AGRICULTURE, TECHNOLOGY, AND CONFLICT

A Thesis

by

CODY JOHN ZILVERBERG

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2007

Major Subject: Agricultural Economics

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Approved by:

Co-Chairs of Committee, Edwin Price
Richard Woodward
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ABSTRACT

Agriculture, Technology, and Conflict. (May 2007)

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Conflict and agriculture have a long, shared history. The purpose of this research is to look at the relationships between agriculture, agricultural technologies, and conflict during current and recent conflicts, large scale and localized. Agriculture and its related technologies are often affected by conflict, but rarely acknowledged as a cause or solution to conflict. Literature reviews in six topic areas illustrate various facets of the relationship between agriculture and conflict.

Research conducted in Santa Cruz del Quiché, Guatemala illustrates the ways farmers were impacted by the country's civil war. It also examines farmer survival strategies during the war, and reveals the presence of minor localized conflict over water resources. Conflict over land is not a major concern at present. Market access for inputs and outputs are shown to have been a problem for a number of farmers during the civil war. The poverty of Santa Cruz farmers indicates that much could be gained by rural development. Research is unable to support the hypotheses that agricultural technologies have prevented or caused conflict in Santa Cruz del Quiché, or that they have played a large role in recovery from the country's civil war.

The author recommends that future research be undertaken in regions with a diverse set of agricultural technologies, and/or a recent history of significant

technological change in agriculture. Policy recommendations include providing secure access to markets during war time, increasing capacity for home-based rural production, and continuing research into resilient crops. Finally, the author suggests that the responsible decision to develop, adopt, or introduce an agricultural technology must take into account the social consequences of that decision, including how the new technology may alleviate or contribute to conflict.

ACKNOWLEDGEMENTS

I would like to thank Hector, Angélica, Juan Carlos, Maria Isabel, Francisca, Lucía, and everybody at Acción Cultural Guatemalteca for their assistance in carrying out this research. Thank you to Domhnall and Myriam for their hospitality, and to my advisors and everyone at the Borlaug Institute for their support and advice. Finally, I would like to thank Wesley for her loving support and understanding throughout the entire process.

NOMENCLATURE

ACG	Acción Cultural Guatemalteca (Guatemalan Cultural Action)
CEH	Comisión para Esclarecimiento Histórico (Commission for Historical Clarification)
CGIAR	Consultative Group on International Agricultural Research
CIIDH	Centro Internacional para Investigaciones en Derechos Humanos (International Center for Human Rights Research)
CPR	Comunidad de Población en Resistencia (Community in Resistance)
departamento	A Guatemalan political unit similar to a U.S. state
municipio	A Guatemalan political unit similar to a U.S. county
PCA	Principal Components Analysis

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CHAPTER I

INTRODUCTION

Conflict has surely existed since humanity came into being, and when agriculture entered the scene, it was quickly caught up in conflict as well. The book of Genesis describes the creation of the world in chapters one and two, records the first human conflict in chapter three when "gatherers" Adam and Eve eat of the forbidden fruit, and records the first instances of agriculture and agriculture-related conflict in chapter four. Whether historical or mythological, this biblical story demonstrates the long, shared history of agriculture and conflict.

Much has changed in the practice of agriculture and conflict since Biblical times, but the purpose of this research is not to provide a history of conflict and agriculture. Rather, it is to look at the relationship between the two in current and recent conflicts, paying special attention to the role played by agricultural technologies. Natural resources, especially land and water, are an important part of the interaction because their control is necessary for agricultural production.

Agriculture is often affected by conflict, but rarely acknowledged as a primary cause of conflict. Consequently, in order to resolve conflict, leaders tend to look for political solutions and overlook technical ones. While this is the correct approach for many situations, there are others where a more appropriate response would be to combine political efforts with a recognition of the role that technology may have had in causing the conflict and/or the role that technology may play in resolving the conflict.

This thesis follows the format of the *American Journal of Agricultural Economics.*

The investigation into this topic continues with an explanation of the methods that were used to conduct field research in Guatemala and the statistical tools used to analyze the data that was collected (Chapter II), followed by a brief history of Guatemala and the communities where the research was conducted, with special emphasis placed on agriculture and conflict (Chapter III). Together, these two chapters provide the background for understanding the rest of the study. The next chapter (Chapter IV) is divided into six sections, each focusing on a particular relationship between agriculture and conflict. Each of the sections begins with a literature review and a general conceptual model. They are followed by one or more hypotheses specific to Santa Cruz del Quiché, Guatemala, and the methodology used to test the specific hypotheses. Each section concludes with the results of the tested hypotheses and a discussion of the topic. The final chapter (Chapter V) includes conclusions and recommendations. The bibliography and appendices follow.

CHAPTER II

METHODOLOGY

A. Definition of Terms

It is necessary to explain what is meant by the words technology and conflict. For this research, both terms will be defined very broadly. The first two definitions of conflict given by The American Heritage College Dictionary (1993) are "A state of open, often prolonged fighting; a battle or war" and "A state of disharmony between incompatible or antithetical persons, ideas, or interests; a clash." Throughout this research, conflict will be understood to include both of these definitions, meaning anything from interstate and intrastate war, to community-level conflict and domestic disputes. Conflict does not imply violence, although violence may reveal the presence of conflict. Conflict may not manifest itself in violence when it is resolved by local authorities or traditional conflict resolution methods, or when it goes unresolved but remains at the level of tension without producing violence.

Technology is the "application of science" (The American Heritage College Dictionary, 1993). Thus, technology should not be understood as merely physical tools or machines. Using a mechanical tractor for turning the earth is an easily recognized agricultural technology, as is the use of chemical fertilizers, herbicides, and insecticides. However, the application of technology is not always focused upon physical tools. Other examples of technology are the use of integrated pest management, crop rotation, and improved seeds. Tools, machines, and ideas do not need to be considered "advanced" in order to be technology. Thus, the use of a hoe or a plough are both

technologies for working the soil. This does not mean that these very different technologies should be considered "equal." On the contrary, we must look at technologies from many perspectives in order to discern and differentiate their true natures and the consequences of their use.

B. Choice of Research Location

Research was conducted in the *municipio* of Santa Cruz, located in the *departamento* of Quiché, Guatemala. A *municipio* is a Guatemalan political unit similar to a U.S. county, and a *departamento* is similar to a U.S. state. This site was chosen because of its long history of conflict, including a recent thirty-six year civil war, as well as the important role played by agriculture in the local economy and the livelihood of its residents. A detailed description of the area is included in Chapter III.

C. The Questionnaire

A number of methods for gathering data related to the topic of this research are available. Among them are surveys, the use of focus groups, interviews with key persons within communities, and the use of secondary data. Recognizing that none of these approaches is perfect, a survey was selected as the method of gathering data. The survey format was chosen to allow for the collection of data from a large number of respondents from a given geographic area over a short time period. Face to face interviews permit lengthy questionnaires and allow the participation of illiterate persons, both of which were concerns for this research. The survey format also allowed for

private conversations about sensitive subjects such as the civil war. Police records were considered as a source of complementary, secondary data, but were not pursued because of concerns regarding their reliability and accessibility.

The research questionnaire combined seventy-one questions covering the following topics: demographics such as age, gender, and education; agricultural practices; agricultural technology use; interaction between agricultural practices and conflict; perceptions of conflict; and perceptions of crime. A summary of the questions is provided at the end of this section and a complete version of the questionnaire is included in the appendix.

An initial questionnaire was developed in Spanish and used to conduct five interviews in July, 2006. Based on the results, questions were revised, added, and removed before finalizing the questionnaire for use in August, 2006. Many questions were open-ended, leaving respondents freedom to interpret the questions. Follow up questions were permitted. All questions were asked orally and the interviewer recorded answers by hand. Oral interviews rather than written surveys were conducted because most respondents were illiterate. Interviews were not tape-recorded in order to preserve the respondents' anonymity.

For questions that had a limited, discrete set of probable answers, answers were printed on the questionnaire form. This allowed the interviewers to check the corresponding box, rather than write every answer by hand. However, answers were not limited to the pre-printed choices -- interviewees were allowed to respond in the way they felt most appropriate. If the interviewee's answer was not listed, the interviewer

recorded it in the space provided. The duration of the interviews ranged from less than half an hour to two hours, according to the depth with which the person responded to the open-ended questions.

The first twenty-two questions were demographic in nature. Among the data recorded were: community, gender, age group, marital status, education, family size, native language, religion, occupation, income, materials used in home construction, technology use, and amount of land owned.

These were followed by questions that asked for the respondents' perceptions of their land's productivity and detailed descriptions of their agricultural practices, recorded on a plot-by-plot basis. The record of the agricultural practices focused on the technologies used and the processes undertaken at different periods, from land preparation to harvest and storage.

The number of domestic animals owned by the family was recorded. For each type of animal, the technologies used in the care of the animal were recorded. For example, vaccination and a chicken house were two technologies commonly used in raising chickens.

After detailed explanations of the raising of crops and the care of domestic animals, respondents were asked several questions regarding the changes that had occurred in their farming practices, as well as the communities' reactions to these changes. These questions were followed by questions that address the issue of conflict more directly, explicitly asking about possible connections between conflict and the

agricultural changes that occurred. Then, respondents were asked to compare past and future conflict levels with the current level of conflict.

Next came a series of questions asking the respondents to compare their use of technology with their neighbors and surrounding communities. The series was followed by questions relating differential technology use with conflict. Questions were also asked to determine the families' access to credit, ownership of tools, and access to water.

Question fifty-eight began a series of questions specifically addressing the Guatemalan civil war and its impact upon agriculture. This was followed by questions that addressed the reaction of people to new technologies and the perception of crime. Finally, the survey concluded by giving the respondent the opportunity to ask questions and make further comments.

D. Data Collection

In addition to the five preliminary interviews, eighty-two interviews were conducted during a two-week period in August 2006. With one exception, all of the interviews were conducted in the city of Santa Cruz or in the following communities of the Santa Cruz *municipio*: Choacaman, Chicabracan I, Chicabracan II, Xatinap, Pacaja II, and Pachó Lemoa. Some communities are reachable by public microbuses and a short walk, but others are served by public transportation only twice a week, on market days. To reach these communities on a non-market day, a pickup and driver may be hired in the town square. The only other alternative is to walk for up to an hour and a half from the nearest bus stop.

Three local interviewers, bilingual in Maya K'iche' and Spanish, were employed to conduct research. One foreign interviewer (the author) was bilingual in English and Spanish. Due to the suspicion with which foreigners are currently viewed as a result of mining concessions recently granted by the government, it would have been dangerous and unproductive to enter communities and ask questions about land use and ownership, even if accompanied by native speakers from a neighboring village. For that reason, the research team entered several communities by accompanying the coordinators of a women's microcredit program run by the grassroots non-governmental organization Acción Cultural Guatemalteca (ACG). After being introduced by the microcredit coordinators, the team began interviewing women on an individual basis. On one occasion, the team entered a village with a group of ACG coordinators during the celebration of a development project. This provided the opportunity to interview men and women who were not involved with the microcredit program. On other occasions, interviews were conducted at the ACG offices in Santa Cruz del Quiché.

Language issues were a special challenge. Respondents who did not speak Spanish were interviewed in K'iche' and their answers were recorded in Spanish. Translation from Spanish to K'iche' was difficult for the more abstract concepts covered by the interview, but translation was not a great concern for more concrete concepts such as those involving farming practices. There were also challenges with language use for interviews conducted in Spanish. These challenges were partly caused by the low level of education and limited vocabulary of many of the respondents. Another difficulty was that one of the interviewers (the author) was not from the area where the interviews were

conducted and was unfamiliar with some local expressions and words. Occasional misunderstandings required the interviewers to diverge from the questionnaire and attempt to rephrase questions in language that was more easily understandable by the interviewees.

Four interviewees referred to agriculture outside of the Santa Cruz *municipio*, and these were removed from the dataset. Two other interviews were also removed from the dataset because they were poorly administered by the interviewer. Of the eighty-seven interviews conducted, eighty-one were included in the final dataset.

E. Statistical Methods

A combination of quantitative and qualitative methods were used to analyze the responses to the survey. Many direct quotations appear throughout this document, chosen by the author to make a particular point. The quantitative methods used are described in more detail in this section. The particular ways in which the described methods are applied are discussed in more detail in Chapter IV.

One of the challenges presented by this research was the development of indices for the perception of conflict and crime. If one is interested in knowing how much conflict or crime another person perceives there to be, it is certainly possible to ask that person directly. One of the survey questions (#70) was just such a direct question. However, such a question suffers from being rather abstract in nature. How much crime is "little" crime, or "some" crime, or "lots" of crime? Conflict, being less concrete than crime, is even more difficult to judge. Imagine a stranger appearing and asking, "How

much conflict is there in your neighborhood?" These difficulties led the questionnaire to be developed with numerous questions that addressed perception of crime and conflict, each of which approached the topic from a different angle. The questions sought to elicit perceptions of crime or conflict in concrete situations, or for specific issues. The responses to these questions were then combined to form two separate indices, one each for the perception of conflict and crime. A description of the process used to create the indices follows.

Questions relating to conflict were grouped into one of four categories, according to their topic. The first category, "technology type," included questions 35, 46, 48, and 67. These questions addressed the issue of conflict caused by different agricultural practices across time or between people. The second category, "development organizations," included one question, number 49. This question asked if there were conflicts between people who participated in ACG (or other development organizations) and those who did not. The third category, "resources," included questions 56 and 57. These questions asked if there were local disagreements or conflicts over the use of land and water. The fourth category, "language," included questions 63 and 64. This pair of questions asked if there previously had been, or currently existed conflicts between people who spoke different languages.

All questions were to be answered in a yes/no format. The answers were coded as one (yes) or zero (no). Next, the means of the answers for each of the four groups were calculated, using as many responses as were available. That is to say, if only one question in the group was answered, that response was used as the mean. If multiple

questions were answered, the mean was calculated from all of the usable responses. Forty-nine of the eighty-one respondents had responded to at least one question in each category.

Rather than calculate a simple average, principal components analysis (PCA) was used to calculate the principal component for the remaining forty-nine cases. PCA is a method useful for simplifying multidimensional data so that patterns may be discerned and similarities and differences may be highlighted (Smith, 2002). Basically, it is a "variance maximizing (varimax) rotation of the original variable space" (StatSoft, 2003). PCA is commonly used to reduce a large number of variables to a more manageable number, as was done in Donald et al. (2001) and Griffith et al. (2000).

Calculating the principal component from the data was accomplished by following a series of five steps as described by Smith (2002). First, the values for the four conflict categories were arranged in a 49 x 4 matrix, which shall be referred to as "*A*." Second, the mean of each column was calculated and subtracted from the values for that column, yielding matrix "*B*." Next, the 4 x 4 covariance matrix, "*C*," was calculated based upon *B*. The fourth step required calculating the eigenvectors and their accompanying eigenvalues for the covariance matrix, yielding 4 x 4 matrix "*D*." At this stage, the principal component (eigenvector) was identified by having the highest eigenvalue (Table 1).

The purpose of using principal components analysis for this research was to reduce the conflict variables to a single variable with maximum variance, therefore all components except the principal component were discarded (Table 2). Finally, the new

dataset was created by multiplying the transpose of the principal component on the left side of the transposed original dataset *A*.

Table 1. Total variance explained, conflict index

Component	Eigenvalues		
	Total	% of Variance	Cumulative %
1	1.803	45.1	45.1
2	0.877	21.9	67.0
3	0.795	19.9	86.9
4	0.525	13.1	100.0

Table 2. Principal component values, conflict index

Variable	Principal Component
Conflict Over Technology Type	0.535
Conflict Over Development Organization	0.803
Conflict Over Natural Resources	0.684
Conflict Over Language	0.635

One additional transformation was applied to the data on conflict. The final dataset was divided by 2.66, the maximum possible value that any one of its items could take. This had the effect of scaling all data to the range from zero to one. The scaled data became the conflict index that was used as the dependent variable in a logistic regression. The logistic model is explained in more detail in Chapter IV. The PCA

conflict index was found to be closely correlated with a simple average of the four conflict question categories (0.98).

Creation of the crime index proceeded similarly to the process described above. Questions 68, 69, and 70 were the only questions relating directly to crime. Possible answers to questions 68 and 69 were "yes" or "no," coded as: one (yes) or zero (no). Question 70 had four possible answers and was coded on a scale from zero to three. A principal components matrix was extracted from these three variables for the seventy-six cases that had responded to all three questions, using the same procedure that was described for the conflict index (Table 3). The principle component (Table 4) was multiplied by the original data matrix to yield a single crime index for each case. The crime index for each case was divided by the maximum possible value, 3.53, having the effect of scaling the data to the range from zero to one. The PCA crime index was also found to be closely correlated with a simple average of the responses to the three crime-related questions (0.99).

Table 3. Total variance explained, crime index

	Eigenvalues		
Component	Total	% of Variance	Cumulative %
1	1.550	51.7	51.7
2	.763	25.4	77.1
3	.687	22.9	100

Table 4. Principal component values, crime index

Variable	Principal Component
Danger_Woman	.744
Danger_Man	.726
Crime Assessment	.685

The logit model was used to estimate two relationships which will be described in more detail in Chapter IV. Logit is a binary response model of the following form

$$P(y = 1 \mid x) = G(\beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k)$$

where $z = \beta_0 + \beta_1 x_1 + \ldots + \beta_k x_k$ and G is restricted to values between 0 and 1, such that $0 < G(z) < 1$ for all real numbers z. $G(z)$ is the probability that y will occur, given x. The function used for the logit model takes the following form:

$$G(z) = \exp(z)/[1 + \exp(z)]$$

This function guarantees that all values will be between 0 and 1 (Wooldridge, 2006). Logistic models whose dependent variables were not binary, were also used to estimate relationships. The dependent variables in these cases were the crime and conflict indices described previously. The indices took on values between 0 and 1, but unlike the binary dependent variable in a logit model, the indices were continuous. Despite this difference, the same logistic equation G, described above, can be used for both models.

CHAPTER III

REGIONAL HISTORY AND GEOGRAPHY

A. From Pre-Conquest to Early Independence

Guatemala is intimately acquainted with agriculture-related conflict, from post-conquest struggles over land, such as that by the Kaqchiqel in 1526 (Herrera, 1966), to the seizing of church and indigenous lands under Justo Rufino Barrios in the late 19th century (Black and Needler, 1983), to the land reforms of the 1950's, their subsequent reversal, and the 36-year civil war that was fought in large part because of extreme rural inequalities. Recently, The Commission for Historical Clarification (CEH) concluded that "the structure and nature of economic, cultural and social relations in Guatemala are marked by profound exclusion, antagonism and conflict – a reflection of its colonial history" (Tomuschat, et al., 1999, Conclusion 1). Because of the central role played by agriculture in the culture and economy of the entire Central American region from colonial times until the present day, agriculture has been inevitably tied to the many conflicts the region has suffered.

Before the Spanish conquest, Mayan populations in the highlands may have reached the land's carrying capacity and sparked conflict between different kingdoms (Handy, 1984). During colonial times, indigenous rebellions were frequent (Perez-Brignoli, 1989; Handy, 1984) and have continued into recent times. Land continued to be expropriated from indigenous subsistence farmers after Guatemalan independence, and because the ruling class's profits were based upon agricultural production, the ruling classes needed to control labor. This led to a society "ruled by terror, violence, and

coercion" (Handy, 1984, p. 33). Small-scale production of cochineal, a dye, in the first half of the 19th century provided income for peasants and may have had a pacifying effect, but in the 1850s, cochineal production declined and Guatemala began searching for a new export crop. After a short experiment with cotton, coffee proved to be the answer. Unlike cochineal, coffee was suitable for growth on large plantations – this led to the further expropriation of indigenous lands (Handy, 1984). In 1877 a new law allowed for the sale of local government and communal lands; on other occasions, indigenous lands believed to be suitable for coffee production were seized with or without compensation (Black and Needler, 1983). Indigenous labor was also exploited through the use of debt peonage for work on plantations and forced labor on public projects (Black and Needler, 1983). One of the results of the land expropriations and forced servitude was an unsuccessful revolt that began in the highlands in 1875 (Handy, 1984). The revolt was put down, and coffee continues to be an important export to this day.

B. Bananas and Conflict

At the end of the 19th century, the United Fruit company began acquiring land and power in Central America, where it produced bananas for export to the United States-- in following decades United Fruit would play a key role in Guatemalan politics and the disastrous course of Guatemalan history. In 1904, Guatemalan dictator Manuel Estrada Cabrera "granted the company a ninety-nine year concession to operate and finish constructing that country's principal rail line...Through such concessions, United

Fruit by 1930 had operating capital of $215 million and owned sprawling properties not only on the three Caribbean islands [Jamaica, Cuba, and Santo Domingo] ... but also in Panama, Honduras, Nicaragua, Colombia--and in its largest domain, Guatemala" (Schlesinger and Kinzer, 2005, p. 67). At the beginning of the 20th century, American Samuel Zemurray expanded his banana business by funding a successful revolution in Honduras. The new president granted Zemurray generous concessions to purchase land, build a railroad to the coast, protection from tax increases, and duty-free importation of building materials. Zemurray was eventually bought out by United Fruit in exchange for United Fruit stock. In addition to becoming the company's largest shareholder, he was named managing director in 1933. In the 1930's, United Fruit was granted further concessions from a Guatemalan dictator, General Jorge Ubico (Schlesinger and Kinzer, 2005). This time, the concessions included exemptions "from import duties on raw materials and from local property taxes" (Black and Needler, 1983). Ubico insisted that laborers not be paid more than 50 cents per day "in order to keep other Guatemalan workers from demanding better pay" (Schlesinger and Kinzer, 2005, p. 70).

According to Perez-Brignoli (1989), the development of an agricultural exporting economy in 19th and 20th century Central America resulted in:

> (1) an enormous concentration of power in the hands of landowners, (2) a tendency to expropriate land from the Indian peasants thereby imposing a distribution of the nation's lands that the peasants never accepted as legitimate, (3) a high degree of violence required for the functioning of the new economic and political structures, and (4) a strong class polarization along with structural weakness in the emerging middle sectors. (Perez-Brignoli, 1989, p. 114).

In a climate of polarization and Cold-war ideology, the progressive Juan José Arévalo became president through legitimate elections in 1945. United Fruit began reporting that its labor disputes were the result of communist intrigues and harassment from the Guatemalan government (Schlesinger and Kinzer, 2005). Jacobo Arbenz succeeded Arévalo as president in 1950 and formed plans to compete with United Fruit's railroad and electricity monopolies, as well as beginning agricultural reforms. The Agrarian Reform Act of 1952 was aimed at altering the imbalance of landholding in the country by forcibly purchasing privately held land, especially fallow land, and distributing it to peasants (Perez-Brignoli, 1989). United Fruit, the major target of the new legislation, held 550,000 acres of land, 85% of which was fallow. The Guatemalan government offered bonds worth $627,572 to United Fruit; this was the value of the land based upon the company's tax declaration. United Fruit responded by claiming that the real value of the land was $15,854,849. Further expropriations increased the government's offer by approximately $500,000 (Schlesinger and Kinzer, 2005). This threat to United Fruit and Guatemala's other large landowners led to even greater cries of "communism" and calls for U.S. intervention. In 1954, the CIA organized an invasion force, and with the Guatemalan army refusing to defend his government, Arbenz went into exile in Mexico.

Arbenz was followed by a series of corrupt and violent military dictators over several decades, the first of which was Castillo Armas, who reversed the reforms that Arévalo and Arbenz had pushed forward. The extreme inequalities within Guatemalan society, especially in the countryside, had not been resolved and gave birth to a civil war

that would last for 36 years. To make matters worse, prices rose faster than wages for rural laborers, leaving them worse off in 1982 than in 1950 (Handy, 1984).

C. Recent Conflict

Structural injustice and "the reluctance to promote substantive reforms that could have reduced structural conflicts" are among the "underlying factors which determined the origin and subsequent outbreak of the armed confrontation" (Tomuschat, et al., 1999, Conclusions 12). During the 1960s and 70s, a process of militarization began, culminating in the Army's assumption of "almost absolute power for half a decade during the 1980s" (Tomuschat, et al., 1999, Conclusions 36). Producer and marketing cooperatives emerged as new forms of agricultural organization in the 1960's and 70's, but the dominate powers in Guatemala saw this independent action as a threat and moved to squelch it. Community leaders were killed and cooperatives were destroyed (Handy, 1984), often in the name of the National Security Doctrine and anti-communism (Tomuschat, et al., 1999, Conclusions 83).

The war was characterized by brutal repression of those identified as opponents through the use of assassinations, "disappearances," torture, and wholesale massacre of indigenous farming communities located in areas where the guerrillas were active. Among the victims were "men, women and children of all social strata: workers, professionals, church members, politicians, peasants, students and academics; in ethnic terms, the vast majority were Mayans" (Tomuschat, et al., 1999, Conclusions 15). State-planned massacres and scorched-earth operations "resulted in the complete

extermination of many Mayan communities, along with their homes, cattle, crops and other elements essential to survival" (Tomuschat, et al., 1999, Conclusions 86). The department of Quiché, where the data for this research was collected, was one of the hardest-hit areas. In his book "Massacres in the Jungle," anthropologist Ricardo Falla documents in detail a number of massacres that occurred in the Ixcán, the northernmost part of the Quiché *departamento* (Falla, 1994). The CEH recorded 344 massacres in Quiché, more than the rest of the country combined (Tomuschat, et al., 1999). The CEH also estimated that country-wide, "the number of persons killed or disappeared as a result of the fratricidal confrontation reached a total of over 200,000" (Tomuschat, et al., 1999, Conclusions 1) and reports that estimates of internally and externally displaced persons "vary from 500,000 to a million and a half people in the most intense period from 1981 to 1983" (Conclusions 66). Ninety-three percent of the human rights violations and acts of violence registered with the CEH were perpetrated by the Guatemalan state (Tomuschat, et al., 1999). The nature of the violence led the CEH to conclude that the Guatemalan state committed genocide (Tomuschat, et al., 1999, Conclusions 124).

D. Santa Cruz del Quiché

1. Geography

As described in the Chapter II, all but one of the interviews were conducted in and around Santa Cruz, the capital city of the Quiché *departamento* of Guatemala. The *municipio* of Santa Cruz del Quiché includes the city of the same name, as well as the

surrounding villages and rural area. The city is located 2021 meters above sea level, at latitude 15° 02' 12" and longitude 91° 07' 00" (Guatemala, Dirección General de Cartografía, 1962). According to Simmons et al.'s (1959) extensive study on the soils of Guatemala, the Santa Cruz del Quiché region is characterized as sandy clay loam with good drainage, a topsoil depth of 20 cm, and a clay subsoil that is plastic when wet and hard when dry. The soil has average fertility and capacity to maintain moisture. The most common slopes range from 10-20 degrees, making erosion a serious danger. Simmons et al. listed two "special problems" for the management of this soil- "maintaining organic material" and "combating erosion."

Traveling to Santa Cruz from Guatemala City requires several hours by public transportation or slightly less in a private vehicle. The region is mountainous, with narrow roads that wind their way past Chichicastenango, an indigenous town famous for its textiles and artisans market. Though Chichicastenango is only 18 km from Santa Cruz, the journey takes approximately 30 minutes because of the nature of the road, which includes a number of 180 degrees cutbacks.

2. History of Santa Cruz

Pre-Columbian Guatemalan agriculture included maize, beans, chili peppers, and squash. It was so productive that population densities in Guatemala may have reached contemporary levels (Perez-Brignoli, 1989), approximately 400,000 for the Quiché *departamento* and over 35,000 in Santa Cruz (Guatemala, Instituto Nacional de Estadística, 1994), which was once the capital of the K'iche' kingdom. The K'iche' were a small warrior group that most likely invaded the region in the early 13th century

and later expanded their power to dominate "much of the Guatemalan highlands, piedmont, and coast" (Fox, 1976). Carmack (1976) describes some of the parallels between the Aztecs of Mexico and the K'iche' of Utatlan:

> they both experienced a meteoric rise to power; much of their power derived from great military conquests; they protected their political center with impregnable defenses; tributary colonies were established in order to support the ruling lords; populations near the capital were socialized into easily controlled administrative units; complex levels of stratification emerged, including middle sectors; history was secularized, filled with hero kings and conquerors; human sacrifice to patron gods on a grand scale was instituted; war captives became a large rural labor force, complementing the services of slaves; populations became urbanized, in terms of nucleation, occupational specialization, and large numbers; an elite art style was formalized and used to support authority.

Though the Spanish destroyed the ancient city of Utatlan, also known as Gumarcaj, present-day Santa Cruz rests on the site of the pre-conquest city's ruins. Many K'iche' continue to visit the ruins on the outskirts of Santa Cruz to perform traditional Mayan religious ceremonies.

Simmons, Tarano, and Pinto's comments on Santa Cruz, made in 1959, remain an accurate description of present day agriculture: most production is the subsistence cultivation of maize and beans on small plots, work is done with hand tools, much of the cultivated area is severely eroded, and productivity could be increased. Simmons et al. also suggested that the best use of land would be for the production of livestock and animal products, taking care not to overgraze, causing further erosion. In addition, they commented on the size of familial landholdings, stating that 3.5 hectares, much more than most current residents of Santa Cruz own, were inadequate to support a family of five, smaller than most families in Santa Cruz today. Ricardo Falla reported in 1972 that

the majority of residents' livelihoods in neighboring San Antonio Ilotenango came from their intercropped harvests consisting primarily of maize, beans, lima beans, and squash. A large percentage, probably more than ten percent, of the population went to the coast for at least one month per year to work as wage laborers on coffee and cotton plantations. At the end of the nineteenth century, San Antonio was known for its wool production, but by the 1970's only a few small flocks remained, resulting in a lack of natural fertilizer (Falla, 1972).

3. Modern Santa Cruz

In 2002, the population of the *municipio* was 62,369, of which 20,870 were urban residents and the remaining 41,499 lived in rural areas (Guatemala, Instituto Nacional de Estadística, 2003a). More than 82% (51,279) of the *municipio*'s residents identify themselves as Mayan (Guatemala, Instituto Nacional de Estadística, 2003a), the majority of whom speak K'iche' as their first language. Few tourists venture all the way to Santa Cruz; consequently, its market and businesses cater to the local population, unlike nearby Chichicastenango. Santa Cruz includes many of the signs of a modern city, such as ATM machines, a mall, and a movie theatre, while maintaining its indigenous heritage; most of the women walking around town still wear the patterned skirt traditional in the area. Like many Latin American cities, Santa Cruz suffers from air pollution caused by dust and the exhaust from old vehicles.

4. The Communities of Santa Cruz

Most of the interviews for this study were conducted in the communities surrounding Santa Cruz. In contrast to the city, the nearby hills offer breathtaking views

of green forests, corn fields, and deep ravines. Occasionally, deep scars mark the tremendous loss of soil caused by erosion of the steep slopes. In this land surrounding the city are many small communities of indigenous farmers. Despite the region's dense population, homes are dispersed throughout the countryside, rather than being clustered around village centers. Much of the rural population has little formal education and remains illiterate. While most men speak both Spanish and K'iche', many women cannot speak Spanish because they did not attend school as children.

CHAPTER IV

CONFLICT AND AGRICULTURE

Chapter IV is divided into six sections (A through F), each of which explores a different aspect of the connection between agriculture and conflict. The first five sections deal with the time periods before and during conflict, and are ordered to proceed from the most intuitive relationships between agriculture and conflict, to the least intuitive. The chapter concludes with a final section that looks at post-conflict recovery options. Each of the six sections is divided into six parts: a literature review, a conceptual model, hypotheses specific to Santa Cruz del Quiché, methods of testing the specific hypotheses, results, and discussion.

A. Conflict's Impact on Agriculture

> For all conflicts, as for all natural disasters, the most important impacts are the suffering, injury and death of men, women and children. The losses in output, means of production and infrastructure seem insignificant in comparison. Yet these material losses are also important, for they undermine the ability of conflict survivors to subsist and recover. This is most obvious in agriculture, where the destruction of crops and livestock results, at best, in reduced food security and, at worst, in famine and death. Indeed, in many cases, deaths resulting indirectly from conflict (through famine, for example) exceed deaths from direct violence. (United Nations, Food and Agriculture Organization, 2000, "Conflicts, Agriculture and Food Security")

1. Literature Review

Agriculture has long been a target of warfare. "Ravaging of cropland was central to warfare of most societies of the past," from the Egyptian pharaoh Kamose in his conquest of the Hyksos to the Assyrian king Sargon's destruction of his enemy's fields and fruit trees (Hanson, 1998), to the Spartans, who timed their attacks upon Athens to

occur just before the harvest (de Soysa and Gleditsch, 1999). Modern examples also abound. Take, for example, the "scorched earth" tactics carried out by General William Sherman in the United States' civil war from 1861-1865 and by the Guatemalan state during the 1980's.

Whether the destruction is intentional or not, war can devastate agriculture, as recently occurred in Angola, where "agricultural output fell to less than 10 percent of its pre-war level" (Addison, 2005, p. 2). During the decades of war in Afghanistan, much of the country's irrigation works have been damaged (United Nations, FAO/AGL, 2005) and the increase in poppy cultivation (United Nations Office on Drugs and Crime, 2004; United Nations, 2006) has impacted society not only through the lost production of agricultural "goods," but also by an increase in the production of agricultural "bads." In Iraq, agricultural development was used as a pretext and hydro-engineering was used as a weapon to accomplish the destruction of 90% of the marshlands that were home to the Ma'dan people, commonly known as the Marsh Arabs. The environmental destruction devastated the local productivity and combined with military operations to displace over 100,000 people, from a population estimated at 250,000 in 1991 (Human Rights Watch, 2003). During Guatemala's recent civil war, thousands of widowed women were left to provide for their families, "often with no material resources after the scorched earth policies [carried out by the Guatemalan state] resulted in the destruction of their homes and crops" (Tomuschat, et al., 1999, Conclusions 29). So, although the technology of destruction has "advanced" far beyond the limited weapons available in the pharaohs' days, destruction of agriculture continues to be a strategy and consequence of warfare.

Large-scale conflict often impacts agricultural production unintentionally. De Soysa and Gleditsch (1999) list a number of examples where agriculture was either disrupted unintentionally or the effects of intentional destruction lasted much longer than the perpetrators had intended. Among them are the following: French and Belgian agriculture was severely damaged by destruction to crop lands during World War I; in 1938, Chinese forces dynamited a dyke on the Yellow River and the resulting floodwaters carried off the crops and topsoil from millions of hectares; during the Vietnam War, the U.S. sprayed anti-plant agents and planted mines that continue to make agriculture a dangerous activity in Vietnam (de Soysa and Gleditsch, 1999). In Guatemala's recent civil war, destruction of agriculture was meant not only to weaken the economic and social support of the guerillas, "but above all, to destroy the cultural values that ensured cohesion and collective action in Mayan communities" (Tomuschat, et al., 1999, Conclusions 32). Agriculture was a target because of corn's symbolic importance for the Mayan culture (Tomuschat, et al., 1999).

Indirect impacts of war include the breakdown of markets for agricultural production, the loss of seed stock, and the loss of the human capital that occurs when adult farmers are killed before they can pass on their agricultural knowledge to the next generation (de Soysa and Gleditsch, 1999). In northern Uganda, the ongoing conflict has disrupted cattle markets and spelled disaster for pastoral farmers (United Nations Development Program, 2005). Guatemala lost "professionals, academics and researchers...[creating] a vacuum during a specific period of political and cultural history...[and resulting] in the loss of an important part of the pedagogic and intellectual

capacity to educate several future generations in Guatemala" (Tomuschat, et al., 1999, Conclusions 58). Among those who were lost during the war were many indigenous farmers who were unable to pass on their knowledge of farming practices to the next generation.

2. Conceptual Model

The purpose of this section is to develop a general conceptual model for the way in which conflict may disrupt agriculture. A better understanding of how this occurs will improve our ability to use technology as prevention, relief, and cure of war's destruction. The following section builds upon the general conceptual model by formulating hypotheses specific to Santa Cruz.

Figure 1 displays the way in which conflict may disrupt agriculture, and the consequences that may result. The beige colored boxes indicate starting points – the direct impacts of conflict. White and red boxes are intermediate and end results. Some of the direct impacts, such as "Destruction of infrastructure and danger limit travel" are much more likely to occur when there is widespread conflict than when the conflict is limited to a community or family disagreement. Others, such as "Farmers killed" or "Intentional and unintentional destruction of agriculture", are likely in both large and small-scale conflict situations, though the magnitude of the disruption may differ.

"Dangerous to work in fields" is one of the most direct impacts. The risk to one's life associated with working in fields, away from the safety of the home, increases the marginal costs of production. When farmers are killed as a result of conflict, their death represents a loss of expert knowledge, or technology, that must be replaced.

Farmers' deaths prevent them from passing on general agricultural knowledge to their children, but they also prevent farmers from handing down location-specific knowledge (technology) of land that may have been farmed by the same family for generations. General agricultural knowledge may be gathered, over time, from one's neighbors, but the location-specific knowledge will take longer to recuperate. The loss of general and location-specific knowledge increases the marginal costs of production.

The destruction of infrastructure and the insecurity brought about by a conflict situation limit travel, both by farmers and by those who supply them with inputs and purchase their outputs. On the supply side, this reduces the marketing potential for agricultural outputs, and reduces the supply of agricultural inputs. Both factors increase the marginal costs of production. On the demand side, limited mobility by consumers reduces consumption and shifts the demand curve downward

Also causing the demand curve to shift downward is the destruction of agriculture, whether intentional or unintentional. This effect occurs indirectly, through the impact of reducing wealth. Also reducing wealth is the loss of on-farm and off-farm employment opportunities caused by the disruption. The direct destruction of agriculture and its means of production, including standing crops, animals, and tools, increases the marginal costs of production as well.

As indicated by Figure 1, the aforementioned factors impact both the supply and demand sides, by increasing the marginal costs of production and decreasing demand. The net result is a reduction of equilibrium production.

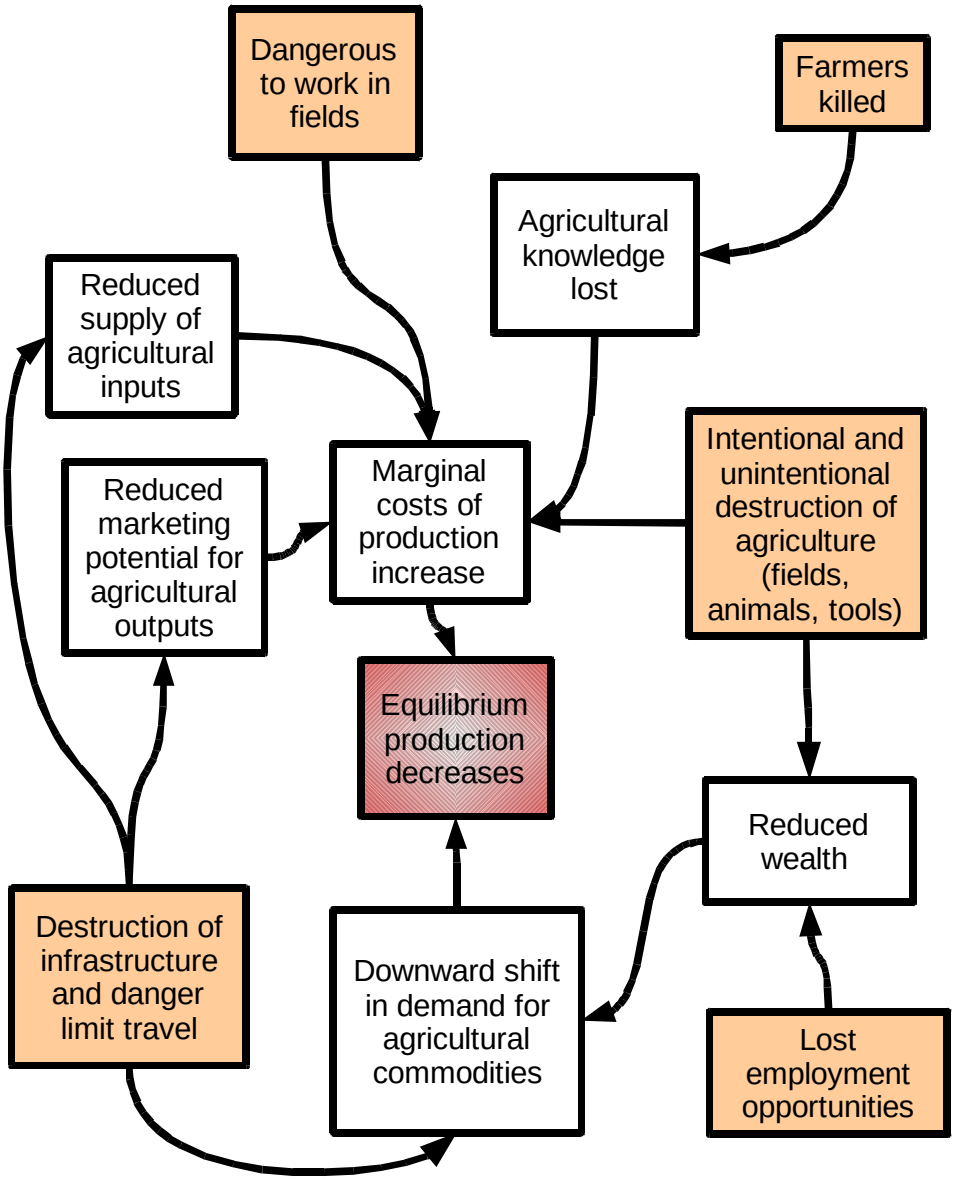

Figure 1. Conflict's impact on agriculture

3. Conflict's Impact on Guatemalan Agriculture

The Guatemalan Commission for Historical Clarification collected 669 cases of massacres that occurred during Guatemala's thirty-six year civil war. More of these

occurred in the Quiché *departamento* than in the rest of the country combined (Tomuschat, et al., 1999). One of several expected consequences of massacres, assassinations, and the general climate of fear is a breakdown in the functioning of markets (United Nations, Food and Agriculture Organization, 2000). This relationship is illustrated in Figure 1 by the boxes "Reduced supply of agricultural inputs" and "Reduced marketing potential for agricultural outputs." A second expected consequence of the large number of lives lost, also represented in Figure 1, is that much social capital, in the form of farmer knowledge, was lost. These expectations led to formation of the hypotheses H_{0A}*: The civil war caused a breakdown of Santa Cruz del Quiché markets,* and H_{0B}*: The civil war caused a loss of farmer knowledge in Santa Cruz del Quiché*.

4. Methods

Interview questions 58 through 60 (Appendix A & B) asked participants if they modified their agricultural practices during the civil war, how their agricultural practices were modified during the war, what agricultural difficulties they faced during the war, and how they responded to these difficulties. Each participant's answers to the questions were classified in two ways. The first manner of classification included twelve non-exclusive categories: Crops destroyed, Difficult to work, Death in family, Did not have own land, Difficult to buy inputs/sell outputs, Animals died, Sold animals, Fear of losing a family member, Emigrated, Modified crops grown, Other, and No problem. The answers given by a respondent were included in more than one category, if applicable. The number and percentage of respondents who identified each of the difficulties above were calculated and reported. In order to evaluate H_{0A}, the percentage of respondents

who reported "Difficult to buy inputs/sell outputs" was examined. Individual responses are also reported for further illustration. Without measurements of farmer knowledge from before and after the war, it is not possible to directly measure the gain or loss of agricultural knowledge among farmers. For that reason, a proxy was used to evaluate H_{0B}. An examination was made of the anecdotal stories provided by families who identified "Death in the family" as one of the agricultural difficulties faced during the civil war.

5. Results

Table 5 displays the quantitative results of testing H_{0A} and H_{0B}. Lack of market access was a more frequently reported problem than loss of a family member, though both were reported by small minorities of respondents.

Table 5. Selected impacts of the civil war upon farm families. Categorization of questions 58 – 60 (N = 81)

	Frequency	Percent
Difficult to buy inputs/sell outputs	5	6%
Death in family	3	4%

Qualitative evidence relating to the hypotheses was also gathered. Fear was frequently mentioned when interviewees spoke about the time of the civil war. Two respondents explicitly connected fear or danger to difficulties associated with market access: "We planted less land because one didn't know if they were going to live to eat, and there wasn't time, and you couldn't sell in the market because the army grabbed

people to integrate them into the army...." (#2)[1], "A person was afraid to go to the market. You couldn't buy anything...We didn't sell corn anymore" (#33), and another made the connection by implication: "In those days, you couldn't go to the market, or only for a little bit. You couldn't get the best seed, but after five or eight years you could work more peacefully" (#37). Other indications of market failure were price distortions: "We didn't have animals; we sold them cheap. We sold a whole chicken for fifty cents when a pound of chicken cost sixty cents" (#34) and "We used to plant a lot, now we plant very little. There were many setbacks, loss of life. Also because of the increase in price of fertilizer and we couldn't pay a hired hand" (#39).

In all three cases of death reported by interviewees, the victim was an adult male. Two of the respondents explicitly link the death with agricultural difficulties: "We were little. I was three years old when my father died. We didn't farm anymore. There were seven of us. My mom looked for work so she could feed us..." (#55) and "My father 'disappeared' when the maize was ready to harvest. We went to the capital and when we came back, the paramilitaries had taken the harvest. My mom cried. We didn't have seeds anymore. We bought seeds and planted, but it didn't produce maize. We planted, but my brothers were little and they didn't worry about the maize...We didn't have money to buy chemical fertilizer...We put dead leaves on it but it didn't produce" (#60). The third respondent who reported a family death, related the death to general difficulty

[1] The number in parentheses indicates the number of the interview particpant. The names of participants were not recorded, in order to protect their identity. Researchers made the best effot to record participants' responses literally, but when that was not possible, interviewers recorded abbreviated versions. All quotations from the interviews have been translated by the author from the written Spanish recorded by the interviewer.

rather than explicitly linking the death to agricultural problems: “My dad died. They killed him and we were left without a dad and we couldn’t do anything” (#63).

The Guatemalan civil war impacted agriculture in other ways not directly related to the two hypotheses. They were results of the climate of fear and insecurity, caused by incidents like this one: “We endured hunger because we didn’t want to go out. Helicopters went by. Many people were going to the fair in Panaxic, Quiché and they grabbed them and killed them like animals in the ravine” (#54). Section C, “Agricultural Technology and Survival Strategies During Conflict,” further explores the theme of response to the violence.

6. Discussion

While both problems -- the breakdown of the market and the loss of farmer knowledge -- most likely presented serious difficulties for those who were impacted, it is not clear from the data that they affected a large portion of the population, since neither was mentioned by more than 6% of survey respondents. The five people who reported difficulty in purchasing inputs or selling outputs came from four different villages. Possible explanations for this are that these five people were specifically targeted by security forces and for that reason had more cause to fear venturing into the market, or that these five people were among a few people who, previous to the outbreak of the conflict, had strong ties to the market and thus felt its loss most keenly. On the other hand, while it is possible that only five of the survey respondents experienced difficulties because they were unable to access the market, it is quite likely that these issues affected many people who did not explicitly mention them as difficulties. The fact that the five

people who reported difficulties relating to market access came from four different communities shows that accessing markets was not a problem limited to a small geographic area.

Three respondents, 4% of the total, reported a death in the family. For two of the three respondents, the death of the family member clearly represented lost knowledge as well as an important source of labor. Is this an accurate representation of the percentage of families who experienced a death or "disappearance?" For comparison, a rough calculation can be made of the proportion of Santa Cruz families who experienced a death as a result of the war. Of the deaths and disappearances recorded in the CIIDH database (Ball, 1999), approximately 1.9% occurred in the Santa Cruz *municipio*. The CEH (Tomuschat, et al., 1999) estimates that 200,000 people were killed or disappeared nationwide. Multiplying 200,000 by 1.9% gives an estimate of 3,800 victims in Santa Cruz, which is more than 10% of the 1981 population and approximately 6% of the population in the 2002 census (Guatemala, Instituto Nacional de Estadística, 2003a). If every one of the violations had affected a different household, the proportion of households affected would be approximately 57% of the 1981 population and 35% of the 2002 population, based on an average household size of 5.7 and 5.9 in 1981 and 2002, respectively (Guatemala, Instituto Nacional de Estadística, 2003a). Of course, many of the violations affected the same family, but based on the numbers above, it seems that the proportion of families that lost a family member must be higher than the 4% reported to this research team. There are several possible explanations: 1) The communities covered by the interviews had lower rates of war related deaths than other Santa Cruz

communities, or 2) The participants did not report all of the deaths to the research team, or 3) The family members of the victims also died, or moved away from the *municipio*, and therefore did not participate in this survey, or 4) A combination of the aforementioned factors occurred. The third possibility is almost certain to have occurred, while the second is also probable, since participants were not directly asked if they had lost family members, and many participants may have purposely withheld that information out of fear, or for other reasons.

The following sections will continue to explore the ways that agriculture is impacted by conflict, but before concluding this discussion, it is worth sharing one more quotation that came out of the interviews. When asked if the family had continued to farm in the same manner during the war (question 45), one middle-aged man replied, "The quality of planting wasn't the same. Ears of corn were big before, with more kernels. The armies burned the fields and they don't produce the same anymore" (#4). It may be difficult to believe that a corn field stopped producing as it had in the past due having been burnt, but this belief points to another important impact of the war—the psychological effect it had upon farmers. Fear was widespread, certainly having a great impact upon agriculture: "Everyone was scared. The army was hidden in the forest. A person couldn't work" (#41). Though the peace accords were signed more than ten years ago, and major fighting ended in Guatemala long before that, many people still fear returning to their homes and their fields.

The following are additional responses with relevance to the war's impact on Santa Cruz's farmers:

> The army killed many people. They blamed the indigenous people (#36).
>
> The violence is a little better now. The animals died. It's hard to recover that. They burned houses too. I was 12 or 10 years old. They killed people (#54).

B. Natural Resources as Sources of Conflict

> Severe environmental scarcities often contribute to major civil violence. Poor countries are more vulnerable to this violence, because large fractions of their populations depend for their day-to-day livelihoods on local renewable resources, such as cropland, forests, lakes and streams, and coastal fish stocks." (Homer-Dixon and Blitt, 1998, p. 15)

1. Literature Review

The role of natural resources in civil conflict has been much studied in recent years, but research has not yet provided conclusive results (Ross, 2004). History, on the other hand, provides numerous examples of conflict involving water resources, such as the Six Day War of 1967 and a 1989 incident in which Syrian jets shot down a Turkish survey plane. Other conflicts over water have occurred or are brewing in East Africa, the Middle East, southeast Asia, North America, and South America (Ward, 2002; Gleick, 1993). Land has often shown to be a source of conflict, as in the examples of the Philippines and Guatemala given below.

Thomas Homer-Dixon's (1994) research into the causal relationship between environmental scarcity and violent conflict links resource scarcity and/or degradation to

reduced agricultural and economic productivity that can result in conflict. His comment that "undue attention" is paid to "climate change and stratospheric ozone depletion" and assertion that the world is already suffering from "shortages of good land, water, forests, and fish" is supported by a number of case studies. In the Middle East, competition for water between Israeli and Palestinian farmers contributes to the long-lasting conflict in the region. The drying up and salinization of Palestinian wells has led many to abandon farming and look for work elsewhere. In the Philippines, population growth combined with scarcity of good farm land has led rural residents to move to the cities or open marginal land for farming. These fragile forest ecosystems are severely damaged by the switch to agricultural production; the result is "horrendous environmental damage, particularly water erosion, landslides, and changes in the hydrological cycle. This has set in motion a cycle of falling food production, the clearing of new plots, and further land degradation." This exacerbation of the economic situation contributed to the country suffering from "serious strife for many decades." In India, tensions are high and violent conflict has erupted on at least one occasion as a result of the large number of migrants from Bangladesh, where population pressure that causes reduced farm plot sizes combines with water use restrictions to create a "push" effect, moving people out of the country in search of better opportunities. The Shining Path guerrillas of Peru were based in an area of the country that had experienced increasing population and soil degradation which resulted in serious reductions in per-capita income and caloric intake. Haiti and South Africa have shown similar connections between environmental degradation, overpopulation, and conflict. Among the consequences of environmental

degradation is the weakening of states, which could lead them to fragment or become more authoritarian (Homer-Dixon, 1994).

Disputes over land have been closely related to violent conflict throughout Guatemala's history, as recounted in Chapter III of this document. Other documented conflicts include the construction of the Chixoy dam and the return of refugees to Huehuetenango. Several thousand Guatemalans were relocated by their government without just compensation for their land when a hydroelectric dam was built on the Chixoy river between 1975 and 1983. The ongoing civil war provided the opportunity to label as subversive the communities that resisted relocation, and by the time the dam waters began to rise in January 1983, ten communities of the Chixoy River Basin had been massacred, including 444 people in the community of Rio Negro (Rose Johnston, 2005). A smaller scale conflict is reported by César Castañeda (1998). During the war, residents of Unión Ojo de Agua, Huehuetenango, Guatemala, fled their homes to escape the violence. When they returned, they found that the army had brought settlers to occupy land adjacent to their own, and that an irrigation project, supported in part by the Taiwanese government, had taken their water for the use of the new settlers. When the situation was not resolved to their liking, the returning owners broke the irrigation pipe and took hostage an agricultural technician (Castañeda, 1998).

2. Conceptual Model

As population increases, the demand for scarce natural resources increases. This is especially true in rural areas, where land and water are means of production. Figure 2 represents the increase in rural population as a rightward shift of the demand curve. The

supply of agricultural land is very steep, almost vertical, in order to represent the limited possibility of bringing marginal lands into agricultural production. When demand increases, the price of land increases. Figure 2 illustrates the way in which the area under the demand curve, labeled "Unmet Demand," increases from "Unmet Demand 1" to "Unmet Demand 2." This unmet demand represents rural people who are landless or do not have sufficient land to provide for their families.

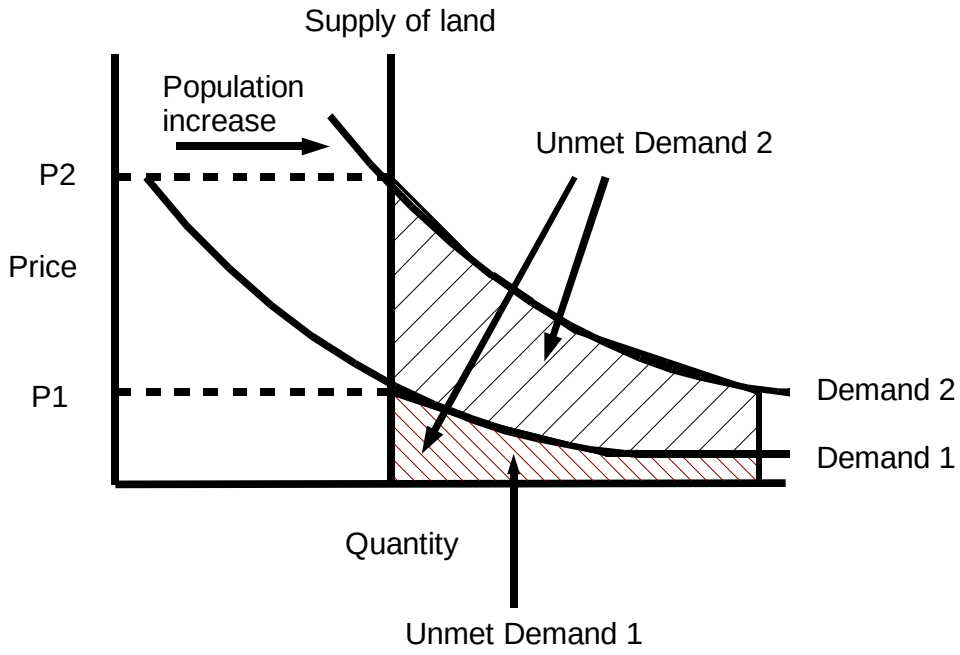

Figure 2. Population increase and resulting "unmet demand" for resources

What happens next depends upon two other factors (Figure 3). Alternative employment opportunities may act as a pressure release valve by providing a way for landless and "under-landed" farmers to support themselves and their families. If those opportunities are lacking, there will be a growing population of desperate people. Weak

institutions that are unable or unwilling to enforce property rights or create the climate for a just distribution of resources make it impossible to resolve resource conflicts through the judicial system.

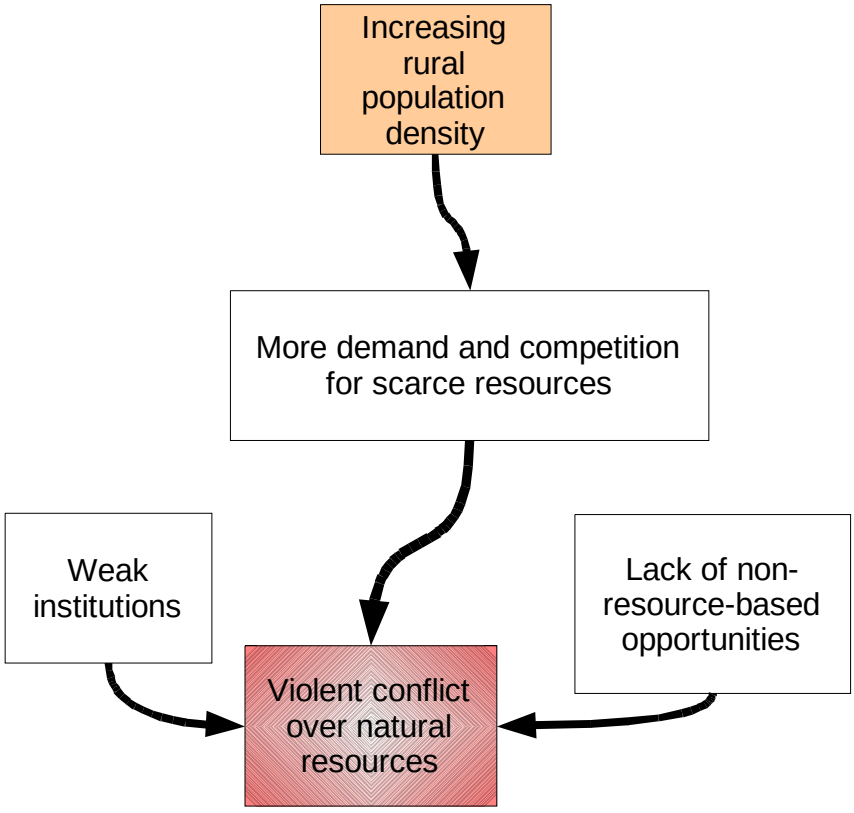

Figure 3. Natural resource conflict

3. Natural Resources Conflict in Guatemala

In Santa Cruz del Quiché, the high, increasing population density and the regional importance of agriculture led to increasing demand for both land and water resources, giving both the potential to spark local conflict. After being divided among numerous children for generations, parcels of land are not large enough to support families. Off-farm employment opportunities are limited, but Guatemala City and the

United States are able to relieve some of the social pressure by providing employment. The Guatemalan government has repeatedly shown itself unwilling to undertake major land reform, and the judicial system and police force are corrupt. Based on these conditions, two hypotheses are formed: H_{1A}*: Farmers of Santa Cruz del Quiché perceive that water is a source of conflict*, and H_{1B}*: Farmers of Santa Cruz del Quiché perceive that land is a source of conflict*.

4. Methods

Interview questions 56 and 57 are used to address the hypotheses H_{1A} and H_{1B}. The interview questions asked if there had been local conflicts or disagreements over the use of water and land. A "yes/no" answer was recorded, and if the respondent replied in the affirmative, the interviewer followed-up by asking what happened and how the conflict was resolved. The percentage of affirmative answers to each of these questions is reported, as well as selected responses that illustrate the particular conflict, or lack of conflict, that occurred.

5. Results

Table 6 presents the results of testing hypotheses H_{1A} and H_{1B}. There is some support for both hypotheses, albeit not overwhelming. Approximately one-third of respondents said that water use had been a source of disagreement or conflict. The percentage was higher in the communities of Xatinap I and San José Pachó Lemoa, where 42% (5 of 12 cases) and 46% (6 of 13 cases) of respondents answered in the affirmative.

Table 6. Perception that water and land are sources of conflict (N = 81)

		Frequency	Percent
Water Conflict Question 56	Yes	27	33%
	No	29	36%
	NA	25	31%
Land Conflict Question 57	Yes	8	10%
	No	53	65%
	NA	20	25%

Some of the respondents provided detail on water use issues in their communities. The following explain water regulation: "There's a water construction committee, and a maintenance one, too. So there's a work party, but some people don't go. If they don't go three times, they lose their right to water for two or three months" (#36); "Every ten years there is a potable water project. If you don't sign up, you don't have the right to the water of your father, or brother, etc. You have to get water from somewhere else. If you want to use the water from your family, the rest of the community will not be in agreement. The conflict remains at the level of discussions" (#2). Both of the aforementioned conflicts arose from the noncompliance of certain individuals with decisions made by their communities. In both cases, though, water remains at the heart of the issue. If there hadn't been competition for the scarce water resource, the community water regulation organizations would not have been formed, and the conflict brought about by noncompliance would not have arisen.

Many respondents maintained that the conflicts associated with water do not become violent. Instead, they remain at the level of "discussions." An exception to this was the community of Xatinap I, which actively protected its water from being taken for

other uses: “They wanted to take our water. We protested and the water stayed. When we went to protest, they said we were going to burn something, but we just protested. It’s our right” (#50), “They said they would take it somewhere else. The neighbors didn’t agree that they take the water. They got together and the water wasn’t taken elsewhere because they completed documents and protested” (#51).

For the most part, conflicts about water use had to do with home consumption rather than agricultural use. The lack of conflict over water for agricultural purposes is explainable, because during the rainy season there is ordinarily sufficient water for crops without resorting to irrigation, and during the dry season, water is in such short supply that irrigation is prohibited.

Only one-in-ten people said that land had been a source of conflict or disagreement. A typical response to this question was: “No, because everyone has their own land” (#211). Nevertheless, there were responses such as “Sometimes people move the boundary stone to increase their land” (#2), and at least one person identified the civil war as engendering land-based conflict because of the loss of land titles: “If you don’t have the legal papers? Parents buried the papers. They killed the parents. The people who were left didn’t know where the papers were” (#5).

6. Discussion

Water is clearly a source of conflict for many farmers in Santa Cruz, though not necessarily for agricultural purposes. Residents have developed methods to deal with water use issues, such as “well associations” and restrictions on what the water can be used for, and who can use it. However, the water projects can themselves be sources of

conflict, as one respondent explained: “Through the projects there are many disagreements. Some say that other people use more water, and there isn’t enough for other people” (#39). Others responded that conflict arises because other people misuse water (#211), or don’t pay for using a community well (#228). The rapid population growth in Santa Cruz is likely to increase demand for water, creating the potential for elevated conflict levels in the future.

Surprisingly, land was not frequently mentioned as a source of conflict. This was contrary to expectations, because Guatemala’s civil war is often linked with land conflict by commentators. In addition, peasant land invasions of large plantations continue to be reported in the national newspaper, and the amount of land held by the average interviewee is not enough to support a family. So, why wasn’t land more frequently mentioned as a source of conflict? It is possible to speculate, but there is no clear answer. Perhaps land conflict is not as serious a problem as is often reported. Perhaps it is a less serious problem in Santa Cruz than in other parts of the country. Or, perhaps the poverty caused by insufficient landholding among farmers is interpreted by outsiders as a problem of land, but seen by local residents more directly, as a problem of poverty. While there is clearly an unjust distribution of land in Guatemala, where the land distribution Gini coefficient is 0.84 (Guatemala, Instituto Nacional de Estadística, 2003b), articulating land as a source of conflict may be unlikely unless it has been taught as such by activist leaders.

The following are additional responses with relevance to land and water resources:

> Sometimes there's water, but it doesn't get here anymore. Right now we're in a well association. [The conflicts are] just discussions (#31).
>
> Each person has their limit and there's no reason for someone to fight (#33).
>
> There were conflicts. Some had lots of land and others didn't have any. People move the 'monjon' that marks the edge of the land (#37).
>
> No, [there isn't conflict]. Every one has their hydrant (*chorro*). Before, everyone went to wash in the river (#40).
>
> They say that some people were going to buy mining company land. Some people tried to buy land for the mining company's use. But the people "went on strike" (*se pusieron en huelga*) and prevented it (#53).
>
> Yes, [there is conflict], because the water must be taken care of and some people don't use it well (#211).
>
> Yes, [there is conflict], because some people don't pay because it's a common hydrant (*chorro*) (#228).

C. Agriculture, Technology, and Survival Strategies During Conflict

> Little by little we got some chickens and seeds, but you could only cook at night so that we wouldn't be discovered because of the smoke. When the moon's out, you can't build a fire. Case 0928, Ixcán, Quiché, s.f. (ODHAG, 1998, p. 163)

1. Literature Review

Given that farmers living in conflict areas face high levels of risk, the risk aversion literature may be expected to shed some light on the strategies farmers adopt under such circumstances. However, based on his research in Southern Sudan, Deng (2002) found that households tended to specialize their assets and livelihood activities

rather than diversify them in response to risk arising from exposure to civil war. Tofte (2004) reports that the Aluakluak and Ngop peoples of Southern Sudan came to rely more upon subsistence farming as a result of regional war. This change came in response to the loss of markets and employment opportunities. Farmers also cultivated the same fields for longer periods of time due to insecurity, and displaced people depended upon fishing and the gathering of wild foods (Tofte, 2004).

Famine survival strategies is another area of research that may provide insight to conflict survival strategies. Among rural Ethiopian peasants, famine survival strategy causes a shift in thinking from a subsistence economy to a cash economy. Animals, for instance, are sold for cash which is used to buy food (Rahmato, 1991). The crises precipitated by conflict may cause similar reactions, though conflict may restrict certain options that are available to the victims of famine. For example, while Ethiopian peasants may travel longer distances than normal during famine in order to find a market with better prices for both buying and selling (Rahmato, 1991), during conflict peasants may be unable to attend local markets, let alone travel to more distant ones. Another of the Ethiopian peasants' famine survival strategies is to migrate in search of wage labor (Rahmato, 1991). The strategy of selling one's labor is also used by households in times of conflict. Other conflict survival strategies include collecting wild foods, looking for credit, and reducing consumption (Hussain and Herens, 1997). Meludu (2006) found that Nigerian farmers adopted a number of survival strategies during conflict, including relocation, a reduction of labor utilization, and the cultivation of new crops as a result of not hiring labor, among others.

An interesting example of conflict survival strategies is that of the Guatemalan Communities in Resistance (CPRs). The CPRs were composed of villagers in northern Quiché who were forced by the Guatemalan army to flee their homes. They entered the jungle where the army had difficulty locating them because of the terrain and the presence of guerillas. Even so, vigilance was constant and danger was never far away, forcing the communities to move from place to place for their own protection (ODHAG, 1998). The following testimony illustrates some of the challenges faced by the CPRs:

> This went on for fourteen years, and the organization was born with the help of the refugees in Mexico. Little by little we got some chickens and seeds, but you could only cook at night so that we wouldn't be discovered because of the smoke. When the moon's out, you can't build a fire. One time the people were desperate and built a fire during the day. A helicopter came and dropped bombs, but we went to one of our refuges and nobody died. Case 0928, Ixcán, Quiché, s.f. (ODHAG, 1998, p. 163).[2]

Individuals and communities left their homes in haste in order to save their lives, but once in the jungle, they began to organize. Ironically, the communities fled from an army that acted in the name of anti-communism, but it was in the jungle that community-based work and distribution were developed as strategies to survive the attacks of the army:

> On repeated occasions, the army and the patrols destroyed the crops or carried off the harvest to cut off the food supply of the population that it considered combatant, that is, with the guerillas. The practice of collective work and the distribution of production were basic survival mechanisms, but with time they developed into teachings of new forms of distribution of work and community values. (ODHAG, 1998, p. 163).

[2] All quotations from ODHAG, 1998 have been translated from Spanish by the thesis author

Agricultural changes were not limited to collective work. The CPRs stopped hunting animals to avoid attracting the army's attention, and the resultant proliferation of animals meant greater agricultural losses. In response, the CPRs shifted production from many small fields to a small number of large fields. This strengthened the transition to collective work, as did the recurring displacement which weakened ownership claims over particular plots of land (Falla, 1994). Collective agricultural work was done by most men between 7 a.m. and 3 p.m. from Monday through Saturday. After 3 p.m., the men collaborated with the women in "individual cultivation or personal interests" (Manz, 1994).

In addition to organizational changes, desperation and insecurity led to changes in diet, as the people searched for resources not traditionally used:

> During five or six months without eating tortillas, we were dying of hunger, and because of that we began to eat lots of things that we found while walking, sometimes a little water, sometimes a banana was what we ate, and that's why sometimes companions began to kill animals. For example, they ate snakes, mice, other animals, we even ate a horse. Why did our people have to go through things and eat things we could call undignified? Because of the conflict, the armed confrontation that is here. Case 2052, Chamá, Alta Verapaz, 1982. (ODHAG, 1998, p. 159).

> Here, we ourselves looked for the solution to our life, that's why we're here, because here we think: we find the solution to our food and defend our life, because we can't die of hunger because there were edible plants in that place, like the "mojón," and other plants too. We thought: here are lands to work and we planted maize. Case 4079, Aldea Sumal, Quiché, 1984. (ODHAG, 1998, p. 184).

The army's efforts to destroy the livelihood of the CPRs was more successful with relation to corn than certain other crops. A witness explains:

> The army cut the banana trees to the ground, but new shoots sprang up. It also cut down the cassava that had just been planted, but it also started sprouting again. The same happened to the sugar cane: The soldiers cut it to bits, but it began to grow again. More appear. That's what happens to us—one dies, but more are on their way. (Falla, 1994, p. 176).

2. Conceptual Model

This model continues from the point where the model in section A ended. Increasing marginal costs and decreasing demand lead to reduced equilibrium agricultural output (Figure 4). Because the cost of agricultural labor has risen, farmers may choose to abandon agriculture completely or to reduce the amount of agricultural labor used. If they choose to reduce their labor, farmers may choose to employ new, labor saving techniques, or they may find that it is optimal to switch to raising crops that give higher returns to low quantities of labor input, represented by "Crop 2" in Figure 5.

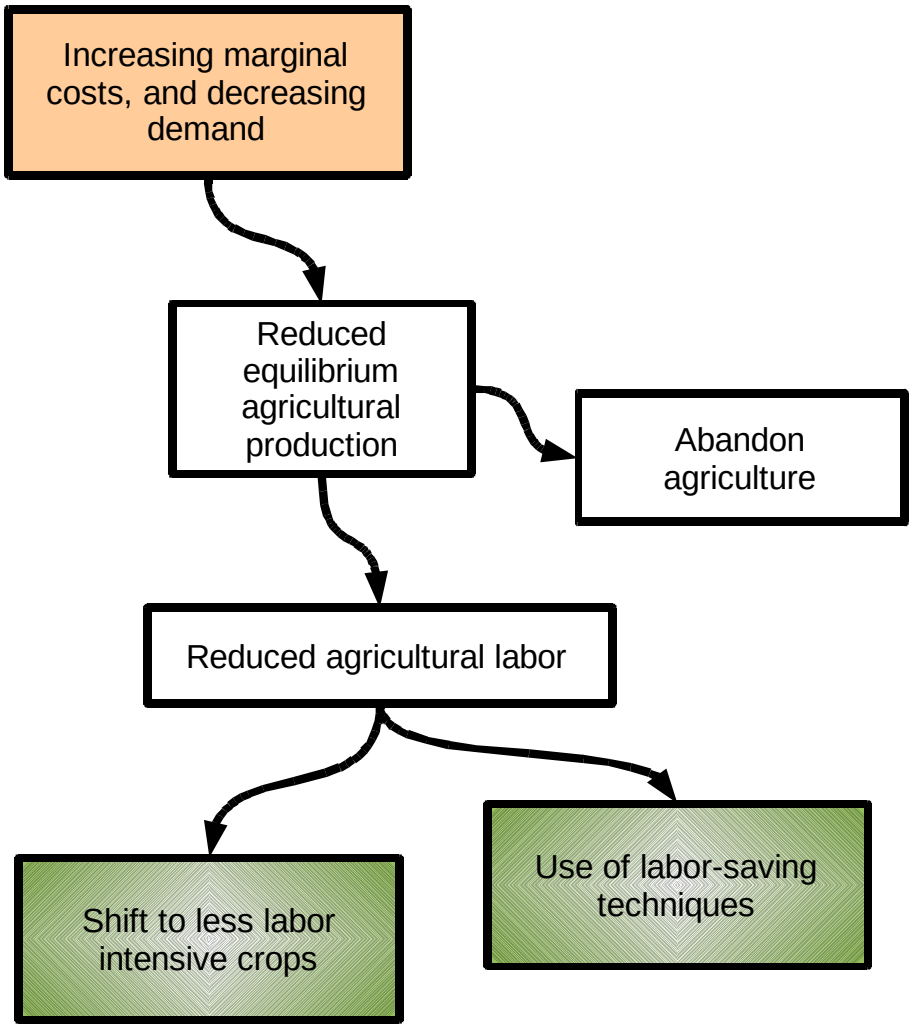

Figure 4. Conflict survival strategies

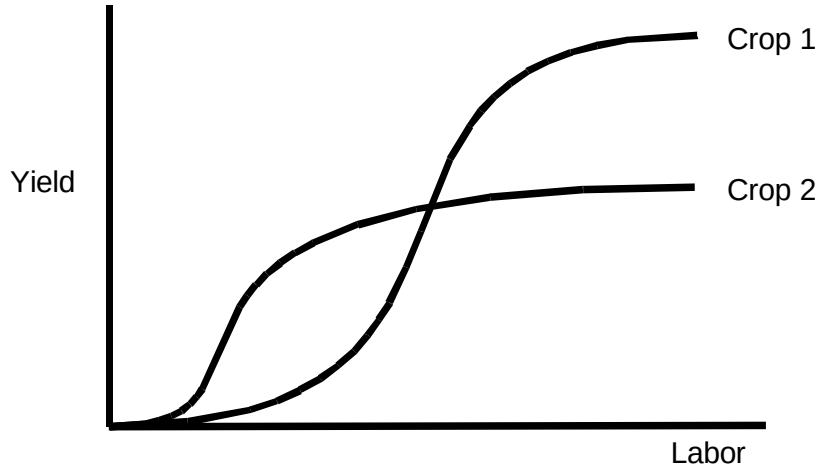

Figure 5. Labor intensity of different crops

3. Conflict Survival Strategies in Guatemala

Individuals react differently to the adversity that conflict brings. During the civil war, insecurity was clearly a part of life for Quiché residents, including farmers. How did they react? Four hypotheses are suggested as possible responses by Santa Cruz farmers, based upon the conceptual model presented above. The first is general in nature: *H_{2A}: Santa Cruz farmers responded to the civil war by modifying their agricultural practices*. The second is more specific. Because of the personal danger associated with working alone or in small groups, the following hypothesis is suggested: *H_{2B}: Santa Cruz farmers reduced the amount of agricultural labor used during the civil war*. The third hypothesis builds upon the second. If agricultural labor is dangerous during times of conflict, and if farmers reduce their risk by reducing the amount of time invested in agricultural labor, they may choose to shift the focus of their efforts to productive activities that require less labor. The hypothesis takes the following form: *H_{2C}: Santa Cruz farmers shifted to less labor-intensive crops during the civil war*. The

fourth and final response is hypothesized to happen under the most extreme conditions of insecurity, *H_{2D}: Santa Cruz farmers abandoned agriculture during the civil war*.

4. Methods

Interview questions 58 through 60 asked participants if they modified their agricultural practices during the civil war, how their agricultural practices were modified during the war, what agricultural difficulties they faced during the war, and how they responded to these difficulties. Each participant's answers to the questions were classified in two ways. First, the way in which each farmer responded to the war was placed in one of three exclusive categories: "Abandoned agriculture for one or more seasons," "Modified agriculture," or "Did not change agriculture." This classification was used to examine hypotheses H_{2A} and H_{2D} by calculating the percentage of farmers that responded in each of these fashions.

The second manner of classifying questions 58 through 60 included twelve non-exclusive categories: "Crops destroyed," "Difficult to work," "Death in family," "Did not have own land," "Difficult to buy inputs/sell outputs," "Animals died," "Sold animals," "Fear of losing a family member," "Emigrated," "Modified crops grown," "Other," and "No problem." Respondents were classified in multiple categories when applicable. The "Difficult to work" category was used to examine H_{2B}. The "Modified crops grown" category was used to test H_{2C}.

5. Results

Of the Santa Cruz farmers interviewed, more than one in five modified their agricultural practices during the civil war (Table 7), providing support for H_{2A}.

However, 21% is lower than expected, and the most common change was a reduction in the amount of labor. Twice as many farmers (44%) reported no change to their agricultural practices during the civil war. This will be discussed in more detail in the following section.

Table 7. Response to the civil war.
Categorization of questions 58 – 60 (N = 81)

	Frequency	Percentage
Abandoned agriculture for one or more seasons	13	16%
Modified agriculture	17	21%
No change to agriculture	36	44%
NA	15	19%
Total	81	100%

In addition to those farmers who modified their agricultural practices, a high percentage (16%) of farmers completely abandoned agriculture, as hypothesized by H_{2D}. Many returned to agriculture after a year, but others did not return to agriculture for two or more years.

As seen in Table 8, more than one fourth of all farmers reduced the amount of agricultural labor used during the civil war, supporting H_{2B}. One of the reasons for reducing agricultural labor was that a death occurred in the family. Two examples of this were previously mentioned in section A: "My father 'disappeared' when the maize was ready to harvest. We went to the capital and when we came back, the paramilitaries had taken the harvest. My mom cried. We didn't have seeds anymore. We bought seeds and planted, but it didn't produce maize. We planted, but my brothers were little

and they didn't worry about the maize...We didn't have money to buy chemical fertilizer...We put dead leaves on it but it didn't produce" (#60), and "My dad died. They killed him and we were left without a dad and we couldn't do anything. We took care of the land, but we couldn't do it like him. Sometimes we didn't have enough food and we only ate once or twice per day" (#63).

Table 8. All reported impacts of the civil war upon farm families. Categorization of questions 58 – 60 (N = 81)

	Frequency	Percentage
Animals died	3	4%
Sold animals	2	2%
Crops destroyed	3	4%
Modified crops grown	0	0%
Emigrated	6	7%
Did not have own land	2	2%
Difficult to buy inputs/sell outputs	5	6%
Difficult to work	18	22%
Reduced agricultural labor	21	26%
Fear of losing a family member	2	2%
Death in family	3	4%
Other	3	4%
No problem	34	42%
NA	18	22%
Total	119	

Agricultural labor decreased when families completely abandoned farming, as explained by the following respondents: "We couldn't plant anymore because of fear, fear of the armies because they say we are part of the guerilla, but we're not. For one year we didn't plant" (#34), "You couldn't work anymore for the fear. That's why you

couldn't care for the crops. There was a great persecution" (#42), and "We stopped planting because of the violence" (#31).

Other farmers reduced the amount of time spent in the fields out of fear, but continued to farm, as the following respondents explained: "The house burned. We couldn't travel to the capital or the coast to work. That's why we sold the animals to get money. We didn't work much in the corn for fear of the army. A few went to a different community to hide, and came back to work in the corn...We sold the animals cheap, and others sold their land cheap. People went to the fields less" (#5), "We stopped farming one area because there wasn't time. There wasn't time to work anymore because the highway passes nearby, so the soldiers went by frequently" (#33).

Though some Santa Cruz farmers reported that their animals died or were sold because of the conflict, there was a complete lack of support for H_{2C}. No farmer mentioned a change in the type of crops planted, nor a shift in the importance of one crop over another.

6. Discussion

It is important to note that, with one exception, only people currently engaged in farming were interviewed. For that reason, the sample excluded individuals who had farmed previous to the war, but subsequently abandoned agriculture permanently. If these individuals were included in the sample, the percentage of farmers who abandoned agriculture would be higher.

Age had little if any impact on the percentage of people who reported no change to their agricultural practices during the civil war. Table 9 shows that the 18-25 year-old

age class reported changes to their agricultural practices less frequently than other age classes, perhaps because they were very young when major fighting occurred. However, this result is not statistically different from the population as a whole.

Table 9. People who reported no change to agricultural practices*

Age Class	# in Age Class	# No Change in Farming	% No Change in Farming	z stat	p value
18-25	12	7	58%	0.92	0.36
26-35	23	10	43%	-0.15	0.89
36-45	23	11	48%	0.27	0.79
46-55	15	5	33%	-0.90	0.37
56-85	7	3	43%	-0.11	0.91
Total	80	36	45%		

* Note: The total is 80 instead of 81 because the age of one person was not available. The z statistic was calculated as the difference from the population mean. A two tailed significance test was used.

Less work in the fields and limited access to the market meant less food to eat. Some people coped by going hungry: "Before, a person didn't want to leave [the house]. We barely planted. We barely ate. A person didn't want to leave the house to run errands. I went to leave some corn to be ground at the mill, and they killed some people in front of us. My mom got the jitters (*nervios*)[3]. Maybe from so much fear. All the frights we had! Now it's a little better" (#54).

When asked about changes to their agricultural practices during the war, many replied that it was "The same" (#307). Some experienced fear, but did not report changes to their manner of farming: "We stayed in the house. We still went out to farm" (#52), while prayer was the only reported response of some farmers: "We prayed to God

[3] Unlike "jitters," *nervios* refers to a long term condition.

that nothing would happen" (#225). Why did so many farmers report no change to their agriculture? Was change not necessary, or were they unable to change? During the civil war, much of the violence was targeted at community leaders. Those who were not activists may have felt they had little to fear, and therefore no need to adapt their farming practices. In some cases, such as the community of Cuarto Pueblo, in northern Quiché, this false sense of security was the death of many people who were indiscriminately killed by the army (Falla, 1994). What options did the farmers have, other than to abandon farming? For those with few resources, there are few alternatives.

In addition to agricultural adaptations, some responses revealed alternative, non-agricultural survival strategies. For instance, a weaver explained: "We looked for markets we could get into. That's why I didn't have so much trouble to maintain my family" (#42). This weaver was the previously mentioned exception to the rule that only currently active farmers were interviewed. He had abandoned farming during the war and never returned to it, perhaps because he already had a trade that was able to provide for his family. It is likely that many other Santa Cruz farmers did the same, but were not included in the survey because of the survey design. Another respondent (#115) sold firewood to compensate for lost agricultural income. However, this man was from outside the Santa Cruz *municipio* and is not included in the dataset.

What determined whether farmers chose to abandon, modify, or make no changes to their agricultural practices? It appears that the most important factor was fear. Extreme cases caused entire families to emigrate, abandoning their fields. Less intense fear caused total or partial abandonment of fields, but did not lead families to

emigrate. Finally, for many families, fear was not enough of a deterrent to prevent them from farming.

In light of the difficulties faced by farmers during the war, why did they not switch to less labor intensive crops, as H_{2C} suggested? If many people were unable to work in their fields, why did so few report other income generating activities, such as weaving or gathering firewood? The answer to both of these questions may be that they lacked the opportunities to do so. Switching to alternative crops would require knowledge of the crops and how to care for them, in addition to access to seeds and other technology that may have been necessary. It is quite likely that all of these ingredients were missing. In addition, switching to different crops requires foresight and planning. Unless you anticipated having difficulty working in your fields, you would not have reason to consider switching crops. The seasonality of agriculture means that the decision to switch crops could be delayed by a full growing season.

Many farmers who emigrated to Mexico or other parts of Guatemala found employment to support their families (Castañeda, 1998). Why didn't more interview respondents report using their excess labor in home based production activities? The simplest answer is that the interview was specifically looking for agricultural strategies, and may have overlooked non-agricultural adaptations, but there are probably other explanations as well. Santa Cruz farmers were only partially integrated into the cash economy, preferring to grow most of their own food. Complete reliance on a cash income would have been unusual. However, the greatest obstacle was probably lack of

opportunity. Only the most fortunate would have had the combination of marketable skills, capital, and market access necessary to engage in home-based production.

> The following are additional responses relevant to survival strategies:
>
> The community left its community because of the army. The army displaced them. Animals, people, and crops died. The people are now in a different place. They emigrated and were displaced (#4).
>
> [We overcame the difficulties of the war by] asking other people for seeds to plant (#37).

D. Agricultural Technology in Conflict Reduction and Prevention

> The coming of a tool, then, can be a cultural event of great influence and power. Once that is understood, it is no longer possible to be simpleminded about technological progress. It is no longer possible to ask, What is a good tool? without asking at the same time, How well does it work? and, What is its influence? (Berry, 1981, p. 105-106)

1. Literature Review

Agricultural technology may be able to prevent or end conflict through both indirect and direct means. The possibility of directly preventing or ending conflict will be addressed in the "Discussion" of this section. The indirect influence is suggested by Indra de Soysa and Nils Petter Gleditsch (1999), of the International Peace Research Institute, Oslo, in their report on agriculture and conflict. They conclude: "Building peace and prosperity will require greater attention to the role of agriculture in creating livelihood, resurrecting development, alleviating poverty, and breaking the vicious cycle of violent conflict and scarcity" (p. 60). More recently, although Per Pinstrup-Andersen (2006) admits that there is no consensus on the issue of poverty as a cause of conflict, he

hypothesizes that technological change in agriculture leads to improved nutrition, reduced poverty, and sustainable natural resource management, which in turn lead to reduced armed conflict and terrorism (Figure 6).

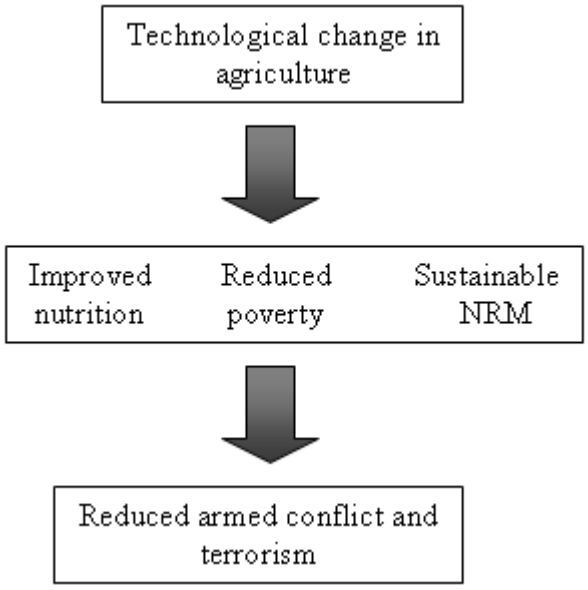

Figure 6. Technological change reduces conflict and terrorism

Based on Pinstrup-Andersen (2006)

If Pinstrup-Andersen, de Soysa, and Gleditsch are correct, Norman Borlaug has certainly prevented a number of conflicts through his efforts to develop and disseminate agricultural technology. The technologies of the Green Revolution, which include improved crop varieties, chemical fertilizer, herbicide, insecticide, and the increased use of irrigation, saved millions of people from starvation and hunger. Indeed, Borlaug himself believes in the poverty-conflict connection, as he often quotes fellow Nobel laureate Lord John Boyd Orr as saying "you cannot build peace on empty stomachs" (Borlaug, 1970). The United Nations has also endorsed this view in a recent Human

Development Report: “Failure to address pastoral destitution has encouraged the institutionalization of violent conflict and raiding as part of pastoralism in Karamoja” (United Nations Development Program, 2005) and in at least one other document:

> Linking agricultural technology development and application to poverty alleviation and eventually to peace requires taking into account the needs of those farmers who are vulnerable to shocks of various kinds and have low ‘opportunity cost’ in turning to violence...It will be important to develop a range of technology to address issues of scale- and location-sensitivity. Likely technologies for such areas include the improvement of farming systems of arid and semi-arid lands. These include traditional drought-tolerant crops, such as millet, sorghum, and barley as well as small- and large-ruminant livestock systems. In crop management, moisture- and soil-conserving technologies are important lines of research and development, including conservation tillage, water harvesting and small-scale irrigation systems. (United Nations University Institute of Advanced Studies, 2004, p. 17)

2. Conceptual Model

The conceptual model builds upon that of Pinstrup-Andersen (2006). Figure 7 illustrates how technological change may increase or decrease armed conflict. The upper portion of the figure will be discussed in the following section. The lower portion of the figure traces the process by which technology may reduce conflict. Advances in agricultural technology provide opportunities for improvements in nutrition, natural resource management, and the reduction of poverty. Improvements in these three areas increase the opportunity cost of conflict and consequently lead to societies with less armed conflict and terrorism.

Traditional or high-tech methods of plant breeding may produce more crops with higher vitamin levels, for example, improving the health of those who eat them. Nutrition may also be improved by agricultural technology that produces higher yields per unit area of land, if the farm family chooses to consume the increased production. Alternatively, if the extra production is sold, income is increased. Other technologies that increase efficiency may not increase production, but rather reduce costs. Such technologies increase profits and reduce poverty. Agricultural technologies that contribute to sustainable resource management may provide environmental stability or enhancement, meaning that environmental resources may continue to provide benefits to those using them in the future. Sustainable natural resource management prevents the deterioration of wealth and the forced migration of farmers who must abandon land that has become unproductive.

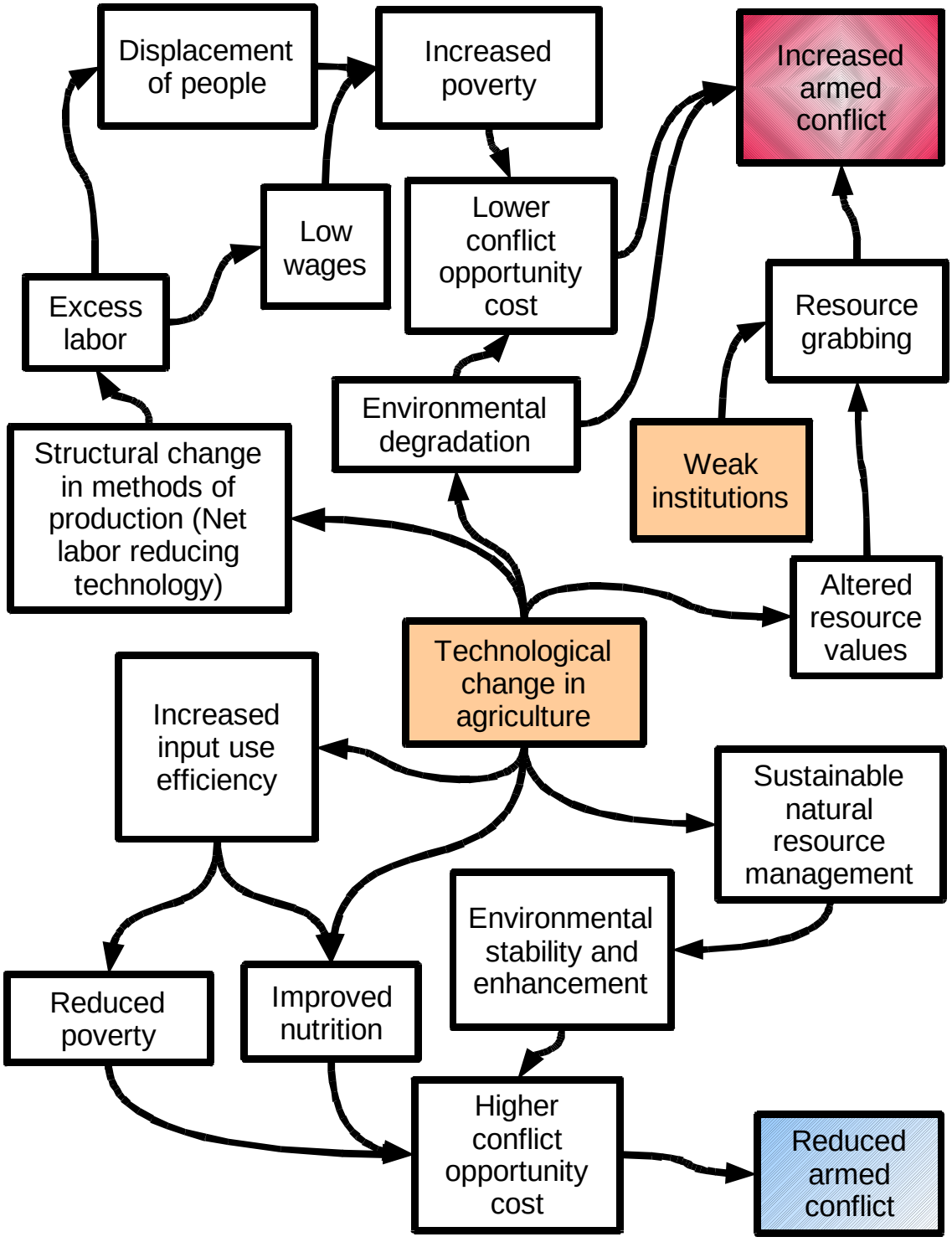

Figure 7. Conflict increase/decrease as a result of technological change

3. Conflict Reduction and Prevention in Guatemala

Though much more traditional than U.S. agriculture, Santa Cruz agriculture has undergone a number of technological changes during the lifetimes of the current generation, such as the use of synthetic fertilizers, herbicides, insecticides, and animal vaccination. By increasing production per unit area, it is hypothesized that these or other technologies may have eliminated or prevented conflict by their use. The hypothesis is formally stated as *H_3: Agricultural technologies newly introduced to Santa Cruz have prevented conflict through the alleviation of poverty and the reduction of competition for natural resources.*

4. Methods

There is an inherent methodological difficulty in measuring an event that does not occur. How do you know when a conflict has been prevented? It would be possible to set up an experiment in which a technology was introduced to various locales where the level of conflict was measured before and after introduction. However, this type of experiment would likely be extremely costly and time consuming, making it impossible for this study. For that reason, a very direct approach was used—after farmers had explained the changes that had occurred in agriculture, they were asked if the changes had helped to resolve any conflict (question 36) or if there would have been more conflict if the changes had not occurred (question 37). Lacking a measure of conflict, farmers' perception of conflict was used as a proxy for conflict. The first question relied on the farmers' perceptions of what happened, and the second required farmers to speculate about events that did not occur.

5. Results

Both questions demanded critical thinking and an attempt to link events - new agricultural technologies and social conflict-- that are not typically considered to be closely related. This would present a challenge for anybody, well educated or not, and the questions appeared to be difficult for many respondents, who, after a confused expression on their faces, shook their heads and said "no." Of the eighty-one individuals in the survey, less than thirty answered both of the questions (Table 10). The small number of responses was usually caused by one of two problems: 1) because the respondents were confused by the questions, or 2) because the respondents did not report any changes to their agricultural practices, rendering the questions irrelevant. In most cases where the individual responded in the affirmative, they were either unable or unwilling to provide further explanation, or they provided an explanation that displayed a lack of understanding of the question's intent. One such response was, "There would be more dead animals [without vaccination]" (#39). As always, there were some exceptions. One of these was the man who replied that corralling animals was a technology that prevented conflict with neighbors, because the animals were prevented from wandering onto others' property (#37).

Table 10. Perception that technologies resolved or prevent conflict (N = 81)

		Frequency	Percent
Did the changes help to resolve any conflicts (question 36)	Yes	6	7%
	No	14	17%
	NA	61	75%
If the changes had not happened, would there have been more conflict? (question 37)	Yes	8	10%
	No	19	23%
	NA	54	67%

6. Discussion

While the indirect impact of agricultural technology upon conflict is uncertain because of doubt about the link from poverty to conflict, the question of a direct link from agricultural technology to conflict prevention has gone almost unasked. Can agricultural technology play a direct role in conflict prevention? For instance, could advanced breeding techniques produce crops with low moisture requirements that would eliminate the threat of "water wars?" Could they develop a hardy, fast growing shrub used as a boundary marker to reduce disputes over land ownership? Could more efficient irrigation and water harvesting technologies reduce local competition for scarce water resources? The question is not whether these technologies can be developed—many such technologies already exist or are under development. The question is whether or not they could prevent or end conflict, and whether they have done so in the past.

One such example provided by history follows. In the 1850's and 1860's, southern U.S. cattle herders were met with violence as they drove their cattle north. The cause was babesiosis, also known as "Texas Fever." Southern cattle had developed

resistance to this tick-borne disease, but when northern cattle herds came into contact with southern cattle or the pastures they had occupied, the northern herds were devastated by the sickness. Some northerners reacted violently, barring the southerners and their herds passage into their territory. Sometimes these conflicts resulted in death. Eventually, laws were established to prevent the southern cattle from coming north, but a final resolution was not achieved until Texas Fever was eradicated by "dipping" cattle in chemical solutions that killed the ticks (Strom, 2000; Hope, 2005).

We may look to the future for validation of another example. It has been argued that the genocide in Rwanda was set in motion by the crash of the price of coffee in the 1980's (Verwimp, 2002). Figure 8 shows how highly dependent Rwanda has been on coffee to provide it with foreign exchange. Figure 9 shows the correlation of falling coffee prices with conflict intensity, as well as the unstable price history of commodity coffee. Since 2001, Dr. Tim Schilling has lead an international effort to transform the way coffee is processed and marketed in Rwanda. By linking coffee growers to cooperative processing centers rather than processing coffee in their own homes, the growers are able to sell a premium product on the specialty coffee market. This is important because specialty coffee not only sells at a higher price, but also because its price is more stable than that of commodity coffee (Schilling, 2006). By introducing new processing technology and linking farmers more directly to their markets, Dr. Schilling is helping to reduce the country's reliance on the price of commodity coffee, and may also be contributing to Rwanda's stability.

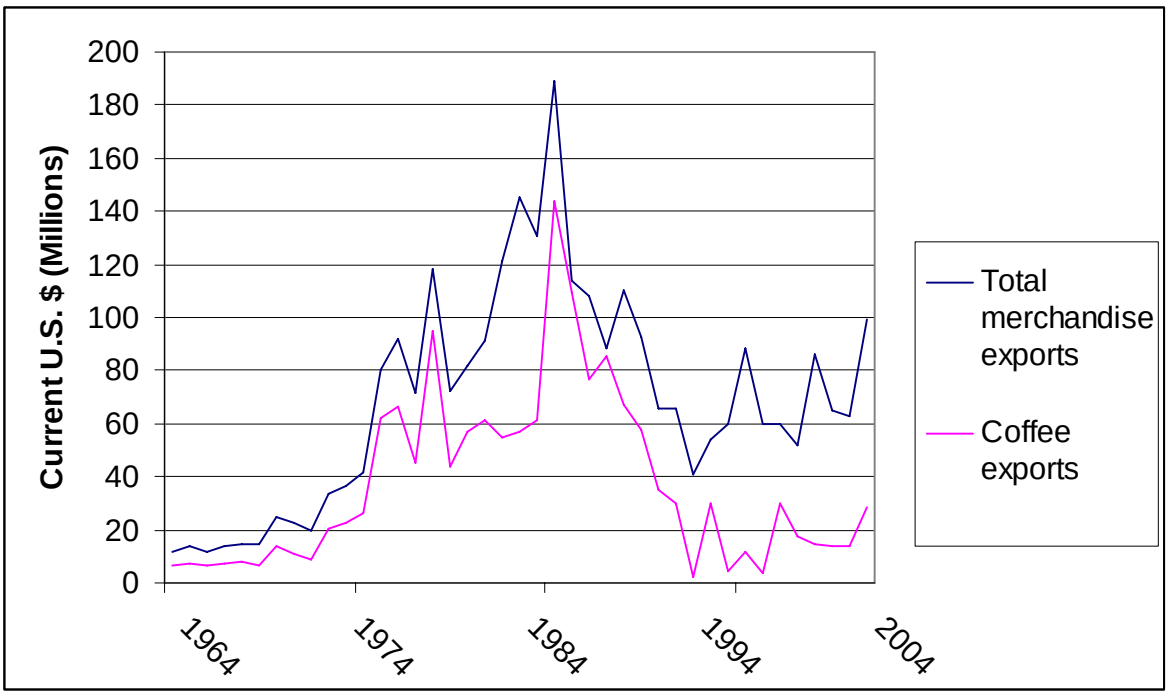

Figure 8. Rwanda's total merchandise exports and coffee exports

Sources of data: WTO, 2006; FAOSTAT, 2006

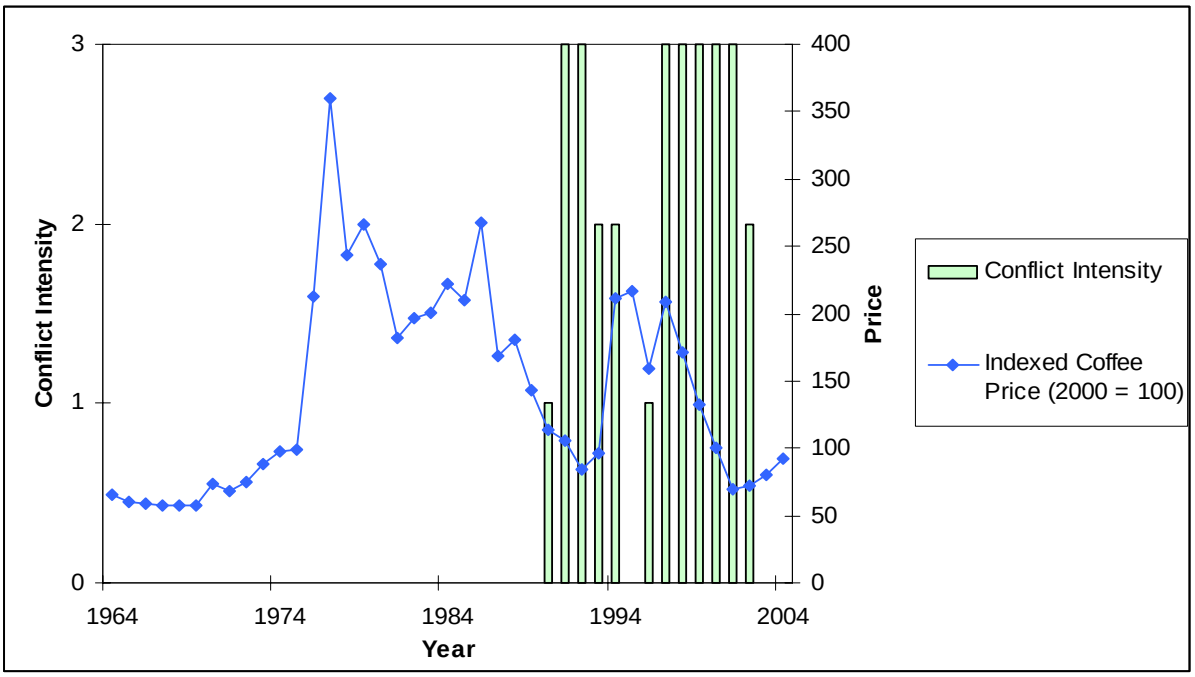

Figure 9. World coffee price and Rwandan conflict intensity*

Sources of data: United Nations Conference on Trade and Development, 2006; Gleditsch, et al., 2002

* Conflict intensity is measured on a scale from 0 to 3. In order to be scored as a level one conflict, at least 25 battle-related deaths must have occurred in a given year, for a given conflict. This means that, even for years that are scored 0, there may have been low levels of conflict. Level two conflicts include "more than 25 battle-related deaths per year and a total conflict history of more than 1000 battle-related deaths, but fewer than 1,000 per year," and level three conflicts include conflicts with "at least 1000 battle-related deaths per year." For more detail on this data, see Gleditsch, et al. (2002) and Strand, et al. (2005).

E. Agricultural Technology as a Cause of Conflict

> Although technology can be viewed as having a sociopolitical neutral core – as the neutralist argues – in fact much more than a technological core is transferred. The additional components of the transfer are, at the least, values which suggest how requirements generated by the core technology are to be met and, at the most, actual social, political, economic, and technological strategems [sic] for meeting these requirements. (Levy, 1982, p. 281)

1. Literature Review

Agricultural technology, Tefsa Gebremedhin (1996) reminds us, is a means rather than an end -- the correct choice of technologies "can make a large difference in the quality of life, health, safety, productivity, equity, and *stability of society*" (p. 209, emphasis added). Case studies revealing a connection between agricultural technology and conflict have been carried out by a number of researchers. The western Sahel, including the countries of Mali, Burkina Faso, and Niger, was the site of drought and famine in the final decades of the twentieth century; consequently it has been a recipient of development aid, including projects such as the construction of dams, boreholes, and expanded irrigation. Keith Moore's (2005) study explains that while the previously mentioned development efforts have led to improvements in production, they have also increased conflict in an area where competition for access to water and arable land is increasing. Irrigation projects have led to expanded cultivation along water access routes, such as streams and wetlands. Livestock corridors, where cultivation is prohibited in order to allow livestock to pass from one place to another, are provided for in theory; in practice, however, nomadic herders find that access to water for their livestock has been cut off by new fields, and that old migration routes enriched with

animal manure have come under cultivation. Multiple deaths have occurred from the resulting conflicts and the situation has been further complicated by ethnic differences (Moore, 2005).

Increasing irrigation agriculture has had similar results in Ethiopia as pastoralists such as the Afar and Karrayu have been forced from their land. In contrast to the farmer-herder conflicts of the western Sahel, the displacement of pastoral groups in Ethiopia resulted in increased competition *between* pastoral groups, rather than with farmers. At times, this conflict has "inflicted heavy losses of life and property on the competing pastoral groups" (Gebre, 2001). A further twist in the difficulties faced by the Afar and Karrayu is that their land was seized not only for its agricultural potential, but also for its value as a national park (Gebre, 2001; Kassa, 2001). Thus, they find themselves competing for land with two interest blocs, rather than one.

Another example occurred in the Sahel, where dams built in Mali and Mauritania nearly led to an interstate war during the late 1980s. As land values along the Senegal river increased in anticipation of the dams' construction, the Mauritanian elite "rewrote legislation governing land ownership, effectively abrogating the rights of black Africans [ethnically Senegalese] to continue farming, herding, and fishing along the Mauritanian riverbank" (Homer-Dixon, 1994, p. 12). The killing of a number of farmers led to retaliations in Senegal, and hundreds of people were killed in both countries. Furthermore, the Mauritanians stripped ethnically Senegalese farmers of their citizenship and seized their riverside property (Homer-Dixon, 1994). A similar case occurred in the Sudan when elite Sudanese expanded mechanized agriculture into Southern Sudan and,

in the process, drove off the smallholders already there, many of whom went on to join rebel forces in their struggle against the government (de Waal, 2005).

Africa is not the only continent to provide examples of agricultural technology causing conflict. At the end of the 19th century, the American West was fenced in by a new invention – barbed wire. This technology was both a symbolic and a physical boundary designed to prevent the free movement of animals. Some men resisted this control over access to the free range and its resources by cutting the wire fences built by others. "Warfare" had begun (Netz, 2004, p. 32). In central Texas, farmers and small ranchers cut the fences of larger cattlemen, but eventually "lost the battle against the broader trend" (Brown, 1996). Also resulting in violence ranging from vandalism to murder, was the unhappy ending to the story of Texas Fever. Though mandatory "dipping" of cattle eradicated the disease in the southern U.S. and ended the North-South conflict over the issue, the technological solution also *caused* problems. Resistance to cattle dipping primarily came from southern smallholders, for whom the expense of cattle dipping was prohibitive and represented a threat to their livelihood (Strom, 2000; Hope, 2005).

According to George Collier (2005), the introduction of synthetic fertilizers and herbicides in Chiapas, Mexico, altered the structure of agriculture. Relatively wealthy farmers with enough money to purchase the new inputs rented land from poorer farmers, and then hired the poor farmers to work on their own land! Use of chemical inputs reduced the amount of agricultural labor required, and the depressed demand for labor resulted in unemployment, contributing to hardships "comparable to the circumstances

that led Rolando, a major in the EZLN, to join the rebel army around 1986" (Collier, 2005, p. 104). Chemical herbicide allows weeds to be controlled in less time than it would take to weed by hand – it substitutes capital for labor. However, the aforementioned example from Chiapas should be considered carefully, because it is questionable whether the use of agricultural chemicals reduces the overall demand for labor. In fact, the use of agricultural chemicals can actually increase the quantity of labor demanded in one of two ways. First, the application of insecticide requires additional labor. Second, using agricultural chemicals, including herbicide, insecticide, and fertilizer, usually increases agricultural productivity per unit area. Increased productivity means that more labor is required to harvest the crop. It also means an increase in the amount of money in the local economy, which may lead to increased employment.

Mechanization of the California tomato harvester in the mid 20th century led to the displacement of farm laborers and small farmers (Hightower, 1973), but widespread conflict did not occur, perhaps because of the strength of the U.S.'s institutions. Introduction of the cotton picker in the U.S. around the same time eliminated many unskilled jobs and led to "massive migration of often poorly educated people...from the South's cotton farms" (Dorner, 1983), but it was the adoption of the cotton gin in the early 19th century that increased the incentive to grow cotton, strengthened the plantation system, and "set several forces in motion which led to the Civil War" (Rasmussen, 1977, p. 296).

Rapid advances are being made in biotechnology by using methods that include rDNA techniques and cell fusion techniques, but despite the benefits these technologies promise, there may be reason for concern as well. Busch et al. (1991) point to the potential development of substitutes for agricultural commodities currently grown in the developing world. For countries that depend upon a small number of export crops, losing the market for one of them could have serious consequences, even leading to political instability (Busch et al., 1991).

Though not focused on agricultural technologies, there has been much recent research into the causes of civil war. Collier and Hoeffler (2004) found that countries with high proportion of primary commodity exports, with respect to GDP, were at higher risk of civil war, but it has been argued that this result is "quite fragile" (Fearon, 2005). In any case, food and non-food agriculture were among the commodity exports considered, but Collier and Hoeffler found that "Of the many potential disaggregations of primary commodity exports permitted by this data, only one was significant when introduced into our baseline regression, namely oil versus non-oil" (p. 580). In other words, reliance upon agricultural exports was not found to put countries at significantly greater risk of civil conflict.

2. Conceptual Model

The conceptual model for this section is illustrated by the upper portion of Figure 6, where the pathways are similar to those in the lower portion of the figure, but the outcome is, of course, more conflict rather than less. Agricultural technologies that degrade the environment reduce its ability to provide for people in the short term, long

term, or both. Environmental degradation may also cause conflict more directly, as when the harmful environmental practices of one farmer cause losses for neighbors, such as poor water quality or a suitable environment for invasive species.

Some impacts that should have positive consequences, such as technologies that increase the value of water and land resources by increasing their marginal production, can have negative consequences when accompanied by weak institutions that are unable to uphold property rights. The combination of these factors creates a situation in which powerful members of society may become "resource grabbers," by attempting to take control of resources that were not worth their time before the introduction of the new technology.

The most complex path to increased armed conflict in the upper portion of the figure begins with technological changes that cause structural change in the methods of production. A prime example of this, is technology that has the effect of reducing net labor demand. Conflict may be avoided if agricultural laborers can turn to an alternative means for their livelihood. In any case, the wage rate will fall as the demand for labor declines. If local employment alternatives are not available, farmers will be forced to emigrate in search of work. Both displacement and lower wages have the impact of increasing poverty. Increased poverty and environmental degradation both decrease the opportunity cost of conflict, making armed conflict a more attractive option.

3. Agricultural Technology as a Source of Conflict in Guatemala

The foregoing studies suggest that agricultural technologies can be a direct source of conflict. Modern agrochemicals, such as those used in Santa Cruz, are

sometimes accused of causing environmental damage. If the accusation is true, farmers who use them may experience more conflict with their neighbors. The following hypothesis is proposed to see if agricultural technologies have had a direct impact on conflict: *Santa Cruz farmers who use nontraditional agricultural technologies perceive higher levels of conflict*. A second, similar hypothesis is also suggested. For the second hypothesis, the word "conflict" is replaced by the word "crime." This is done out of the belief that vandalism and crimes of vengeance may be manifestations of conflict associated with the use of a particular agricultural technology. The individual using the technology may perceive this type of criminal act as crime, rather than "conflict" associated with their use of the technology. The hypothesis is stated thus: H_{4B}: *Santa Cruz farmers who use nontraditional agricultural technologies perceive higher levels of crime*.

4. Methods

To test H_{4A} and H_{4B}, two relationships were estimated by regression, with perception of conflict and perception of crime as the dependent variables. The indices for perception of conflict and crime were created using principal components analysis, as described in Chapter II.

Independent variables used in the regression to test H_{4A} included the following:

<u>Demographic</u>

Microcredit – 1 if a participant in microcredit, 0 if not

Total_Owned – Amount of land owned, measured in cuerdas. This variable is included as a proxy for wealth.

Gender – 1 if female, 0 if male

Ed_Elementary – 1 if the highest educational level was elementary school, 0 otherwise

Ed_Middle_Plus – 1 if the highest educational level was middle school or above, 0 otherwise

Lan_Spanish – 1 if the respondent's native language was Spanish, 0 otherwise

Lan_Kiche_and_Spanish – 1 if the respondent considered both K'iche' and Spanish to be native languages, 0 otherwise

Language variables are included as a proxy for ethnicity. The proxy for wealth (Total_Owned) and the proxy for ethnicity (Lan_Spanish and Lan_Kiche_and_Spanish) were somewhat correlated. However, the correlation was not strong enough to prevent running the regression.

Researcher

Research_2 – 1 if the interview was conducted by researcher #2, 0 otherwise

Research_3 – 1 if the interview was conducted by researcher #3, 0 otherwise

Research_4 – 1 if the interview was conducted by researcher #4, 0 otherwise

*Research_1 was the author

Technologies Used

Vaccinate – 1 if the respondent vaccinated at least one agricultural animal, 0 otherwise

Herbicide – 1 if the respondent used herbicide, 0 otherwise

Insecticide – 1 if the respondent used insecticide, 0 otherwise

Chemical_Fertilizer – 1 if the respondent used chemical fertilizer, 0 otherwise

A logistic regression was run, using equation *G* described in Chapter II:

$$G(z) = \exp(z)/[1 + \exp(z)]$$

where z is equal to:

$$\alpha + \beta_1 * \text{Microcredit} + \beta_2 * \text{TotalOwned} + \beta_3 * \text{Gender} + \beta_4 * \text{Ed\_Elementary} + \beta_5 * \text{Ed\_Middle\_Plus} + \beta_6 * \text{Lan\_Spanish} + \beta_7 * \text{Lan\_Kiche\_and\_Spanish} + \beta_8 * \text{Research\_2} + \beta_9 * \text{Research\_3} + \beta_{10} * \text{Research\_4} + \beta_{11} * \text{Vaccinate} + \beta_{12} * \text{Herbicide} + \beta_{13} * \text{Insecticide} + \beta_{14} * \text{Chemical\_Fertilizer}$$

Stepwise deletion was used to eliminate variables with extremely high standard errors because the algorithm was unable to converge on a solution. This presents methodological problems because the user does not know if they have removed the correct variable. Also, once a variable included in the theoretical model has been removed from the regression, the significance of the coefficients of the remaining variables is diminished and unclear. Three variables were removed in the following order: Herbicide, Chemical_Fertilizer, and Research_2.

To test H_{4B}, only minor changes were made to the process described above. The dependent variable was the crime index, and the independent variables were the same as in the previous regression. As before, a logistic regression was run, but it was not necessary to use stepwise deletion because none of the variables suffered from extremely high standard errors.

5. Results

The first of the two regressions, with the independent variable "Conflict Index," yielded the results seen in Table 11. The number of valid cases was reduced from forty-nine to thirty-seven because of missing values in one or more of the independent variables. The most frequently missing data was the educational level. The most statistically significant variables, using the Wald test, were Lan_Spanish and Lan_Kiche_and_Spanish, but as can be seen, the results obtained were not significant for any of the variables.

Table 11. Parameter estimates with dependent variable: Conflict Index

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Constant	-.744	1.127	-3.064	1.577
Microcredit	-.930	1.359	-3.730	1.870
Total_Owned	-.019	.041	-.103	.066
Gender	1.675	1.662	-1.747	5.097
Ed_Elementary	-.184	.613	-1.447	1.078
Ed_Middle_Plus	-.282	1.669	-3.720	3.155
Lan_Spanish	-2.250	1.578	-5.501	1.001
Lan_Kiche_and_ Spanish	-2.242	1.845	-6.043	1.558
Research_3	-.978	1.224	-3.499	1.543
Research_4	-.979	.691	-2.402	.444
Vaccinate	-.118	.605	-1.364	1.128
Insecticide	.605	.945	-1.342	2.552

$R^2 = 0.313$, N = 37
No significant variables

The second of the two regressions, with the independent variable "Crime Index," yielded the results seen in Table 12. The number of valid cases was reduced from seventy-six to fifty-seven because of missing values in one or more of the independent variables. Four variables were significant using a Wald test: Microcredit, Lan_Spanish, Research_4, and Chemical_Fertilizer. Microcredit was negatively signed while the other three variables were positively signed.

Table 12. Parameter estimates with dependent variable: Crime Index

Parameter	Estimate	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Constant	-.224	.976	-2.193	1.746
Microcredit**	-2.515	1.023	-4.580	-.450
Total_Owned	-.029	.031	-.092	.034
Gender	1.173	.891	-.626	2.972
Ed_Elementary	-.075	.317	-.716	.565
Ed_Middle_Plus	-1.249	.798	-2.860	.362
Lan_Spanish**	1.342	.637	.057	2.628
Lan_Kiche_and_ Spanish*	.943	.569	-.205	2.091
Research_2	.191	.688	-1.198	1.580
Research_3	-.175	.563	-1.312	.962
Research_4*	.678	.355	-.039	1.395
Vaccinate	.074	.337	-.607	.754
Herbicide	-1.050	1.059	-3.187	1.086
Insecticide	-.538	.419	-1.384	.307
Chemical_ .Fertilizer*	1.706	.902	-.114	3.526

$R^2 = 0.374$, N = 57
** significantly different from 0 at the 0.05 level

* significantly different from 0 at the 0.1 level

A test was also run to check the correlation between the crime and conflict indices. The results, presented in Table 13, show very little correlation.

Table 13. Correlations

	Conflict Index N = 49
Crime Index N = 76	.070 N = 47

6. Discussion

The most surprising of the results is that the correlation between the crime and conflict indices is extremely weak. One possible explanation for this is that perceptions of crime and conflict are not, in fact, closely related. This would be the case if people are able to accurately distinguish between common criminal activity and the manifestations of conflict between two or more parties, or it could mean that conflict is unlikely to translate into criminal activity. An alternative explanation is that there were methodological errors. Crime is a tangible concept—a person is typically aware of having been the victim of a crime. Reports of crime appear in the newspaper every day. Conflict, on the other hand, is much more abstract if it does not result in physical action. Even when it does result in physical action, it may be difficult to connect the physical action to the underlying conflict. Therefore, naming conflict is much more difficult than naming crime. In the case of this study, the issue was further complicated by language

barriers. Many people who were interviewed in Spanish had difficulty understanding what was meant by the word conflict, presumably because Spanish was not their first language. For example, when asked if there was any conflict as a result of changes in agriculture (question 35), one person replied affirmatively, and when asked for detail, said, "Who knows what happened? (*¿Saber qué pasó?*)" (#62). Another who replied affirmatively, when asked for more detail said, "There are people who don't use organic fertilizer and the earth knows that it is [chemical] fertilizer it's given. That is the conflict" (#41). Is this answer the result of misunderstanding the language, or is the personification of the earth and the indication of a conflict between earth and farmer the result of a different worldview? Those people who were interviewed in K'iche' often gave responses indicating that they did not fully understand the questions that asked about conflict, although they were able to respond to more concrete questions regarding their farming methods. Language issues may also be part of the explanation for why the dummy variable indicating researcher #4 was significant at the $p = 0.1$ level. Researcher #4 conducted many interviews in K'iche' and may have used translations somewhat different from the other interviewers.

When crime was on the left hand side, the variables Microcredit and Lan_Spanish were significant at the $p = 0.05$ level. The negative sign on Microcredit means that participants in the microcredit program were less likely to perceive elevated levels of crime. Causation has not been established, but a possible explanation for this is that the participants are part of an organized social group. Perhaps, participation in this group provides a level of protection that less connected members of the community

don't benefit from. Alternatively, participation in the group may merely provide the *perception* of security, but in fact the members are subject to the same rates of crime as everyone else.

The positive sign on Lan_Spanish indicates that native Spanish speakers are more likely to perceive elevated levels of crime. This variable was included as a proxy for ethnicity and culture. A potential explanation for the sign of this variable is that native Spanish speakers, a minority in Santa Cruz, are to some extent outsiders, and for that reason feel less secure. Alternatively, the ability to speak Spanish may provide them with wider access to information, making them more aware of criminal activities beyond the local area. Ability to read the Spanish-language *El Diario*, a very popular national tabloid which frequently carries stories of violent crime, may increase the perception of crime.

Surprisingly, Chemical_Fertilizer was the only technological variable that was significant in either regression. Its positive sign indicates that persons who use chemical fertilizer are more likely to perceive elevated levels of crime. This corresponds to hypothesis H_{4B}, but the lack of a similar relationship to conflict weakens support for the hypothesis. Does this mean that agricultural technologies are causing relatively little direct crime and conflict in Santa Cruz? Probably so, because of the relative homogeneity of their use or disuse. Chemical fertilizer was a source of conflict when it was first introduced in Quiché (Falla, 1972). Despite near-universal adoption of chemical fertilizer, this research's interviews indicated that there is still considerable suspicion surrounding all types of agricultural chemicals. One indication of this is that

insecticide and herbicide have been adopted by very few farmers. The homogeneity of agricultural chemical use leaves little room for differentiation between farmers who use agricultural chemicals and those who do not. Overall, the results do not support the hypotheses that technology affects perceptions of crime and conflict.

F. Agricultural Technology and Recovery from Conflict

> ...as unpopular as it may be to say, every practicing scientist, whether in the physical, biological, or social sciences has a moral responsibility to consider the implications of his or her work for contributing to the ultimate amelioration of the human condition. (Burkhardt, 1991, p. 325)
>
> [The amount of conflicts and disagreements among people today] are the same as they were before the signing of the peace. There is no change. They told us they would make reparations for the damages that they did to us, but they didn't do it. They did not replace the burned houses. They killed people. My father disappeared. (#60, question 38)

1. Literature Review

What is agricultural technology's role in conflict recovery? Section A reviewed the devastating impact that conflict can have on agriculture, while section D examined the important role investments in agricultural technology play in poverty alleviation and conflict prevention. Taken together, one can conclude that investments in agricultural technology in post conflict areas will work to prevent a country or region from falling into a cycle of poverty-induced conflict. Improvements in agricultural technology and markets in post-conflict areas can have the impact of reducing poverty and environmental degradation, thereby eliminating the feedback loop that fuels further conflict. However, special care should be taken when introducing net labor-saving technologies to ensure that displaced laborers have positive options to turn to.

Countries that recently experienced civil conflict are likely to have many competing demands for a small budget, therefore "aid financing can help create the conditions for peace and human development" (United Nations Development Program, 2005). Successful examples of achieving food security by investing in agriculture are post-war Korea, where agriculture was rebuilt with U.S. aid money in areas where it had been completely destroyed, and post-World War II Europe, where agricultural infrastructure "remained intact" (Messer, et al., 1998, p. 33). However, Messer and her co-authors contend that modern civil wars do not tend to result in the two extreme cases presented above. Instead, they leave infrastructure severely damaged, "but still-entrenched interests render it impossible to make a fresh start. Traditional ways may no longer be appropriate, but individuals cannot modernize because they are already fully occupied trying to cope in the old underproductive ways" (Messer, et al., 1998, p. 33).

"Rebuilding" agriculture raises the question of what should be rebuilt, from both material and policy perspectives. If, for instance, the conflict was fueled by an inegalitarian social structure that oppressed rural farmers, "rebuilding" the old society is unlikely to result in peace. Post-conflict needs and foreign aid money must improve upon the old society to create a new society that is less likely to fall back into conflict. The rural poor must not be neglected in this work. Tony Addison explains:

> ...the domestic and aid resources used in rebuilding infrastructure and services will have low returns if policies that hold back the livelihoods of smallholders and micro-entrepreneurs are retained. A thorough and early reconsideration of sector policies-especially towards agriculture which is the main livelihood of many of the poor-is therefore needed (Addison, 2005, p. 9)

Of course, while maintaining the goal of improving the structure of agriculture in a country after it has been ravaged by conflict, aid agencies must address immediate needs and avoid creating dependency. "Water may be a first priority for rural populations, followed by tools, seeds, and animals for food production" (Messer, et al., 1998). The CGIAR centers (Consultative Group on International Agricultural Research) helped to rebuild Rwanda and Angola's agriculture after the genocide and civil wars of the mid-1990's as part of their 'Seeds of Hope' and 'Seeds of Freedom' projects (Varma and Winslow, 2005). In the case of Guatemala, recovery is often complicated by the loss of the primary breadwinner. Widowed women have been left with "no material resources...after the destruction of their homes and crops" (Tomuschat, et al., 1999, Conclusions 29). Clearly, for recovery to occur, resources and technology must be provided outside of the agricultural sphere in order to support agriculture. In addition, there are effects of war upon agriculture that will not be repaired with any level of technology or investment. As Tomuschat, et al. (1999) point out: "terror does not automatically disappear when the levels of violence decrease; on the contrary, there are cumulative and lasting effects, which to overcome, require time, effort and the direct experience that things have changed" (Conclusions 47).

2. Conceptual Model

As noted, armed conflict can tremendously disrupt agriculture. When the conflict ends, however, the flows of people and investment may reverse. People who had fled to escape the violence may return to their homes, carrying with them the experiences and knowledge gained while in exile. National and international

reconstruction efforts may invest large sums of money to rebuild the country's or region's infrastructure. Figure 10 shows how conflict may result in the use of new agricultural technology. The damage caused by large-scale conflict draws international attention and aid money to help to rebuild the country. National governments also have an interest in rebuilding, but may face a restricted budget as they emerge from conflict. The influxes of money and people bring with them agricultural technologies that the country's farmers may not have had access to previously.

Displacement of farmers, both internally and externally, is another way in which they are exposed to new agricultural technologies. When the conflict ends and farmers return home, they may attempt to put into practice the techniques and tools that they saw while exiled. The disruption brought about by displacement also causes a breakdown in traditions that are not possible or practical under refugee conditions. Having already broken with tradition while displaced, resettled farmers may become more open to considering alternative farming practices. In this way, development aid and farmer displacement may lead to the adoption of new agricultural technologies.

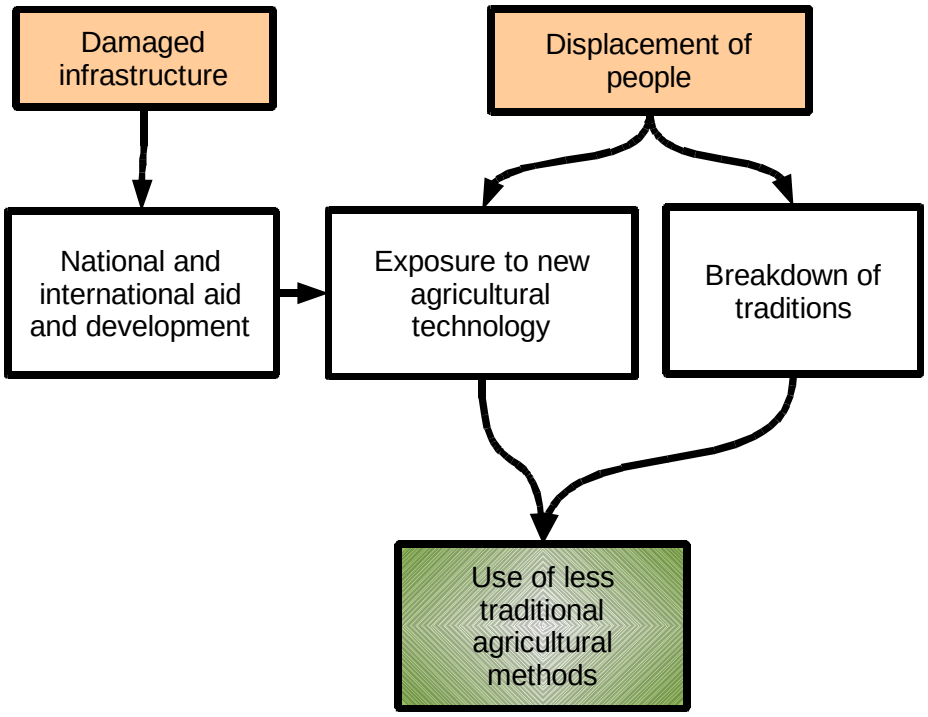

Figure 10. Change in agricultural technology as a result of conflict

3. Agricultural Recovery in Guatemala

Between 1981 and 1983, between 500,000 and 1,500,000 Guatemalans were internally or externally displaced (Tomuschat, et al., 1999), including many from Santa Cruz. Because of their exposure to alternative methods of farming and/or their access to development organizations, these displaced people may have adopted new farming practices. This suggests the following hypothesis: *H_5: Santa Cruz farmers displaced by war use less traditional agricultural technologies*.

4. Methods

Two logit regressions and one multinomial logit regression[4] were used to test H_5. For more information on these models, please see Chapter II. The multinomial logit regression was run using the software package LIMDEP (LIMDEP, 2007). A logit model was applied for dependent variables insecticide and animal vaccination. For each dependent variable, a one (1) indicated that the technology was used and a zero (0) indicated that it was not used. The dependent variable of the multinomial logit regression included four mutually exclusive classifications of the method of fertilization used: organic only, synthetic and active organic, synthetic and passive organic, or synthetic only. Descriptions of the four categories follow:

- **Organic only** systems did not apply any synthetic fertilizers. Instead, they used one or more of the following means to fertilize their crop: pasture animals on the field, manually apply animal manure to the field, leave or bury plant residue in the field, or manually apply plant residue gathered from the forest floor.
- **Synthetic and active organic** systems applied organic material as described in "organic only." In addition, they also applied synthetic fertilizer.
- **Synthetic and passive organic** systems applied organic material by pasturing animals in the field. In addition, these systems supplemented the organic fertilizer with synthetic fertilizer. The word "passive" is a bit of a misnomer, because pasturing animals in a field is certainly not effortless. "Passive" is

[4] Thank you to Justin Baker for help with the multinomial regression

meant to indicate that no organic fertilizer materials are added to the field by direct human application.

- **Synthetic only** systems relied entirely upon purchased synthetic fertilizer. They did not make use of any organic fertilizer.

The independent variables were the same in all three regressions. They included many of the same variables as those used for the regressions in section E: participation in microcredit, the amount of land owned, primary school education, middle school or higher education, speaking Spanish as a native language, and speaking both Spanish and K'iche' as native languages. In addition, a binary variable was added to indicate whether or not the interview respondent had emigrated during the war. The binary variable for emigration was derived from the survival strategies data gathered in section C.

5. Results

Complete results for the three regressions can be found in Appendix C. Only one instance of a statistically significant variable occurred in the three regressions. In the multinomial logistic regression, the microcredit variable was significant for the "Synthetic and Active Organic" case. The interpretation of this result is that participation in the microcredit program increases the probability of choosing the farming system "Synthetic and Active Organic" over the baseline "Organic Only." Microcredit also appeared to increase the likelihood of choosing "Synthetic and Passive Organic" or "Synthetic Only" over "Organic Only," although the variable was not statistically significant for these cases ($p < 0.2$).

The dataset included only six cases of persons who had emigrated, and one of these could not be included in the model because it was missing a value for another variable. The small number of instances of emigration, combined with a relatively large number of variables, made the multinomial regression difficult. Consequently, the model was modified slightly. The dependent variable was reclassified to be binary: the "Organic Only" and "Synthetic and Active Organic" categories were merged and assigned the value 0, and the "Synthetic and Passive Organic" and "Synthetic Only" categories were merged and assigned the value 1. The new dependent variable was now divided along lines of greater or lesser dependence upon synthetic fertilizer. A logit regression was run with the new dependent variable. Two variables from this regression were found to be significant: Lan_Spanish ($p = 0.008$) and Lan_Kiche_and_Spanish ($p = 0.012$). The signs on both variables were negative, indicating that native Spanish and bilingual speakers were more likely to depend primarily on chemical fertilizer (Table 14). As can be seen from Table 15, this model performed better (80% correct) than a naive model (70% correct).

Table 14. Parameter estimates with dependent variable: Binary fertilizer type*

	B	S.E.	Wald	df	Sig.
Emigrated	-0.755	1.526	0.245	1	0.621
Microcredit	0.726	0.908	0.639	1	0.424
TotalOwned	-0.020	0.052	0.144	1	0.704
Ed_Elementary	1.212	0.799	2.301	1	0.129
Ed_Middle_Plus	0.954	1.945	0.241	1	0.624
Lan_Spanish***	2.726	1.021	7.131	1	0.008
Lan_Kiche_and_Spanish**	2.468	0.987	6.251	1	0.012
Constant	-2.830	1.137	6.196	1	0.013

N = 60

* Dependent variable = 0 if fertilizer type is "Organic Only" or "Synthetic and Active Organic" categories; Dependent variable = 1 if fertilizer type is "Synthetic and Passive Organic" or "Synthetic Only."

*** significantly different from 0 at the p = 0.01 level
** significantly different from 0 at the p = 0.05 level

Table 15. Performance of binary fertilizer type model*

Observed		Predicted		
		Binary Fert Type		Percentage Correct
		0	1	
Binary Fert Type	0	38	4	90.5
	1	8	10	55.6
Overall Percentage				80.0

* Binary Fert Type = 0 if fertilizer type is "Organic Only" or "Synthetic and Active Organic" categories; Binary Fert Type = 1 if fertilizer type is "Synthetic and Passive Organic" or "Synthetic Only."

6. Discussion

No variable other than microcredit was remotely significant for the original three regressions. The most obvious interpretation of this variable's significance is that microcredit participants are using their loans to purchase chemical inputs, although other interpretations are certainly possible. It may be that more progressive farmers, those who purchase chemical inputs, are also more likely to participate in microcredit.

Results from the final regression indicate that the most significant determinant of whether or not a Santa Cruz farmer adopts the use of chemical agricultural inputs is the farmer's native language, a proxy for ethnicity. Of course, the significance of these results is in question, given that the model was the result of adjusting the dependent variable based on the results from previous models. Nevertheless, the results provide information that is worth speculating upon, and they point to an area that may merit future research. The results from this regression indicate that native Spanish speakers were more likely than native K'iche' speakers to use "Synthetic only" and "Synthetic and passive organic" fertilization techniques. The sign for Lan_Spanish was also positive in the regression that placed insecticide use on the left side, though the result was not quite significant (p = 0 .102).

K'iche' resistance to the use of agricultural chemicals may be a result of their cultural emphases on tradition and environmental concerns. As further evidence that there is some tension between the two ethnicities, Table 16 is presented. Twenty-three percent of respondents said that there is conflict between persons who speak different languages (question 63). It is encouraging to see that this is lower than the equivalent

number who said that there was conflict between people who spoke different languages before and during the war (question 64).

Table 16. Conflict between people who speak different languages

	Before and during the war		Currently	
	%	N	%	N
Yes	30%	24	23%	19
No	42%	34	54%	44
NA	28%	23	22%	18

Why was emigration not found to have a significant impact on farmers' use of technologies? Several explanations are possible. The first is that farmers who emigrated may not have come into contact with agricultural technologies different than those they were already using. This might be the case if they went to stay with relatives, sought refuge in the city, or escaped into the jungle. None of these destinations would have been likely to expose the refugees to new, useful agricultural technologies. Another explanation is that farmers who emigrated did, in fact, come into contact with new agricultural technologies but were unable or unwilling to adopt them. Question #65 asked participants if they would like to continue working with the same tools they currently use, or if they would change something. Some farmers replied by saying that they would like to use a tractor, if they could afford it. Many others replied that they

would like to continue using the same tools they currently use, but after a short pause, would say something to the effect, "Well, if we had money, we'd hire a tractor." The point is that Santa Cruz farmers are very much aware of agricultural technologies that they are not currently using, but they are prevented from using them because of financial constraints. The tractor is an extreme case because of its high cost, but many Santa Cruz farmers also limit their use of agricultural chemicals because they lack the money to purchase them, despite the relatively low cost. Poor farmers have relatively few choices regarding agricultural technology. Consequently, the technologies they employ may change very little during and after conflict.

Peace and economic development may help to raise farmers' wealth and lead to more ability to choose amongst technologies. However, a decade after the end of the civil war, Santa Cruz is not optimistic. Figure 11 shows the results of question 38, which asked respondents to compare the current level of conflict to past conflict levels, and question 39, which asked respondents to speculate whether there would be more conflict in the future than there is currently. Many people (33%) said that there are less conflicts and disagreements among people today than there were in the past, but a majority (52%) claimed that they are equal to or greater than in the past. That's not good news for a country that recently ended a 36-year civil war. To make matters worse, 26% said that there will be more conflict and disagreements in the future, compared to 16% who said that there will be less. Does this indicate a failure of development—or a lack of sufficient development effort? If the situation today is comparable to the situation during the civil war, what will Guatemala's future hold?

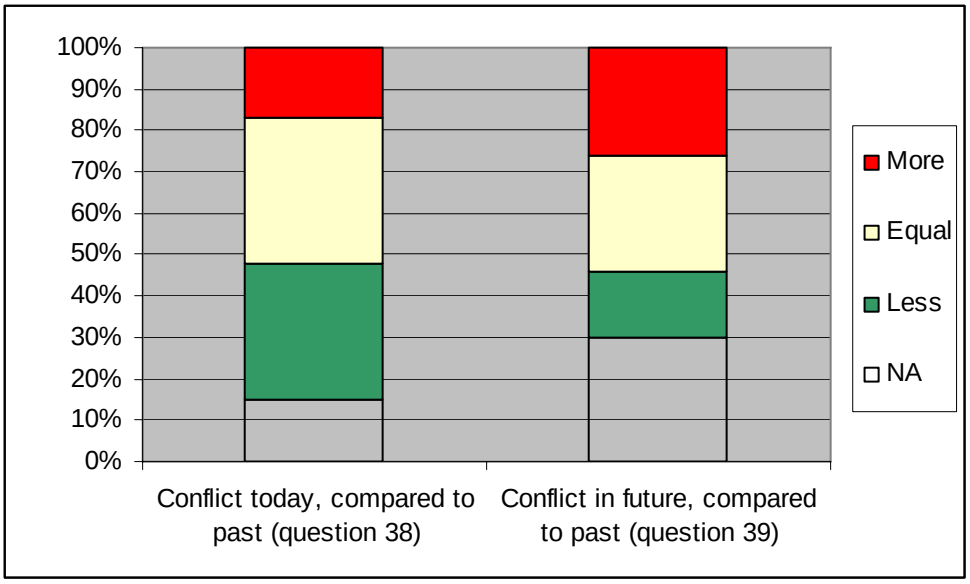

Figure 11. Pessimistic view of future conflict[5]

It would be nice to finish this chapter with a more uplifting story, so the Rwandan recovery effort will be briefly returned to. After the genocide occurred in 1994, much of the countryside's homes, agricultural land, and livestock had been destroyed or severely damaged. In 2001, an agricultural development project started with the goal of putting money in the hands of farmers, many of whom had been widowed or orphaned by the genocide. The project aided existing coffee cooperatives and encouraged others in the production and marketing of high-quality coffee. The success of the project has led to its expansion and provided hope for what the future may bring (Cleboski, 2007).

[5] Responses were not found to differ significantly across age groups

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

A. Introduction

Though the previous chapter was divided into six sections, the literature review demonstrates that these six topics are closely related. For example, the case studies used to illustrate how agricultural technology can cause conflict could have been used to connect natural resources with conflict, and vice versa. Likewise, the agricultural technologies used in recovery are partially determined by the nature of the conflict and its impact upon agriculture. The recovery technologies, in turn, can provoke new conflict, alleviate old conflict, or alter the relationship between people and natural resources.

In the following section, the most important findings of this research are discussed, and each is followed by one or more recommendations. Section C examines some of the weaknesses of the current study and proposes areas for future research.

B. Important Findings and Recommendations

1. Market Access and Labor During Wartime

Poor market access and reduced use of agricultural labor are shown to be two problems for Santa Cruz agriculture during the war. Mitigation of these difficulties would be achieved by increasing farmers' ability to utilize idle labor through home-based production. Capacity to produce for the market could be increased by raising the general level of education, as well as by focusing on trade-based education. These skills

would raise incomes during times of peace and provide resources to fall back on during conflict. Of course, market-based production is not useful when one doesn't have access to the market, so this problem must be addressed as well. During war, market access is largely a security issue. One way to address this is by providing a secure service that would deliver finished products to the market and inputs to producers, without requiring that the producers themselves leave their homes.

2. Water and Land

This research shows that in Santa Cruz, one out of three residents consider water to be a source of conflict. Development of clean, sustainable water resources would benefit many communities by improving health and reducing competition for existing sources. If water resources are adequate to provide for irrigation, there is also potential for raising agricultural productivity by growing a crop in the dry season. However, ambitious projects such as these must proceed with caution, lest the intended beneficiaries become victims of powerful resource grabbers. Other beneficial technologies would include advances in water harvesting and water saving technologies, such as more efficient irrigation works and crops that demand less water. More efficient water use would reduce the regional demand and competition for this scarce resource.

Surprisingly, land was not perceived to be a source of conflict by a large portion of the population, despite the unequal distribution of land in Guatemala, which may limit a country's agricultural productivity (Vollrath, 2007). Nevertheless, a well-planned redistribution of land that provides beneficiaries with access to the capital, knowledge, and technologies necessary for success may be able to play a role in stabilizing the

society through increased production and the resultant reduced poverty. Such a policy must proceed with caution, keeping in mind that land redistribution was a key issue that led to the 1954 coup and subsequent civil war. If land redistribution is done in such a way as to anger powerful landowners, it could once again result in greater turmoil rather than less.

3. Alternative Crops

According to the literature, displaced Guatemalans found that some crops, such as banana, cassava, and sugar cane, grew back after having been destroyed by military forces. Research in Santa Cruz revealed the failure of the traditional corn and bean intercropped system in a number of cases. However, research did not indicate that farmers switched to alternative crops during the war, nor did it reveal any crops that were regarded as relatively more war resistant.

This lack of support for what was found in the literature may be due to the unavailability of such alternative crops, indicating that Santa Cruz farmers may benefit from the development of such alternative crops. Cultivation of perennial crops would benefit farmers who are limited in their ability to work in their fields because of conflict. Alternatively, if plant breeders were able to give other agricultural crops resilient qualities such as those possessed by banana, cassava, and sugar cane, it would provide farmers with insurance against periods of conflict. Imagine, for example, if corn possessed the ability to grow back from its roots -- the destruction of indigenous Guatemalan farmers' fields would have been less catastrophic. This sounds far-fetched, but similar research is already underway. Plant breeders of perennial wheat at

Washington State University claim to be "very close" to their goal (Washington State Magazine Online, 2004). The Texas Agricultural Experiment Station is also testing lines bred in Washington (AgNews, 2006). The Land Institute, founded by Wes Jackson in Salina, KS, is striving to create "an agricultural system with the ecological stability of the prairie and a grain yield comparable to that from annual crops" (Jackson, 1996; The Land Institute, 2004). While The Land Institute is pursuing its research for ecological reasons, a potential side effect is that perennial grain crops may provide increased food security to people who live in chronic conflict areas.

4. Rural Development

Rural development is essential to breaking the chronic conflict cycle in developing nations (Pinstrup-Andersen, 2006; Borlaug, 1970). Great opportunities for agricultural and social advancement present themselves when fighting has come to an end and peace agreements have been signed. Unfortunately, these opportunities are not always seized upon. One such recent failure is Guatemala, where ideological warfare has been replaced by escalating rates of violent crime and a lack of opportunity for young people. Ten years after the peace accords were signed, the country has failed to provide security and improve the quality of life for many of its citizens, including farmers. While the problems of security and injustice in Guatemala go far beyond the ability of rural development to solve, rural development *can* make a contribution.

This research shows that Santa Cruz farmers who emigrated during the war do not utilize technologies that are different from their neighbors who did not emigrate, and agricultural technologies appear to have changed little in recent decades. Santa Cruz,

where household income is extremely low and families do not own enough land to support themselves through subsistence agriculture, is an area that is in great need of increased development. Microcredit programs may be particularly useful forms of development because, in addition to the economic benefits they impart, this research has shown that they also have the ability to reduce their participants' perceptions of crime.

5. Ethnicity and Technology Development

Illustrating the importance of ethnicity, this research finds that being a native Spanish speaker increases the perception of crime. In addition, the results suggested that K'iche' speakers may be less likely to depend upon chemical fertilizer than Spanish speakers. If this relationship is generalizable, it highlights the need for cooperative development of technologies that are more acceptable to K'iche' farmers. Instead of simply exporting developed-world technologies, agricultural research should be undertaken in conjunction with local farmers to develop scientifically, culturally, and socially appropriate technologies. Developed-world technologies may provide an excellent starting point for such research.

Leaders who seek to prevent, end, or reduce conflict should consider the role that agricultural technologies may play, in addition to traditional political resolution strategies. The responsible decision to develop, adopt, or introduce an agricultural technology must take into account the social consequences of that decision, including how the new technology may alleviate or contribute to conflict.

6. Causation and Prevention of Conflict

Technologies are not shown to have directly caused or prevented conflict in Santa Cruz. A deeper understanding of these relationships at the community level may require the use of alternative research methodology.

C. Implications for Future Research

Despite the lack of support for some of the hypotheses in the locality of Santa Cruz, the general models of the relationships between agricultural technology and conflict should not be disregarded. Research in other areas of the globe, focusing on different technologies, may arrive at different conclusions.

One important weakness of this study was that it did not include farmers who had abandoned agriculture as a result of the conflict. Future research examining the impacts of war or technology should attempt to include persons who have abandoned farming, for whatever reason. Doing so will allow a more complete perspective of the topic.

Future studies would also benefit from choosing a location where a wider variety of agricultural technologies are employed, and/or a location that has undergone a significant, recent change in agricultural technology. The relatively small number of different agricultural technologies employed in Santa Cruz, combined with the lack of many significant changes to agriculture in the preceding decades, limited the potential of such research in Santa Cruz. When most farmers use the same technology, there are few alternatives for comparison. When technologies have changed little in recent years, there are few impacts of new technology to measure. The lack of technological variation

in Santa Cruz prevented identification of the reasons that technology did not change in the region. A broader cross section would overcome this weakness.

This study was limited to examining impacts at a local level. Future studies may choose to engage in cross-national research that examines how a country's adoption or development of agricultural technology impacts its propensity for conflict.

Finally, an investigation worthy of further research would examine the way a technology's development process impacts its effectiveness and social utility. For example, Stemerding et al. (2002) found that Malian farmers who conducted their own experiments and developed technologies for rice production, using integrated production and pest management (IPM), not only increased profits and decreased expenses in many cases, but were also empowered in their interactions with outsiders. This suggests that cooperatively designed agricultural technologies such as IPM may have greater potential to reduce conflict.

This research concludes with the hope that it will encourage further studies into the relationships between agricultural technologies and conflict.

REFERENCES

Addison, T. 2005. "Agricultural Development for Peace." United Nations University. WIDER Research Paper. 2005/07. Helsinki, Finland

AgNews. 2006. “Perennial Wheat Research Looks at Options for Producers.” 27 November 2006. Available at http://agnews.tamu.edu/dailynews/stories/SOIL/Nov2706a.htm (10 February 2007).

American Heritage College Dictionary, The. 1993. “Technology.” Third Edition. Boston: Houghton Mifflin Company.

Ball, P. 1999. AAAS/CIIDH Database of Human Rights Violations in Guatemala (ATV20.1). Available at http://hrdata.aaas.org/ciidh/data.html (30 January 2007).

Berry, W. 1981. *The Gift of Good Land*. San Francisco, CA: North Point Press.

Black, J. K., and M. C. Needler. 1983. "Historical Setting." In R. F. Nyrop, ed. *Guatemala: A Country Study*. Washington, DC: Headquarters, Dept. of the Army.

Borlaug, N. 1970. *The Green Revolution, Peace, and Humanity.* Nobel Lecture. Oslo, Norway.

Brown, R. M. 1996. "Violence." In C. A. Milner II, C. A. O'Connor, and M. A. Sandweiss, eds. *The Oxford History of the American West*. New York: Oxford University Press, pp. 393-425.

Burkhardt, J. 1991. "Biotechnology, Ethics, and the Structure of Agriculture." In C. V. Blatz, ed. *Ethics and Agriculture: An Anthology on Current Issues in World*

Context. Moscow, ID: University of Idaho Press, pp. 317-330.

Busch, L., W. B. Lacy, J. Burkhardt, and L. R. Lacy. 1991. *Plants, Power, and Profit: Social, Economic, and Ethical Consequences of the New Biotechnologies*. Cambridge, MA: Basil Blackwell, Inc.

Carmack, R. M. 1976. "Ethnohistory of the Central Quiché: The Community of Utatlan." In D. T. Wallace, and R. M. Carmack, eds. *Archaeology and Ethnohistory of the Central Quiché*. Albany, NY, Institute For MesoAmerican Studies, State University of New York at Albany.

Castañeda, C. 1998. *Lucha Por la Tierra, Retornados y Medio Ambiente en Huehuetenango*. Guatemala City: Flacso.

Cleboski, L. 2007. Personal communication. 11 February 2007.

Collier, G. A. 2005. *Basta!: Land and the Zapatista Rebellion in Chiapas*. Third Edition. Oakland, CA: Food First Books.

Collier, P. C. and A. Hoeffler. 2004. "Greed and Grievance in Civil War." *Oxford Economic Papers* 56:563-595.

de Soysa, I., and N. P. Gleditsch. 1999. "To Cultivate Peace: Agriculture in a World of Conflict." International Peace Research Institute, Oslo (PRIO). Oslo, Norway.

de Waal, A. 2005. "Sudan's Historic Peace Deal is Only the Start." *Financial Times*, 13 January 2005. London.

Deng, L. B. 2002. "Confronting Civil War: A Comparative Study of Household Assets Management in Southern Sudan." Institute of Development Studies, IDS Discussion Paper 381. September 2002.

Donald, P. F., R. E. Green, and M. F. Heath. 2001. “Agricultural Intensification and the Collapse of Europe’s Farmland Bird Populations.” *Proceedings of the Royal Society B: Biological Sciences* 268(1462): 25–29.

Dorner, P. 1983. "Technology and U.S. Agriculture." In G. F. Summers, ed. *Technology and Social Change in Rural Areas: A Festschrift for Eugene A. Wilkening.* Boulder, Westview Press, pp. 73-86.

Falla, R. 1972. "Hacia la Revolución Verde: Adopción y Dependencia del Fertilizante Químico en un Municipio del Quiché, Guatemala." *Estudios Sociales*, no. 6:16-51

---. 1994. *Massacres in the Jungle: Ixcán, Guatemala, 1975 - 1982*. Translated by B. Manz. Boulder, CO: Westview Press.

FAOSTAT. 2006. "FAOSTAT Homepage." Available at http://faostat.fao.org/ (20 March 2006).

Fearon, J. D. 2005. “Primary Commodity Exports and Civil War.” *The Journal of Conflict Resolution* 49(4):483-507.

Fox, J. W. 1976. "Quiché Expansion Processes: Differential Ecological Growth Bases Within an Archaic State." In D. T. Wallace, and R. M. Carmack, eds. *Archaeology and Ethnohistory of the Central Quiché*. Albany, NY: Institute for MesoAmerican Studies, State University of New York at Albany.

Gebre, A. 2001. "Conflict Management, Resolution, and Institutions among the Karrayu and their Neighbors." In M. A. Salih, Ton Dietz, and Abdel Ghaffar Mohamed Ahmed, eds. *African Pastoralism*. London: Pluto Press.

Gebremedhin, T. G. 1996. *Beyond Survival: The Economic Challenges of Agriculture & Development in Post-Independence Eritrea*. Lawrenceville, NJ: The Red Sea Press, Inc.

Gleditsch, N. P., P. Wallensteen, M. Eriksson, M. Sollenberg, and H. Strand. 2002. "Armed Conflict 1946–2001: A New Dataset," *Journal of Peace Research* 39(5): 615–637. Data available at http://www.prio.no/jpr/datasets.asp.

Gleick, P. H. 1993. "Water and Conflict: Fresh Water Resources and International Security." *International Security* 18(1):79-112.

Griffith, J. A., E. A. Martinko, and K. P. Price. 2000. "Landscape Structure Analysis of Kansas at Three Scales." *Landscape and Urban Planning* 52:45-61.

Guatemala, Dirección General de Cartografía. 1962. Diccionario Geográfico de Guatemala. Guatemala City.

Guatemala, Instituto Nacional de Estadística. 1994. X Censo Nacional de Población y V de Habitación. Available at http://ccp.ucr.ac.cr/bvp/censos/zip/guate/index.htm (4 November 2006).

Guatemala, Instituto Nacional de Estadística. 2003a. Censos Nacionales XI de Población y VI de Habitación 2002. Guatemala City, Guatemala.

Guatemala, Instituto Nacional de Estadística, 2003b. Tomo I Características Generales de las Fincas Censales. IV Censo Nacional Agropecuario 2003. Available at http://www.ine.gob.gt/censosA.html (4 November 2006).

Handy, J. 1984. *Gift of the Devil*. Boston, MA: South End Press.

Hanson, V. D. 1998. *Warfare and Agriculture in Classical Greece, Revised Edition*.

Berkeley, CA: University of California Press.

Herrera, F. 1966. *Agrarismo Guatemalteco: Sinopsis Histórica*. Guatemala City: Editorial Landívar.

Hightower, J. 1973. *Hard Tomatoes, Hard Times: A Report of the Agribusiness Accountability Project on the Failure of America's Land Grant College Complex*. Cambridge, MA: Schenkman Publishing Company.

Homer-Dixon, T., and J. Blitt. 1998. *Ecoviolence: Links Among Environment, Population, and Security*. Lanham, MD: Rowman & Littlefield Publishers, Inc.

Homer-Dixon, T. F. 1994. "Environmental Scarcities and Violent Conflict: Evidence from Cases." *International Security* 19:5-40.

Hope, H. 2005. "Dip That Tick: Texas Tick Fever Eradication in Arkansas, 1907-1943." The Arkansas Historic Preservation Program. Available at http://www.arkansaspreservation.org/publications/ (11 January 2007).

Human Rights Watch. 2003. "The Iraqi Government Assault on the Marsh Arabs." Human Rights Watch, January 2003.

Hussain, A., and M. Herens. 1997. "Child Nutrition and Food Security During Armed Conflicts." *Food, Nutrition and Agriculture* 19:17-25.

Jackson, W. 1996. *Becoming Native to This Place*. New York: Counterpoint.

Kassa, G. 2001. "Resource Conflicts Among the Afar of North-East Ethiopia." In M. A. Salih, T. Dietz, and A. G. M. Ahmed, ed. *African Pastoralism.* London, Pluto Press.

Land Institute, The. 2004. “Introduction and Mission.” Available at

http://www.landinstitute.org/vnews/display.v/ART/2000/08/10/37a747b43 (12 January 2007).

Levy, E. 1982. “The Responsibility of the Scientific and Technological Enterprise in Technology Transfers.” In R.S. Anderson, P.R. Brass, E. Levy and B.M. Morrison, eds. *Science, Politics, and the Agricultural Revolution in Asia.* Boulder, CO: Westview Press, Inc., pp. 277-297.

LIMDEP. 2007. “LIMDEP.” Available at http://www.limdep.com (10 February 2007).

Manz, B. 1994. "Epilogue: Exodus, Resistance, and Readjustments in the Aftermath of Massacres." In R. Falla. *Massacres in the Jungle: Ixcán, Guatemala, 1975 - 1982*. Boulder, CO: Westview Press.

Meludu, N. 2006. “Conflict Management Strategies for Effective Performance of Agricultural Extension: A Case of Ife – Modakeke Saga in Osun State, Nigeria.” *International Journal of Agricultural Rural Development* 7(1):143-151.

Messer, E., M. J. Cohen, and J. D'Costa. 1998. "Food from Peace: Breaking the Links between Conflict and Hunger." *Food, Agriculture, and the Environment Discussion Paper 24.* Washington, DC: International Food Policy Research Institute.

Moore, K. M., M. Bertelsen, S. Cissé, and A. Kodio. 2005. "Conflict and Agropastoral Development in the Sahel." In K. M. Moore, ed. *Conflict, Social Capital, and Managing Natural Resources: A West African Case Study.* Wallingford, UK: CABI Publishing.

Netz, R. 2004. *Barbed Wire: An Ecology of Modernity*. Middletown, CT: Wesleyan

University Press.

ODHAG (Oficina de Derechos Humanos del Arzobispado de Guatemala). 1998. *Guatemala: Nunca Más: I: Impactos de la Violencia*. Vol. 1. Four volumes. Guatemala City: Oficina de Derechos Humanos del Arzobispado de Guatemala.

Perez-Brignoli, H. C. 1989. *A Brief History of Central America*. Translated by R. B. Sawrey A., and S. S. de Sawrey. Berkeley, CA: University of California Press.

Pinstrup-Andersen, P. 2006. "The Impact of Technological Change in Agriculture on Poverty and Armed Conflict." USDA, March 2, 2006.

Rahmato, D. 1991. *Famine and Survival Strategies: A Case Study from Northeast Ethiopia*. Uppsala: The Scandinavian Institute of African Studies.

Rasmussen, W. D. 1977. "The Mechanization of American Agriculture." In A. Fusonie, and L. Moran, eds. *Agricultural Literature: Proud Heritage-Future Promise*. Washington, D.C., Association of the National Agricultural Library, Inc., and the Graduate School Press, U.S. Department of Agriculture, pp. 295-315.

Rose Johnston, B. 2005. "Volume One: Chixoy Dam Legacy Issues Study: Executive Summary: Consequential Damages and Reparation: Recommendations for Remedy." Santa Cruz, CA. Center for Political Ecology, March 17, 2005.

Ross, M. L. 2004. "What Do We Know About Natural Resources and Civil War?" *Journal of Peace Research* 41(3):337-356.

Schilling, T. Presentation of the SPREAD Project. 15 November 2006. Texas A&M University, College Station, TX.

Schlesinger, S., and S. Kinzer. 2005. *Bitter Fruit: The Story of the American Coup in*

Guatemala. The David Rockefeller Center Series on Latin American Studies, Harvard University. Cambridge, MA: Harvard University Press.

Simmons, C. S., J. M. Tarano T., and J. H. Pinto. 1959. *Clasificación de Reconocimiento de los Suelos de la República de Guatemala*. Guatemala: Editorial del Ministerio de Educación Pública, "José de Pineda Ibarra".

Smith, L. I. 2002. A Tutorial on Principal Components Analysis. Available at http://kybele.psych.cornell.edu/%7Eedelman/Psych-465-Spring-2003/PCA-tutorial.pdf (6 February 2007).

StatSoft, 2003. "Principal Components and Factor Analysis. " Electronic Textbook: StatSoft. Available at http://www.statsoft.com/textbook/stfacan.html (6 February 2007).

Stemerding, P., A. Musch, and Y. Diarra. 2002. *Social Dimensions of Integrated Production and Pest Management: A Case Study in Mali*. Rome: Food and Agriculture Organization of the United Nations.

Strand, H., J. Carlsen, N. P. Gleditsch, H. Hegre, C. Ormhaug, and L. Wilhelmsen. 2005. Armed Conflict Dataset Codebook: Version 3-2005. International Peace Research Institute, Oslo (PRIO). Available at http://www.prio.no/cscw/armedconflict (1 May 2006).

Strom, C. 2000. "Texas Fever and the Dispossession of the Southern Yeoman Farmer." *The Journal of Southern History* 66(1):49-74.

Tofte, A. H. 2004. "War and Cattle: Livelihood Strategies and Perceptions of Wealth and Poverty in Southern Sudan." MS thesis, Agricultural University of Norway. Aas, Norway.

Tomuschat, C., O. Lux de Cotí, and A. Balsells Tojo. 1999. "Guatemala Memory of Silence." Guatemalan Commission for Historical Clarification (CEH). Available at http://shr.aaas.org/guatemala/ceh/report/english/toc.html (1 December 2006).

United Nations. 2006. "UNDP Holds First Counter-Narcotics Workshop for Afghan Legislators." *UN News Centre*. 29 August, 2006.

United Nations Conference on Trade and Development. 2006. "Beyond 20/20 WDS Report Folders: Trade and Commodity Price Indices" UNCTAD Handbook of Statistics Online. Available at http://stats.unctad.org/Handbook/TableViewer/tableView.aspx?ReportId=199 (4 March 2006).

United Nations Development Programme. 2005. "Human Development Report 2005: International Cooperation at a Crossroads: Aid, Trade, and Security in an Unequal World." Available at http://hdr.undp.org/reports/global/2005/ (1 December 2006).

United Nations, Food and Agriculture Organization (FAO). 2000. "The State of Food and Agriculture 2000." FAO Economic and Social Department. Rome.

United Nations, FAO/AGL. 2005. "Afghanistan." AQUASTAT. Available at http://www.fao.org/ag/agl/aglw/aquastat/countries/afghanistan/index.stm (29 December 2006).

United Nations Office on Drugs and Crime. 2004. "Afghanistan Opium Survey 2004." Available at www.unodc.org/unodc/en/crop_monitoring.html (1 December 2006).

United Nations University Institute of Advanced Studies. 2004. "Agriculture for Peace: Promoting Agricultural Development in Support of Peace." UNU-IAS Report. Tokyo, Japan.

Vollrath, D. 2007. "Land Distribution and International Agricultural Productivity." *American Journal of Agricultural Economics* 89(1):202-216.

Ward, D. R. 2002. *Water Wars*. New York: Riverhead Books.

Washington State University. 2004. "Full Circle." Washington State University Magazine Online. Available at http://www.washington-state-magazine.wsu.edu/stories/04-summer/wheat/index.html (10 February 2007).

Wooldridge, J. M. 2006. *Introductory Econometrics,* Third Edition. Mason, OH: Thomson South-Western.

World Trade Organization, (WTO). 2006. "Time Series." International Trade Statistics. Available at http://stat.wto.org/StatisticalProgram/WsdbExport.aspx?Language=E (20 March 2006).

APPENDIX A

ENGLISH VERSION QUESTIONNAIRE

Date_____ Researcher_____

1. Location

Community	Municipio	Departamento
	Santa Cruz	Quiché

2.

Man	Woman

3. How old are you?

18-25	26-35	36-45	46-55	56-65	66-75	76-85	86+

4. Are you…

Married	Living Together	Divorced	Widowed	Single	Separated

5. Have you gone to school? What grade have you finished? (Ask the same of the spouse.)

	None	Elementary	Middle	Secondary	University	NA
Husband						
Wife						

6. How many children do you have? How old is the youngest? How old is the oldest?

Number	Youngest	Oldest

7. What is your native language?

K'iche'	Spanish	

8. What language do you speak at home?

K'iche'	Spanish	

9. Do you read or write any languages?

	K'iche'	Spanish	
Read			
Write			

10. What is your religion?

Catholic	Evangelical (protestant)	Mayan Spirituality	Charismatic	None	

11. What is your profession? spouse's profession? (If does not have spouse, write 'NA')

	Agriculture		
Husband			
Wife			

12. Do you or your spouse have another occupation? What is the other occupation?

	Yes	No
Husband		
Wife		

occupation_____

occupation_____

13. What is the family's total weekly income?14. The house...

			Floor			
Rented	Owned		Earth	Concrete	Tile	

(If the house is rented...) How much do you pay in rent?_____

Roof						
Steel	Thatch	Teja	Duralita	Terraza	Wood	

Is there electricity?			How do you get water?	
Yes	No		Well	Tap

15. (If from a well...) How many minutes is the well from the house?

NA	-5	6-15	16-30	31-45	46-60	60+

16. Does your family have a telephone? Is it cellular or a land line?

Cellular	Land line	No

17. Does your family have a television?

Yes	No

18. Do you know how to use a computer?

Yes	No

19. Do you use email?

Yes	No

20. How many cuerdas or hectáreas of land does your family rent?

Cuerdas		Hectáreas

21. How many cuerdas or hectáreas of land does your family own? (not rented)

Cuerdas		Hectáreas

22. What type of land is it (not rented)? Arable, forest, or other? How many cuerdas or hectáreas?

Arable		Forest			
Cuerdas	Hectáreas	Cuerdas	Hectáreas	Cuerdas	Hectáreas

23. How would you classify your family's land…?

Very productive	Average	Not productive

24. Comparing your family's land with your neighbors' land, how would you classify your land?

More productive	Equal	Less productive

25. Comparing your family's land with the land in other communities, how would you classify your land?

More productive	Equal	Less productive

26. What crops does your family grow? (Ask about each plot of land. Fill the table for each plot.)

Posible crops are: corn, beans, lima beans, peanuts, chayote, apples, bananas, plantains, rice, oranges, amaranth, cardamom, elderberry, vegetables, etc.

Data							
Plot	1	2	3	4	5	6	7
Crops on the plot	Corn, Bean, Lima Bean	Corn, Bean	Corn				
Month Planted							
Own land							
Cuerdas or Hectáreas							
Quintals 1. 2. 3.							
Price 1. 2. 3.							
Distance from house in meters							
Theft is a problem							

(If a crop is close to the house...) Why is it close to the house?

Please explain the process your family uses to farm. (Indicate the techniqes and methods used for each plot. Below, write the phrases that do not fit in the table.)

Prepare the Soil							
Plot	1	2	3	4	5	6	7
Large hoe							
Pickaxe							
Burn							
Paid labor							
Chop with machete							
Crop rotation							
Fallow							
Animals							
Machinery ( )							
Green fertilizer (velvet bean)							
Fertilizing trees							
Shade trees							
Living fence							

Planting							
Plot	1	2	3	4	5	6	7
Hybrid seeds (selected)							
Hybrid seeds (purchased)							
Traditional seeds (selected)							
Traditional seeds (purchased)							
Fertilizer N P K %							
Organic fertilizer							
Sharpened stick							
Large hoe							
Paid labor							

Cultivation, Weeding, Etc.							
Plot	1	2	3	4	5	6	7
Insecticide							
Herbicide							
Sprayer							
Sharpened stick							
Weed with hoe							
Weed by hand							
Weed with machete							
Machinery ( )							
Paid labor							
Hoe for furrows							
Fertilizer N P K %							
Animal fertilizer							
Irrigation							
Integrated pest control							

Harvest, Transport, Storage, Processing							
Plot	1	2	3	4	5	6	7
Harvest by hand							
Sack							
Leave stalks in ground							
Clean with canvas and wind							
Animals for transport							
Animals eat and fertilize							
Plastic storage							
Chemical pill							
Value added/ Processing							

27. Does your family hunt? Does your family gather any food products in the forest/mountain/wilderness? Explain. What tools are used?

Hunt			Gather	
Yes	No		Yes	No

28. Which of the following animals do you and your family raise…? Do you raise any other animals? Indicate which of the following methods and techniques you use for each animal. Do you use any other techniques or methods?

	Chickens	Pigs	Turkeys	Rabbits	Beef Cattle	Dairy Cattle
Number						
Immunizations						
Animal shelter						
Pesticide						
Corral						
Breeding Strategy						
Incubation						
Value Added/ Processing						
Artificial insemination						

	Mules /Horses	Goats	Ducks	Geese	
Number					
Immunizations					
Animal shelter					
Pesticide					
Corral					
Breeding Strategy					
Incubation					
Value Added/ Processing					
Artificial insemination					

29. Did your father grow the same crops? What has changed?

Yes	No

30. How old were you when you first started farming your own land? What crops did you plant?

31. In the past, did you and your family do anything different to grow crops or raise animals? Please explain the things that have changed.

32. Why did these things change? (From the previous three questions.) Where did the idea for the change come from?

Family	Radio	Television	Training	News paper	Signs	Neighbors	Books	Businesses	

33. What were the results of the changes?

Did it change the way people in the community interact? How?

Yes	No

34. Did anyone disagree with your changes in practice? Why?

Yes	No

35. Was there any conflict as a result of the changes? When I say conflict, I am not referring only to large conflicts, such as war. For example, a disagreement between husband and wife could be a conflict, or when a man gets angry at his neighbor. Another example is when someone is killed. All of these are examples of conflict.

Yes	No

36. Did the changes help to resolve any conflicts? What were they?

Yes	No

37. If the changes had not happened, would there have been more conflict? Why?

Yes	No

38. The conflicts and disagreements among people today are (more / equal / less) than in the past?

More	Equal	Less

Why? When did the change take place?

39. In the future there will be (more / equal / less) conflicts and disagreements than there are currently?

More	Equal	Less

Why?

40. For each crop, indicate whether the technique or method used by your family is better, worse, or the same as the techniques and methods used by other people **in this community**.

	Corn	Bean	Lima Bean	Peanut	Banana	Amaranth	Tomato	Chayote	
Better									
Equal									
Worse									

41. For each crop, indicate whether the technique or method used by your family is better, worse, or the same as the techniques and methods used by other people **in surrounding communities.** (Mention the names of specific communities.)

	Corn	Bean	Lima Bean	Peanut	Banana	Amaranth	Tomato	Chayote	
Better									
Equal									
Worse									

42. For each animal, indicate whether the technique or method used by your family is better, worse, or the same as the techniques and methods used by other people **in this community**.

	Chickens	Pigs	Turkeys	Mules / Horses	Donkeys	Goats
Better						
Worse						
Equal						

	Ducks	Dogs	Cats	Rabbits	Sheep	Beef Cattle	Dairy Cattle	
Better								
Worse								
Equal								

43. For each animal, indicate whether the technique or method used by your family is better, worse, or the same as the techniques and methods used by other people **in surrounding communities.**

	Chickens	Pigs	Turkeys	Mules / Horses	Donkeys	Goats	Ducks
Better							
Worse							
Equal							

	Dogs	Cats	Rabbits	Sheep	Beef Cattle	Dairy Cattle	
Better							
Worse							
Equal							

44. Do the people here use new agricultural methods or techniques other than what your family uses? Have they caused conflicts or disagreements?

Techniques →								
Conflict								
No Conflict								

Why?

45. In this area, what person or community has the best agricultural techniques and methods?

46. Is there conflict between these people (from the previous questions) and others? Why? What happens?

Yes	No

47. In this area, what person or community has the worst agricultural techniques and methods?

48. Is there conflict between them (from the previous question) and others? Why? What happens?

Yes	No

49. Is there conflict between people who participate in [ACG / other development organization indicated above] and those that do not participate? Why? What happens?

Yes	No

50. If the family wanted to borrow money for farming, would it be possible?

Sí	No

51. Does your family borrow money to farm? What is the money used for?

Sí	No

52. Is anyone in your family a member of a development organization?

ACG			None

53. From whom does your family learn about agricultural methods?

ACG	Neighbors	Family					None Indicated

54. (In the first row of the table, write the tools and equipment used.) The tools and equipment used by your family in the field...? How often? (Daily, Weekly, Monthly, Yearly)

Tools →			
Rented			
Shared			
Owned			
Cooperative			

55. (If the family irrigates...) Does your family share a source of water for irrigation?

Yes	No

56. In this area, are there or have there been disagreements or conflict over the use of water? What happened?

Yes	No

57. In this area, is there or have there been disagreements or conflict over the use of land? What happened? How was it resolved?

Yes	No

58. During the civil war, did your family continue farming and caring for animals as before, or did you have to do something different? What changed?

Continued the same	Changed

59. During the civil war, what kind of difficulties did you have to plant, care for crops, harvest crops, and care for animals?

60. What did you do to overcome these difficulties?

61. Have people adopted new ways of farming since the end of the civil war? Do they use new tools or machines? Do they raise new animals? What are the new techniques, tools, machines, and animals?

Techniques		Tools and machines		Animals	
Yes	No	Yes	No	Yes	No

62. Why did they make these changes?

63. Is there currently any conflict between people who speak different languages? Why?

Yes	No

64. Before or during the war, was there any conflict between people who spoke different languages? Why?

Yes	No

65. Would you like to continue using the same tools you now use? What would you change?

Yes	No

66. How do people react when a person begins to farm in a new way? (For example, if a person begins using fertilizer, herbicide, or a tractor.)

67. Is there conflict between people who farm differently? Please explain.

Yes	No

68. Is it dangerous for a woman to travel at night?

Yes	No

69. Is it dangerous for a man to travel at night?

Yes	No

70. Consider the crime here. There is…

Much	Some	Little	None

71. That is all of the questions. Is there anything else you would like to say?

APPENDIX B

SPANISH VERSION QUESTIONNAIRE

Fecha_____ Investigador_____

1. Ubicación

Comunidad	Municipio	Departamento
	Santa Cruz	Quiché

2.

Hombre	Mujer

3. ¿Cuántos años tiene usted?

18-25	26-35	36-45	46-55	56-65	66-75	76-85	86+

4. ¿Está usted…

Casado	Unido	Divorciado	Viudo	Soltero	Separado

5. ¿Ha estudiado en algún centro educativo? ¿Qué grado ha cursado? (Pregunte lo mismo de su esposo(a).)

	Ninguno	Primaria	Básico	Secundaria (Bachillerato)	Universidad	NA
Señor						
Señora						

6. ¿Cuántos hijos e hijas tiene usted? ¿Cuántos años tiene el hijo o la hija menor? ¿El o la mayor?

Número	Menor	Mayor

7. ¿Cuál es su idioma materno?

K'iche'	Español	

8. ¿Qué idioma habla en casa?

K'iche'	Español	

9. ¿Escribe y lee usted algun idoma?

	K'iche'	Español	
Leer			
Escribir			

10. ¿Cuál es su religión?

Católica	Evangelio (protestante)	Espiritualidad maya	Carismática	Ninguna	

11. ¿A qué se dedica usted? ¿su esposo(a)? (Si no tiene esposo(a), marque 'NA')

	Agricultura		
Señor			
Señora			

12. ¿Tiene usted o su esposo(a) otra ocupación? ¿Cuál es la otra ocupación?

	Sí	No
Señor		
Señora		

ocupación_____

ocupación_____

13. ¿Cuánto es el ingreso semanal de la familia?

14. La Casa...

			Piso			
Alquila	Propia		Tierra	Cementada	Piso (Azulejo)	

(Si alquila la casa...) ¿Cuánto paga de alquiler?_____

Techo						
Lámina	Paja	Teja	Duralita	Terraza	Madera	

¿Hay energía eléctrica?			¿El agua es de...?	
Sí	No		Pozo	Potable (Cañarías)

15. (Si es de pozo) ¿A cuántos minutos queda de la casa?

NA	-5	6-15	16-30	31-45	46-60	60+

16. ¿Tiene su familia un teléfono? ¿Es célular o de línea?

Célular	De línea	No

17. ¿Tiene la familia una televisor?

Sí	No

18. ¿Maneja usted una computadora?

Sí	No

19. ¿Usa usted correo electrónico (email)?

Sí	No

20. ¿Cuántas cuerdas o hectáreas de terreno alquila su familia?

Cuerdas		Hectáreas

21. ¿Cuántas cuerdas o hectáreas de terreno le pertenecen a su familia? (no alquiladas)

Cuerdas		Hectáreas

22. ¿Que tipo de terreno le pertenece? ¿Cultivable, boscoso, u otro? ¿Cuántas cuerdas o hectáreas?

Cultivado		Boscoso			
Cuerdas	Hectáreas	Cuerdas	Hectáreas	Cuerdas	Hectáreas

23. ¿Cómo es el terreno de su familia…?

Muy productivo	Mediano	Poco productivo

24. Comparando el terreno de su familia con el terreno de sus vecinos, ¿el terreno de su familia es…?

Más productivo	Igual	Menos productivo

25. Comparando el terreno de su familia con el terreno de otras comunidades, ¿el terreno de su familia es…?

Más productivo	Igual	Menos productivo

26. ¿Qué cultivos cultiva su familia? (Llena la tabla para cada parcela. Si responden en cuerdas, tacha la palabra hectáreas.)

Cultivos posibles son milpa, frijol, haba, manía, chayote, manzana, banano, platano, arroz, naranja, amaranto, cardamomo, sauco, hortalizas, etcetera.

Datos							
Parcelas	1	2	3	4	5	6	7
Cultivos en la parcela	Milpa Frijol Haba	Milpa Frijol	Milpa				
Mes sembrado							
Terreno propio							
Cuerdas o Hectáreas							
Quintales 1. 2. 3.							
Precio 1. 2. 3.							
Distancia de la casa en metros							
Robo es problema							

(Si un cultivo está cerca de la casa...) ¿Porqué está cerca de la casa?

Por favor, explique el proceso que utiliza su familia para cultivar su terreno. (Indique las técnicas o los métodos utilizados para cada parcela. Abajo, escriba las frases que no caben en la tabla.)

Preparar el Suelo							
Parcela	1	2	3	4	5	6	7
Azadon							
Piocha							
Quemar							
Empleados pagados							
Chapear con machete							
Rotativo							
Descanso							
Animales							
Maquinaria ( )							
Abono verde (nescafé, mucuna)							
Árboles aboneros							
Árboles de sombra							
Cerco vivo							

Sembrar							
Parcela	1	2	3	4	5	6	7
Semillas mejoradas (escojidas)							
Semillas mejoradas (compradas)							
Semillas criollas (escojidas)							
Semillas criollas (compradas)							
Abono N P K %							
Abono orgánico							
Palo afilado							
Azadon							
Empleados Pagados							

Cultivar, Limpiar, Etc.							
Parcela	1	2	3	4	5	6	7
Insecticida							
Herbicida							
Bomba							
Palo afilado							
Limpiar con azadon							
Limpiar a mano							
Limpiar con machete							
Maquinaria ( )							
Empleados pagados							
Azadon para surcos							
Abono N P K %							
Abono animal							
Riego							
Control de bichos integrado							

Cosechar, Transportar, Guardar, Procesar							
Parcela	1	2	3	4	5	6	7
Cosechar a Mano							
Costal							
Dejar caña en terreno							
Limpiar con lona y viento							
Animales de carga							
Animales comen y abonan							
Tunel de plástico							
Pastilla química							
Valor Agregada/ Procesando							

27. ¿Caza animales su familia? ¿Consigue su familia alguna comida en el monte/selva? Explique. ¿Cuáles son las herramientas utilizadas?

Caza			Consigue Comida	
Sí	No		Sí	No

28. ¿Cuidan usted y su familia los siguientes animales…? ¿Cuidan algunos otros animales? Indique si utilizan los siguientes métodos y técnicas para cada animal. ¿Utilizan otras técnicas o métodos?

	Pollos	Coches	Pavos	Mulas o caballos	Burros	Cabros	Patos
Cantidad							
Vacuna							
Casa de animales							
Desparasitante							
Corral							
Estrategia de reproducción animal							
Incubación							
Valor agregada o procesar							
Inseminación artificial							

	Perros	Gatos	Conejos	Ovejas	Ganado de res	Ganado lechero	
Cantidad							
Vacuna							
Casa de animales							
Desparasitante							
Corral							
Estrategia de reproducción animal							
Incubación							
Valor agregada o procesar							
Inseminación artificial							

29. ¿Cultivó su padre los mismos cultivos? ¿Qué ha cambiado?

Sí	No

30. ¿Cuántos años tenía usted cuando empezó a cultivar su propio terreno? ¿Qué cultivos sembraba?

31. En el pasado, ¿hacían usted y su familia algunas cosas distintas cuando cultivaban y cuidaban animales? Por favor, explique las cosas que se han cambiado.

32. ¿Por qué se cambiaron esas cosas? (De las tres preguntas anteriores) ¿De dónde vino la idea de cambiar?

Familia	Radio	Televisor	Capacitación	Prensa	Letreros	Vecinos	Libros	Empresas	

33. ¿Cuáles han sido los resultados de estos cambios?

¿Cambió la gente su manera de comportarse? ¿De qué manera cambió?

Sí	No

34. ¿Había alguien que no estaba de acuerdo con los cambios? ¿Porqué?

Sí	No

35. ¿Resultó algún conflicto como consequencia de los cambios? Cuando digo conflicto, no quiero decir solamente conflictos grandes como una guerra, sino, por ejemplo, un desacuerdo entre un señor y su esposa puede ser un conflicto. También, si se enoja un señor con su vecino, o si se mata a alguien, estos también son conflictos.

Sí	No

36. ¿Los cambios ayudaron a resolver algun conflicto? ¿Cuáles fueron?

Sí	No

37. ¿Si los cambios no hubieron pasado, habria más conflicto? ¿Porqué?

Sí	No

38. Actualmente ¿el conflicto y desacuerdos entre la gente es (más / igual / menos) que en el pasado?

Más	Igual	Menos

¿Porqué? ¿Cuándo ocurió el cambio?

39. En el futuro ¿habrá (más / igual / menos) conflictos y desacuerdos que actualmente hay?

Más	Igual	Menos

¿Porqué?

40. Para cada cultivo, indique si la técnica o método que utilizan usted y su familia es mejor, peor, o igual a las técnicas o métodos que utilizan las personas **de su comunidad**.

	Milpa	Frijol	Haba	Manía	Banano	Amaranto	Tomate	Chayote	
Mejor									
Igual									
Peor									

41. Para cada cultivo, indique si la técnica o método que utilizan usted y su familia es mejor, peor, o igual a las técnicas o métodos que utilizan las personas **de las comunidades alrededor.** (Menciona los nombres de algunas comunidades)

	Milpa	Frijol	Haba	Manía	Banano	Amaranto	Tomate	Chayote	
Mejor									
Igual									
Peor									

42. Para cada animal, indique si la técnica o método que utilizan usted y su familia es mejor, peor, o igual a las técnicas o métodos que utilizan las personas **de su comunidad.**

	Pollos	Coches	Pavos	Mulas o caballos	Burros	Cabros	Patos
Mejor							
Peor							
Igual							

	Perros	Gatos	Conejos	Ovejas	Ganado de res	Ganado lechero	
Mejor							
Peor							
Igual							

43. Para cada animal, indique si la técnica o método que utilizan usted y su familia es mejor, peor, o igual a las técnicas o métodos que utilizan las personas **de las comunidades alrededor.**

	Pollos	Coches	Pavos	Mulas o caballos	Burros	Cabros	Patos
Mejor							
Peor							
Igual							

	Perros	Gatos	Conejos	Ovejas	Ganado de res	Ganado lechero	
Mejor							
Peor							
Igual							

44. ¿La gente aquí utiliza algunas técnicas o métodos nuevos además de lo que utiliza su familia? ¿Han causado conflictos o desacuerdos?

Tecnologías →								
Conflicto								
No Conflicto								

¿Porqué?

45. En este area, ¿qué persona o comunidad tiene lo mejor de las técnicas o métodos agrícolas?

46. ¿Hay conflicto entre esas personas (de la pregunta previa) y otros? ¿Porqué? ¿Qué pasa?

Sí	No

47. En este area, ¿qué persona o comunidad tiene lo peor de las técnicas o métodos agrícolas?

48. ¿Hay conflicto entre ellos (de la pregunta previa) y otros? ¿Porqué? ¿Qué pasa?

Sí	No

49. ¿Hay conflicto entre gente que participa en [ACG/otra organización de desarollo indicado arriba] y los que no participan? ¿Porqué? ¿Qué pasa?

Sí	No

50. Si la familia quisiera prestar dinero para cultivar, ¿sería posible?

Sí	No

51. ¿Su familia presta dinero para cultivar? ¿Para qué se utiliza el dinero?

Sí	No

52. ¿Es alguien de su familia integrante de una organización de desarollo?

ACG			Ninguno

53. ¿De quien aprende su familia de métodos agrícolas?

ACG	Vecinos	Familia					Ninguno

54. (Coloque las herramientas y equipo utilizadas en la primera fila de la tabla.) Las herramientas y equipo que usa su familia en el campo, ¿las…? ¿Con qué frequencia? (Diario, Semanalmente, Mensualmente, Añualmente)

Herramientas →					
Propio					
Alquila					
Comparte					
Cooperativo					

55. (Si la familia utiliza riego...) ¿Comparte su familia una fuente de agua para riego?

Sí	No	NA

56. En este area, ¿hay o había desacuerdos o conflictos sobre el uso de agua? ¿Qué pasó?

Sí	No

57. ¿Hay o había conflictos o desacuerdos en esta región sobre el uso de terreno? ¿Qué pasó? ¿Cómo se resolvió?

Sí	No

58. Durante el tiempo de la violencia (la guerra civil), ¿su familia siguió cultivando y cuidando animales como antes, o tenía que hacer algo diferente? ¿Qué cambió?

Siguió igual	Cambió

59. Durante el tiempo de la violencia (la guerra civil), ¿qué clase de dificultades tenía para sembrar, cultivar, cosechar, cuidar animales, etcétera?

60. ¿Qué hizo usted para afrontar estas dificultades?

61. Despues de que terminó la guerra civil, ¿la gente ha adoptado nuevas técnicas de cultivar? ¿Usan nuevos instrumentos o máquinas? ¿Crían animales nuevas? ¿Cuáles técnicas, instrumentos, máquinas, o animales?

Técnicas		Instrumentos y maquinas		Animales	
Sí	No	Sí	No	Sí	No

62. ¿Por qué se hicieron los cambios?

63. Actualmente, ¿hay algun conflicto entre personas que hablan idiomas distintas? ¿Porqué?

Sí	No

64. ¿Antes de la guerra, o durante la guerra, ¿había algun conflicto entre personas que hablaban idiomas distintas? ¿Porqué?

Sí	No

65. ¿Le gustaría seguir trabajando con las mismas herramientas que actualmente utiliza? ¿Qué cambiaría?

Sí	No

66. ¿Cómo reacciona la gente cuando una persona empieza a cultivar de una manera distinta? (Por ejemplo, ¿si una persona empieza a utilizar abono o herbicida, o un tractor?)

67. ¿Hay conflicto entre personas que cultivan de maneras distintas? Explique, por favor.

Sí	No

68. Para una mujer, ¿es peligroso viajar por noche?

Sí	No

69. Para un hombre, ¿es peligroso viajar por noche?

Sí	No

70. Considere el crímen que hay aquí. Hay…

Mucho	Mediano	Poco	No hay

71. Ya no hay más preguntas. ¿Quiere usted decir algo más?

APPENDIX C

REGRESSION RESULTS

The following table displays the results of the multinomial logit model described in Chapter IV, section F. The baseline scenario is "Organic Only" for the dependent variable, and the results below should be interpreted accordingly. For instance, the positive sign on the variable "Microcredit" in the "Synthetic and Active Organic" catagory indicates that participation in a microcredit program increases the probability of choosing "Synthetic and Active Organic" over the baseline "Organic Only."

		B	S.E.	t-stat	P-value
Synthetic and Active Organic	Emigrated	30.121	2037300.000	0.000	1.000
	Microcredit***	3.161	1.122	2.817	0.005
	Total_Owned	-0.003	0.008	-0.419	0.675
	Ed_Elementary	0.466	0.896	0.520	0.603
	Ed_Middle_Plus	-0.475	0.898	-0.530	0.596
	Lan_Spanish	26.950	1539990.000	0.000	1.000
	Lan_Kiche_and_Spanish	-2.467	1.666	-1.480	0.139
Synthetic and Passive Organic	Emigrated	28.843	2037300.000	0.000	1.000
	Microcredit	1.690	1.166	1.449	0.147
	Total_Owned	-0.004	0.008	-0.529	0.597
	Ed_Elementary	0.736	0.901	0.817	0.414
	Ed_Middle_Plus	-0.744	0.902	-0.824	0.410
	Lan_Spanish	27.719	1539990.000	0.000	1.000
	Lan_Kiche_and_Spanish	-1.072	1.553	-0.690	0.490
Synthetic Only	Emigrated	-0.512	2947620.000	0.000	1.000
	Microcredit	1.746	1.163	1.502	0.133
	Total_Owned	-0.004	0.008	-0.431	0.666
	Ed_Elementary	-0.105	0.934	-0.113	0.910
	Ed_Middle_Plus	0.097	0.935	0.104	0.917
	Lan_Spanish	28.635	1539990.000	0.000	1.000
	Lan_Kiche_and_Spanish	0.239	1.501	0.160	0.873

N = 60
***significantly different from 0 at the p = 0.01 level

Chi squared	6.82
Degrees of freedom	18
p value =	0.991

The following are the results from two logit models described in Chapter IV, section F.

Dependent variable: Insecticide

	B	S.E.	Wald	df	Sig.
Emmigrated	1.804	1.150	2.461	1	0.117
Microcredit	-0.358	0.822	0.189	1	0.663
TotalOwned	0.008	0.039	0.037	1	0.848
Ed_Elementary	-0.508	0.714	0.505	1	0.477
Ed_Middle_Plus	-21.164	22,310.634	0.000	1	0.999
Lan_Spanish	1.508	0.922	2.672	1	0.102
Lan_Kiche_and_Spanish	-0.317	1.233	0.066	1	0.797
Constant	-1.216	0.905	1.806	1	0.179

N = 60

Observed		Predicted		
		Insecticide Use		Percentage Correct
		0	1	
Insecticide	0	47	1	97.9
	1	10	2	16.7
Overall Percentage				81.7

Dependent variable: Vaccinate

	B	S.E.	Wald	df	Sig.
Emmigrated	0.428	1.230	0.121	1	0.728
Microcredit	-0.115	0.734	0.024	1	0.876
TotalOwned	0.028	0.044	0.411	1	0.521
Ed_Elementary	0.412	0.639	0.415	1	0.519
Ed_Middle_Plus	19.940	21,366.382	0.000	1	0.999
Lan_Spanish	20.466	13,784.799	0.000	1	0.999
Lan_Kiche_and_Spanish	-0.572	0.878	0.425	1	0.515
Constant	0.382	0.859	0.197	1	0.657

N = 60

Observed		Predicted		
		Vaccinate		Percentage Correct
		0	1	
Vaccinate	0	1	16	5.9
	1	0	43	100.0
Overall Percentage				73.3

VITA

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