying their crops each year. Of the eight participating farmers, two (25%) answered in their introductory survey that they had no previous training with commercial pesticides. Calfus 500 EC is given every year to each farmer growing cotton by the CMDT. Some farmers answered that they were given little training on using this product. Training included instructing farmers to cover their faces with masks and wear gloves when spraying, and washing hands with soap after using. Participants are illiterate and cannot read the safety labels on the product, nor do they understand all the safety and environmental diagrams on the label. Even though Calfus 500 EC is given to be sprayed strictly on cotton, the majority of the farmers also use this commercial pesticide to protect their garden vegetables. In fact, seven farmers (87.5%) reported using Calfus 500 EC on field or garden crops other than cotton. The remaining farmer (12.5%) has never used commercial pesticide ever. Only one farmer (12.5%) has previously used 2.5 EC, a pesticide intended for garden vegetables, in his garden, along with the Calfus 500 EC. The participating farmers answered on their survey that they know of potential health hazards associated with commercial pesticides because of the bad odor or taste in their mouth, or having been educated to wash their hands with soap and to

use protective clothing. Additionally, farmers do not understand proper dosage, as two reported that they were unsure of the water to pesticide solution ratio or liters of solution to area of land ratio and ended up damaging crops, rendering them inconsumable or unsellable.

During the project, I educated the participating farmers in various topics introducing the health and environmental effects of commercial pesticides. Teaching the farmers the foundation principles instead of just instructing them to wear protective gear to protect them really allowed the participants to understand the issues in their entirety. Being educated allows the farmers to make informed, healthy decisions. According to Table 1, four farmers (50%) would prefer to use natural alternatives before 2.5 EC, while the other 50% chose 2.5 EC high in there pesticide treatment preferences. During the conclusion survey, three farmers (37.5%) answered that they would use natural treatments to protect their crops in the future, all mentioning that they have no harmful effects to persons or the environment as part of their reasoning. Two farmers (25%) stated that although they fully understand the hazardous effects of commercial pesticides, they will still opt to use them in the future as they are faster and more potent. One of these farmers stated that only if he had the money would he purchase chemical pesticides. The remaining three farmers (37.5%) would use a combination of both pesticides for better crop protection. Clearly, education affects people differently. Furthermore, farmer's priorities are varying, some farm using the cheapest measure, others farm with the intention of having the best and largest crop in order to make profit, and others farm with safety in mind so that they can feed their family. At least at the end of this project, farmers were able to make more informed decisions about a practice that does affect their lives, the people connected to them, and the environment.

Discussion

Meeting the Goals

Addressing Food Security

Looking at the project objectives, the first goal of increasing farmers' food security was not a tangible goal, but inevitably addresses the overwhelming need in the Konza for access to abundant, safe, and healthy food. While conducting the experimental plots did not necessarily yield more edible crop, it introduced the farmers to a technique that can be scaled-up to produce a healthy, plentiful crop with little to no pest damage. If the technique is practiced, revised, and improved, it has the potential to help farmers secure a better food security situation in the future.

This project that is sustainable has the ability to make a positive change in Mali's food security situation. One reason that I conducted the project with time-consuming people-centered methodology was to stimulate motivation among the participants to ensure the relevant information would be sustained in the community knowledge-base. If these farmers continue to use natural pesticide-control practices in their farming, as well as engage other farmers in in these practices, then the technique will be sustainable, even evolving and improving over time. While I used Bunch's (1982) recommendations to set up a sustainable project, it is up to the farmers to manage and oversee the project's legacy now that I have moved away. After seeing the project feedback that I received during the conclusion surveys, I am confident that the participants will continue to incorporate natural pesticides as crop protection in the future. As is common in Malian culture, the sharing of ideas, property, and each other's physical labor will help in exposing more people to using natural alternatives to chemical pesticides.

Evaluating the Pesticide Effectiveness

Employing an experimental approach was a valuable way to demonstrate the effectiveness of natural pesticides in comparison with chemical treatments. Even though quantifiable data was not available, the qualitative results from the experimental plots clearly showed that using natural pesticides is a more effective solution than using no treatments at all. More importantly, the experiments contributed substantially towards convincing the farmers that natural alternatives are viable options for crop protection. The conclusion survey answers indicate that most participants decided that natural pesticides would be just as effective as their chemical counterparts, even if they required more work to apply and maintain (Table 4).

Most farmers commented that the natural solutions were easy to wash away due to rainstorms, and must be applied multiple times per week to ensure effectiveness against pests, as predicted. While the short-term effectiveness of natural methods is not as great as compared to the chemical pesticides, it has obvious long-term advantages, such as: diminishing the risk of pests building resistance to a particular pesticides, has a less destructive effect on pests, less harmful to the health of humans and animals, causes no damage to the environment or water supplies, costs

less, and locally available (Stoll, 1998, pg. 16). This was the one of the overall concepts that the farmers came to understand through this project.

Introducing the idea of using natural pesticides

While most of the participants had known that plants can be used to naturally repel pests, when I began this project they could not cite specific solution recipes or plants that had recently been used for this purpose. By the end, all participating farmers could produce their own natural pesticide solutions using a variety of plants, and apply the solutions in effective doses. I think that the most important part of introducing this technology of natural pesticides was using a people-centered approach. As the project manager, I conducted one-on-one consultations with each farmer during the initial education stages, instruction of solution and experiment preparation. Doing such effectively gave attention to each individual and to the general issue. This one-on-one approach is different from many other ideas or projects that are initiated in Konza, namely, during a crowded meeting where the idea or technology is discussed, but never quite makes it to individuals because no enthusiasm is generated and there is no follow-through. The people-centered approach I adopted was a successful way to introduce this agricultural technique to the community.

While some of the participating farmers may not use natural pesticides in the future, they now understand the overall idea of incorporating them into farming, including reasons why farmers may opt to choose this method, e.g., because of the harmful effects of the chemicals.

Education on chemical pesticide effects

I believe that educating the farmers was a very crucial part of the project. As stated earlier, being taught about the dangers of chemical pesticides, about how to properly apply pesticides, and about alternatives to chemical pesticides gives the farmers invaluable choices. The observed reactions from the farmers, while learning about the various harmful effects that chemical pesticides have on both humans and the environment, indicated that this was new and valuable information. The obvious reactions reinforced the need for the farmers' school in the scope of the project.

This was also the most enjoyable part of the project for me. As an environmental engineer, I have studied the hydrological cycle and how contaminants can pollute the water system. It was great to be able to pass along this knowledge in an informal setting to a group that has limited formal educational experience and that has never been given the same opportunity by a CMDT or government representative.

The Farmers' School was an effective measure. The participants, like most Malians I interacted with, enjoy social events that allow them to discuss and learn from each other. I had intended for the weekly meetings to be a chance to regularly introduce new topics and for everyone to catch up with each other's experiment progress. But it turned into an unexpectedly effective way to

exchange other relevant information, to discuss other problems affecting their farming, and to brainstorm solutions. Meeting together weekly initiated a supportive community, which stirred enthusiasm among members and moved the project away from paternalism (Bunch, 1982). When planning this project, I had intended for this type of synergy among the participants to occur, but I must attribute the quick growth and acceptance of it to the members' self-initiative. During the majority of these off-topic classes, I mostly observed because I did not have adequate Bambara language skills or relevant agricultural experience to meaningfully contribute to the discussions.

The community gained through having the Farmers' School is an important factor in the future success of this project. If there was no existing participant community, and I left with the participants depending solely on me for the continuation of the project, it would inevitably end. Instead, a network of sharing, collaboration, and support generated during the Farmers' School will help support and maintain the project in the future.

Balancing natural and commercial: Integrated Pest Management

The conclusion surveys indicated that the group of surveyed farmers was split in their decision to use natural or chemical pesticides in the future. Konza is not unlike the rest of the developed world on this issue. However, this project does show that educated, experienced farmers will choose what is beneficial for their current agricultural practice, incorporating factors such as personal financial situation and possible threats to the environment, their families, and their consumers into the decision.

This project demonstrates that a safe, effective pest management system should be available so that all farmers can adequately protect their crops in a way that is most appropriate to them. Not all farmers own the same resources, nor do they farm their land with the same techniques. Using an integrated pest management system, which can incorporate both chemical and natural methods along with utilizing agricultural practices such as crop rotation, understanding pest life cycles, crop diversification, and perhaps other ideas, will offer farmers many options and still keep the consumer and environmentalists appeased.

Lack of Data

When planning this project, I intended for each farmer to closely observe his or her own plot for differences in plant growth, pest presence, and any other visible changes before and after treatment. Additionally, I had arranged for the farmers to perform biomass analysis on all edible or sellable produce at harvest. Since this was a lot of work for me to manage and conduct by myself, I encouraged the farmers to take their own initiative to conduct data collection as part of the experiment. Unfortunately, the amount of data received throughout the experiment was not as much as I had expected during the planning phase. Several factors contribute to this discrepancy between my expectation and reality, including weather, plant disease, and farmers' health or schedule.

The rains in the southern region of Sikasso start in late May and last through to October. They are heavy, sometimes damaging, and are inconsistent. Having farmed the land generation after generation, and carrying previous knowledge passed-down from their ancestors, Malians rely on this indigenous knowledge to decide when to plant. It was typical in Konza for farmers to plant vegetable seeds in June in order to see a crop yield in August. Some of the participating farmers tempted fate and planted their seeds early, hoping to achieve two crop yields in one season, doubling their potential profits. Unfortunately for some of the participating farmers, they planted their seeds too soon; their tomatoes sprouted just in time for the heavy rains to kill them or the tomato plants caught a break and grew to the point of producing fruit when the rains were consistently too heavy and drowned the plants. This happened to several of the farmers conducting experiments, where their entire plots would be wiped out. While I was focused on the effects this would have on my project, the farmers were concerned about the future of their families' food security. I encouraged the disappointed farmers to plant more seeds and told them we would try again during the next round.

The plants were also subject to disease. One farmer was struggling to identify what was happening to one of his vegetable plants. It appeared that all of them, those included in and surrounding the experimental plots were suffering from shrived leaves and decrease production. While the pesticide treatments helped slightly, his crop did not fully recover. It appears that the problem may be linked to the fact that he planted the same crop in the same location for two consecutive years, even though there was some evidence of a problem in the previous planting. We speculated that a disease was responsible, lying dormant in the soil between plantings. Having no way to test the soil or crop for presence of disease (or other problem), we could not move beyond speculation and talked about addressing this in the future, possible by implementing crop rotation and diversification.

Additionally, because the farmer is in charge of his/her own fields and gardens, the individual's health and lifestyle affect the workings of the garden or field, including the quantifiable data collection I had anticipated. Some farmers have livelihoods outside the farm, e.g., mechanic or shop owner, that take time away from maintaining the crops. Other family members are used to help balance out the work load in a normal environment, but during this project, all participants were expected to conduct the experiment themselves. Due to other work, village commitments, or family responsibilities, it was challenging to meet with all the farmers on an individual basis each week and visit the experimental plots. It was also challenging for some of the participants to juggle all of their work and commitments along with this project. Depending on the individual, it may be feasible to conduct a time consuming biomass analysis, or make small observations at the various plots on a weekly basis.

With regards to the biomass analyses, I believe that it was partially my fault for not getting the farmers motivated. First, I did not mention the biomass analysis early in the project. I should have introduced this as part of the farmers' responsibility when recruiting participants so they could have understood that this was a required and needed component. Second, I did not conduct

any biomass analyses with any of the participating farmers. With the other components, I made an effort to take individual time with each farmer to show them how to make the various pesticide treatments and then apply them to their experimental plots, so that each farmer understood the procedure in its entirety. While one-on-one instruction was time consuming, it demonstrated to the participant that that particular part of the project was important. By not taking the time to do this with the biomass analysis, I was unintentionally telling the participants that this was not as important as making the pesticide treatments correctly. Upon starting to harvest the treated plots, I should have conducted a biomass analysis demonstration with each farmer, instructing on the procedure and showed how it was a crucial way to see if the experiment yielded any differences in plant growth and crop health. Afterwards, I think the participants could have easily and confidently continued with biomass analyses through to the end of harvest.

Social and Cultural Influences

With any project conducted cross-culturally, miscommunication, faux-pas, and cultural nuances can influence the outcomes. It is important to take these into consideration when planning but, realistically, they are not entirely preventable.

With Malians history of colonial rule and subsequent heavy dependency on aid organizations, the people have a tendency to "stretch-the-truth" when speaking with people they perceive as more respected, high-powered, and often foreign. Malians have come to associate telling these people what they think they want to hear with receiving a commodity, e.g., livestock, a water well, or a school for the community. We Peace Corps volunteers were informed about this cultural influence early in our service, so that we could look out for this behavior when conducting our baseline surveys. Being aware of this behavior shaped how I asked certain questions during the surveys usually by repeating an individual idea or concept in several differing question formats to be able to better gauge the validity of the answers. This behavior could also have played out during other components of the project. I was most aware of this during individual interactions, ensuring that I maintained more of an "observer" position as opposed to a "provider." Being a Peace Corps volunteer, who had a presence in Konza for almost two years before starting the project, gave me a less-influencing role in the power structure. Living in Konza, in a lifestyle similar to that of the community members, allowed the people of Konza a chance to see me as a person they could relate to, instead of a person that could potentially provide them with a service or goods.

Another potential influence on the outcome of the project was the differences in language. The participants spoke native Bambara. While I immersed myself in the language and tested at an advance level, I am not a native speaker and was not able to fully explain certain concepts or speak certain phrases. I do not believe that this had any large effect on the project but it would have been more ideal, of course, to have a native speaker managing the project.

Although I played an integral role in this project, my personal views on the pesticide issue were not disclosed as to persuade or influence the farmer into making any decision. I never applauded or discouraged, objected or agreed to any answer given on the introduction or conclusion surveys. I understand that each farmer is different in the techniques he practices and in his rationale, which is why the participating farmers had varying conclusions. While some farmers choose to use natural, and others choose chemical, I respect their personal choice on the matter and never interjected my beliefs. This provided that every farmer felt comfortable in making the most appropriate choice for what is best suitable to their farming practice and lifestyle.

"Two Ears of Corn" Model

I believe that the project's successful outcomes are largely due to Bunch's (1982) agricultural improvement model that I employed. I recommend any development worker to review his book before beginning to plan a project. Not just for agricultural improvement work, his recommendations can be helpful in structuring a wide variety of projects.

Using Two Ears of Corn (1982) was a great way to model a small-scale, people-centered project. I was not surprised when parts of the project did not go as expected, as the book gave me good insight into various aspects the leader cannot always plan. However, Bunch provided suggestions on how to overcome obstacles and continue to the end goal of a sustainable, accepted community-driven project, including an evaluation and furthering projects into institutions. Organizing my project after his model was an easy but very thorough way to set the foundations.

Replicating the Project

Before this project is managed in another community, several elements should be considered. It takes a lot of focused time. When planning, I considered the amount of time it would take for me to manage this project, but grossly underestimated the adequate time it needs. Choosing a workable number of farmers, using a select number of pesticide treatments and experimental plants, and organizing a time schedule for weekly visits and working with the participants are all good ways to keep the amount of time manageable for the person who is conducting the project. It takes between four and five months to complete this project, from recruiting participants to analyzing the conclusion surveys. This also varies depending on the farming season and culture in the region and community. Project managers should expect to stay on for the entirety of the project.

This project was not expensive. With purchase of natural pesticide materials such as garlic and soap, and the chemical pesticides, the total amount spent did not exceed 25,000 FCFA, or approximately $50 USD. The additional materials, including those to create the majority of the natural pesticides and to apply the treatments, were available locally at no charge. In order to promote ownership, the farmers were asked to contribute some of the supplies, such as the neem seeds and leaves, hot peppers, and powder soap. With respect to cost, the project was easily feasible for the participants and for the manager.

This project can be replicated in its entirety or in parts. With respect to the objective of determining if the natural pesticides were effective in comparison with the chemical pesticides, only a person interested in this specific goal would repeat the project in its entirety. Certain components are necessary from a purely research perspective, such as the surveys used in determining the effectiveness of the treatments. But this project had goals beyond applied research and I think a Malian could manage a version of this project that eliminates the surveys and focuses primarily on education and technology transfer. A Peace Corps volunteer could also replicate this project, using this project report, or the one I created and gave to the Associate Peace Corps Director for the Agricultural sector (Appendix J), as a guide.

When replicating, it is important to remember that this project deals with the participants' livelihoods. While they are willing to experiment in order to better their crop yield, they are unlikely to take any substantial risks that might damage crops. The project will be most effective when the participants are motivated and engaged in all aspects of the project so manager-encouragement will almost certainly be more effective than methods that might be perceived as "force."

Future Work

The project could definitely be expanded upon in several ways. First, the experiment can be enhanced by conducting controlled test plots, i.e., plots with consistent and comparable treatments, in addition to the plots in the farmers' fields or gardens. This would allow for a more statistically robust evaluation of the effectiveness of the natural pesticides with respect to specific plant/pest combinations without the added variability introduced by different farming practices and behaviors. Control plots in the same location, managing the same plants and keeping the application of pesticides constant throughout the experiment could be beneficial in observing differences between chemical and alternative pesticides. Additionally, having one person in charge of all the controlled plots would ensure the same methodology was followed throughout the experiment. While it is crucial that the farmers conduct their own experiment, the research aspects of the project would be improved by having controlled plots nearby, using the same plants and treatments used by the farmers, for reference with respect to visual and analytical data.

This project incorporated a variety of crops during the experiment. Many farmers tested on several different crops, most of which were repeated by other participants. In order to see the full range of the natural pesticides' aptitude, more types of crops should be used in the future. Certain crops that are especially prone to pests need priority.

An unexpected outcome of one of the classes was a discussion started by the participants on the possibility of bottling the natural pesticide solutions. They argued that there was a general need for these natural pesticide solutions; the farming community would purchase these solutions that they don't know how to make to use in their fields and gardens. At this time, the solutions had

already proven effective for the participants and they were confident that the technology would sell if they continued to use and speak highly of the product. Turning this project into a business proposition was unexpected, but I encouraged it. I had not thought of turning this solution to pest control into an income generating activity, but there is a possibility that this could be a successful endeavor. If pursued, it would be advantageous to do a business cost analysis to see if and to what extent this would be beneficial as an income generator. In Mali, there is a thriving market for natural medicinal remedies. Malians are attracted to using a natural cure for everything, as it is usually less expensive and is deeply rooted in their culture of benefiting from their natural environment. I never saw natural pesticides for sale in the local markets. To start, the participants could bottle their solutions and sell to the farmers in their community. Ideally, as word spreads, the popularity of the product will increase and so will sales. This would be a similar outcome to other products that have recently gained recognition in Mali because of someone's creative idea, e.g., such as cashew fruit juice, dried coconut shavings, and dried mangos.

While I encouraged many of the participants to engage further in the project and take leadership roles, it would have been advantageous to teach a Malian how to manage the continuation of this work. A motivated individual who is enthusiastic about the issue would be ideal. A national has a better chance of gaining support for this project than a Peace Corps volunteer, as they have more connection to the culture, language, and the people whom it serves. They also have more experience and firsthand knowledge of the associated pest/pesticide issues and of farming in general, thus, their observations would be more valuable or insightful. In general, having a Malian take over this project would be more beneficial, and likely improve the output.

A great way to scale-up this project would be to incorporate it into a program within an organization such as the Peace Corps, the Food and Agriculture Organization of the United Nations, or Freedom from Hunger. Upon completion of the project, I wrote up a detailed report for the use of the Peace Corps in hopes that a future volunteer would implement this or a similar project. Peace Corps volunteers generously share their resources and projects in anticipation of making their development work easier and information faster to disseminate. Allowing this project report for open use would give the current volunteers another resource. The report is detailed, offering little room for confusion. This is an easy way for volunteers to provide a feasible, desirable, and different project for their community, as this has no precedent within Peace Corps Mali. Additionally, the Malian Ministry of Agriculture, specifically SOTUBA, has started to engage in using natural alternatives to chemical pesticides. This project report could be used as a guide for implementing small scale, people-centered agricultural improvement activities that would transfer these alternatives to communities. With little cost needed, the man-power to supervise and manage the experiment and classes is the primary limiting factor, which I think could be easily transferable to a national once engaged in the project. Now that the project has proven to be effective at the small scale level, it is desirable to increase the awareness of using natural pesticides by incorporating it into more programs.

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Appendices

A. Initial Ideas
B. Introduction and Conclusion Surveys
C. Introduction and Conclusion Survey Answers
D. Lessons in English
E. Lessons in Bambara
F. Fact sheet in English
G. Fact sheet in Bambara
H. Pamphlet in English
I. Pamphlet in Bambara
J. Peace Corps Report
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A. Initial Ideas

The following ideas were brainstormed after living in Konza for the first few months.

1. Urine Fertilization

A fellow Peace Corps volunteer is currently working on a urine fertilization program, training farmers how to collect and apply urine to gardens, and to corn and millet in the fields, and to fruit producing trees. The program was designed by another Master's International Peace Corps Volunteer, who is writing his thesis on how to organize and implement the urine fertilization program in communities in Mali. He works closely with CREPA, a Malian organization dedicated to improving farming through conducting research.

I could extend on this project, conducting research to see if urine works better on certain crops and if it is enhanced by composting and other factors. Contact with CREPA could also lead to other ideas for this project and ways in which I can assist them in their research goals.

Additionally, I could collect urine from two families from two different communities, a rural community with lack of access to a nutritious diet, and urban community with an improved lifestyle (income) and increased access to a nutritious diet. Use the two types of urine to determine if there is a difference in crop or garden yield. A visible difference, could lead to using this demonstration as a health tool to educate people about good nutrition.

The advantages of the project are that it is low-cost, and it has potential to improve the life of participants by increased crop yield/increased income or better diet

The disadvantages of the project are that collecting urine from two different communities and two families willing to cooperate might be hard to organize on a weekly basis.

2. Soak Pit Project

Many Peace Corps volunteers work on soak pit projects during their service. It is an easy solution to rid standing water in communities. I know that past Masters International volunteers have written their thesis with soak pit projects as a case study. My community is planning to install soak pits at the community pump and well areas, as well as at individual's latrines. I have not been very creative with thesis ideas surrounding this project. Any suggestions would helpful.

3. Pump Replacement and Repair Formation

Out of the five pumps in Konza, only two function currently. Four pumps are the older foot pump model, while the fifth pump is the newer hand pump model. The community wishes to replace the four pumps with India/Mali hand pumps. Additionally, they would like to instruct local community members on how to repair and do preventative pump maintenance. I am not sure how this could be incorporated in a master’s thesis.

4. Empowering Women through Water projects

My women's association has discussed building a women's garden complete with a well and small irrigation system. Each woman will have her own plot and use the produce from the garden to feed their families or to sell to generate income. I have asked if the women would be willing to

build the well themselves (with guidance from myself and my supervisor). They agreed at first, but this has the potential to change when the project time comes closer. I am really interested in Gender and Development issues in Mali. Since women are responsible for the water in the family (gathering, cooking, cleaning, bathing children), it is only makes sense to empower these women through improving their water situation or access to water.

5. Deforestation

During the dry season, the women collect firewood week after week. After finding the right wood, they will cut down branch and stem until they have their cooking fuel for the week. Extra wood is collected during the dry season to provide for the busy rainy season. No organized tree replanting is reforesting the area. Is this considered deforestation? Is there an equal or better, more environmental friendly and efficient fuel? Can women warm water in plastic bottles during the day to use for bathing? Can the community members understand the bigger impact of this action? These are all local issues that are seen throughout Mali and West Africa. Konza could act as a case study for this regional problem.

6. Engineering values and Development

As engineers, we are taught about keeping honest and socially responsible values to the highest respect when we are conducting work that has an impact on a community. How does this apply to engineers working in international development? I find there is an internal struggle with following the slow, bottom-up method of development work and committing to our socially responsible promise to provide infrastructure and basic necessities to communities.

Mali, like most underdeveloped nations, lacks basic infrastructure in most of the rural communities, such as electricity, running water, sewage control and treatment, trash collection, safe roads, and suitable health care centers. Since Peace Corps has been in Mali for the past thirty years, the Water/Sanitation volunteers have been digging soak pits to control the sewage in small communities. Today, we are still building the same soak pits that volunteers built in the 1970s and that volunteers will continue to build in the coming decades. As an engineer with the knowledge of more advanced systems, do I continue to build soak pits based on the slow, established development system or do I try and install a more advanced system that I feel socially responsible for? With regards to trash collection, do I stand back while Malians place their hazardous old batteries in the same trash piles along with their food and plastic scraps, or do I make the more socially responsible choice and outfit my community with a landfill? Would the community be prepared for something like a landfill? Can I make an engineering design less technical for non-engineering educated Malians but still effective to do its fundamental purpose? This would be a case study into how to uphold the basic ethical values even in the developing world.

B. Introduction Survey

1. Name
2. Town
3. Occupation
4. Age
5. Place of Birth
6. Highest level of education
7. Number of spouses
8. Number of people in household that need to be fed on a daily basis
9. Number of people in immediate family
10. How many acres do you own for fields and garden?
11. What will you grow during this current growing season?
12. What problems have you encountered with this crop (as mentioned in question 1) in the past? Please identify any pests or disease that you have had with this particular crop.
13. What do you know about pesticides? How are pesticides destroyed? What is pesticide residual? (Types, success rates, environmental and health effects)
14. Have you ever used (market bought) pesticide before? If yes, which brand? How effective was the pesticide? What were the successes and problems of using the pesticide? (Cost, time consumption, ease of application, pest problem reduction)
15. What do you know about natural pesticides? (Types, success rates, environmental and health effects)
16. Have you ever used natural pesticides to protect your crops before? If yes, which one(s)? How effective was the treatment? What were the successes and problems of using a natural pesticide? (Cost, time consumption, ease of application, pest problem reduction)
17. What are your expectations of this project? (Education, improved crop protection)

Conclusion Survey

1. Name
2. Which crops did you protect with pesticides (both natural and market bought) this past growing season?
3. What was easy about using the market bought insecticide? What was difficult? Please comment on the below categories.
    a. Purchasing insecticide materials
    b. Application of insecticide
    c. Health/Environmental effects
    d. Experimental Results
4. What was easy about using the natural pesticide? What was difficult? Please comment on the below categories.
    a. Purchasing natural pesticide materials
    b. Application of natural pesticide
    c. Health/Environmental effects
    d. Experimental Results
5. Complete the following grid by determining which treatment (natural or commercial) is better in each specific category.

Commercial and natural pesticide comparison					
	Cost	Application	Health	Environment	Experiment
Natural					
Commercial					

6. List the treatments in order of most favorite to least by completing the following preference grid.

Preference of Pesticide Type				
	Type 1	**Type 2**	**Type 3**	**Type 4**
Type 1	X			
Type 2	X	X		
Type 3	X	X	X	
Type 4	X	X	X	X

7. In the future, which method will you use to protect your crop? Why? (Cost, effectiveness, environmental effects, health effects)
8. What other crops are you interested in learning about protecting naturally?
9. How could this educational experiment be improved?

C. Introduction Survey Answers

Introduction Survey Answers

Questions	6/22/2010	7/1/2010
Name	Dramane Kone	Karim Kone
Town	Konza	Konza
Occupation	Farmer, animal husbandry, cashew farmer, tree nursery	Farmer
Age	45	50
Birthplace	Konza	Konza
Highest level of Education	No education (limited Bambara)	Bambara classes
Number of spouses	2	2
Number of people in family to be fed daily	30	25
Number of people in household	6	8
Number of acres of fields	12	17
Number of acres of gardens	2.5	0.25
Items to be grown during this growing season	Cotton, corn, peanuts, beans, tomato, Mali eggplant, hot pepper (big and small), onion, watermelon, cucumber, cashew, limes, mangoes, moringa, jatropha	Millet, corn, peanuts, tigaba, beans, tomato, eggplant, Mali eggplant, hot pepper
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	Yes, eggplant did not produce a lot of fruit, or they were not big enough, leaves of plant were dry and ruined because of pests. Tomatoes did not have pest problem but were killed by using cotton pesticides, also has seen disease where the plant grows big but does not produce any fruit. Pest worms bore holes in cucumbers and ruin the fruit.	Yes, pests have sucked water out of his tomato and hot pepper plants causing them to not fruit. Some of his beans do not produce good fruit.

Questions	6/22/2010	7/1/2010
Name	Dramane Kone	Karim Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	He has previously used and has knowledge on Type 26 and the Cotton pesticide, and how to properly treat vegetables and trees	Does not know anything, has never been taught about pesticides
Have you ever used commercial pesticide? If yes, which brand?	Yes, type 26 on vegetables and Calfus 500 EC on cotton	Yes, Calfus 500 EC on cotton and in his garden
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	5- it worked because he applied it in a regular dose	5- it got rid of his pests
What were the successes and problems with using this pesticide?	Good because is reuced the pest problem and not a big monetary cost	He is scared to use the pesticide because too much could kill his plants (as he has done before), so he needs to learn about proper doseage. It also makes his hands and face very hot or tingle until he washes the area.
What do you know about natural pesticides?	He has studied neem leaves treatment to use in his garden- he attempted to make the solution to see the affects	He knows about the Chetoro tree, where you take the fruit of the tree, soak it in water and then spray on tomatoes. Another farmer in Konza taught him.

Questions	6/22/2010	7/1/2010
Name	Dramane Kone	Karim Kone
Have you ever used natural pesticides before? If so, which kind and how?	Yes, has used neem leaf treatment on eggplant and tree nursery	Yes, he has used the Chetoro tree pesticide on his tomatores (10 years ago)
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide	5- no comparison plot was made to commercial pesticide, so he claimed the neem solution worked as well as a commercial pesticide would	1- it did not work effectively, so he has not used it since
What were the successes and problems with using natural pesticides?	He found good, safe eggplant fruit to eat and sell, so therefore he made money	It is good because it did not take a lot of time to make and apply, but it did not work.
What are your expectations of this project?	He would like to learn to make natural pesticides solution to sell to and teach other farmers. He would like to protect his garden from pests to get good produce, he would like to find other trees that can serve as natural pesticides.	He would like to learn about more effective natural pesticides and about tree farming.

Introduction Survey Answers

Questions	7/25/2010	7/25/2010
Name	Shaiga Kone	Ali Kone
Town	Konza	Konza
Occupation	Farmer	Farmer- business, tree grower
Age	39	40
Birthplace	Konza	Konza
Highest level of Education	Bambara classes	Bambara and Arabic classes
Number of spouses	1	2
Number of people in family to be fed daily	22	60
Number of people in household	8	7
Number of acres of fields	9	20
Number of acres of gardens	0.25	0.5
Items to be grown during this growing season	Corn, millet, cotton, beans, tomato, hot pepper, Mali eggplant, eggplant, cucumber	Corn, cotton, sorghum, rice, beans, Mali eggplant, hot pepper, tomato, sweet potato, eggplant
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	Yes, worms make holes and ruin his tomatoes, eggplant, cucumbers, and beans.	Yes, worms make holes and ruin his eggplant/Mali eggplant, cotton crop, and tomatoes. Pests also suck water out of his beans so they do not produce fruit.

Questions	7/25/2010	7/25/2010
Name	Shaiga Kone	Ali Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	He knows about Foteri, which can kill things in garden and is bought at market. He knows about Calfus 500 EC cotton pesticide. He knows that pesticides can give health problems.	He knows about Foteri and how it can kill termites, Calfus 500 EC is a cotton treatment. He has never been formally trained, but CMDT gives a brief introduction to Calfus.
Have you ever used commercial pesticide? If yes, which brand?	He has used Cafuls 500 EC on his cotton and the Foteri on his garden.	He has used Calfus on his cotton, has used a grass killer in his rice fields, and used Calfus in his garden to prevent worms.
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	3- The pesticides did not kill everything. If the rains come, it washes all the pesticides away and it is not worth the money or effort.	4- It does work
What were the successes and problems with using this pesticide?	It was difficult to buy the pesticide in the market time (time, money) because it is not available locally in Konza.	Doseage was difficult, too much can kill the plants. The smell/taste of the pesticide can be annoying and settle in his mouth.
What do you know about natural pesticides?	He does not know about natural pesticides.	He does know that you can use Chetoro, a tree, as a natural pesticide to put on millet in order to produce a lot of fruit.

Questions	7/25/2010	7/25/2010
Name	Shaiga Kone	Ali Kone
Have you ever used natural pesticides before? If so, which kind and how?	No.	Yes, he has only used Chetoro, but not as a pesticide more as a fertilizer.
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide		
What were the successes and problems with using natural pesticides?		
What are your expectations of this project?	He wants to learn to make natural pesticides for garden and tree nursery application.	He wants to learn all about natural and commercial pesticides and how to make the natural remedies.

Introduction Survey Answers

Questions	7/26/2010	7/26/2010
Name	Mousa "Vie" Kone	Daouda Kone
Town	Konza	Konza
Occupation	Farmer, Mason	Farmer
Age	42	30
Birthplace	Konza	Konza
Highest level of Education	None	None
Number of spouses	3	2
Number of people in family to be fed daily	21	25
Number of people in household	10	7
Number of acres of fields	17	11
Number of acres of gardens	0.5	0.5
Items to be grown during this growing season	Corn, sorghum, millet, Mali eggplant, hot pepper, tomato, onions, beans	Corn, millet, beans, peanuts, cotton, Mali eggplant, tomato, cucumber, onions, carrots
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	He has seen pest problems with his tomatoes and Mali eggplant, where pests ruin the leaves and thwart fruit growth.	Pest worms ruin his tomatos and cucumbers. His Mali eggplant do not grow as big as they should, and pests are drinking water from the bean stalks thwarting their growth.

Questions	7/26/2010	7/26/2010
Name	Mousa "Vie" Kone	Daouda Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	He knows about Caflus 500 EC from using it, he knows that it is harmful and should not be consumed. He has had no fomal education/training.	He knows he has to protect his hands when spraying Calfus 500 EC, and to wash his hands after use.
Have you ever used commercial pesticide? If yes, which brand?	Yes, has only used Calfus 500 EC on his cotton. He was provided with a powder by CMDT to use on his eggplant and tomato.	Yes, he has used Calfus 500 EC on cotton, beans, and tomatos.
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	5- It worked well, it killed the pests and he reapplied every 15 days to keep them away	5- It works well if the rains do not come early and wash it away.
What were the successes and problems with using this pesticide?	He spent a lot of money to purchase the pesticide but it can give people health problems. He insists that store bought compost is better than his homemade compost.	He spent a lot of money to puchase the pesticides.
What do you know about natural pesticides?	He understands that natural pesticides can do no harm to people. He knows about the benefits of neem leaves.	He does know about neem seeds, one can grind the seeds and soak in water, then spray plants. He knows natural pesticides will not harm people.

Questions	7/26/2010	7/26/2010
Name	Mousa "Vie" Kone	Daouda Kone
Have you ever used natural pesticides before? If so, which kind and how?	Yes, he has used the Neem leaves on Mali eggplant and tomato. He boiled leaves in 1 L of water and sprayed the solution.	Yes, he has used neem seeds on Mali eggplant and tomato last year (2009)
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide	3- It worked sometimes, but it was consistent	4- He states one must apply after rain, because if the rains come, it will all be washed away. But when the rains did not wash it away, he states it worked well.
What were the successes and problems with using natural pesticides?	The application process was really easy, one does not have to use special protection equipment. One can literally spray and then eat without worry.	It is very easy to make and apply and there is no money involved.
What are your expectations of this project?	He wants help setting up outside buyers to come to Konza to bulk buy vegetables to sell elsewhere because the competition in the market town is huge.	He wants to be able to better protect his garden and crops.

Introduction Survey Answers

Questions	7/28/2010	8/2/2010
Name	Saliya Kone	Youba Kone
Town	Konza	Konza
Occupation	Farmer, tree farmer	Farmer, tree farmer
Age	39	36
Birthplace	Niena	Konza
Highest level of Education	Up through to class 5	Bambara and Arabic classes
Number of spouses	2	1
Number of people in family to be fed daily	35	27
Number of people in household	7	6
Number of acres of fields	16	6
Number of acres of gardens	0.25	4
Items to be grown during this growing season	Cotton, corn, peanuts, beans, millet, hibiscus, tomato, Mali eggplant, hot pepper, melon	Beans, corn, millet, sorghum, tomato, eggplant, guava, mango, lemon, papaya, Mali eggplant
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	Pests drink water in Mali eggplant so the fruit does not grow big, the leaves dry up and die. Tomato and hot pepper pests that work in the morning drink the plant water, killing leaves and thwarting fruit growth. Pests have made his corn "fall"	Pest worms make holes in the guava fruit and ruin them. Worms have also ruined his tomatos and eggplants.

Questions	7/28/2010	8/2/2010
Name	Saliya Kone	Youba Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	He knows about Calfus 500 EC- he learned through other farmers. CMDT said to wear gloves and wash hands with soap before eating.	He does not know anything.
Have you ever used commercial pesticide? If yes, which brand?	Yes, he has used Calfus 500 EC on cotton and his tomatos. He mixed half a capful into a bucket of water to spray on tomatos.	No.
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	5-He thought it was very successful.	
What were the successes and problems with using this pesticide?	He spent a lot of money on the pesticides. It gives him cold like symptoms after using.	
What do you know about natural pesticides?	He does not know anything.	He does know about Neem. One can mix leaves, petrol, and soap in a water solution to spray.

Questions	7/28/2010	8/2/2010
Name	Saliya Kone	Youba Kone
Have you ever used natural pesticides before? If so, which kind and how?	No.	Yes, he used this solution once.
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide		2- He used it on tomatoes and guava but did not see any difference.
What were the successes and problems with using natural pesticides?		He did not spend money and the application was easy.
What are your expectations of this project?		

Introduction Survey Answers

Questions	9/12/2010	10/2/2010
Name	Haia Kone	Worokia Kone
Town	Konza	Konza
Occupation	Farmer, Womens Association President	Farmer
Age	65	65
Birthplace	Bafaga	Konza
Highest level of Education	None	None
Number of spouses	None	1
Number of people in family to be fed daily		14
Number of people in household		2
Number of acres of fields	Beans and Sorghum- 1	Beans and Peanuts - 0.5
Number of acres of gardens	Rice - 0.5	Rice - 0.25
Items to be grown during this growing season	Rice, peanuts, beans, okra, sorghum	Peanuts, beans, rice
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	Pests drink the water from her rice stalks causing the leaves to die and thwart the growth of rice. Pests are also prevalent in beans.	Pest are ruining her rice.

Questions	9/12/2010	10/2/2010
Name	Haia Kone	Worokia Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	She knows about Calfus 500 EC and how to apply it, her son taught her.	She knows about Calfus 500 EC and the uses of compost, but she does not know doesage and proper application.
Have you ever used commercial pesticide? If yes, which brand?	Yes, she used the Calfus 500 EC on her rice.	No.
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	1- It killed all of her rice, no other rice sprouted afterwards. She has not used it since (3 years ago) since she is unsure about doseage and does not want to risk losing the entire crop again.	
What were the successes and problems with using this pesticide?	She does not know doseage for using Calfus on other crops.	
What do you know about natural pesticides?	She knows about compost having used it on rice as a fertilizer. She has used shea nut shells as a fertilizer as well.	She does not know anything.

Questions	9/12/2010	10/2/2010
Name	Haia Kone	Worokia Kone
Have you ever used natural pesticides before? If so, which kind and how?	No, compost only.	No.
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide		
What were the successes and problems with using natural pesticides?		She wants to learn how to make natural treatments so she can use them and teach other women.
What are your expectations of this project?	She wants to learn about various natural treatments for her rice.	

Introduction Survey Answers

Questions	10/5/2010
Name	Mama Kone
Town	Konza
Occupation	Farmer, business woman
Age	42
Birthplace	Kolondieba
Highest level of Education	Up through 3 class
Number of spouses	1
Number of people in family to be fed daily	10
Number of people in household	6
Number of acres of fields	Peanuts and beans - 1.5
Number of acres of gardens	Rice- 1
Items to be grown during this growing season	Peanuts, rice, beans, hot pepper, okra
Have you encountered any previous problems with these crops? Identify any pests or diseases you have seen in this crop.	Pests are eating leaves off bean plant and ruining crop. Pests drink the water from rice stalks and ruin the crop. Pests are eating the leaves off the okra plant but not harming the okra.

Questions	10/5/2010
Name	Mama Kone
What do you know about pesticides? How are pesticides destroyed? What is pesticide residual?	She knows that Calfus 500 EC kills grass/weeds in rice and bean plots, and she learned this from CMDT people.
Have you ever used commercial pesticide? If yes, which brand?	Yes, has used Calfus 500 EC on rice, beans, and peanuts each year. She sprays rice twice, one while planting and once when leaves sprouted.
On a scale of 1 to 5 (5 being the best), rate the performance of the pesticide	4- It worked well
What were the successes and problems with using this pesticide?	She spent a lot of money to purchase the pesticide
What do you know about natural pesticides?	She does not know anything.

Questions	10/5/2010
Name	Mama Kone
Have you ever used natural pesticides before? If so, which kind and how?	No.
On a scale of 1 to 5 (5 being the best), rate the performance of the natural pesticide	
What were the successes and problems with using natural pesticides?	
What are your expectations of this project?	

Conclusion Survey Answers

Conslusion Survey Answers

Questions	11/13/2010	11/13/2010
Name	Dramane Kone	Ali Kone
Which crops were experimented on using commercial and natural pesticides?	2.5 EC was used on oranges, mali eggplant, green beans, ntombolo tree. Natural was used on ntombolo tree, orange tree, and Mali eggplant	He tested both 2.5 EC and natural (neem leaves, hot pepper, neem seed) on tomatoes.
What was easy about commercial pesticides? What was difficult? Comment on the following:	It is easy to get Calfus 500 EC because CMDT gives it to you in Konza, and then takes the money for it out of your cotton sale at the end of the season (no money upfront).	He did not find any problems with using the 2.5 EC
a. Purchasing of pesticide	It is easy to buy 1,000 CFA 2.5EC and it is easily found in market town if bike/moto is available.	You have to spend money to get buy the pesticide
b. Application of pesticide	It can cover a lot of area without using too much (it goes a long way!)	He says the smell is poten and users should wear face mask and hand protection because it can harm skin.
c. Health/Environmental Effects	Now it is easy since he has been educated in proper care and maintenance, and of all the effects on health and env.	It can harm people and the environment
d. Experimental Results	It worked well!	The treatments worked really well, not pests were seen afterwards. It worked better than natural pesticides.
What was easy about natural pesticides? What was difficult? Comment on the following:		

Questions	11/13/2010	11/13/2010
Name	Dramane Kone	Ali Kone
a. Purchasing of pesticide	It is very easy to make natural pesticide. Plants like hot peppers that are found year round make it easy to make solutions. Some plants like neem seeds are not available year round.	It is difficult to get plans, especially neem seeds. But once found, the rest of the work is easy like making solutions.
b. Application of pesticide	You do not have to worry about harming yourself or others if accidentally consumed.	It is easy.
c. Health/Environmental Effects	It does not harm health or environment	It does nothing to people/environment, you can even drink the nearby well water with no problem
d. Experimental Results	No crops were ruined by insects after spraying, definitely saw an improvement.	It works well with repelling pests. The tomatoes were not as much protected as with the commercial pesticide.
In the future, which will you use to protect your crops? Why?	He will use both, 2.5 EC on trees. Natural will be used in gardens. Pests that are on trees are really strong and need a strong agent to combat. Garden vegetables will be eventually eaten, so he wants to use natural so he does not harm anyone.	He will use 2.5 EC because it lasts longer (10-14 days application cycle) and it has a higher resistance against rain. Even though he knows it has harmful effects, he would still use it.
What else would you have liked to have learned? How can we improve this project?	He would have liked to have done more education/experimentation on other natural plants because there are lots that have potential. He would add more farmers into the classroom part so they can also understand the effects of pesticides.	He would have liked to have learned more about other plants with pesticide properties. He would experiment with other plant combinations to see if there is anything stronger than what we tried.

Conslusion Survey Answers

Questions	11/14/2010	11/14/2010
Name	Daouda Kone	Shaiga Kone
Which crops were experimented on using commercial and natural pesticides?	He tested both 2.5 EC and natural on tomatoes. The cold ruined his cucumbers before testing could start.	He used 2.5 EC and natural on tomatos, eggplant, Mali eggplant, cucumbers, and beans
What was easy about commercial pesticides? What was difficult? Comment on the following:		
a. Purchasing of pesticide	2.5 EC is difficult only if you do not have the money to spend. He is willing to spend money on this, so it was easy for him.	It is easy to buy, he had no problems
b. Application of pesticide	It is easy because he has a hand pump to spray easily and safely, but he is still scared of the potential harmful effects.	It is easier to use 2.5EC than Calfus 500 EC
c. Health/Environmental Effects	He doesn't believe it can harm people badly so he is willing to spray.	Calfus is stronger and more harmful than 2.5 EC, but 2.5 EC is still harmful to people/env.
d. Experimental Results	It worked better than natural pesticides because it is fast and it lasts long.	It got rid of a lot of pests but not all of them. It did not work as well on the eggplant. It is a fast solution to your pest problems!
What was easy about natural pesticides? What was difficult? Comment on the following:		

Questions	11/14/2010	11/14/2010
Name	Daouda Kone	Shaiga Kone
a. Purchasing of pesticide	It is easy to make the solutions.	It is easy to make- you can find the required trees/plants. He is going to save hot pepper from his annual crop each year so he has enough to make more solutions.
b. Application of pesticide	It is easy to spray because you don't need to worry about washing your hands or materials afterwards.	You can spray and then eat, it is much easier than 2.5 EC
c. Health/Environmental Effects	It is good for people and the environment	It is better than commercial because it does not harm health or environment
d. Experimental Results	It worked well but did not get rid of all of the pests	Neem and hot pepper worked well. It is not as fast at 2.5 EC.
In the future, which will you use to protect your crops? Why?	He is going to use both, he will spray some commercial and some natural pesticides because they both work.	He will use natural pesticides because it does get rid of pests (even if it is slower) and does not harm the environment
What else would you have liked to have learned? How can we improve this project?	He would like to look at other plants to see if they will also work at natural pesticides. He suggested the project could provide garden materials like chicken wire, pumps, or wells.	He would have liked to have learned more about plant nursery. He recommends that if farmers work really hard, it would better the project.

Conslusion Survey Answers

Questions	11/14/2010	11/14/2010
Name	Youba Kone	Karim Kone
Which crops were experimented on using commercial and natural pesticides?	He used 2.5 EC and natural on guava trees and beans	He used 2.5 EC and natural on tomatos, lettuce, and beans
What was easy about commercial pesticides? What was difficult? Comment on the following:		It is easy if you know how to use it!
a. Purchasing of pesticide	It is easy to buy 2.5 EC than Calfus	It is easy for him to purchase.
b. Application of pesticide	It is difficult to spray without getting it on your hands. If a spray pump is not available, it burns the skin when in contact.	If you do not know the proper doseage, you could be ruining the crops
c. Health/Environmental Effects	It ruins the environment and can harm people	He hasn't experienced any personal harm to himself or the environment
d. Experimental Results	It worked well, all the pests disappeared	It does work, it kills off the pests
What was easy about natural pesticides? What was difficult? Comment on the following:		

Questions	11/14/2010	11/14/2010
Name	Youba Kone	Karim Kone
a. Purchasing of pesticide	It is easier to get natural pesticides than commercial because you spend little to no money	No money needed. If you know how to make the solutions, the rest is easy.
b. Application of pesticide	It is easy, it does not burn or irritate the skin	No problems.
c. Health/Environmental Effects	No problems	It does not do any harm
d. Experimental Results	Neem and hot pepper worked better than garlic, and stated they worked better than 2.5 EC	It works but it is slower than 2.5 EC
In the future, which will you use to protect your crops? Why?	If he has money, he will purchase the 2.5 EC. If he has no money, he will use the natural pesticides.	He will use both because natural and commercial both work well
What else would you have liked to have learned? How can we improve this project?	He would like to have studied more plants with pesticide abilities. He suggested the project could provide farming tools such as spray pump, gloves, face mask. He really enjoyed getting the Bambara handouts so he can show others.	He liked getting 2.5 EC for free and learning about natural pesticides. He would like to get more commercial pesticides to experiment with.

Conslusion Survey Answers

Questions	11/18/2010	11/18/2010
Name	Saliya Kone	Mousa "Vie" Kone
Which crops were experimented on using commercial and natural pesticides?	He used 2.5 EC and natural on Mali eggplant, tomato, and melon	He used 2.5 EC and natural on Mali eggplant, eggplant, tomato, onion
What was easy about commercial pesticides? What was difficult? Comment on the following:		
a. Purchasing of pesticide	He has never bought 2.5 EC so he doesn't know. A small amount goes a long way but money is an issue.	It is easy to find Calfus, but he has no money to buy the 2.5 EC, so that is harder
b. Application of pesticide	If you do not mix it right, it can damage plants	It is hard because you need gloves and face mask to properly protect yourself. It irritates his skin. After his skin was irritate and he learned about the health/env effects, he swore of 2.5EC and never used it again.
c. Health/Environmental Effects	He know it is bad for health/env but he still uses it	It ruins the environment and harms people.
d. Experimental Results	It worked well	It is hard to spray, he saw the leaves getting burned. But it did work well.
What was easy about natural pesticides? What was difficult? Comment on the following:		Since he has been using natural and seeing the effects, he has not used 2.5 EC

Questions	11/18/2010	11/18/2010
Name	Saliya Kone	Mousa "Vie" Kone
a. Purchasing of pesticide	It is easy because he farms hot pepper and the other materials are readily available.	It is easy to find plants and make the solutions
b. Application of pesticide	It would be easier with a spray pump	He does not have to worry about health effects and there is no smell
c. Health/Environmental Effects	It does not do anything. You can drink the well water	Does not cause any problems
d. Experimental Results	It worked well, he claims there is no difference between commercial and natural pesticides.	It worked well. He sprayed and saw pests fly away.
In the future, which will you use to protect your crops? Why?	He will use natural pesticides because it is easy, no money is spent, and there are no harmful effects	He will only use natural pesticide, neem leaves and hot pepper, because it does not harm him or the environment
What else would you have liked to have learned? How can we improve this project?	He would like more education on garden techniques. He is happy to have been a part of the project, he wished it started earlier, and he would have liked more education in general.	He would like more education. He really liked the lessons part and was very interest in health and environmental effect. He is happy about getting the handouts in Bambara so he can educate others. It was nice to learn so much and not have to spend a lot of money or time doing so.

D. Lessons in English

This is only an example of what could be presented. More topics can be added as necessary.

Lesson 1: Food Security

This natural pesticides project is helping participants to get food security. What is Food Security?

It is defined as everyone, everywhere, at every time can have access to safe, nutritious, and plentiful food that can sustain healthy lives. How can we can food security?

(health, good seeds, farming equipment, education, access to water, nutrition knowledge, pesticides, compost)

Which one of the above mentioned is the most important? Rank them in order.

If people cannot obtain food security, people will go hungry. For more vulnerable populations, like children and elders, this could mean death. Many people in Mali do not have access to safe, nutritious, plentiful food all the time. And this problem does not affect Mali alone.

Every country has some type of Food security problem. In America, some nutritious food items are not easily found, causing their prices to rise. People with a limited income cannot afford these nutritious food items. They resort to junk food, gain weight, live unhealthy lives, and therefore cannot obtain proper food security.

In another country of Pakistan, recent floods have terrorized the country and its people, the water causing most of the country's fields to be washed away. It is also dirtied the country's drinking water supplies. No food and clean water rendered the people of Pakistan unable to get food security.

Adama farms almost everything in his rural village in the Sikasso region. Salad, rice, beans, corn, cucumbers, eggplants, and tomatoes are available in Adama's fields. But, Adama really enjoys the profits from his crops, so he sells all of his crops instead of saving some for his family's food. His family never eats any of the nutritious food Adama farms, and therefore, does not have food security.

In most countries, food security is becoming a hot topic among government officials and non profit organizations. Everyone wants to be a part of the solution to this growing problem, but it is not easy. Even if a universal solution is found, most of the solutions incorporate behavioural change that must be adapted by local people. Therefore, it is up to the individual people to be able to learn about food security and make the appropriate changes in their lifestyle.

You, as the head of the household, as a mother or father, what can you individually do to find food security?

Which is easy? Which is hard?

You must work hard to find food security every day. You can start right now to help aid this problem. You can improve your health situation by washing your hands with soap, or keeping your house sanitary. During this project, you are learning to use natural pesticides to protect your crops. In terms of food security, natural pesticides are better than commercial

pesticides as it offers a safe way to protect your crops. Natural pesticides are extracted from the ground, and then returned to the ground, with no adverse health or environmental effects. Natural pesticides will help us to obtain food security. Next week, we will discuss commercial pesticides, how they are made, how they effect the environment and people's health. We will discuss both the Calfus 500 EC and the 2.5 EC pesticides.

Lesson 2: Environmental effects of Pesticides

What do you know about commercial pesticides?

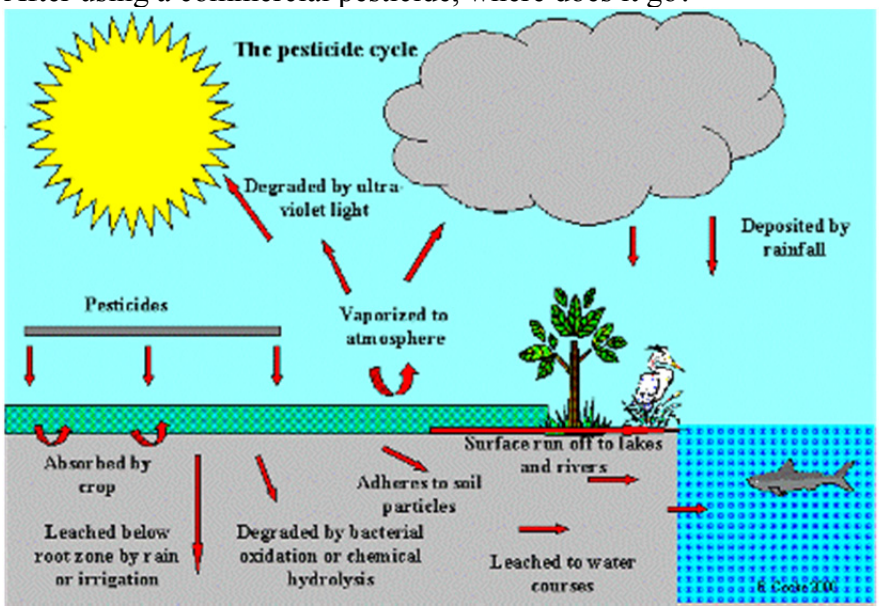
What is a commercial pesticide?

A solution of potent chemicals that are used to kill common crop and garden pests, it is fabricated in another country in a factory, its costs money to purchase the solution, and the treatment is fast and strong.

Where are commercial pesticides fabricated? Because it is made in a factory using expensive equipment, it is not fabricated in Mali. Most pesticides available for sale in Mali are made in China, including Calfus 500 and 2.5 EC.

What do commercial pesticides do? They are made on the sole purpose to rid farmer's crops of pests by killing them off. The gas or liquid effects the nervous system of the insects. Some commercial pesticides can effect a large range of pests, while others are catered to certain plants and only have effects on a small range of pests.

After using a commercial pesticide, where does it go?



There are many ways that pesticides make their way through our environment; they do not stay in one place. If a pesticide in sprayed on, the gas can be transported to many places surrounding the application area by the wind. Some is vaporized into the atmosphere, where it is carried by wind to further distances and deposited back to the ground by rainfall. Pesticides can also leach into the ground by rain or irrigation, where it can adhere to soil particles and travel underground. It can travel to drinking well or pump water sources, and to a water source such as a river or lake. Rain and irrigation will also carry pesticides as runoff through to water sources. These streams and rivers reach a wide range of location, ending with a dumping into the ocean. People wash dishes, clothes, and themselves in these

contaminated bodies of water. Fish that live in contaminated rivers and oceans easily uptake pollutants in water including pesticides through their porous membrane. However, fish cannot expel the pollutants like humans or other animals, so chemicals can build up in fish, and then transferred to humans when eaten. After spraying, humans and animals can traverse through the field or garden and ingest pesticides. Chemicals eventually exit the body, but not before doing some damage along the way.
There are many paths that pesticides can reach humans and animals. Even if you just spray field and garden crops, it can still reach our water, our fish, and our food.

How can pesticides be destroyed? Pesticides will eventually destroy themselves. The original chemical will breakdown into another chemical over and over again until it is not longer a chemical. But, some pesticides do not breakdown early because they are very strong or complicated. Others will breakdown as soon as one week.

What can you do to protect yourself? Do not use commercial pesticides, or use it only when needed, do not drink well water, wash hands with soap after spraying pesticides or working in the garden/fields, do not eat fish during pesticide season, and wear protective clothing.

2.5 EC Lambda-cyhalothrin is common commercial pesticide found in Mali. It is used in gardens to protect common garden crops from pests. It contains 25 g/L of lambda-cyhalothrin and it is in the chemical group pyrethroids. It is listed as moderately toxic when inhaled. There is facial tingling and burning sensation associated with inhalation beginning within 30 minutes and lasting to anything from six hours to two days. It can also cause irritation to nose and throat, dizziness, nausea, fatigue, and seizures. It is believed to be broken down in humans, but since there is no human data, no information is available. It takes five days to break down the chemical in the environment. It has a low water solubility and high potential bind to soil, making it a low potential to contaminate groundwater. It is highly toxic to fish and can accumulate in the fish.

Calfus 500 EC is the common commercial pesticide used by CMDT for protection of cotton in Mali. CMDT readily gives out Calfus 500 EC (it is referred as “bagaji” in Bambara) to Malian cotton farmers at the beginning of the growing season, and then takes out the price of the pesticide at the sale of the cotton back to CMDT. It contained 500 g/L Profenos and it is classified as a cholinesterase inhibitor. It is an insecticide and used in countries all around the world, including the United States. Calfus 500 EC has the ability to poison humans if consumed. It can cause excessive salvation, sweating, muscle twitching, weakness, incoordination, headaches, dizziness, nausea, vomiting, diarrhea, tightness in chest, coughing, and blurred or dark vision. If it is severe, it can cause seizures, loss of consciousness, and even death. Cholinesterase inhibitor pesticides disable the enzyme resulting in symptoms of neurotoxicity including tremors, nausea, weakness, paralysis and death. Exposure to these inhibitor pesticides have been linked to impaired neurological development in fetus/infants. It is a potential ground water contaminant, accumulates in fish, and highly toxic to fish and insects. It is easy biodegradable. There was a public dispute over Calfus 500 EC after large fish kills were plaguing Louisiana and Mississippi during 1994-1996. Additionally, many farmers are listed as using this pesticide to commit suicide because of its rapid and sure effects.

Lesson 3: Health effects of Pesticides

Last week, what did we talk about? Commercial pesticides can harm both the environment and people who interact with that environment. Have you ever experienced health effects from using pesticides?

Pesticides can enter humans three different ways: dermal, inhalation, and ingestion. Pesticides in contact with human skin can permeate through to the blood stream. The gas from spraying pesticides can be inhaled through the nose and mouth, move to the lungs, and then into the bloodstream. Pesticides can be consumed if eaten on food or in water, or if residue is on your hands. Chemical pesticides can harm areas that are not far from the area of contact, like the eyes or hands. It can also harm areas that are far from the area of contact and which you would not be able to see, such as the kidneys or the reproductive system. Once the chemicals enter the bloodstream, it can reach many parts of the body. Some chemicals can sit in fat and remain dormant and not do much harm, while others can harm specific areas of the body.

How do the chemicals leave the body? Some chemicals will degrade easily and leave the body quickly, while others take longer but will eventually leave. Most chemicals are excreted in urine, but can also be released in sweat, semen, breast milk, saliva, bile, and through breathing. The liver will break down the chemicals into other chemicals (called metabolites) until it can pass through urine. Some metabolites are more toxic than the original chemical.

There are two different exposure times. An acute exposure is usually one time, like if a person walked through a field after it had just been sprayed. A chronic exposure is many exposures of a long period of time, like if a person sprayed their field once a week for twenty years. Chronic exposures can cause more severe health effects in people. Many severe health problems will not show up until much later after the exposure, so the person will not necessarily associate the problem with the chemical exposure.

People are not the same in that some people will get a reaction to a small amount of chemical interaction but others won't get a reaction until exposed to a large amount of chemical. It is important to protect yourself even if your fellow farmers are not feeling sick during pesticide use.

What parts of the body do pesticides harm?

1. Respiratory system (lungs, throat, nose)- irritation, coughing, asthma, suffocation
2. Skin – cysts, discoloration, cancer
3. Nervous system (brain, spinal cord)- pins and needles feeling, weakness for several months, dizziness
4. Liver – nausea, vomiting, dizziness, cancer, liver disease
5. Kidney and Urinary tract- kidney disease, cancer
6. Reproductive System- toxicity to sperm, impotence, infertility, low birth weight, cancer, premature birth

Calfus 500 EC is very potent. Do you see any live insects after you spray? No. Because it is meant to attack the nervous system and kill. It can cause excessive salvation, sweating, muscle twitching, weakness, incoordination, headaches, dizziness, nausea, vomiting, diarrhea, tightness in chest, coughing, and blurred or dark vision. If it is severe, it can cause seizures, loss of consciousness, and even death. Cholinesterase inhibitor pesticides disable the enzyme resulting in symptoms of neurotoxicity including tremors, nausea, weakness,

paralysis and death. Exposure to these inhibitor pesticides have been linked to impaired neurological development in fetus/infants.

2.5 EC causes irritation to nose and throat, dizziness, nausea, fatigue, and seizures. It is believed to be broken down in humans, but since there is no human data, no information is available. In heavy consumption, it can cause death.

How can you protect yourself? Wear protective face cover, gloves, long clothing, and closed toe shooes. Do not spray commercial pesticides. Keep chemicals in a safe place away from children, animals, and food items.

Lesson 4: Natural Pesticides and comparing the two

What are natural pesticides?

Natural pesticides are solutions made from local, naturally available plants used to protect plants and crops without killing the intended pests. Malians use natural methods to cure illnesses such as colds, malaria, and back aches, medicines made from natural plants. It is no wonder that we can also use plants to help in our gardens and fields. Because the natural methods come from the ground (plants) and return to the ground, they do not have any harmful effects to the environment or people. Perhaps the only side effect is that some of the solutions can be strong, so people need to take care to wash their hands with soap afterwards so the hot pepper does not get in their eyes afterwards.

You can know make your own natural pesticides as our project has instructed you. It is very easy. You do not spend much money. And it won't make you sick.

What are the positives and negatives of commercial pesticides? What are the positives and negatives of natural pesticides? Chart it out.

E. Lessons in Bambara

Lesson 1: Dunkafa

Nin projet be se ka mogow deme ka dunkafa soro. Dunkafa ye mun ye?
Dunkafa ye mogow bee, waati bee, yorow bee, mogow be se ka dumuni soro, dumini min saniyalen don, min te dese, min ka di, min vitamin caman b'a la walisa mogow be se ka balo ka baarake.
Mun ani mun be dunkafa soro?
Keneya, kisenuman, seneminnaw, kalanke, tobilicogo, ji, nogo, fura
Jumen nafa ka bon ni u bee kan? Jumen be kofe ?

Ni dunkafa te soro, an ka mogow bena kungo soro, denmisen be sa. Anw be na mun ke sisan ka dunkafa soro?

Jamanaw bee, mogow bee be kuma dunkafa kan sisan. Nin geleya te Mali la doron. Ameriki, an ka dumni be dese, ola wari be ciara. Mogow don te se ka nin dumini soro. Normalement, dumini min be dese, o ye dumini numan ye, min vitamin caman b'a la. Ni mogow te a soro, u te bonya, u be banaw soro joona. Dunkafa te seka soro u fe.

A waati ma men, jamana Pakistani ye sanji caman soro, a ye a duguma bee ke ji la. U ka dumini bee tine. U ka ji fana tine, ji caman ye o ka jimin nogo. Dunkafa tun te se ka soro.

Adama be fen caman sene Mali la, dumini min a nafa ka bon, vitamin b'a la. Nka, Adama be wari fe, ola a be a ka nako ani folo fen fere sugu la. A denbaya te foyi soro, u be to dun doro. U ten a dunkafa soro.

Jamana caman, organization caman be dunkafa solution nine, nka a ma nogo. Hali ni u ye solution soro ka deme bo, u te se ka mogow bee deme. O fana, dunkafa solution ye mogo jogo yelema ye. Ola, mogow o mogow ka kan ka jija ka u ka dunkafa soro. I be se ka mun ke ka dunkafa soro? Jumen ka nogo ka ke? Jumen ma nogo ka ke?

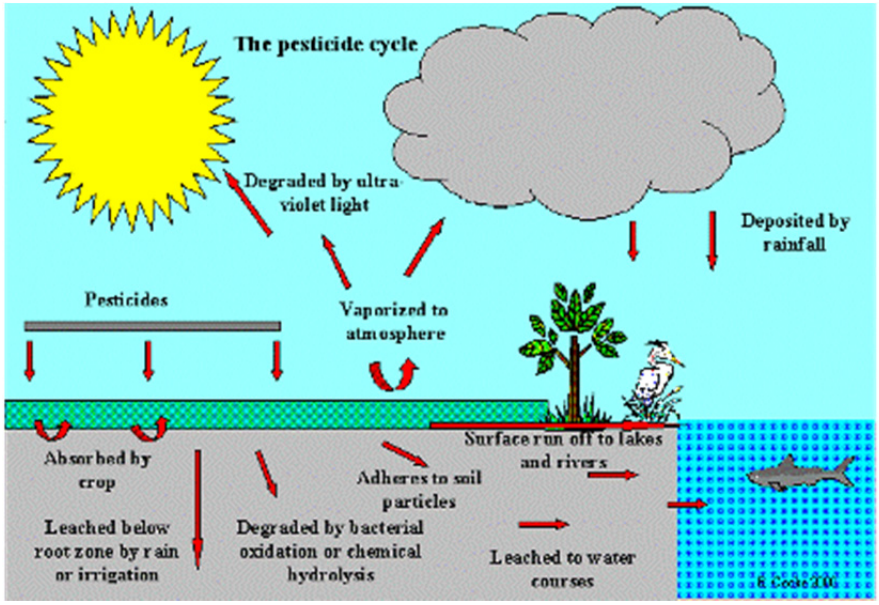
Aw be jija ka dunkafa soro don o don. O fana, an be baarake sisan k'a soro. Anw be bamanan fura dilan, k'a cogo kalan k'aw nako fiye. An be o fiya walisa fengmanen t'o tine. Dunkafa ye dumini min saniyalen don ye, min m'a nogo tubabu fura fe, min i be se ka taa ka dun hali ni i m'a ko. Bamanan fura be bo duguma, i n'a fo Malijirini, foronto, layi, k'a soro ka fiye ka segn duguma. A te duguma tine, a t'aw ka nako fenw tine, a te mogow bana. O la, bamanan fura b'aw deme ka dunkafa soro.

Dogokun n'a taa, anw be ne kuma tubabufure ko la. A be dilan cogo lo, a be yalayala duguma cogo la, a be mogo banaw cogo la. An be kuma bagaji ani 2.5 EC kan.

Lesson 2: Tubabu Fura

Aw be mun ni mun don tubabu fura la?
Tubabu fura ye mun ye ?
O ye fura ye min chemical (posion) b'a la, a ka farin barisa a be fenw faga. A be bo yoro ka jan (jamana were), I be wari bo ka san, a fura ka tele, a ka jugu.
U be dilan min?

Tubabu fura be dilan usine na machine fe. Anw te se k'a dilan yan. U be bo jamana were. Caman min be Mali la be dilan Chine.
A be mun ke ?
Fura be fengnamine faga. Fura do be min be se ka fen kelen kelen fiye. Fura do be min be se ka fenw caman faga.
A be taa min?



Fura be se ka yalayala dugukolo la, sira caman be. Tubabu fura te to yoro kelen. Fura be fiye, o kofe fine be se k'a gazi taa a yoro ka jan. Don be yele ka ke kabanogo ye. Ni sanji nana, a fura be soro ji kono ani a be na duguma yoro were soro. Fura be taa fo dugukolo kono, ka yalayala fo a ye ji sira soro. N'a ye ji sira soro, a be anw kolon ji walima pompe ji nogo. O fana, ni yiri walima nakofenw walima folofenw do be, o be se ka ji sama, ani fura be ji kono, o la o fana be fura soro. Ni sanji nana, a be se ka fura jigi ka taa fo baji, min jege be, min anw b'anw ko, min anw ka misi be ji min. Anw ka bagan be folo walima nakofenw dun, walima bin min be folo la kerefe, a be na fura do dun. Fura be segin a yere kono dooni sanni a be bo a bo walima sugenji la. N'a fura ka jugu, peut etre a te bo joona, ani aw b'a soro waati min aw b'a faga ka sugu dun. Fur ate bo jege la. A be to jege kono. Waati min anw ye jege mine k'a dun, peut etre anw be fura dun, nka anw t'o don. Sira caman be, min tubabu fura be se ka yalayala anw dugukolo la. Anw be anw ka nako ani folo fiye, nka a be se ka anw ka ji soro, anw ka jege, anw ka dumuni soro.
Tubabu fura be ban cogodi?
Fura caman be ban dooni dooni. A be waati ke, ka soro ka ke poison were, fo a te poison ye, fo a ye ji ye doro. Nka, fura do be min u t'a ke joon barisa u ka jugun.
Aw be se ka mun ke k'aw protégé?
Ka na fura caman fiye waati bee, ka bamana fura fiye doron, ka na folo don fura fiye waati kofe, folo and nako fura waati min fengnamine juguyara kosebe, ka na yoro fiye min be dalala walima baji kerefe, ka na kolon ji min, aw tege ko safine fe baara kofe, ka na jege dun fura fiye waati la.
2.5 EC poison togo ye lambda-cyhalothrin. A be dilan Chine. A be nako fenw ani malo fiye. N'a ye mogow soro, I b'a fo tasuma be I fara la. A be damine minute 30 maga waati kofe, a te ban fo heuri 6 peut etre fo tile 2. Ni dooni dunna doron, mogow be fe ka foono, nyenamine

be mogow mine, kan/nu be tooro, segin be. Ni caman dunna, mogow be sa. Dugukolo la, a be yelema ka ke poison were tile duru fura waati kofe, a ka tele. Ola, kalanmogow b'a fo a te se ji nogo. Nka, n'a ye ji soro joona, a be jege soro ka ciara jege kone k'a tine.
Bagaji (Calfus 500 EC) poison togo ye organophosphorus. A fana be dilan Chine. Qourri be fiya doron. N'I y'a dun, I be washi kosebe, musclei be yereyere a yere ma, a be mogow segin, kungolo be I dimi, I be foono, konoboli be, sogosogo be, nye be fin. Ni caman dunna, I be bin ka sunogo, I be se ka sa. Bagaji be se ka a yere yelema ka ke bagaji were fo a ma farin. A b'a ke waati dooni kono. Ni a sorola dugukolo kono, a be se ka ji nogo. A be ciara jege kono, a te bo. Jege be sa, walima mogow be a dun. Malo fiye ma nyn barisa a be ji soro joona, malo be jsegin ji kono. Senekelaw caman be faga Bagaji fe. Don be, u b'a min k'u yere faga. Don be, u y'a soro u hakili t'a la, u be sa. 1994-1996 jege caman salen don kokoji min be baji d la Ameriki. Senekelaw ye bagaji caman fiye, a ye ji soro ka yalayala baji kono fo a ye kokoji soro ka jege soro. A ye jege caman faga.

Lesson 3: Mogow saniya ani tubabu fura
Dogokun temena, anw tun be mun ni mun kalan ?
Bagaji be se ka dugukolo tine, a fana be se ka mogow bana.
Aw deli la ka banaw soro bagaji fe wa?
Mogow be se ka bagaji soro sira saba, ka dun, mogow fara, ani mogow finen (lungs).
Bagaji be se ka yoro tooro, yoro min man jan. I n'a fo, dow be I nye soro k'a tooro. A be se ka taa yoro ka jan ka yoro were banaw, yoro min I t'a don, I t'a ye. I n'a fo, bagaji be don I da la, nka a be I kono tooro.
Bagaji be fara soro, a be jigi fo joli sira la. N'I ye bagaji gazi soro, a be jigi fo joli sira la. Bagaji be yalayala joli sira la ka yoro caman soro. Bagaji dow be taa ka segin bu kono, a te banaw di mogow ma. Bagaji dow be taa yoro min a be se ka mogow bana. Bagaji dow be min be bo joone, dow be min te bo fo san caman.
A be bo mogow la cogodi?
Bagaji caman be bo sugenji la. (Liver) be bagaji yelema ka ke bagaji were walisa a be se ka bo. Dow be, a yelmani ka farin ka teme bagaji folo kan. Bagaji be se ka bo wosiji, lawaji, shinji, daji, konoji, ani mogow fine.

Waati min I ani bagaji be nyogen soro be ke sugu fila. Sugu kelen, a waati kera sine kelen, I n'a fo I tun be yalayala folo kono bagaji fiye waater kofe ka gazi dow soro. Sugu were, a waati kera sine caman, I n'a fo I be I ka folo fiye kalo o kalo fo san mugan. Nin ka jugu barisa a be banaw juguya di mogow ma. Waati min I ye bagaji soro ani waati min banaw damine be se ka janya fo ni I ye banaw soro, peut etre I hakili t'a la ka fo a da be bagaji la.

Mogow bee te kelen ye. I ka jole ani n ka joli te kelen ye. Mogow dow be se ka banaw soro hali ni u ma bagaji caman soro. Mogow dow be banaw soro ni bagaji caman sorola.

A be se ka mun ni mun banaw?
1. Fine sira – nu, kan
2. Fara
3. Hakili
4. Liver
5. Rien

6. Densoro cogo

Bagaji ye poison ye min ka jugu ke teme 2.5EC kan. A te se tama, a farikolo be yereyere a yerema fo a be sa. Ni I ye dooni soro, I be I segin, I be fe ka foono, I farikolo be yereyere a yerema. Ni I ye caman soro, a be se ka I ka farikolo tine, I n'a fo I te se tama, walima a be mogow faga. O fana, mogow b'a don bagaji be se ka musokonoma tine sanni a be jigi. A den ten a hakili numan soro, a hakili be na suma.

Anw be se k'anw kisi cogodi?
Ka n'a bagaji fiye, ka gan don, ka da fini don, ka bagaji mara magazine kono, min den ani bagani ani dumini t'a soro.

Lesson 4: Bamanan Fura
Bamanan fura ye mun ye?
A be bo jiri la, a soroli ka nogo.
Mogow deli la ka bamanan fura ke mogow banaw fura ye, ka sogosogo fura, ka sumaya fura, ka kono dimi fura. Aw bee be se ka bamanan fura cogo ye sisan barisa n y'aw kalan projet la.
Aw te wari caman bo, fura t'aw bana, a cogo ka nogo.
Bamana furaji be bo jiri la, a be segin jiri la, a te dugukolo tine.
Fura don be, i n'a fo foronto, min ka farin. Aw be aw tege ko safine fe fura fiye kofe walisa foronto ji te I nye soro.

An k'anw kalan segin a kan. Mun ani mun ka nyn bamanan fura la? Mun ani mun ma nyn bamanan fura la ? Mun ni mun ka nyn tubabu fura la ? Mun ni mun ma nyn tubabu fura la ? Munna ?

F. Fact Sheet in English

Using Natural Pesticides to Combat common field and garden pests

What do you know about Commercial pesticides?

Without formal instruction, commercial pesticides can be harmful and destructive to the user and the environment. Pesticides are costly. User knowledge, including dosage and application practices is rarely transferred to the farmer. Farmers may be treating their gardens and fields without understanding what the effects are to the people and to the environment. This paper will help to explain those principles, as well as provide a cheaper, easier, safer alternative to commercial pesticides.

Pesticides are made with toxic chemicals so complicated most are hard to pronounce. They have powerful smells and most irritate the skin or eyes after direct contact. These chemicals can build up in our environment, in animals, and in humans through various routes, and can cause a lot of damage (See Figure 1). After pesticides are used in crops, rain can cause contaminated runoff to merge into streams and rivers used for fishing, washing, bathing, and drinking. Most chemicals are known to build up inside fish species, which are then ingested by humans. Pesticides will seep into the soil, and be transported into groundwater and contaminate people's well or pump water. Root systems of other plants will also take up the pesticides found in the ground. If not protected properly, animals can feed on just treated crops, transferring the pesticide into their system. Most chemicals will eventually leave animal and human systems through urine, but not before doing some damage to the system.

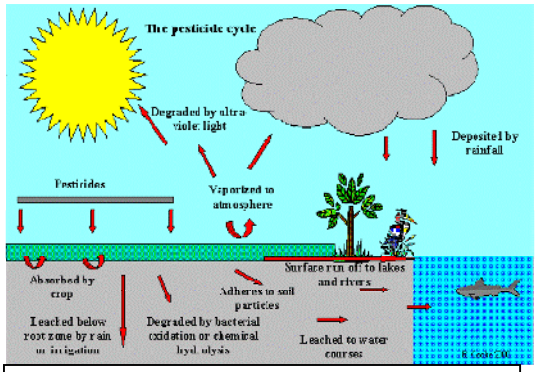


Figure 1 : Pesticide cycle, how pesticides move through our environment

Humans can ingest chemicals through the mouth, the skin, or the lungs. If a lot of chemicals are ingested, it can cause irritation in the lungs, skin, damage to nervous system, nausea, dizziness, liver and kidney disease, infertility, premature births, low birth weights, cancer, and even death. Long exposures to these chemicals will increase the risk of more serious health problems. The rampant use, and the misuse of pesticides is causing chemicals to build up in our environment and in humans.

An Alternative to Chemicals

Farmers all around the world have been using natural pesticides for a long time. Plants have been used to make medicinal treatments for human ailments, as mosquito repellents, as well as to protect crops. Natural methods provide a safer, easier, and cheaper way to protecting crops against pests. *Preventative Crop protection* is important to preventing pests from ruining crops. Practices include crop rotation, regular soil tillage, diversification, use of thorns and ash, and knowledge of pest life cycles.

Natural pesticides are made from local, abundant plants that have natural abilities to repel pests. Plants with such abilities are abundant in Mali, making it easy for farmers to find and make the treatments. Since the natural pesticide comes from a plant (i.e. the ground), it can return to the ground safely without risk of harming the environment or the user. There are no known health or environmental effects when using natural pesticides.

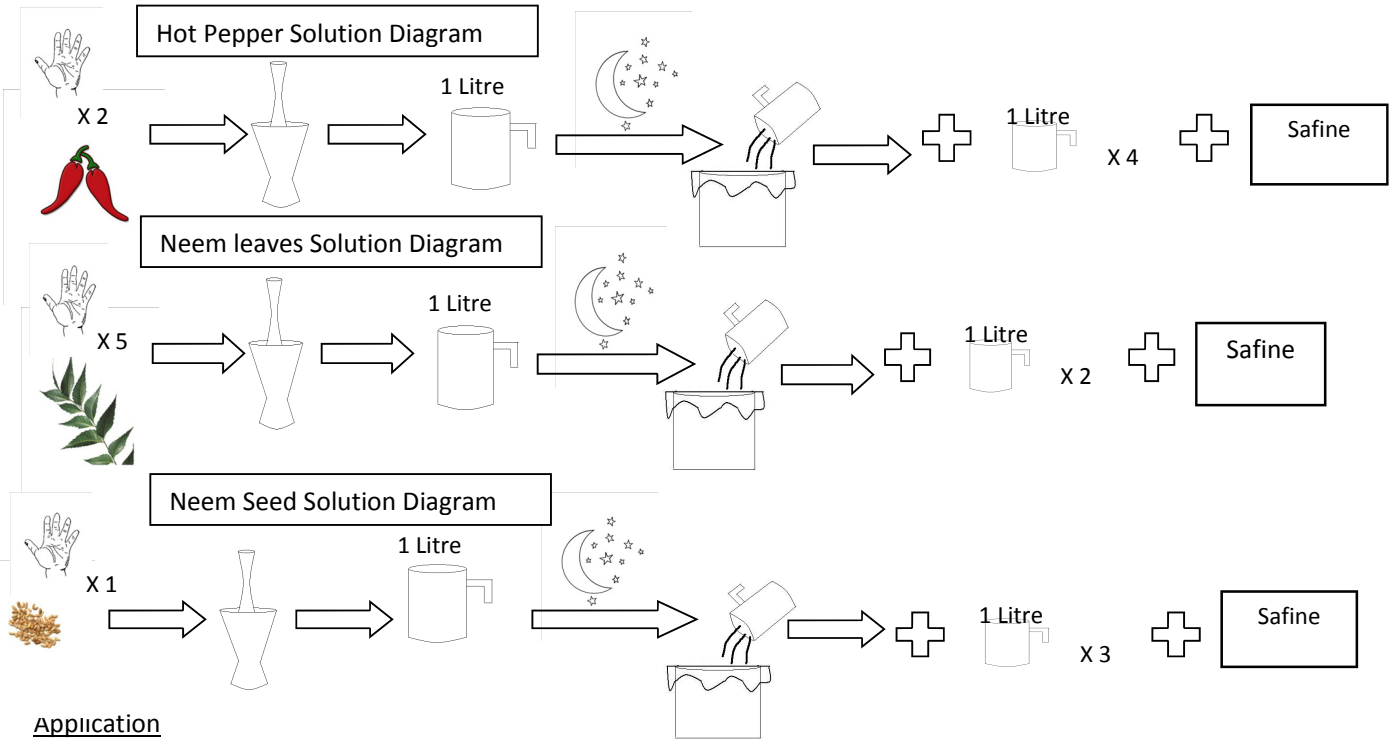
Studied natural pesticide solutions can be made out of neem seed, neem leaves, hot pepper, and garlic. Other plants, like moringa roots, located in Mali have potential pesticide abilities but have not been studied thoroughly.

Natural Pesticide Solution Recipes

Everything needed to make natural pesticide solutions can be found at the local boutique and do not cost much. All natural solutions are made in a mixture of natural plant, water, and soap powder. The plant pesticide properties are extracted in water and then added with soapy water that will allow the solution to stick to the plant parts.

Neem leaves – crush five large handfuls of leaves into a pulp, sit overnight in 1 L water, strain and add 2 L of soapy water
Neem seed – remove the husks of one handful of seeds, crush seeds into a pulp, sit overnight in 1 L water, strain and add 3 L of soapy water
Hot pepper – crush two handfuls of peppers, sit overnight in 1 L water, strain and add 4 L of soapy water
Hot pepper and neem leaves – crush four handfuls of neem leaves and one handful of hot pepper, sit overnight in 1 L water, strain and add 3 L of soapy water

Hot pepper and neem seed – crush half handful of neem seeds and one handful of hot pepper, sit overnight in 1 L water, strain and add 4 L of soapy water
Garlic – crush half a bulb of garlic, sit overnight in 1 L water, strain and add 1 L of soapy water



Application

Puncture small holes in the cap of a small boisson bottle (35 cl). Use this to apply treatments to crops. Treatments can be sprayed over the crop generously until all of the plant is covered. Apply one bottle to one meter squared plot in field or garden, or to one full grown tree. Rice, corn, beans, tomatoes, cucumbers, squash, guava, orange, and eggplants have all been successfully tested with solutions. Pepeniers and adult crops both can be treated. If your crop was not mentioned above, try using natural pesticides to combat pests, it will not hurt your crop!

You should start treatment applications when you first see pests to prevent further crop damage. Application should be after large rain storms, as rain will wash away the pesticide. Be consistent with your treatments, two or three times a week should work well. Wash your hands after using the solutions, as some of them are rather strong, like the hot pepper, and can irritate eyes or skin temporarily.

If the dosage is too strong, you will notice a burning and curling of the plant leaves, lower the dose or add more water to the solution. If the treatment is too weak, you notice that pests have not disappeared, increase the dosage or decrease the amount of water in the solution. Start treatments when you first notice the pests, and keep applying through harvest. Because natural pesticides contain no harmful chemicals, there are no health concerns when consuming prayed crops, even right off the plant!

The solutions can be kept for a long time without losing their pesticide abilities. In fact, the solutions will actually get stronger over time. Keep solutions covered in a dry, cool place away from the reach of animals or children.

Try Experimental Plots First!

If you are unsure of the capabilities of these treatments, or want to see the difference for yourself, try treatments in experimental plots. Mark off a portion of your field or garden, choose one treatment, and treat regularly. Do not treat the rest of field or garden. You should be able to see a difference!

Cost

The cost of commercial pesticide 1 L of 2.5EC is 5,000 CFA. Neem seeds, leaves, and other plant extractions are available at no cost. Most farmers farm hot peppers or can be found locally at low cost. The only cost is soap powder, 25 CFA per solution made. Since solutions are made approximately every one or two weeks, the cost of natural pesticides is affordable. Farmers are more likely to pay little every week than pay out a large amount one time.

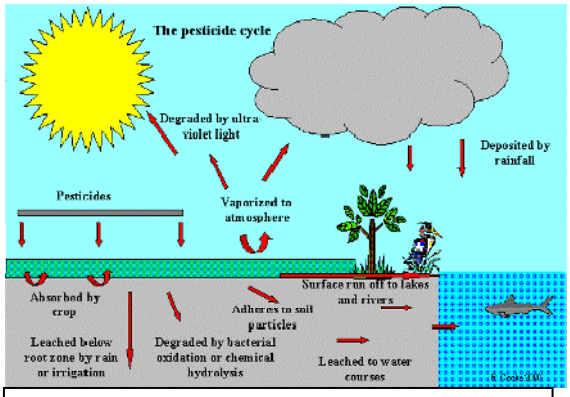
G. Fact Sheet in Bambara

Bamana Fura Bɛ Se Ka fɔrɔ and nakɔ fengnenama fagalanw

I bɛ mun don tubabu fura fengnenama fagalanw kan?

N'i m'a kalankɛ, tubabu fura bɛ se ka duguma and I yɛrɛ tiŋe. I bɛ wari caman bɔ ka tubabu fura san. Nka, sɛnɛkɛlaw te a fura cogo don kosɛbɛ. U tɛ fura fiye hakɛ jate don, u tɛ a mara cogo don, fo mɔgɔw bɛ se ka u kalankɛ. Donniya min ka kan ka kɛ a baarakɛ law la ani fura hakɛ min ka kan ka ta, a ka dogo sɛnɛkɛla minw be o fɛnw ninw don. A ka c'a la sɛnɛkɛlaw be ni fura ninw kɛ u ka nakɔ ni fɔrɔw la ka sɔrɔ u t 'a don u bɛ mun kɛ mɔgɔw ni sigida la. Nin seben bɛna gnefoli kɛ u kan, ani ka sira wɛrɛ fɔ min ka nogo, min ka saniya, min wari man ca ni tubabu fura ye.

Tubabu fura bɛ dilan bagaji caman fɛ. Fengnenama fagalanw dilannen don ni posonniw ye, u kasa ka bon ani u caman bɛ farikolo ni gnekisɛw bana. Nin posonniw/bagajiw bɛ se ka fara gnongon kan sigi da la walima mɔgɔw ni baganw kɔnɔ sira caman fɛ ka cenni lase u ma. Fura bɛ o sɔrɔ siraw caman fɛ ka sɔrɔ ka cenni kɛ (Jaa 1 file). Fengnenama fagalan kelen ko fɔrɔ la sanji bɛ se ka a woyo ka taa n'a ye kow ni baw kɔnɔ, mɔgɔw be jɛgɛw minɛ o baw ni o kow la ani u bɛ finiw ko o bajiw ni o kojiw la ani u minniji fana bɛ ta o ji ninw na. Posonni ninw caman bɛ se ka to jɛgɛw kɔnɔ, mɔgɔw bɛ olu minw dun, u bɛ se ka sensen ka jigi dugu jukoro jiw la k'an ka kɔlɔnjiw ni ponpejiw cen. Jiridiliw fana bɛ se k'u sama dugu jukoro. Nin baganw ma kolosi ka gne u bɛ se ka sɛnɛfɛn furakɛlen ninw dun o min bɛ ke sababu ye ka posonni se u kɔnɔ. Posonni caman bɛ bɔ baganw ni mɔgɔw farikolo la sugunɛ fɛn ka sani o cɛ u bɛ se ka cenni kɛ farikolo la. Posonniw bɛ se ka se mɔgɔw kɔnɔ u da fɛ walima farisogo fɛ walima nun fɛ u ninakili to, u bɛ se ka cenni kɛ farisogo ni fugonfugon na, u bɛ daji caya bila mɔgɔw la ani gnɛnamini, ani bignendimi ni komakilidimi, ani dɛnsorobaliya, ani kansei , ani hali saya. Ni mɔgɔw mɛnna nin posonni/bagaji ninw koro u bɛ se ka bana jugu caman bila I la. Ni sɛnɛkɛlaw bɛ waati caman kɛ tubabu fura koro, u bɛ se ka banaw juguya sɔrɔ ni mɔgɔw min ma waati caman kɛ u koro ye. Sisan, tubabu fura caman bɛ mɔgɔw kɔnɔ ani dugukolo kɔnɔ parce que mɔgɔw t'a cogo don kosɛbɛ nka u bɛ son ka u ka yoro caman fiye san o san.



Jaa 1 : Bagaji yalayala dugukolo la cogo

Bagaji wɛrɛw bɛ sɔrɔ

Dignen sɛnɛkɛlaw bɛɛ bɛ baarakɛ ni bagajiw ye bi ko tɛ. Mɔgɔw bɛ yiri caman kɛ ka u ka banaw furakɛ, dɔ bɛ kɛ sosogennanw ye ani ka sɛnɛfɛnw lakana. Bamana furaw da ka nogon, u baarali ka nogon fana wa u bɛ sɛnɛfɛnw lakana fana. Sɛnɛfɛnw lakanani kunbɛn nafa ka bon walisa fengnenamaw kana u cen. Nin fɛn ninw keli I na fɔ: Sɛnɛfɛnw fo gnogon ko foro kelen na ani sɛnɛfɛnw suguya caman senenni, ngoni ni bugurije, ani fengnenama donni ka gni.

Bamana fura bɛ dilan ni jiri caman ye minw bɛ fengnenamaw gen. O jiriw ka ca Mali la, u sɔrɔ ka di sɛnɛkɛlaw fei u baara cogo ka nogo. I komi bamana furaw bɛ bɔ jiriw la o la u bɛ se ka segin dugukolo la ka sɔrɔ u ma cenni kɛ sigida la ani u baarala la. Bamana furaw tɛ cenni kɛ sigida la, u tɛ bannaw kɛ mɔgɔw la fana.

Mali la bagaji bamana furaw bɛ se ka dilan ni maliyirini kisɛ ye ani a furabulu, foroton ani layi ani jiri wɛrɛw minw bɛ sɔrɔ Mali la.

Bamana Fura Dilan Cogo

Fɛnw min bɛ se ka fura ji dilan bɛ se ka sɔrɔ butiki la, a wari man ca. Mogow bɛ ji ani safinɛ mugu ani yiri nagama ka kɛ bamana fura ye. Fagalenw cogo bɛ bɔ ji la. Safinɛ mugu bɛ k'a la ka fura dɛmɛ ka nakɔfɛnw ani fɔrɔfɛnw minɛ.

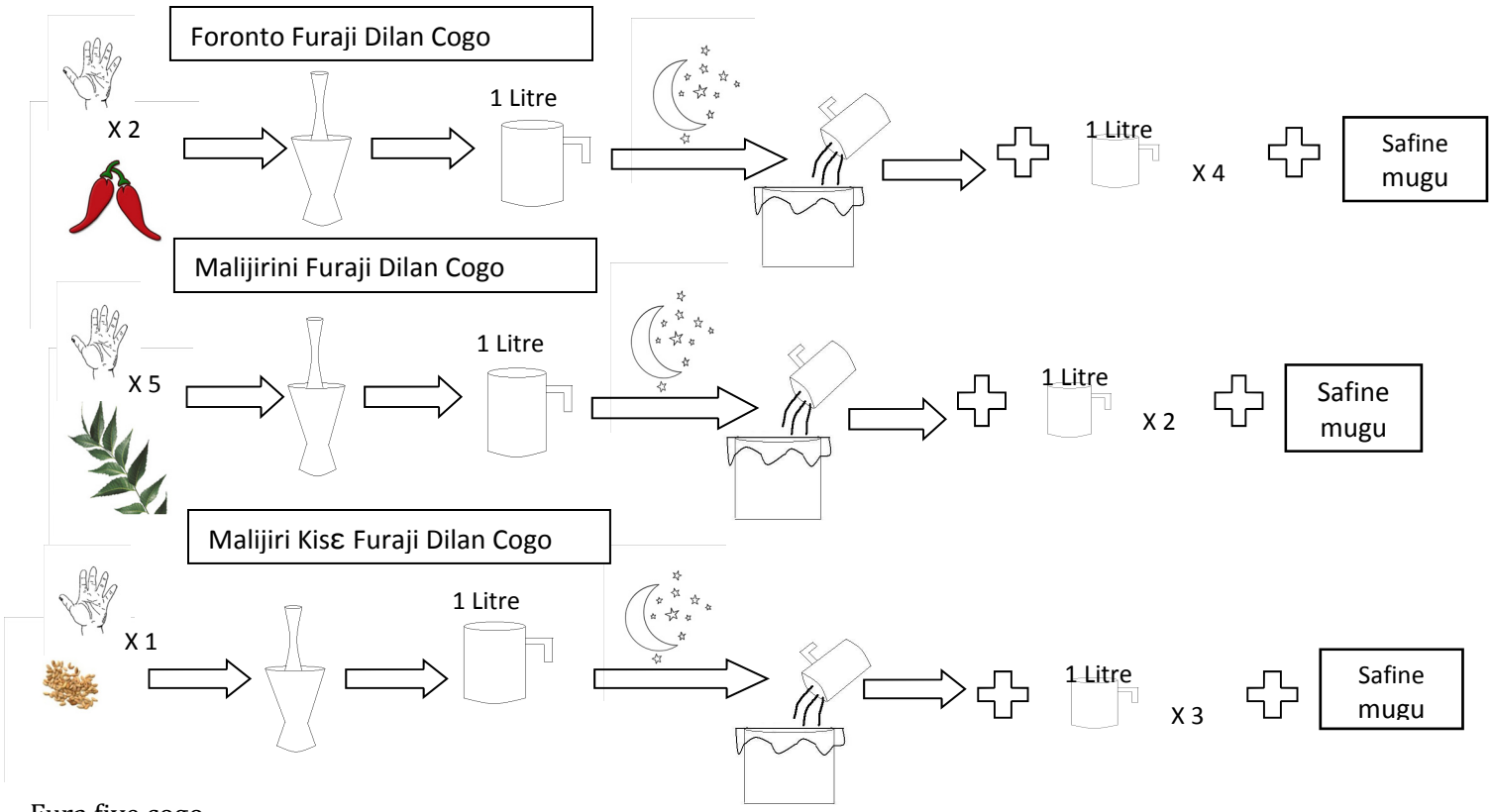
Mali jirini bulu- Bulu bolo duuru taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je, k'a sensen ka ji litiri fila ani safinɛ mugu k'a la

Mali jirini kisɛ- Kisɛ fara wooro ka bolo kelen taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je, k'a sensen ka ji litiri saba ani safinɛ mugu k'a la

Foronto- Foronto bolo fila taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je, k'a sensen ka ji litiri naani ani safinɛ mugu k'a la

Foronto ani Mali jirini bulu- Bulu bolo naani taa ani foronto bolo kelen taa k'a susu ŋogen fɛ, k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je,k'a sensen ka ji litiri saba ani safinɛ mugu k'a la

Foronto ani Mali jirini kisɛ- Kisɛ fara wooro ka bulo kelen taa ani foronto bolo kelen taa k'a susu ŋogen fɛ, k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je, k'a sensen ka ji litiri naani ani safinɛ mugu k'a la
Layi- layi demi taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu bɛ je, k'a sensen ka ji litiri kelen ani safinɛ mugu k'ala



Fura fiye cogo

Boisson bouteilli (35 cl) taa k'a dasogo walisa a bɛ se ka ji bɔ dooni dooni. I bɛ se ka I ka yoro fiye bouteilli fɛ. Ni fura waati sera, I bɛ nakɔfɛnw ani fɔrɔfɛnw fiye fo yoro bɛɛ ye dɔ soro. Normalement, bouteille kelen bɛ se ka fɔrɔ walima nakɔ meteri kelen kari fiye, walima jiri ba kelen fiye. Malo, kaba, shɔ, tomati, cɔncɔn, coso, bouyaki, lenmuruba, aubergine ani goyo deli la ka bamana fura sɔrɔ problem t'a la. Pepeniers ani jiri ba bɛ se ka fiye problem t'a la. N'i bɛ fe ka nakɔfɛnw walima fɔrɔfɛnw fiye min m'a fɔ, I b' o fiye, bamana fura tɛ se k'a banaw.
I ka kan ka daminɛ furalike waata min I ye fengnenama ye I ka nakɔ la walima fɔrɔ la. Ni sanji ba na na, i bɛ yoro fiye, barisa sanji bɛ se ka bamana fura jigi jɔɔna. Bamana fura ma farin kosɛbɛ, k'i ka yoro fiye sinɛ fila walima saba dɔgɔkun kɔnɔ. Ka na filikɛ, n'i hakili bɔra ani I tɛ yoro fiye, fengnenamaw bɛ na ka tinɛkɛ. Fura fiye waati kɔfɛ, mɔgɔw ka kan ka u tɛgɛ ko safinɛ fɛ, barisa foronto gazi bɛ mɔgw nye ani fara tɔɔrɔ.
Ni a fura ji ka farin, i bɛ n'a ye, fura bɛ na bolo jeni. N'a kera, ji dooni fara fura ji kan, walima ka na fura caman fiye.
Ni a fura ji man farin, I bɛ ne fengnenamaw ye I ka yoro la. N'a kera, ji dɔɔni dɛsɛ fura ji la, walima k'i ka fura caman fiye. Fura daminɛ waati min fengnenamaw bɛ fe ka tinɛkɛ, ka fura ban waati min dɛnw bɛ baana. Bamana fura tɛ banaw fosi di mɔgɔw ma, mɔgɔw bɛ se ka nakɔdɛnw taa k'a dun, hali ni a dunna fura fiye waati kɔfɛ!
Fura ji bɛ se mɛn ka waati caman kɛ, a tɛ foyi kɛ fura la. Ni a fura bɛ segin dɔɔni, a bɛ farin kosɛbɛ. I bɛ fura ji mara k'a datugu yoro min ji t'a sɔrɔ, tile t'a sɔrɔ, ani dɛnmisɛnw ani baganw t'a sɔrɔ.

Experimenti Lajɛ Fɔlɔ

N'i tɛ da bamana fura la, I ka kan ka a lajɛ dɔɔni dɔɔni fɔlɔ. I ka nakɔ walima fɔrɔ kɔnɔ, k'i ka yoro fintini taa k'a bɛrɛ walima drapu k'a la walisa I bɛ se k'a yoro ye. Bamana fura kelen taa ka nin ka yoro fiye dɔrɔn. Ka na yoro wɛrɛ fiye. N'i ye a yoro fiye kosɛbɛ, I bɛ na differenci ye.

Songon

Ni mɔgɔw bɛ bagaji 2.5 EC san, u bɛ na 5,000 CFA bɔ ka litiri kelen san. Nka, ni mɔgɔw bɛ bamana fura dilan, u tɛ na wari fosi bɔ ka mali yiri ni walima yiri wɛrɛ sɔrɔ. Sɛnɛkɛlaw caman bɛ foronto sɛnɛ, walima u bɛ se ka foronto sɔrɔ, a wari man ca. Mɔgɔw bɛ na wari bɔ dɔrɔn ka safinɛ mugu san waati min u bɛ fura dilan, o ye 25 CFA ye. Safinɛ mugu fintini bɛ se ka fura ji caman dilan, a wari tɛ na cayara. Mɔgɔw bɛ son ka wari dɔɔni dɔɔni bɔ dɔgɔkun o dɔgɔkun ka tɛmɛ ka wari ba bɔ siŋɛ kelen.

H. Pamphlet in English

Natural vs. Commercial

Without formal instruction, commercial pesticides can be harmful and destructive to the user and the environment. Pesticides are costly. User knowledge, including dosage and application practices is rarely transferred to the farmer. Farmers may be treating their gardens and fields without understanding what the effects are to the people and to the environment.

Pesticides are made with toxic chemicals so complicated most are hard to pronounce. They have powerful smells and most irritate the skin or eyes after direct contact. These chemicals can build up in our environment, in animals, and in humans through various routes, and can cause a lot of damage (Figure 1)

Humans can ingest chemicals through the mouth, the skin, or the lungs. If a lot of chemicals are ingested, it can cause irritation in the lungs, skin, damage to nervous system, nausea, dizziness, liver and kidney disease, infertility, premature births, low birth weights, cancer, and even death. Long exposures to these chemicals will increase the risk of more serious health problems. The rampant use, and the misuse of pesticides is causing chemicals to build up in our environment and in humans.

Farmers all around the world have been using natural pesticides for a long time. Plants have been used to make medicinal treatments for human ailments, as mosquito repellents, as well as to protect crops. Natural methods provide a safer, easier, and cheaper way to protecting crops against pests. *Preventative Crop protection* is important to preventing pests from ruining crops. Practices include crop rotation, regular soil tillage, diversification, use of thorns and ash, and knowledge of pest life cycles.

Natural pesticides are made from local, abundant plants that have natural abilities to repel pests. Plants with such abilities are abundant in Mali, making it easy for farmers to find and make the treatments. Since the natural pesticide comes from a plant (i.e. the ground), it can return to the ground safely without risk of harming the environment or the user. There are no known health or environmental effects when using natural pesticides.

In Mali, natural pesticide solutions can be made out of neem seed, neem leaves, hot pepper, and garlic.

Care and Storage

Because natural pesticides are made from plants, and returned back to the ground, there are no risks to your health or the environment. However, solutions can be strong, so wash your hands after use and refrain from ingesting.

Solutions can be stored for a long time, they will only get stronger. Store in a dry, cool place away from food and out of reach of children and animals.

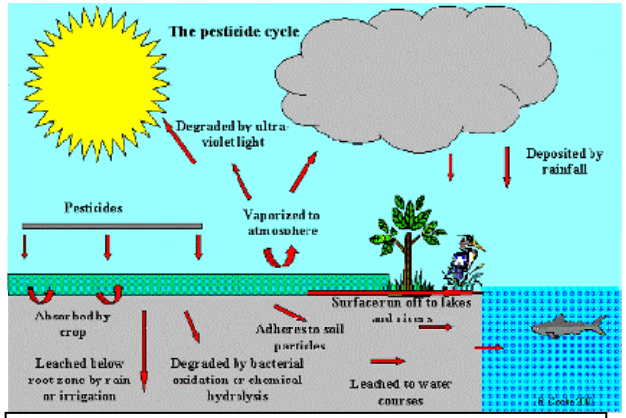


Figure 1: Pesticides in the environmental cycle

For more information, contact Peace Corps/Mali or RPCV Gemma Kite at kite.gl@gmail.com

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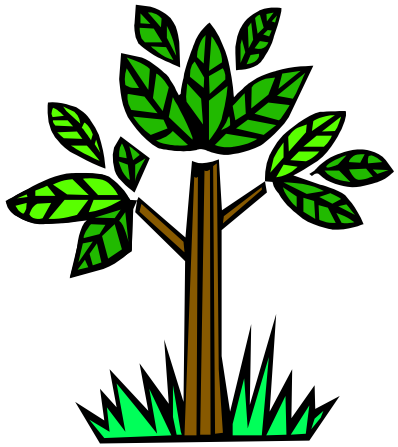
United States of America
Peace Corps
Mali

Natural Pesticides for Garden and Fields

How To Guide



Using natural methods to combat common pests in your gardens and fields is safer, cheaper, and easier than commercial pesticides.

How to Make Natural Pesticide Solutions

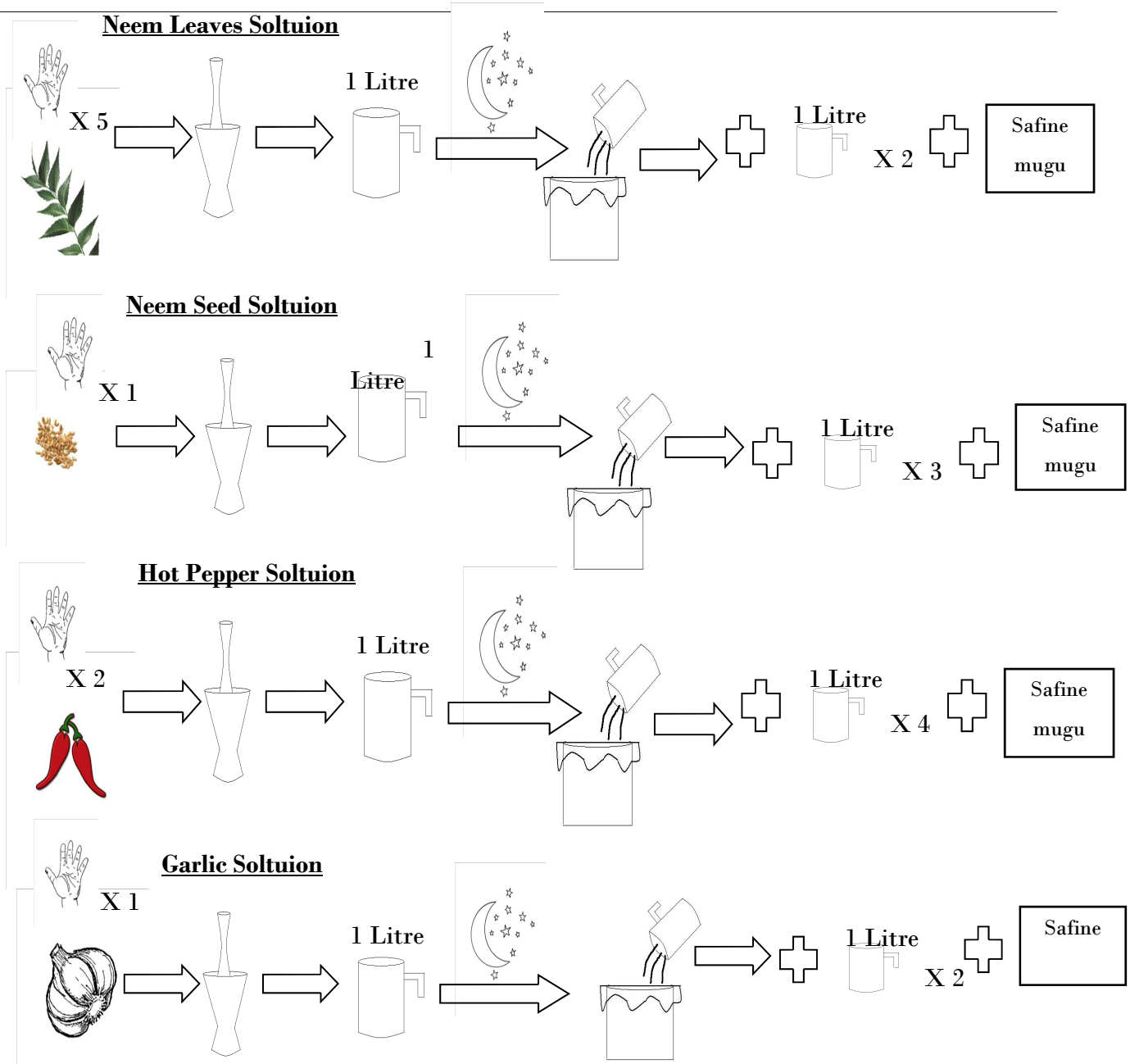
Everything needed to make natural pesticide solutions can be found at the local boutique and do not cost much. All natural solutions are made in a mixture of natural plant, water, and soap powder. The plant pesticide properties are extracted in water and then added with soapy water that will allow the solution to stick to the plant parts.

Neem leaves – crush five large handfuls of leaves into a pulp, sit overnight in 1 L water, strain and add 2 L of soapy water
Neem seed – remove the husks of one handful of seeds, crush seeds into a pulp, sit overnight in 1 L water, strain and add 3 L of soapy water
Hot pepper – crush two handfuls of peppers, sit overnight in 1 L water, strain and add 4 L of soapy water
Garlic – crush half a bulb of garlic, sit overnight in 1 L water, strain and add 1 L of soapy water
Hot pepper and neem leaves – crush four handfuls of neem leaves and one handful of hot pepper, sit overnight in 1 L water, strain and add 3 L of soapy water
Hot pepper and neem seed – crush half handful of neem seeds and one handful of hot pepper, sit overnight in 1 L water, strain and add 4 L of soapy water

See solution diagrams on the next fold!

Application

Apply solutions generously to garden or fields at dusk time. Apply when pests are visible or before they appear to prevent crop damage. If solutions are too strong (you notice plant leaves burned or dried), add more water to the mixture. If solutions are not strong enough (pests won't go away), add less water to the mixture or spray more on your plants. These solutions have successfully worked on rice, beans, tomato, guava, orange trees, cucumbers, squash, and eggplants. Try it out on all your plants to protect them from future damage!



I. Pamphlet in Bambara

Bamana fura walima Tubabu fura

N'i m'a kalankɛ, tubabu fura bɛ se ka duguma and I yɛrɛ tiŋɛ. I be wari caman bɔ ka tubabu fura san. Nka, sɛnɛkɛlaw tɛ a fura cogo don kosɛbɛ. U tɛ fura fiye hakɛ jatɛ don, u tɛ a mara cogo don, fo mɔgɔw bɛ se ka u kalankɛ. Donniya min ka kan ka kɛ a baarakɛlaw la ani fura hakɛ min ka kan ka ta , a ka dogo sɛnɛkɛlaw minw be o fɛnw ninw don. A ka c'a la sɛnɛkɛlaw be ni fura ninw kɛ u ka nakɔ ni fɔrɔw la ka sɔrɔ u t'a don u be mun kɛ mɔgɔw ni sigida la.

Tubabu fura bɛ dilan bagaji caman fɛ. Fengnenama fagalanw dilannen don ni posonniw ye, u kasa ka bon ani u caman bɛ farikolo ni gnekisew bana. Nin posonniw/ bagajiw bɛ se ka fara gnongon kan sigi da la walima mɔgɔw ni baganw kɔnɔ sira caman fɛ ka cenni lase u ma. Fura bɛ o sɔrɔ siraw caman fɛ ka sɔrɔ ka cenni kɛ (Jaa 1 File).

Posonniw bɛ se ka se mɔgɔw kɔnɔ u da fɛ walima farisogo fɛ walima nun fɛ u ninakili to, u bɛ se ka cenni kɛ farisogo ni fugonfugon na, u bɛ daji caya bila mɔgɔw la ani gnenamini, ani bignendimi ni komakilidimi, ani dɛnsorobaliya, ani kansei, ani hali saya. Ni mɔgɔw mɛnna nin posonni/bagaji ninw koro u bɛ se ka bana jugu caman bila u la.

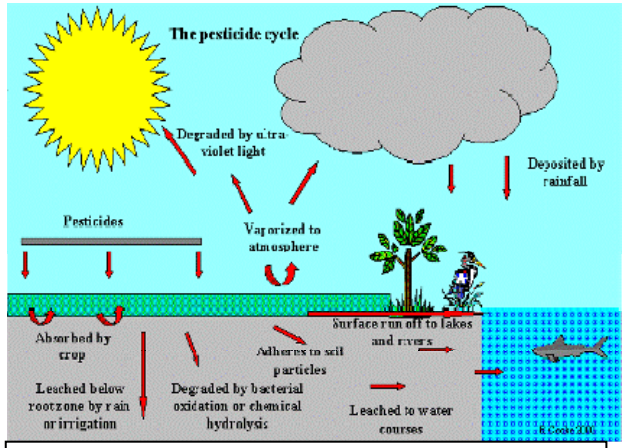
Dignen sɛnɛkɛlaw bɛɛ bɛ baarakɛ ni bagajiw ye bi ko tɛ. Mogw bɛ yiri caman kɛ ka u ka banaw furakɛ, dɔ bɛ kɛ sosogennanw ye ani ka sɛnɛfɛnw lakana. Bamana furaw da ka nogon, u baarali ka nogon fana wa u be sɛnɛfɛnw lakana fana. Sɛnɛfɛnw lakanani kunben nafa ka bon walisa fengnenamaw kana u cen. Nin fɛn ninw keli I na fo: Sɛnɛfɛnw fo gnogon ko fɔrɔ kelen na ani sɛnɛfɛnw suguya caman senenni, ngoni ni bugurije, ani fengnenama donni ka gni

Bamana fura bɛ dilan ni jiri caman ye minw be fengnenamaw gen. O jiriw ka ca Mali la, u sɔrɔ ka di sɛnɛkɛlaw fɛnw a u baara cogo ka nogo. I komi bamana furaw bɛ bɔ jiriw la o la u bɛ se ka segin dugukolo la ka sɔrɔ u ma cenni kɛ sigida la ani U baarala la. Bamana furaw tɛ cenni kɛ sigida la, u tɛ fɛn ke mɔgɔw la fana.Mali la bagaji bamana furaw bɛ se ka dilan ni maliyirini kisɛ ye ani a furabulu, foroton ani layi ani jiri wɛrɛw minw bɛ sɔrɔ Mali la.

Mara cogo

I komi bamana furaw bɛ bɔ jiriw la o la u bɛ se ka segin dugukolo la ka sɔrɔ u ma cenni kɛ sigida la ani u baarala la. Bamana furaw tɛ cenni kɛ sigida la, u tɛ fɛn kɛ mɔgɔw la fana. Nka, furaji ka farin dɔɔni, ola, i b'i tɛgɛ ko fura fiye waati kɔfɛ, ka n'a fura dun.

Furaji bɛ se ka mara waati ka jan, a bɛ furaji farina kosɛbɛ. I bɛ furaji bila yoro min tile t'a sɔrɔ, ji t'a sɔrɔ, dɛnmisɛnw ani baanw t'a sɔrɔ.



Jaa 1 : Bagaji yalayala dugukolo la cogo

N'i be fɛ ka dɔ kalan, i bɛ mɔgɔw wele Peace Corps/Mali la walima letteri ci RPCV Gemma Kite

Corps de la Paix
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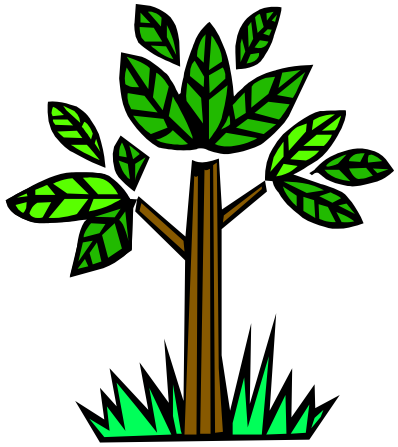
20-21-35-53

United States of America
Corps de la Paix
Mali

Nakɔw ani Fɔrɔw
Bamana Furaw Dilan Cogo



Bamana fura bɛ se ka nakɔw ani fɔrɔw fengnenama kunbɛn. A cogo ka nogo, a songon man gɛlɛn, a tɛ cenne kɛ ni bagaji ye.

Bamana Fura Dilan Cogo

Fɛnw min bɛ se ka fura ji dilan bɛ se ka sɔrɔ butiki la, a wari man cha. Mɔgɔw be ji ani safinɛ mugu ani yiri nagama ka kɛ bamana fura ye. Fagalenw cogo bɛ bɔ ji la. Safinɛ mugu bɛ k'a la ka fura dɛmɛ ka nakɔfɛnw ani fɔrɔfɛnw minɛ.

Mali jirini bulu- Bulu bolo duuru taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu be je, k'a sensen ka ji litiri fila ani safinɛ mugu k'ala

Mali jirini kisɛ- Kisɛ fara wooro ka bolo kelen taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu be je, k'a sensen ka ji litiri saba ani safinɛ mugu k'a la

Foronto- Foronto bolo fila taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu be je,k'a sensen ka ji litiri naani ani safinɛ mugu k'a la

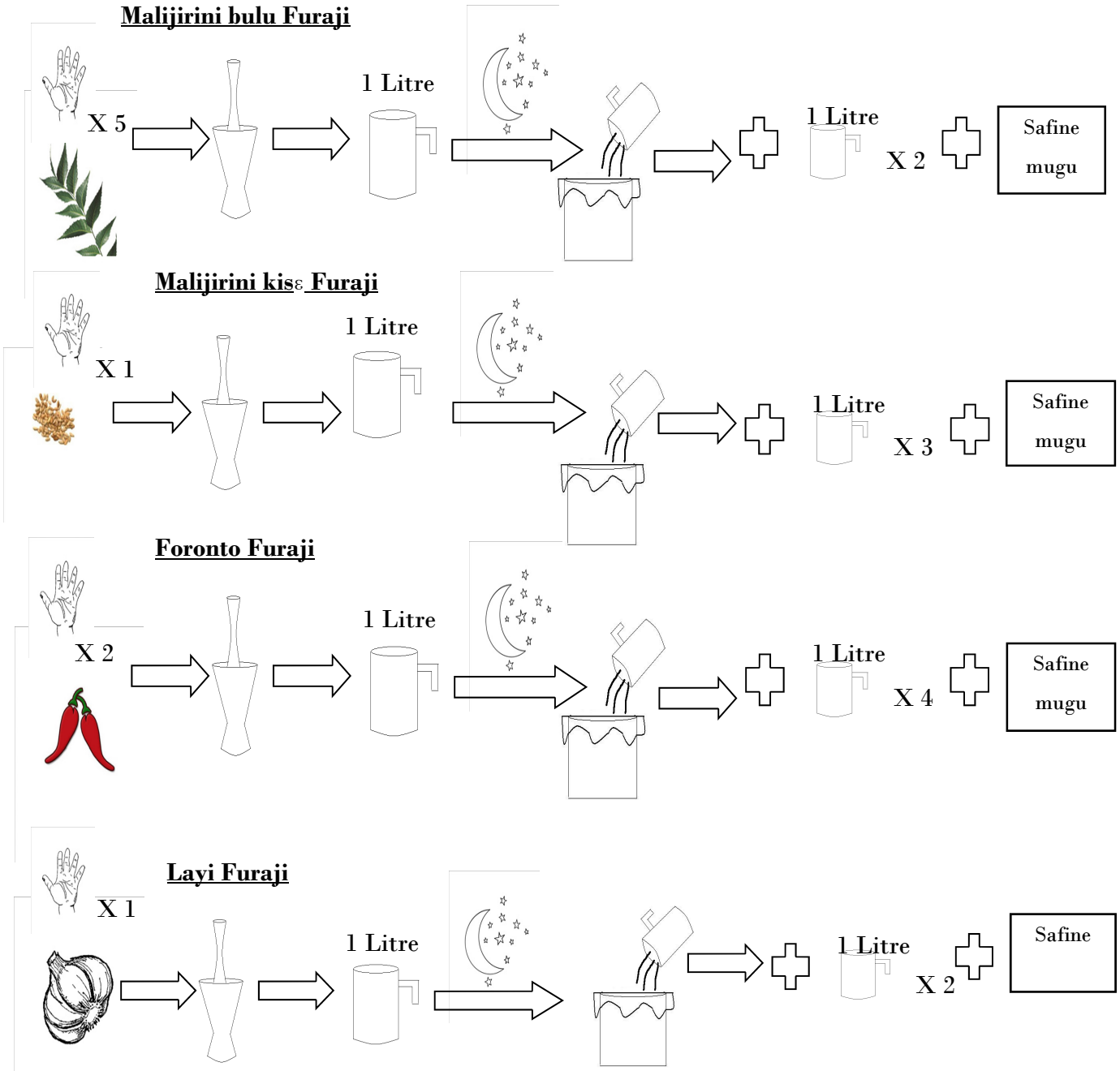
Layi- laeit demi taa k'a susu k'a segin ji litiri kelen kɔnɔ fo dugu be je, k'a sensen ka ji litiri kelen ani safinɛ mugu k'ala

Foronto ani Mali jirini bulu- Bulu bolo naani taa ani foronto bolo kelen taa k'a susu nyogen fɛ, k'a segin ji litiri kelen kɔnɔ fo dugu be je,k'a sensen ka ji litiri saba ani safinɛ mugu k'a la

Foronto ani Mali jirini kisɛ- Kisɛ fara wooro ka bulo kelen taa ani foronto bolo kelen taa k'a susu nyogen fɛ, k'a segin ji litiri kelen kɔnɔ fo dugu be je, k'a sensen ka ji litiri naani ani safinɛ mugu k'a la

Fura fiye cogo

Wula fɛ, yorow fiye walisa ji bɛ yorow bɛɛ sɔrɔ. Fura fiye daminɛ waati min i ye fengnenama ye walima sanni u sera i ka yoro la walisa i bɛ se ka u kunbɛn. Ni furaji ka farin (jiribulu bɛ jeni), ji dɔ fara furaji kan. Ni furaji man farin (fengnenama ma bo), ji dogoya walima furaji caman fiye. Mɔgɔw deli la ka shɔ, malo, tomati, aubergine, goyo, cɔncɔn, bouyaki, lenmuruba jiri ani jirini fiye bamana fura fɛ, u m'a problem foyi sɔrɔ. A lajɛ k'i ka yorow furakɛ k'u kisi!



J. Peace Corps Report

Introducing Natural Pesticides to Combat Common Field and Garden Pests

Mali, West Africa

Report delivered to Peace Corps/Mali
November 2010

Gemma Kite
RPCV Mali 2008-2010

Outline

I. Project Scope and Goals

The purpose of this project was to introduce or further instruct rural farmers in using natural pesticides as a method of crop protection. The idea of using natural methods to protect crops is not new. Malians have been using plant extracts to cure physical and mental ailments for a long time. It is no surprise, then, that plant extracts would also be used to protect gardens and fields.

The project has two goals. First, the project aims to show the positive effects of using natural pesticides on crops through experimentation. Second, through a series of formations, the farmers are educated on topics such as food security, environmental and health effects of commercial pesticides, and differences between using natural versus commercial pesticides. Education is an important part of this project, as many farmers rampantly use commercial pesticides without understanding the full effects of these chemicals.

This project report was created with the sole purpose of helping other Peace Corps volunteers implement this project. It will explain the project scope so that it can be replicated easily within the Peace Corps community.

II. Background

The idea for this project came from my Peace Corps homologue, from a conversation on commercial pesticides used in the cotton fields. After he stated he knew the treatments were dangerous because of the smell and slight tingling feeling he felt in his hands when spraying, I asked if he knew of alternative ways to protect his crops. His lack of formal training on how to safely handle and use the commercial pesticide and no information on alternatives to pesticides spurred the idea for this project.

Malian farmers are given Calfus 500 EC (500 g/L Profénos) or known as Bagaji in Bambara to use on their cotton. CMDT gives the pesticide at the beginning of cotton growing season, the cost of it taken out of the profits at the end of the season when the cotton is sold back to CMDT. Bagaji is given with little or no instruction on its use, including dosage, handling and storage. Many farmers know that Bagaji is harmful because of its' pungent odor and the skin or eye irritation experienced if it comes into contact with the farmer. However, they have no idea about the serious health effects or the environmental effects of this product. Because most farmers cannot read, it is imperative that this information is disseminated through verbal formations. These types of formations take time, manpower, and money resources, which is probably why CMDT is not conducting these seminars.

Many Malian farmers use 2.5 EC (25 g/L lambda-cyhalothrin) on their gardens. The packaging for this common pesticide is in English and includes pictures to explain to the user to wear protective clothing when using and that it should not come into contact with bodies of water where fish inhabit. After asking my small group of farmers, it is not clear if every farmer would be able to understand these pictorials.

Malians understand the importance of using natural remedies to cure medical ailments and for protecting crops. Natural crop protection is more than just alternatives to pesticides. It includes a combination of using good agricultural practices that prevent a good habitat for

pests to cause damage. Crop rotation, diversification, farmer knowledge of pest cycles, and soil tillage practices all help to prevent favourable habitats for pests. Encouraging farmers to first incorporate these practices into their farming is important and easy (no cost involved).

Many plants exist in Mali that have natural abilities to repel pests. Neem, garlic, and hot pepper have all be successfully studied and experimented with in Mali. Other trees and plants that are readily available in Mali also have potential to become natural pesticides, including moringa roots, but lack experimental data. These plants are abundant in supply in Mali, cheap to buy or free for the taking, and have no harmful health or environmental effects. For farmers that have no resources to purchase chemicals, these natural remedies offer an easy and cheap solution to protecting their crops from pest damage.

In America, the organic movement has changed the way people think about the environment, what they eat, how they dress, and their behaviour to their environment. In Mali, the majority of rural subsistence farmers might not necessarily understand organic but practice organic as they have no means to purchase chemicals to protect their crops. Farmers would not per say choose to be organic, as most would rather treat their crops with chemicals to increase their crop yield to make money. Additionally, most do not understand the environmental effects that cause Americans to choose organic. So, in educating farmers about the environmental and health effects of harmful chemicals, there is hope that Malian farmers will switch to using alternatives to chemicals. Western countries are pushing more and more for their imported produce to come from organic sources. While most rural farmers will never export their crops to a Western country, having them understand and practice organic will have a snowball effect for other farmers in Mali and other West African countries.

This project was facilitated with several participants, as it is useful to have many minds on one topic than just you and another farmer. With a larger group, they can exchange ideas and assist each other in ways that you would not be able to as a foreigner.

III. Experiment

Part one of this project was using experiment plots to show the success of natural pesticides. Choose a group of farmers that is manageable in size. Use farmers that you know will work consistently and are motivated to undertake this project. Homologues can make good references of people they know. I chose a group of eight male farmers and three female rice growers. This was a good number to work with and took up a generous amount of my time.

Each farmer does not grow the same crops in the fields and gardens, so your experiment will have some variation in crops used, but that is a positive. Malians are interested to see the wide range of applications for natural pesticides. Natural pesticides have been tested on lots of produce and field crops worldwide. In my project, my farmers tested on tomatoes, eggplant, Malian eggplant (goyo), squash, cucumber, rice, beans, orange trees, guava trees, and jatropha tree nursery.

Have each farmer mark off a small plot in the field or garden for each pesticide used. For example, if the farmer is trying three types of natural pesticides, mark five different plots. One plot acts as a control, no pesticide is applied. Commercial pesticide (2.5 EC) will be

used on another plot. The remaining three plots will be used for the three different natural pesticide solutions. Tie old fabric or plastic on long sticks to mark off the various plots. I used red fabric for hot pepper, white for garlic, green for neem, and a neutral color for commercial. All plots should be the same size, and should contain the same crop. This way, it will be easy to see any visual differences during the experimentation.
After the plots are prepared, the solutions can be made and sprayed. With each farmer, instruct them on how to make the various natural solutions. If a farmer farms hot pepper, it would make sense to include the hot pepper solution as one of his treatments. You can choose or the farmer can choose which solutions he/she would like to use. The first time, make the solutions together so they can understand the process. Hand them a copy of the brochure that instructs them on how to make the solutions (Appendix) for future use.

The natural solutions are easy to make. The pesticide property needs to be extracted from the plant by mortar and pestle and sit in water overnight. After a good 8 or 10 hours, the water can be sieved and mixed with more water and soap powder. The solutions will be ready in the morning but are recommended to be applied in the afternoon due to the potential of the sun's damage on neem products. The solution recipes are as follows:

Neem seed-shell dried neem seeds and crush one handful, sit overnight in one liter of water, sieve out the seeds and add three liters of soapy water.
Neem leaves-crush five handfuls of leaves, sit overnight in one liter of water, sieve out the leaves and add two liters of soapy water.
Hot pepper-crush two handfuls of hot pepper, sit overnight in one liter of water, sieve out the pepper and add four liters of soapy water.
Garlic-crush one bulb of garlic, sit overnight in one liter of water, sieve out garlic and add two liters of soapy water.
Neem seed and hot pepper- crush one handful of dried peeled neem seed and one handful of hot pepper, sit overnight in one liter of water, sieve out hot pepper and seeds and add four liters of soapy water.
Neem leaves and hot pepper- crush four handfuls of neem leaves and one handful of hot pepper, sit overnight in one liter of water, sieve out hot pepper and leaves and add three liters of soapy water.

Keep solutions in closed containers away from the reach of children and animals. Although natural solutions are not harmful, they are strong and care should be taken. Solutions can last a long time, they will actually get stronger over time.

Before the project, collect several discarded soda bottles (35 cl). Give one to each participating farmer. Have the farmer poke holes in the bottle cap so it can be used as an easy way to spray their plots. Also, if each farmer uses the same size bottle, it is easy to regulate the treatment dosage for all farmers.

Purchase 2.5 EC at your local market or in your banking town. It comes packaged in either small containers (approx. 1,000 CFA) or by 1 litre bottles (approx. 5,000 CFA). If you do purchase the pesticide in the large bottle, you will need to collect additional soda bottles to give some of the pesticide to each farmer for the duration of the experiment.

After the solutions have been made with the farmer, arrange so that you can go to his field or garden for the first application. Since the natural solutions are made up to between 3 and 5 L, transfer about 1 L into another bottle to be easily transported to the plots, and store the rest at home. Spray each solution in the appropriately marked plot. Fill the soda bottle and use to spray generously over the plants, approximately 1 bottle per 1 meter squared if the plot is packed. For the commercial pesticide, one full bottle cap is mixed with one litre of water to spray. For small plots, use a half cap full with a half litre of water. Begin application of pesticides when the farmer first sees signs of damage or pest, and/or before the pests appear if he has knowledge of the pest cycle. Use the pesticide all the way until harvest, with the exception of the commercial pesticide which should be stopped 10 days before harvest.

Commercial pesticide needs to be sprayed every 10 to 14 days (as on packaging). Natural pesticides need to be sprayed more frequently, as they are not as strong and will disappear after heavy rains. It is recommended to apply natural pesticides two to three times a week, or after a big rainstorm. In order for the experiment to be successful, the farmer needs to be consistent in his method and time of application.

If the solutions are too strong, you will notice a burning of the plant leaves. Add more water to the solution or decrease the dosage. If the solutions are not strong enough, you will notice the pests have not receded, add less water in the solution or increase the dose.

Continue the experiment through to harvest. Visit the farmer's plots frequently so you can discuss any differences, successes or problems with the experiment. Take any necessary plant measurements if desired (plant length, fruit size). Conduct a visual inspection of any pests or damage done by pests. Ask the farmer to conduct this inspection weekly and report back to you. This will ensure the farmer is fully involved in the results of the project. At harvest time, you can conduct a biomass survey. Weigh the amount of edible produce or crop from each plot compared to the control plot. There could be a significant difference.

When handling the solutions, wash hands with soap after applying or touching the solutions, as they are strong and can cause slight skin or eye irritation. Use protective gloves or face mask when handling the commercial pesticide, as this does have severe health effects if ingested.

IV. Farmers School

The second part of this project is to conduct a farmers school, in which the participants can come together to talk about their experimental plots, and to learn about various related topics. The school is to be facilitated at the same time of the experiment. Topics for the seminars may include an introduction to food security, environmental effects of pesticides, health effects of pesticides, commercial pesticide use, care, and storage, the organic movement, and a compare/contrast natural vs. commercial.

Each week, no matter if there was no seminar topic to present, the participants meant to update each other on their experimental plots in a roundtable type manner. This was also a great way to exchange other relevant information, to discuss other problems affecting their

farming, and to brainstorm solutions. Before the project started, when choosing farmers, it is important to explain that this school is a necessary step to the project and they need to set aside an hour each week to come and meet.

More topics can be added if desired. You can ask your participants if they want to learn anything else before the project wraps up. Included in the appendix are the lessons I presented in both English and Bambara. You can conduct more research add to its content.

V. Project Timeline

My project was conducted during the rainy season, beginning in May through to the end of November. This project can be facilitated whenever a farmer is growing something. If they have access to a good water source, you could even conduct this during the dry season. Give yourself three or four weeks to talk about this project to potential participants so that you can choose farmers that are motivated to be a part of the project. The experiment could take as short as one month or as long as four months depending on the rains and what is experimented on. During my experiment, the excess of rains ruined the first round of crops, making the farmers have to replant another set of crops to experiment on.

VI. Project Costs

The costs of this project are not a lot, but probably will need to be funded by the volunteer. Also, it depends on what you want your farmers to be responsible for. Since it is an experiment, it might be appropriate for you to purchase the commercial pesticide. One litre bottle at 5,000 CFA should last you for all or most of the experiment if you don't take on an exuberant amount of participants. It is reasonable for the farmers to provide for the natural pesticide solutions, which is soap powder and hot pepper or garlic (if not farmed by the farmer), as the cost does not amount to much in the end. Additionally, farmers are more likely to pay out little every week than pay a large sum of money at one time. Each time solutions are made, the farmer will pay 25 or 50 CFA (depending on the amount of solution) for soap, and perhaps 100 CFA for garlic or 250 CFA for hot pepper. If a farmer makes a solution every two weeks, that is 400 CFA for two or three months, the farmer will be paying out a lax of 2200 CFA for the project. If garlic or hot pepper is hard to find, limit your natural pesticide solutions to neem or other trees/plants found in Mali.

VII. Appendices

The lessons in English and Bambara can be found in Appendix D and Appendix E respectively.

K. Human Subject Research Approval

Cornell University
Office of
Research Integrity and Assurance

East Hill Office Building, Suite 320
395 Pine Tree Road
Ithaca, NY 14850
p. 607-255-5138
f. 607-255-0758
www.irb.cornell.edu

Institutional Review Board for Human Participants

Concurrence of Exemption

To: Gemma Kite
From: Matthew Aldridge, Senior IRB Administrator
Date: October 06, 2010

RE: **Protocol ID#:** 1009001638
Project(s): Introducing Natural Pesticides in Rural Farming Techniques, Mali, West Africa

A member of the Office of Research Integrity and Assurance (ORIA) has reviewed the above-referenced project and found it to qualify for **Exemption from IRB Review** according to paragraph #2 of the Department of Health and Human Services Code of Federal Regulations 45 CFR 46.101(b).

This proposal has not been evaluated for scientific merit, except to weigh the risk to the human participants in relation to the potential benefits.

Please be aware of the following:

- Exemption from IRB review does not absolve the investigator from ensuring that the welfare of the research subjects is protected and that methods used and information provided to gain participant consent are appropriate to the activity. It is your responsibility as a researcher to familiarize yourself with and conduct the research in accordance with the ethical standards of the Belmont Report (http://ohsr.od.nih.gov/guidelines/belmont.html).
- You must notify the ORIA office of changes or amendments to the above-referenced protocol **BEFORE** their implementation.
- You are not required to submit progress reports or requests for continuing review/approval to ORIA, unless you modify your study protocol.

c: Michael Walter