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Insight

Why Shade Coffee Does Not Guarantee Biodiversity Conservation.

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ABSTRACT. Over the past decade, various strategies have emerged to address critical habitat losses through agricultural expansion. The promotion of shade-grown, premium-priced coffee has been highlighted as one alternative. Our research, based on interviews with farmers in Chiapas, disputes some of the assumptions made by shade coffee campaigners. Results revealed a predisposition to converting forest to shade coffee production due to the socioeconomic challenges farmers face and the potential for increasing incomes. To ensure that their well-being is improved at the same time as reducing environmental impacts, there is clearly a need to provide more detailed information on who is responsible for enforcing certification criteria and how this should take place.

Key Words: *alternative coffee; conservation; biodiversity; Mexico*

INTRODUCTION

Agriculture is one of the greatest reasons for declines in global biodiversity (Donald 2004, Green et al. 2005). Furthermore, with increasing human populations and greater affluence, both the area devoted to farming and the intensity of farming are likely to increase. A major challenge we face is how to cope with this increasing demand of agricultural production and the need to meet biodiversity conservation objectives (Harvey et al. 2008). The response of conservationists can be categorized into two broad philosophies: promote more benign forms of agriculture, for example, through agri-environment schemes or marketing environmentally sensitive products; or minimize the impacts of agriculture on specific areas, for example, by intensifying production to allow land to become available for reserves. The key question, raised by Green et al. (2005) is: which is more effective at protecting biodiversity?

It has been recently acknowledged that protected areas alone are not enough to ensure biodiversity conservation, but the surrounding agricultural matrix should also be considered in successful management strategies (Vandermeer and Perfecto 2007, Harvey et al. 2008). Shade coffee, that is, coffee produced under a tree canopy, is probably the archetypal example of benign agricultural practices. Studies in the last 20 years have shown that shade coffee is an agroecosystem where biodiversity can be conserved, unlike coffee varieties that are grown in the open (Perfecto and Armbrecht 2002).

Moreover, during the last decade, shade coffee has been promoted as a commercial activity that is compatible with the conservation of forest and its related fauna (Perfecto and Armbrecht 2002, Rappole et al. 2003, Dietsch et al. 2004, Tejeda-Cruz and Sutherland 2004, Raman 2006) since shade coffee maintains a high species diversity of animals and plants (Perfecto et al. 1996, Moguel and Toledo 1999, Perfecto and Armbrecht 2002). Literature has documented the importance of shade coffee for arthropods (Nestel et al. 1993, Perfecto and Snelling 1995), amphibians (Pineda and Halffter 2004, Pineda et al. 2005), resident and migratory birds (Greenberg et al. 1997*a*,*b*, Tejeda-Cruz and Sutherland 2004, Komar 2006, Raman 2006), and mammals (Estrada et al. 1993, 1994, Gallina et al. 1996, Cruz-Lara et al. 2004, Numa et al. 2005, Williams-Guillen et al. 2006). Linked to this, it has also been suggested that shade coffee plantations may play an important role as buffer zones around protected areas and forest patches (Moguel and Toledo 1999, Dietsch et al. 2004,

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Tejeda-Cruz and Sutherland 2004, Raman 2006) and can improve the quality of the landscape matrix (Perfecto and Vandermeer 2002, Pineda and Halffter 2004, Pineda et al. 2005).

As a response to declining migratory bird populations, shade coffee was promoted as a conservation measure and adopted by a wide range of individuals and organizations. 'Green markets', aimed at northern consumers, conceived the concept of shade-grown coffee which, in turn, became a 'conservation friendly' development strategy (Sherry 2000, Rappole et al. 2003, Rainforest Alliance 2009, Greenberg 2001, Conservation International 2008). The three major initiatives are those led by the Rainforest Alliance, the Smithsonian Migratory Bird Center, and a partnership between Starbucks and Conservation International (Conservation International 2008, Rainforest Alliance 20080, Greenberg 2001). These schemes have established sets of certification criteria that have added tree shade requirements to production practices. The objectives of these programs are to maintain and enhance shade coffee, and to convert sun coffee and other agricultural land into shade coffee sites, while at the same time helping to improve the living conditions of small coffee growers through premium prices. As a rule, these programs do not allow for the creation of new coffee plantations at the expense of primary forest (Conservation International 2008, Greenberg 2001, Sustainable Agriculture Network 2009).

Although both Europe and USA have shown a recent decrease in per capita coffee consumption, certified sustainable coffee has experienced a considerable increase. Experts predict this demand will continue to grow over the next few years (Rivera and Villalobos 2004, Villalobos and Rivera 2004); sustainable coffee production in Latin America has grown at a constant rate in recent years (Villalobos 2004). To exemplify the effects that these initiatives have had on coffee prices and producers' incomes, Starbucks and Conservation International report that their partnership's initial efforts in Chiapas, Mexico resulted in a 40% price premium over local prices, and up to a 100% increase in exports from the previous year for those farmers producing shade-grown coffee. (Conservation International 2008).

There is documented evidence that shade coffee conservation benefits are limited by the fact that many forest-associated species are rare or absent in shade coffee plantations (Roberts et al. 2000*a*, Rappole et al. 2003, Tejeda-Cruz and Sutherland 2004, Donald 2004, Guevara 2005, Raman 2006). The conservation value of shade coffee is dependent on a variety of factors such as the distance between coffee plantations and forests (Parrish and Petit 1996, Roberts et al. 2000*a*,*b*, Perfecto and Vandermeer 2002), the structural complexity of the ecosystem (Gallina et al. 1996, Greenberg et al. 1997*b*, Calvo and Blake 1998, Raman 2006), food availability (Johnson and Sherry 2001), and canopy tree species composition (Raman 2006). Finally, different taxa may respond at different spatial scale levels in shade coffee landscapes (Perfecto et al 2003, Pineda et al. 2005).

Additionally, a number of studies over the past decade indicate a distinct and relentless tendency. Approximately 80% of Mesoamerican vegetation has been converted to agriculture, following a deforestation trend that advances 1.2% per year (Harvey et al. 2008, FAO 2005). Landscape transformation is not the only threat to biodiversity loss. Various studies indicate that there are strong influences from market forces, from more input-intensive mechanized production, migration, and a raft of public policies. All of these drivers lead to shifts in diversified smallholder agroecosystems (Conway et al. 1996, Perfecto et al. 1996, Angelsen and Kaimowitz 2001, as cited in Harvey et al. 2008).

Under this scenario, we provide preliminary evidence that the integration of forest conservation goals and rising income generation in shade-grown coffee activities does not guarantee that forested areas will not be converted into agricultural plots within coffee growers' properties. Additionally, we provide a critical analysis of the role of shade coffee as a key component in conservation strategies at the local level. A concern is also raised: under which conditions could shade coffee be used as an ecologically sound alternative? We will shed light on how small-scale coffee growers make decisions on land use when confronted with the choice to switch from conventional to 'eco-friendly' labeled coffee. On the other hand, we discuss the potential effects of these decisions on the remaining primary forest. A critical, but so far unanswered question is whether or not promoting shade coffee increases the demand for shade coffee, thus encouraging conversion of forest (Rappole et al 2003).

Fig. 1. Map showing El Triunfo Biosphere Reserve and the three communities studied in Chiapas, Mexico.

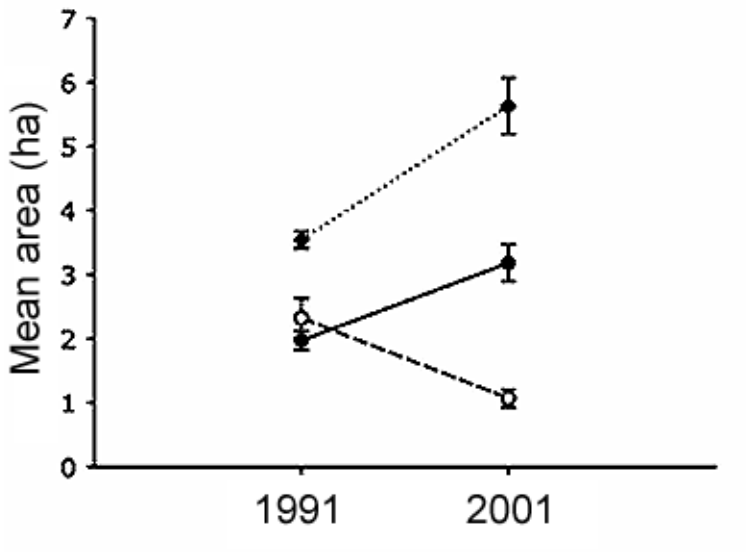
METHODS

We carried out 57 semi-structured interviews with 28 farmers inside and 29 farmers outside the El Triunfo Biosphere Reserve, Chiapas, Mexico. This protected area is located in the Sierra Madre de Chiapas in southern Mexico, and has an area of 119,117 ha of which 25,719 comprise the core zones. The remaining 93,458 ha constitute a buffer area with an approximate population of 14,000 people (Tejeda-Cruz and Sutherland 2004). We interviewed producers outside the reserve in two communities: Chimalapa from the Motozintla municipality, approximately 60 km south east; and Poconichim, from the Chenalhó municipality, approximately 160 km north (Fig. 1). Coffee production is the main economic activity in all localities.

Interviewees were chosen via a snowball technique in each location. This process is based on the assumption that a 'bond' or 'link' exists between the initial sample and others in the same target population, allowing a series of referrals to be made within a circle of acquaintance (Atkinson and Flint 2001). Interviews included a variety of social, environmental, and economic themes relating to coffee producer families. Coffee growers were questioned about the changes that they had experienced over 10 years, from 1991 to 2001, in the social, environmental, and economic spheres of their livelihoods. In particular, interviewees were asked whether they would convert the forested areas on their property into shade coffee if coffee prices increased. We also included further complementary questions related to property size, current land–use patterns, number and name of tree species used for shade coffee, area of forest remaining on their properties, years producing coffee, current and past coffee production (bags/ha), and producers' age. (see Appendix 1, sections E and D).

Numerical analysis was performed using SPSS release 11.0.1. Monte Carlo simulations (10,000 iterations) were used to overcome problems related to small sample sizes associated with asymptotic

Fig. 2. Changes after ten years of property size (♦) in hectares, forest size patches (°), and coffee plantations (•) within properties in Chiapas, México (mean area ± se).



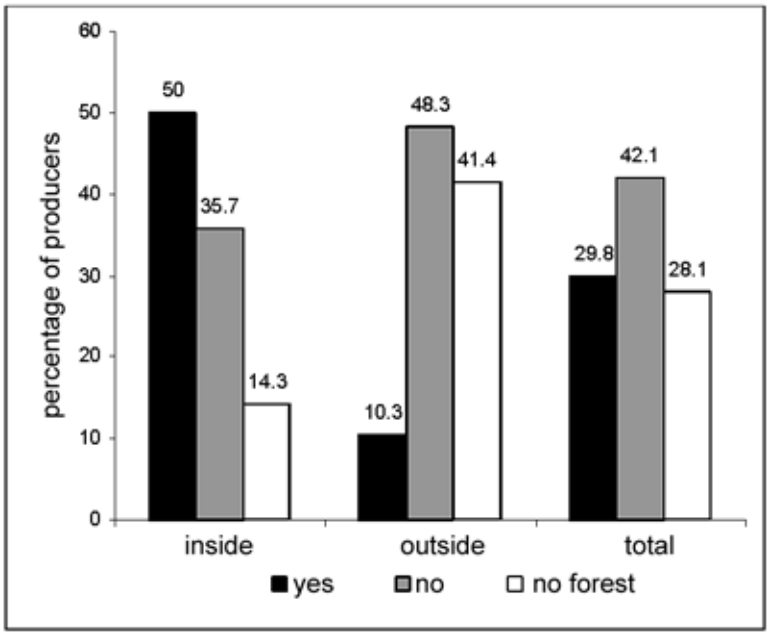
tests. We report Monte Carlo probabilities for all tests comparing means, and used the main question "If coffee prices increased would you expand onto the remaining forest in your property to cultivate shade coffee?" as a binary dependent variable. The Gini splitting algorithm implemented by DTREG classification trees routine (Sherrod 2007) is an appropriate algorithm for dichotomous dependent variables to classify responses as positive, would transform forest, and negative, would not transform forest, using all the variables mentioned before that refer to the current social and land use situation. Responses related to the situation 10 years before were excluded. We also excluded the answers expressed by those producers who currently had no forest left within their properties. A maximum of 10 splitting levels below the root was specified, and we set the minimum size node to split in 10. Branches at the left side of the tree consisted of individuals who will not expand into the forest and branches at the right side of the tree consisted of producers that would expand into the forest. We used a V-fold cross-validation to determine the optimal tree size to avoid the problem of "overfitting" (Sherrod 2007).

RESULTS

According to growers' responses, there has been a steady increase in the cultivation area used for coffee, allegedly at the expense of forests. During the 1991–2001 decade, the mean area dedicated to coffee per plot increased by 1.3 ± 0.34 ha per producer, while the area of forest declined by 1.25 ± 0.3 ha. This is in spite of an increased mean property size of 2.09 ± 0.13 ha. (Fig. 2).

From the total number of interviewees, 29.8% stated they were likely to change forest remnants into coffee plantations, whereas 42.1% would not use their forest and 28.1% either did not have forest or did not answer (χ^2 = 11.77, df = 2, P = 0.002). Producers likely to convert forest into coffee plantations had, on average, larger properties (7.21 ± 0.63 ha v 3.9 ± 0.47 t = 3.85 p<0.001) with larger areas of coffee (4.50 ± 0.4 ha v 1.95 ± 0.25 t = 4.96, p < 0.001) than those who stated they would not clear. Producers with smaller plots retain more useful trees for fruit, wood, and firewood, probably as a strategy to increase their income.

Fig. 3. Percentage of producers likely to transform remaining forest if coffee prices are constantly high inside and outside El Triunfo Biosphere Reserve, Chiapas, Mexico (Chi-Square = 11.77, df = 2, P = 0.002). No forest refers to producers that cannot expand because they have no forested land left.



Ominously, the loss of primary forest was over three times higher inside the reserve than outside (1.64 ± 0.49 ha v 0.52 ± 0.19). Furthermore, farmers inside the buffer area are more likely to convert their forest to coffee than those outside the reserve (Fig. 3). Fifty percent of the producers in the buffer area are likely to transform forest remnants into coffee if coffee prices increase, whereas 35.7% said they would not; 14.3% have no forested land left. In contrast, outside the reserve only 10.3% are likely to convert forest to coffee, and almost half of the producers said that they did not intend to transform their forested land.

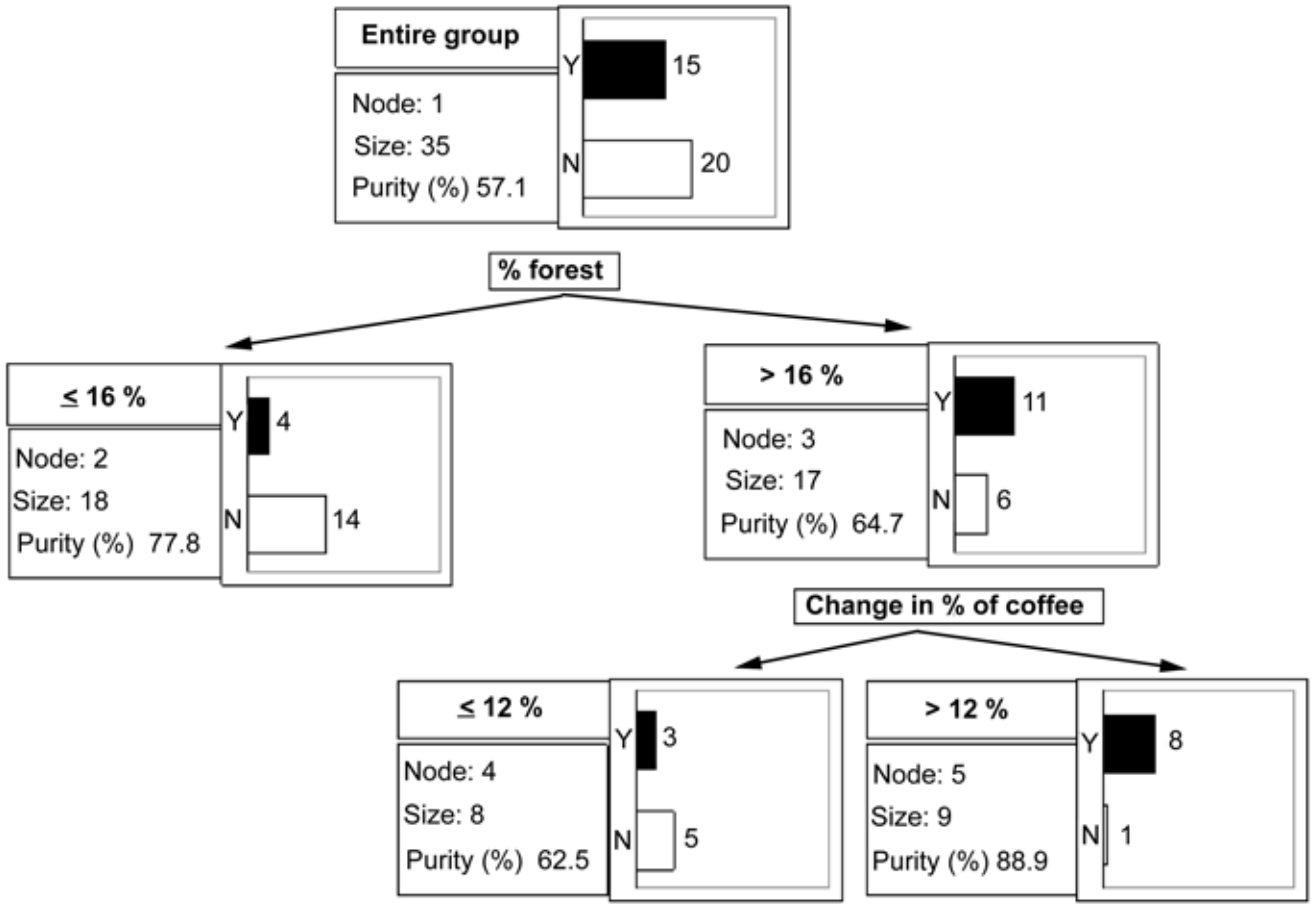
Results from the classification tree (Fig. 4) show that only two predictors were selected by the algorithm used to construct the tree. The highest proportion of producers who would expand into remaining forest were those who still have more than 16% of forested land in their properties and have shown an increment above 12% in the area they use for coffee cultivation during the last 10 years.

DISCUSSION

There has been recent conversion of forest to coffee and this is likely to continue if premium coffee prices increase or even remain stable. The contradictory responses of producers inside the reserve may be explained by the fact that plots and remaining forest areas were significantly larger inside the reserve, as it has only been occupied relatively recently. Both sites outside the reserve, Poconichim and Chimalapa, have been settled by humans for centuries. Because the inter-generational property division process has been taking place for longer, land is scarcer. The buffer area, Laguna del Cofre, was colonized during the 1950s and still has large portions of forested land for individual and communal use. The average areas devoted to coffee in the buffer zone were more than double the size of their counterparts outside.

For the last 10 years, different alternative coffee regimes have been adopted in the reserve's buffer area. Farmers are paid a premium price and can access credits not otherwise available. Crucially,

Fig. 4. Classification tree analysis of the responses to the question: "If coffee prices increased would you expand onto the remaining forest in your property to cultivate shade coffee?" (Y = yes, N = no, 35 samples). Percentage of remaining forest within properties (node 2), and change in the percentage of land used for coffee cultivation during a ten-year period (node 3) were the most important explanatory variables. The misclassification rate of the model built with the training data was 17% while the misclassification rate of the validation model was 40%.



conversion of forest is generally not allowed. For example, in 2001, producers under Conservation International's scheme received 40% above local prices for their coffee (Conservation International 2008). This increase in prices may, however, result in the conversion of forests into shade coffee, revealing an unconcealed conflict between income generation and conservation. During field work in 2000, 2002, and 2008, we recorded a point that is noteworthy: producers introduced to alternative coffee production did convert portions of remnant forests in their properties into shade coffee. This provides preliminary evidence that we believe should be studied further. This observation may be correlated with the figure that shows a constant increase in sustainable coffee areas in Latin America (Villalobos 2004). Moreover, international market trends may urge producers to enlarge their coffee production area as the sustainable coffee market is the only sector that shows a growth tendency that is expected to continue (Rivera and Villalobos 2004, Villalobos and Rivera 2004).

These findings point out that in-field application of certification criteria should be very rigorous as producers in our study areas showed a keen interest in expanding their coffee plantations (Silva-Rivera 2006). We believe that even growers that follow the conventional coffee route will continue to expand the area dedicated to coffee. Moreover, these producers might eventually join the alternative coffee faction because: (1) the government specifically asks growers to be part of a legal organization in order to grant credits and subsidies, and (2) producers are attracted by the premium prices that are definitely higher compared to conventional prices, especially after the crises unleashed in 1998–1999 (Silva-Rivera 2004). Although we recognize that an increase in intensity and area planted is not inevitable and would not necessarily be tied to population numbers, a precautionary approach may be advisable. We agree with O'Brien and Kinnaird (2003) who point out that enforcement in protected areas is required, especially when potential conflicts between development and biodiversity conservation arise. We acknowledge that the relative conservation benefits of shade coffee plantations vary according to local conditions. Although shade coffee is important as a vestige of primary forest in a highly transformed area, holding a high biodiversity in relation to surrounding impoverished land uses is a poor ecological replacement for large tracts of pristine forest (Donald 2004). This may be specifically the case for the El Triunfo biosphere reserve.

CONCLUSIONS

To achieve development that combines people's well–being with sustaining a fully functional and diverse biosphere is a major challenge, especially since success with integrated sustainable development strategies is elusive (Adams et al. 2004). The idea of an environmentally friendly coffee can generate benefits for both local communities and ecosystems. However, shade–grown coffee criteria must specifically address the prevention of forest clearance, and regional conditions should be considered for places where there are still large tracts of primary forest. Forgetting to account for the fact that shade coffee does not equate to an original forest can generate a series of misunderstandings, and there will always be an underlying risk of misinforming both consumers and local coffee growers on the real conservation role of shade-grown coffee. More importantly, if shade coffee advocates aim to develop an alternative that is socially just and ecologically sound, development programs emphasizing sustainable management, meaning intensive rather than extensive land use, should be combined with more rigorous enforcement. This enforcement can be undertaken by field inspections and penalties in order to prevent the use of forest areas by farmers to the detriment of local biodiversity. It is essential to monitor the development of this growing market and the environmental effects that it may have. The driving forces behind the increasing areas under cultivation, the factors that may lead to a lack of enforcement, and who should be responsible to enforce certification criteria, considering the various intervening social and economic aspects at the local level, need to be accounted for in greater detail. To fail to do so might potentially encourage plantations producing coffee that is sold under a conservation scheme to further hasten the process of biodiversity loss.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol15/iss1/art13/responses/

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APPENDIX 1. Community level semi-structured questionnaire.

COMMUNITY LEVEL (L)
SEMI-STRUCTURED INTERVIEW

Section A. Administration

A1N H ID No. _____
A2N Interviewees' name _____
A3N Surname _____
A4N Responsibilities in the organisation_____
A5N Sex_____
A6N Date_____
A7N Locality_____
A8N Time started _____
A9N Time finished _____
A10N Interviewer's code _____

Section B. Household profile

B1L List of all hh members	**B2L** Sex 1= male 2= female	**B3L** Relationship with interviewee **CODE A** 1= him/herself 2= spouse 3= partner 4= son/daughter 5= grandson/daughter 6= niece/nephew 7= sister/brother 8= grandfather/ mother 9= friend 10= other (specify)	**B4L** Age	**B5L** Marital status 1= married/ cohabitation 2= divorced 3= separated 4= widow 5= single	**B6L** occupation	**B7L** Language(s) spoken	**B8L** Ethnic origin	**B9L** religion
1. Interviewee								
2. Other members living in the household								

Section E. Environmental quality

E1L Do you or your family use agrochemicals in your crops? _____ 1= yes 2= no

E2L If no, go to **E4L.** If yes, how often do you use agrochemicals in your crops? _____

E3L How many applications do you make each season (yearly)? _____

E4L Did you use agrochemicals in the past? _____ 1= yes 2= no

E5L Can you explain why? _____

E6L If the answer was yes in E4L, what made you change opinion? _____

E7L Please mention the fruit and wood trees in your plantation

Wood trees	**Fruit trees**

E8L Please describe how tree diversity in your coffee plantation has changed comparing ten years ago and today. (species diversity)
_____

E9L Please describe how the quantity of trees in your coffee plantation has changed comparing ten years ago and today. (more or less shade)
_____

E10L How many hectares in your property is still forest? _____

E11L How many hectares were forested when you acquired the property? _____

E12L If coffee prices increased would you expand onto the remaining forest in your property to cultivate shade coffee? ____ 1= yes 2= no

E13L Please explain why _____

E14L Has the organisation influenced or changed your opinion concerning forests? _____ 1= yes 2= no

E15L How _____

Section D. Economic equity

Subsection D.a. Production and other economic activities

D1L For how long have you or your family dedicated to coffee production? _____

D2L What did you do before dedicating to coffee? _____

D3L Why did you or your family decide to produce coffee? _____

D4L How were labour conditions when you were young?
_____

D5L Do you consider that labour conditions for coffee producers have changed comparing ten years ago and today? ____ 1= yes 2= no

D6L Why? _____

D7L How many hectares of your property have coffee? _____

D8L Ten years ago, how many hectares had coffee? _____

D9L How much of your land has other crops? _____

D10L Ten years ago, how much of your land had other crops? _____

D11L Beside coffee, please mention other crops in your property _____
1= vegetables
2= maize
3= maize associated with leguminous plants
4= beans
5= chili
6= cacao
7= fruit trees (citrics, mangoes, etc..)
8= other _____

D12L What are the advantages of keeping the mentioned crops?
_____

D13L Describe the changes you have made in your productive activities comparing ten years ago and today
_____

D14L Why did you decide to make these changes?
_____

D15L What are your plans (ten years from now) concerning your agricultural activities?
_____