sustainable agriculture use throughout the entire region of each site. We did not have the time or resources to do this. We do, however, discuss some implications of sustainable agriculture for regional deforestation impacts in the ***Putting the Findings in Perspective*** section of this publication.

- **Our data on crop outcomes and inputs are primarily recall data.** Almost all of our data came from farmers' recollection of past agriculture outcomes over a four-year period. These data may, therefore, be influenced by farmers' ability to remember details about past years. We overcame this problem, in part, by using the data for the most recent complete year of harvests for most of our analysis. Some of our results may be biased because farmers who use sustainable agriculture may have been inclined to answer questions in a way they thought would please the interviewers. This potential bias may be particularly noteworthy in our results on the use of fire to prepare agricultural fields. We did, however, attempt to triangulate farmers' responses as much as possible to minimize bias.
- **Our results are limited to the characteristics of our samples.** By narrowing our sample, we were able to come up with clear and precise findings for the areas included in our study. Our findings are, therefore, particularly useful to other sites with similar environmental, physical, socioeconomic, cultural, and institutional characteristics.
- **Our analysis is limited to specific sustainable agriculture techniques.** The farmers included in our samples only adopted a limited subset of sustainable agriculture techniques. We can, therefore, say little about the potential conservation impacts of the techniques that were not adopted by farmers. Farmers' willingness to adopt a specific technique, however, can be interpreted as an indicator of the technique's success in terms of its socioeconomic value and, to a lesser extent, its conservation importance. Although farmers chose to adopt only one or two techniques, this does not compromise the representativeness of the study results. In fact, because two independent projects arrived at the same primary technique, there is some evidence that supports the notion that these two sites, and the behavior we observed in farmers related to sustainable agriculture adoption and use, are typical.
- **We only included projects carried out by NGOs.** Our research is limited to those sustainable agriculture projects that are implemented by local conservation organizations. Results may be different for similar projects implemented by development organizations or government agencies.
- **Our sample came from one region of Latin America.** The distance between our two studies sites is relatively small and, in many ways, the characteristics of these two sites are very similar. Had we included other sites from around the world, our results might have been different. However, many of the characteristics found in our sample also are found in many other countries, and we believe that our results will be useful to others working under similar conditions.
- **We included only subsistence crops in our analysis.** We did not look at cash crops because most sustainable agriculture projects with a conservation goal have focused on subsistence farmers in agricultural frontiers. We believe that the results would be different for cash crops, especially those that mimic secondary forests, such as shade-grown coffee and cardamom.

Despite these caveats, the strength of association and consistency in the study results lead us to believe that we arrived at some pretty telling insights. While prudence should be used to interpret and generalize our results — as is the case with all studies of this nature — we believe that the findings can be of great use to conservation project managers around the world who are attempting to implement similar projects.

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*For the complete in-depth results from both study sites, see the two case studies listed in the Reference section of this publication or visit **www.BSPonline.org**.*

In this section, we present the results of our analysis from our study sites in Guatemala and Mexico. Much of our analysis is associated with agricultural outcomes, and it is a well-known fact that agricultural production and yield often vary from harvest to harvest. At both sites, farmers generally enjoy two harvests annually: the first takes place in April-May, and the second, main harvest occurs in November-December. In addition to collecting the same data for each of these harvests, we also collected data for four years of harvests from 1995 to 1998. We collected these additional data to control for variation between years. All data were based on farmers' recollections of past outcomes.

In our analysis, we combined area planted, production, and yield data for the two crops for each year to create total annual amounts. For much of our analysis, we wished to link sustainable agriculture use with conservation outcome. Therefore, we wanted to allow as long as possible for project implementation at each site to increase our chances of observing any possible effects. Ideally, we would have used the crop data we collected for 1998. Unfortunately, because of issues related to the timing of the study, we had to complete the data-collection phase just before the second harvest of 1998, so our data are incomplete for that year. Therefore, for those analyses in which we want to observe the maximum effect of sustainable agriculture, we use the latest year for which we have complete crop data — 1997.

Subsistence maize production was the focus of this study.

We designed the study to examine both subsistence and cash crops. After completing the data-collection phase, however, we concentrated our analysis on maize production because there appeared to be little variation between the SA User and SA Non-User groups with respect to the cultivation of other crops, including beans, pepper, coffee, and cardamom. As we mentioned earlier, most sustainable agriculture interventions, including those that took place at the two sites in our study, focus principally on subsistence crops. At both of our study sites, maize is the primary subsistence crop and is the major target of sustainable agriculture activities. For these reasons, almost all of our analyses of crop characteristics, including area planted, production, yield, and inputs, center on maize.

Although we designed the data-collection instruments to collect information on multiple plots cultivated by each farmer, we discovered during the data-collection phase that most farmers had only one primary plot of land devoted to maize. In our analysis, note that we use either farmers or plots of land as our unit of analysis, depending on the question we are trying to answer.

The data analysis phase of this study proved to be the most challenging aspect of our work. Given the complexity of trying to isolate the effects of sustainable agriculture projects on conservation outcomes, we needed to use many different types of data analyses and statistical tests. In addition to requiring a sophisticated level of knowledge related to statistics, our analysis also required a high level of proficiency in the use of statistical software. For these reasons, we found it necessary to hire a statistician to assist us with the analysis.

While this specialist was not part of the study team during the conceptualization and design phases of the project, she was integrated into the team soon after data collection began. She worked closely with BSP, Línea Biósfera, and Defensores de la Naturaleza to help analyze the data from each of the sites individually and in combination for our final analysis. During the data-collection phase of the study, each country team met frequently with BSP and our analysis specialist.

In this section, we provide separate analyses from the Guatemala and Mexico sites, and we provide combined analyses from the two sites where the results are insightful. Most of the results we present compare only two factors (*bivariate* analysis) but, where appropriate, we also present the results of looking across more than two factors (*multivariate* analysis).

*The **P value** is a way of gauging the likelihood that the difference we see in our analysis is due to chance or some random distribution of the data. So, for example, a P value of 0.01 simply means that there is a 1% chance that the difference we see is the result of chance and, conversely, we can be 99% confident that the difference we see is a real one. With our research design and sample, a P value of less than 0.05 ($P < 0.05$) can be regarded as being statistically significant. When an analysis is statistically significant, it means that the pattern or association that we see between two variables is very strong. Throughout this document, we are careful to use the word "significant" only in the statistical sense.*

For our bivariate analysis, we used two types of statistical tests to see if there was a difference between the two variables we were analyzing. If the data we were analyzing were continuous, we used the t-test of significance. If the data we were analyzing were categorical, we used a X^2 (chi-square) test of significance. We also include the *P value* for each of our statistical analyses. And we use the convention of "n" to denote the sample size. In some of the results, you will see "n (%)" in titles or headers, signifying that both numbers and percentages are shown in the corresponding tables. Sometimes the number of farmers or plots in a particular analysis will be lower than the totals we have in the sample. This is most commonly the result of missing data and information.

In addition to statistical significance, we discuss programmatic significance in our analysis. At times, statistical analysis may produce results that, in the real world, have little relevance. In other words, just because a relationship between two variables may be statistically significant, it does not mean that the relationship is noteworthy. Conversely, sometimes an analysis does not turn out to be statistically significant, but the results are extremely important from a practical perspective. We might find, for example, that a certain sustainable agriculture technique consistently saves, on average, 20% of the total amount of labor farmers need to invest in their plots to prepare them for planting. While this relationship may not prove to be statistically significant for a variety of reasons, it is probably extremely important to farmers!

The Importance of Looking Beyond Statistical Significance

Paying attention to both statistical and programmatic significance is extremely important when conducting data analysis, particularly as it relates to testing the utility of a specific tool or strategy for achieving conservation success. Relying merely on statistical significance can be dangerously misleading. For example, we might find that there is a statistically significant relationship between farmers' maize yields and their use of a particular brand of machete that appears to be physically identical to all other brands. Perhaps we find that farmers who use Macho brand machetes have consistently and significantly higher yields than farmers who use other brands. Do we immediately run out and buy a whole bunch of Macho brand machetes and distribute them to farmers all over our project area with the expectation that they will suddenly, and somewhat magically, lead to increases in crop yields? Probably not.

Upon further investigation, we might find that those farmers who live in the valley where land is flat and fertile have higher crop yields. Investigating even further, we find that it just so happens that the sole storeowner who sells agricultural tools in the valley carries only the Macho brand of machete, whereas the storeowners further up the mountainside carry many different brands. A more meaningful relationship, we discover, is between geographic location — including environmental, physical, and biological factors — and crop yield.

In our bivariate analysis, we sometimes talk about *odds ratios*. An odds ratio (OR) indicates the increased likelihood one group has over another for a given factor. So for example, let us compare yields for farmers who use chemical fertilizers with those of farmers who don't. If we came up with an OR of 2.3 for those who use fertilizer, that means that farmers who use fertilizer are 2.3 times as likely to have a high yield than those who don't.

The purpose of our multivariate analysis was to determine what combination of variables is most predictive of a certain outcome. So, for example, you will see below that the outcome of the amount of area planted to maize by farmers in Mexico is primarily a function of: (1) total amount of labor invested in the plot, (2) number of years a farmer has worked his plot, (3) family size, and (4) user status. The advantage of multivariate analysis over bivariate analysis is that it provides the opportunity to gauge the relative importance of one variable over others.

For our multivariate analysis, we used two types of statistical tests as well. If the variable we were trying to predict (the *dependent* variable) was continuous, we used linear regression. If the dependent variable was categorical, we used logistic regression. In both of these types of analysis, our goal was to find those variables that best predict the outcome of the dependent variable. Each of these analyses provides information about how changes in multiple variables can be predictive of the dependent variable. The combination of these predictor variables (or *independent* variables) is often referred to as a "model." The statistic we use that describes the extent to which the model of independent variables accurately describes the dependent variable is called the R^2.

The R^2 statistic is expressed as a value from 0 to 1. It reflects the extent to which the independent variables in the model explain the variance in the dependent variable. The closer the value is to 1, the better the model describes the dependent variable. A value of 1 would mean that the independent variables explain 100% of the variance in the dependent variable.

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We evaluate the extent to which our analysis supports each Conventional Wisdom with the scale and symbols shown below. This design allows you to quickly assess our findings.

Conventional Wisdom Scale

There is strong evidence that agrees with the Conventional Wisdom.

AGREES ■ □ □ □ □ DISAGREES

There is some evidence that agrees with the Conventional Wisdom.

AGREES □ ■ □ □ □ DISAGREES

It is unclear whether the evidence agrees or disagrees with the Conventional Wisdom or the results are mixed.

AGREES □ □ ■ □ □ DISAGREES

There is some evidence that disagrees with the Conventional Wisdom.

AGREES □ □ □ ■ □ DISAGREES

There is strong evidence that disagrees with the Conventional Wisdom.

AGREES □ □ □ □ ■ DISAGREES

Direct Impact of Sustainable Agriculture on Biodiversity

The first section of our framework looks at the direct impacts of sustainable agriculture projects on biodiversity, including amount of area under cultivation, fallow area and duration, and contamination.

Area Planted to Subsistence Crops

Conventional Wisdom: Adoption of sustainable agriculture techniques for subsistence crops leads to a reduction in the area of land that farmers need to have under cultivation to meet household demands. Reduction in demands for new agricultural lands means less need to deforest new lands, thus reducing rates of deforestation.

OUR ANALYSIS AGREES □ □ ■ □ □ DISAGREES WITH THE CONVENTIONAL WISDOM

According to the Conventional Wisdom, for sustainable agriculture to affect rates of deforestation, it is necessary for two intermediate outcomes to occur: crop yield (production/unit of area) must improve and this must, in turn, lead to a decrease in the amount of land a farmer needs to plant to feed his family. So, in addition to looking solely at area planted, we need to examine the results of our analysis of farmers' yields at both our study sites. In addition, to understand what influences yield, we need to look at a variety of other factors besides the use of sustainable agriculture. These factors, such as the use of fertilizer and pesticide and the amount of labor the farmer invests in his plots, could disproportionately increase yield between farmers. Other factors, such as pest infestation, could decrease yield. We included these factors and other potentially confounding variables in our data collection and analysis.

Similarly, area planted can be influenced by many different environmental and social factors other than sustainable agriculture. We controlled for many of these variables, including family size, soil quality, rainfall, and slope, in our sampling strategy. We included others, such as the sale of crops, availability of labor, access to credit, and land ownership, in our data collection and analysis.

Bivariate Analysis

If we look at area planted to maize at the farmer level at both sites, we see that Guatemalan farmers who use sustainable agriculture are significantly more likely to plant *more* area to maize than those who do not use sustainable agriculture — just the opposite of what the Conventional Wisdom predicts. But Mexican farmers who use sustainable agriculture plant significantly *less* area than farmers who do not use sustainable agriculture — just what the Conventional Wisdom predicts. On the surface, these results seem to be contradictory. As you will see later, they are, in fact, completely logical.

Average Area Planted to Maize in Hectares for SA Users and SA Non-Users, for 1997 – Guatemala and Mexico

SITE	SA USERS (n)	SA NON-USERS (n)	P VALUE
Guatemala	*1.2 (152)*	*0.9 (150)*	*0.002*
Mexico	*1.9 (149)*	*2.4 (150)*	*0.015*

As shown in the following table, the average plot size is significantly different between plots in which sustainable agriculture is used and plots in which it is not used in both Guatemala and Mexico. Note, however, that again the relationship is opposite between the two sites. In Guatemala, SA Plots are significantly larger than Non-SA Plots. In Mexico, SA Plots are significantly smaller than Non-SA Plots. These results are similar to the user-level results because most farmers have only one plot.

Average Area Planted to Maize in Hectares for SA Plots and Non-SA Plots, for 1997 – Guatemala and Mexico

SITE	SA PLOT (n)	NON-SA PLOTS (n)	P VALUE
Guatemala	*1.2 (167)*	*1.0 (147)*	*0.056*
Mexico	*1.8 (150)*	*2.4 (145)*	*0.000*

Farmers experiment with sustainable agriculture – used on the right side, but not on the left side of the photo.

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When we look at the yield data, we see some even more interesting results. SA Users and SA Non-Users in Guatemala have almost identical yields. But in Mexico, yield is significantly higher for the SA Users than for the SA Non-Users. As far as programmatic significance goes, the difference in Mexico is extraordinary: SA Users yield on average 1.5 times more maize than SA Non-Users.

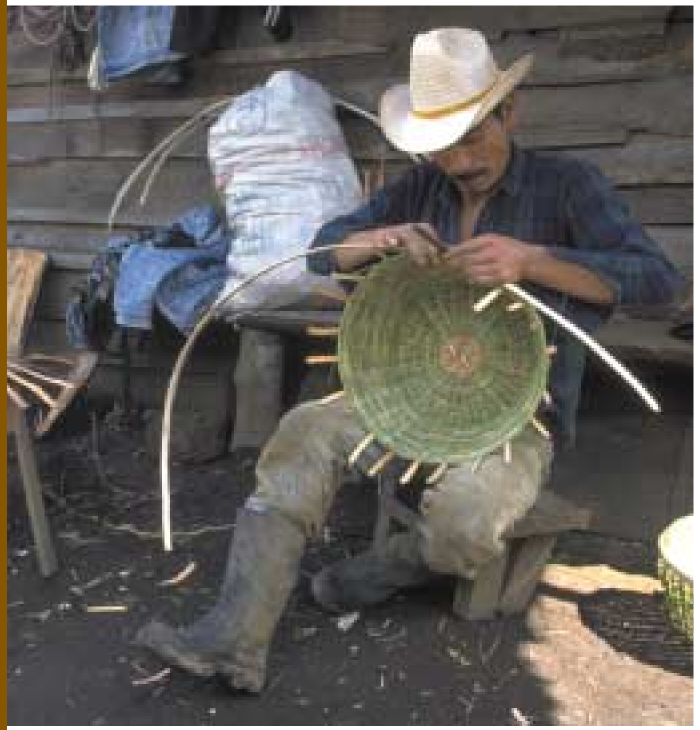
Average Yield of Maize in Kilograms (kg) for SA Users and SA Non-Users, for 1997 – Guatemala and Mexico

SITE	SA USERS (n)	SA NON-USERS (n)	P VALUE
Guatemala	*1081.7 (151)*	*1072.6 (144)*	*0.890*
Mexico	*1300.1 (146)*	*845.5 (145)*	*0.000*

The plot-level results confirm these findings. There is really no difference in yield between SA Plots and Non-SA Plots in Guatemala. But in Mexico, the difference is statistically significant on the same order of magnitude as we saw at the user level.

Average Yield of Maize in Kilograms (kg) for SA Plots and Non-SA Plots, for 1997 – Guatemala and Mexico

SITE	SA PLOTS (n)	NON-SA PLOTS (n)	P VALUE
Guatemala	*1076.7 (167)*	*1087.2 (147)*	*0.870*
Mexico	*1333.0 (146)*	*853.0 (145)*	*0.000*



In addition to selling some surplus maize and cash crops, some families in the Sierra de las Minas collect plant materials from the Reserve to weave baskets that they sell in regional markets to earn extra cash.

To make sure we were truly looking at the effects of sustainable agriculture use, and not some other factor, we looked at inputs that might affect this outcome. For use of fertilizer and pesticide and access to credit, there were virtually no differences between SA Users and SA Non-Users and between SA Plots and Non-SA Plots. When we looked at the total amount of labor (family members plus paid labor) invested in maize production, we found no statistical relationship between SA Users and SA Non-Users in either Guatemala or Mexico. But there may be important differences between these two groups and our two sites from a programmatic perspective. In Guatemala, it appears that SA Users use about five days of labor per hectare *less* than SA Non-Users. In Mexico, it appears that SA Users use about 5.5 days of labor per hectare *more* than their SA Non-User counterparts.

Average Amount (in Days) of Total Labor Used by SA Users and SA Non-Users, Controlling for Size of Plot (Days/Hectare), for 1997 – Guatemala and Mexico

SITE	SA USERS (n)	SA NON-USERS (n)	P VALUE
Guatemala	*60.5 (149)*	*65.5 (144)*	*0.174*
Mexico	*69.8 (148)*	*64.0 (147)*	*0.489*

We also looked to see if one type of farmer was more likely to sell surplus maize than the other. Indeed, in both Guatemala and Mexico, SA Users were significantly more likely to sell maize than SA Non-Users. The numbers for Guatemala, however, show only marginal programmatic significance because they are relatively small.

Number of SA Users and SA Non-Users Who Sold Maize, From 1997 Harvest – Guatemala and Mexico

SITE	SA USERS (%)	SA NON-USERS (%)	P VALUE
Guatemala	*33 (21.4)*	*13 (8.4)*	*0.004*
Mexico	*77 (51.3)*	*55 (36.7)*	*0.014*

In terms of how much farmers sold, there was virtually no difference between SA Users and SA Non-Users in Guatemala. In Mexico, however, SA Users sold significantly more than SA Non-Users — almost 450 kg more, representing on average an added income of 675 pesos (U.S. $87 at the 1997 exchange rate).

Amount of Maize Sold in Kilograms (kg) for SA Users and SA Non-Users, From 1997 Harvest – Guatemala and Mexico

SITE	SA USERS (n)	SA NON-USERS (n)	P VALUE
Guatemala	*416.3 (31)*	*428.1 (12)*	*0.944*
Mexico	*1457.6 (71)*	*1021.6 (43)*	*0.040*

While we were looking for the direct links between sustainable agriculture and deforestation through changes in crop yields and area planted, we came across what is arguably sustainable agriculture's greatest benefit to conservation — fire reduction. This factor has not been addressed widely in previous studies but demonstrates a high degree of association (in the same direction) at both study sites. Fire is one of the major threats to habitat in tropical forests near human settlements. Most often, people set fires that burn large tracts of primary forest. In the traditional preparation of plots for cultivation, farmers burn vegetation before planting to increase soil fertility. Sustainable agriculture discourages burning and instead encourages farmers to turn agricultural waste back into the soil to increase fertility.

In both the Sierra de las Minas in Guatemala and El Ocote in Mexico, fire is one of the biggest threats to the reserves. Often, serious forest fires are started by agricultural fires that burn out of control. We found that, by an overwhelming majority, SA Users in Guatemala and Mexico were less likely to use fire to prepare their plots than SA Non-Users. In fact, in Guatemala SA Non-Users were 7.7 times more likely to use fire than SA Users; in Mexico, SA Non-Users were 16.6 times more likely to use fire!

Number of SA Users and SA Non-Users Who Use Fire To Prepare Agriculture Land, for 1997 – Guatemala and Mexico

SITE	SA USERS (%)	SA NON-USERS (%)	P VALUE	ODDS RATIO
Guatemala	*33 (21.6)*	*140 (90.8)*	*0.000*	*7.7*
Mexico	*4 (2.7)*	*141 (94.0)*	*0.000*	*16.6*

Number of SA Plots and Non-SA Plots in Which Fire is Used for Preparation, for 1997 – Guatemala and Mexico

SITE	SA PLOTS (%)	NON-SA PLOTS (%)	P VALUE	ODDS RATIO
Guatemala	*16 (10.7)*	*67 (60.7)**	*0.000*	*5.4*
Mexico	*7 (5.2)*	*132 (96.4)*	*0.000*	*19.4*

**This is from a total of n = 110 because there were many missing data for this question.*

We were able to cross-check these results because in the first half of our interview with farmers, we asked the simple question: "Do you use fire in the preparation of your agricultural fields?" The results are in the table above. Later on, as we collected data on each of the farmer's plots, we asked how the land was prepared — through use of any combination of the following techniques: simple cutting of vegetation, mixing vegetation into the soil, burning, and use of herbicides. We then compared plots in which fire was used with plots in which fire was not used. At the plot level, SA Plots are 5.4 times less likely to be burned in Guatemala and almost 20 times less likely to be burned in Mexico. The positive effects of sustainable agriculture are clear for this factor.

Although burning can be extremely destructive to biodiversity, it controls weed growth and adds nutrients to the soil so some farmers prefer it for cultivating maize.

Multivariate Analysis

In our multivariate analysis, we looked at the combination of factors at each site that were most predictive of four main outcomes: (1) user status (whether a farmer was an SA User), (2) area planted to maize, (3) yield of maize, and (4) whether farmer used fire to prepare his fields. For each factor, variables are listed in order of importance (i.e., the proportion of the outcome variable they describe). From the multivariate analysis, we can also determine the direction (positive or negative) of the relationship. The R^2 of the model is included as well.

User Status

In Guatemala, the combination of variables that best predicted whether or not a farmer is an SA User included: (1) use of fire, (2) age of the farmer, (3) perception of positive effects of sustainable agriculture, and (4) visits by an extensionist. Our analysis showed that sustainable agriculture users were less likely to burn their plots, older, more likely to perceive benefits of sustainable agriculture, and more likely to receive a visit from an extensionist than non-users. The R^2 was 0.97.

In Mexico, the variables that best describe user status are: (1) use of fire, (2) age of the farmer, and (3) visits by an extensionist. SA Users were less likely to burn their plots, younger, and more likely to receive a visit from an extensionist than SA Non-Users. The R^2 was 0.90.

Combining the Guatemala and Mexico data, we found that the variables most predictive of sustainable agriculture use across both sites are: (1) use of fire, (2) visits by an extensionist, and (3) perception of positive effects of sustainable agriculture. SA Users were less likely to use fire, more likely to be visited by an extensionist, and more likely to perceive benefits of sustainable agriculture. Age dropped out of the model because it had the opposite relationship to user status in Guatemala and Mexico. The R^2 for the combined analysis was 0.88.

Area Planted to Maize

Variables that predict the amount of area planted to maize in Guatemala include: (1) user status, and (2) number of years a farmer has worked his plot. Area planted is greater when the farmer is an SA User and the longer the plot has been cultivated. The R^2 is a very low 0.052, meaning we could not come up with a model that was very predictive of area planted in Guatemala.

In Mexico, variables in the model for area planted include: (1) total amount of labor invested in the plot (not controlling for size), (2) number of years a farmer has worked his plot, (3) family size, and (4) user status. Area planted is greater with increased investments of labor, the longer the plot has been cultivated, the greater the family size of the farmer, and when the farmer is an SA user. The R^2 is 0.27.

Combining Guatemala and Mexico, variables that predict the amount of area planted to maize include: (1) total amount of labor invested in the plot, (2) number of years a farmer has worked his plot, (3) age of farmer, (4) visits by an extensionist, and (5) problems with agricultural pests. Area planted is greater with increased investments of labor, the longer the plot has been cultivated, the older the farmer, the greater the likelihood the farmer has been visited by an extensionist, and the more likely the farmer has problems with agricultural pests. The R^2 is 0.20.

Maize Yield

In Guatemala, maize yield is most predicted by (1) number of years a farmer has worked his plot, and (2) the area of the plot. Yield is higher in older, smaller plots. The R^2 is a low 0.05.

In Mexico, maize yield is most predicted by (1) the area of the plot, and (2) user status. Yield is higher in smaller plots farmed by an SA User. The R^2 is 0.13.

Looking at both Guatemala and Mexico combined, yield is described best by (1) the area of the plot, and (2) user status. Yield is higher in smaller plots farmed by an SA User. The R^2 is a low 0.08. This low R^2 is to be expected because yield is a function of very different conditions in Guatemala and Mexico, as we will see later.

Use of Fire

In Guatemala, variables that best describe whether a plot is burned are (1) user status, and (2) total amount of labor invested in the plot. Plots that are burned are more likely to be farmed by an SA Non-User with higher total amounts of labor invested. The R^2 is 0.61.

In Mexico, variables that best describe whether or not a plot is burned are (1) user status, (2) age of the farmer, and (3) use of herbicides. Plots that are burned are more likely to be farmed by an older SA Non-User who uses more herbicides. The R^2 is 0.90.

Combining Guatemala and Mexico, variables that best describe whether a plot is burned are (1) user status, and (2) age of the farmer. As for Mexico, plots that are burned are more likely to be farmed by older SA Non-Users. The R^2 is 0.75.

Farmland that is left in fallow often leads to regeneration of forests.

Fallow Area and Duration

Conventional Wisdom: Adoption of sustainable agriculture leads to increases in fallow area and duration, thereby allowing for greater recovery of forested areas.

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We looked at three main factors for this analysis: (1) whether or not farmers had land in fallow at the time of the interview, (2) the amount of land in fallow, and (3) the length of time the land has been in fallow. For all three of these analyses, there was no statistical difference between SA Users and SA Non-Users. For our first factor, actual land in fallow, there were, in fact, almost exactly equal numbers for SA Users and SA Non-Users.

Number of SA Users and SA Non-Users Who Had Land in Fallow in 1998* – Guatemala and Mexico

SITE	SA USERS (%)	SA NON-USERS (%)	P VALUE
Guatemala	*135 (87.7)*	*139 (90.3)*	*0.549*
Mexico	*85 (57.4)*	*90 (60.0)*	*0.653*

** At the time of the survey.*

With respect to the amount of land in fallow, farmers in the two groups in Guatemala were almost identical. In Mexico, however, while there is similarly no statistical difference between the two groups, it appears that SA Users tend to have slightly less land in fallow.

Amount of Land in Fallow (ha) for SA Users and SA Non-Users in 1998 – Guatemala

AMOUNT (ha)	SA USERS (%)	SA NON-USERS (%)	P VALUE
< 0.7	*48 (31.2)*	*46 (29.9)*	*0.941*
0.7 < 2.1	*61 (39.6)*	*66 (42.9)*	
2.1 < 3.5	*20 (13.0)*	*19 (12.3)*	
3.5 < 7	*3 (1.9)*	*5 (3.2)*	
7+	*3 (1.9)*	*3 (1.9)*	

Amount of Land in Fallow (ha) for SA Users and SA Non-Users in 1998 – Mexico

AMOUNT (ha)	SA USERS (%)	SA NON-USERS (%)	P VALUE
< 1	*4 (2.7)*	*2 (1.3)*	*0.710*
1 < 3	*25 (16.7)*	*20 (13.3)*	
3 < 5	*21 (14.0)*	*28 (18.7)*	
5 < 10	*22 (14.7)*	*27 (18.0)*	
10+	*13 (8.7)*	*13 (8.7)*	

Concerning the amount of time farmers have left land in fallow, both groups of farmers are nearly identical in both Guatemala and Mexico.

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Amount of Time (Years) Land Has Been in Fallow for SA Users and SA Non-Users in 1998 – Guatemala

TIME (YEARS)	SA USERS (%)	SA NON-USERS (%)	P VALUE
< 1	27 (17.5)	29 (18.8)	0.603
1 < 3	102 (66.2)	102 (66.2)	
3 < 5	5 (3.2)	6 (3.9)	

Amount of Time (Years) Land Has Been in Fallow for SA Users and SA Non-Users in 1998 – Mexico

TIME (YEARS)	SA USERS (%)	SA NON-USERS (%)	P VALUE
< 1	4 (4.7)	1 (1.1)	0.246
1 < 3	43 (50.6)	43 (47.8)	
3 < 5	31 (36.5)	42 (46.7)	
5 < 10	5 (5.9)	4 (4.4)	
10+	2 (2.4)	0 (0.0)	

Contamination of the Environment

Conventional Wisdom: Adoption of sustainable agriculture techniques leads to decreased contamination of the adjacent environment.

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It turns out that relatively few farmers in either the SA User or SA Non-User groups use chemical fertilizer or pesticide. At both sites, farmers reported that they have problems with agricultural pests, but the relationship is the opposite between Guatemala and Mexico. In Guatemala, SA Plots were more likely to have problems with pests than were Non-SA Plots. In Mexico, SA Plots were less likely to have problems with pests than were Non-SA Plots. Both relationships are statistically significant.

Reported Problems With Agricultural Pests in SA Plots and Non-SA Plots, for 1997 – Guatemala and Mexico

SITE	SA PLOTS (%)	NON-SA PLOTS (%)	P VALUE
Guatemala	161 (97.0)	127 (87.6)	0.001
Mexico	116 (77.9)	134 (92.4)	0.000

According to the project teams, some SA Users in Guatemala have problems with insect infestations in plots they do not burn because burning acts to control insect populations. In Mexico, project team members often found that initial use of sustainable agriculture techniques caused an increase in rodent infestations. They also found, however, that SA Users sometimes used a variety of integrated pest management techniques, primarily natural insect repellents made from garlic and onion, which proved to be very effective.

In Guatemala, only 15 farmers reported using pesticides in their plots and virtually none reported using chemical fertilizer. In Mexico, farmers used pesticides more frequently. In both sites, however, pesticide use was lower in SA Plots than in Non-SA Plots. According to the project managers in Mexico, SA Users are less inclined to use pesticides because velvetbean decreases insect infestations and weeds. Nevertheless, the number of farmers who use pesticides is so small that this result is not programmatically significant.

Use of Pesticides in SA Plots and Non-SA Plots, for 1997 – Mexico

INPUT	SA PLOTS (%)	NON-SA PLOTS (%)	P VALUE
Insecticide	21 (17.4)	37 (27.6)	0.050
Herbicide	22 (14.9)	69 (49.3)	0.000

In addition to the destruction of forests they cause when they go uncontrolled, fires set for agricultural purposes contribute to severe air pollution during the dry season.

As we saw in a previous analysis, there is a significant difference between SA Users and SA Non-Users in the use of fire in agriculture. Smoke is another form of contamination, and it is clear that sustainable agriculture is effective at reducing the amount of smoke released into the atmosphere from preparation of agricultural lands. In addition, because agricultural fires sometimes escape into nearby forests — especially during particularly dry periods — reduced burning by farmers most likely reduces contamination of the atmosphere from forest fires.

Indirect Impact of Sustainable Agriculture on Biodiversity

The second section of our framework looks at the indirect impacts of sustainable agriculture projects on biodiversity, including attitudes related to biodiversity and conservation and involvement in community-level organizations.

Attitudes Concerning Conservation

Conventional Wisdom: Farmers who participate in sustainable agriculture projects have attitudes about conservation that are more positive than those who do not participate. These attitudes leave them more open to participating in future conservation activities.

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According to our quantitative data, significantly more SA Users than SA Non-Users perceive that sustainable agriculture has positive effects. But it is less clear the extent to which SA Users have more positive attitudes about

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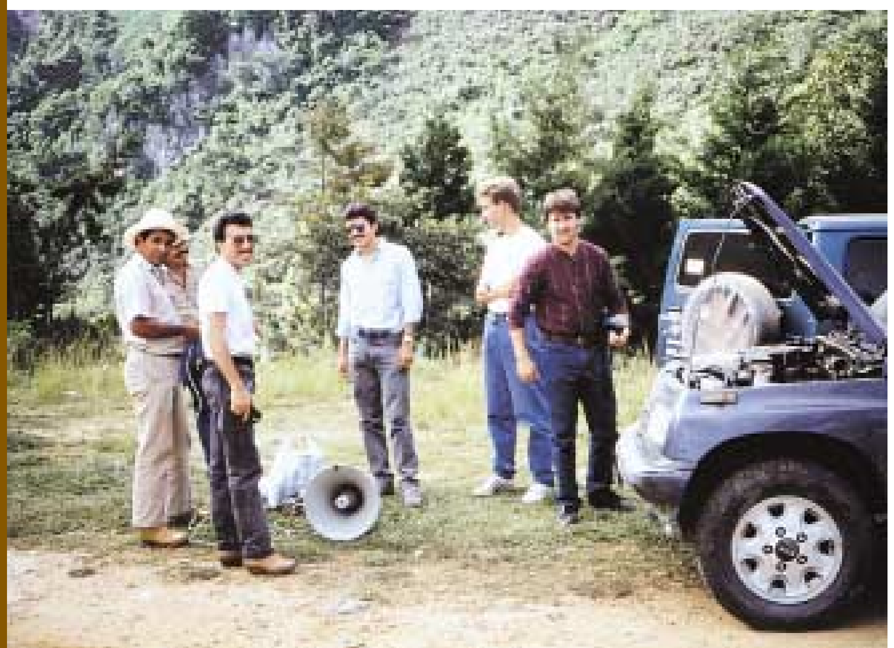
Number of SA Users and SA Non-Users Who Perceive Positive Effects of Sustainable Agriculture – Guatemala and Mexico

SITE	SA USERS (%)	SA NON-USERS (%)	P VALUE
Guatemala	*151 (98.0)*	*7 (4.6)*	*0.000*
Mexico	*127 (84.7)*	*67 (45.3)*	*0.000*



Environmental education often goes hand-in-hand with sustainable agriculture projects. Here, Defensores de la Naturaleza staff set up a megaphone with a car battery to do a presentation to farmers.

the environment. We asked farmers if sustainable agriculture had any positive effects on water, soil, air, and the forest. The only significant difference between SA Users and SA Non-Users was in Guatemala, for water. According to the results from Mexico, 65 (44.8%) of farmers who use sustainable agriculture say that the reason they do not use fire to prepare their agricultural plots is to protect the forest. In Guatemala, 143 (93%) SA Users and 103 (66.7%) SA Non-Users report that they do not use fire in their fields in order to protect the forest (P = 0.035).

During some of the focus group interviews we conducted in both Guatemala and Mexico, SA Users demonstrated a clear awareness of the connection between their actions and the environment. Representatives of both Defensores de la Naturaleza and Línea Biósfera attribute this awareness to the environmental education activities that accompanied their sustainable agriculture extension projects.

Selected Focus Group Comments

At times, it is nice to burn your fields, but the truth is we haven't realized that we, in fact, are the ones responsible for polluting the environment — we're destroying nature. We're the ones lighting the fires, but still we ask "Where is all this smoke coming from?"

José, SA User, Mexico

We could reduce the amount of pollution if people would just understand the causes — if all farmers would quit burning we could then stop the forest fires.

Antonio, SA User, Mexico

Fire is a problem because when we burn our fields, fertility drops and the rains wash away the soil...

Anonymous SA User, Guatemala

Sustainable agriculture] is good, because we know that if we were to cut down the entire forest, after awhile, it would stop raining.

Juan, SA User, Mexico

To unite the community, we must teach everyone to prepare their plots with hoe and machete alone [as opposed to using herbicides] because that way, we will not contaminate the water.

Miguel, SA User, Mexico

Participation in Community Organizations

Conventional Wisdom: Farmers who participate in sustainable agriculture projects are more likely to be involved in other community and outreach activities than farmers who do not participate.

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We looked at various ways that farmers might participate in community activities or be exposed to other opportunities that might foretell their involvement in future conservation activities. In addition to looking at membership in community organizations, we also looked at the extent to which farmers are visited by an extensionist. Finally, we looked at the extent to which farmers have participated in cross-community exchanges to learn new agricultural techniques or other technological innovations.

In Guatemala, SA Users were significantly more likely to report belonging to a community organization than SA Non-Users. In Mexico, however, there was no significant difference. According to the project teams, these results reflect the relatively low level of official community organization in Guatemala and the high level of community mobilization in Mexico. In Mexico, most farmers belong to *ejido* organizations that are part of greater regional organizations, so the need for community organizations per se is minimal. In Guatemala, on the other hand, communities are often required to self-mobilize in order to take any collective action.

***Ejidos** were established in Mexico during the land-reform movement of the last century. They are a form of land tenure in which farmers are guaranteed use-rights to fixed amounts of land.*

Number of SA Users and SA Non-Users Who Participate in a Community Organization – Guatemala and Mexico

SITE	SA USERS (%)	SA NON-USERS (%)	P VALUE
Guatemala	*59 (38.4)*	*26 (16.7)*	*0.000*
Mexico	*89 (59.7)*	*96 (65.8)*	*0.285*

In both Guatemala and Mexico, SA Users are significantly more likely to have been visited by an extensionist than SA Non-Users. This makes sense because the programs of both Defensores de la Naturaleza and Línea Biósfera rely heavily on extension programs to train farmers. In addition, these results are clearly biased by the fact that these organizations conducted the data collection and necessarily sampled SA Users with whom they had interacted to include in the study. We also looked at the extent to which community members participated in cross-community exchanges or visits, but very few farmers were involved in these.

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