The Role of Organic Production in Biodiversity Conservation in Shade Coffee Plantations

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A dissertation submitted in partial fulfillment of the requirements for the degree of:

Doctor of Philosophy

University of Washington

2008

Program Authorized to Offer Degree: Department of Biology

University of Washington
Graduate School

This is to certify that I have examined this copy of a doctoral dissertation by

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Abstract

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I researched the impact of organic agriculture in coffee plantations in Nicaragua. First, I compared the structure and composition of the shade tree layer in organic production and in conventional coffee plantations that use synthetic inputs. I found that organic certification per se does not affect tree cover composition or shade levels. However, coffee plantations infested with the fungus *Mycena citricolor* have significantly lower levels of shade than non-infested plantations. This effect is more evident in organic farms located in humid areas.

In a separate field experiment, bird diversity and abundance were compared in organic and conventional shade coffee plantations over a two-year period. Farms were alike in structure and composition of the shade tree layer. Results indicate that bird diversity and abundance were not influenced by pesticide use in conventional plantations but were related to tree canopy structure and composition.

Last, I present the results of a survey conducted in Nicaragua among coffee growers, agronomists and policy makers in the coffee sector. Both organic and conventional farmers are well aware of the environmental benefits of growing coffee under shade and preserving forest fragments. Medium to large farm owners maintain as much area under coffee cultivation as they have forest. Small farm owners prefer denser shade levels than medium and large farm owners but the preference for shade grown cultivation was almost unanimous. Agronomists and policy makers supported forest fragment preservation and growing coffee under shade. At the same time they favored certifying coffee grown inside protected areas as a tool to control pesticide use and expansion of coffee plantations. This presents an important challenge for certification agencies that in theory do not endorse coffee grown within protected areas.

Results indicate that priority be given to encourage farmers to grow coffee under diverse shade. Strict organic standards should not be a prerequisite to certify coffee as bird-friendly. Additional attention should be given to the landscape setting, in particular the maintenance of forested patches. This approach is critical in areas where coffee is grown adjacent to the last fragments of cloud forests in the highlands of Central America

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ACKNOWLEDGEMENTS

This research project has had many contributors over the last 10 years, but first and foremost I want to thank Martha Groom for her support over the last three years of my graduate work and Gordon H. Orians for his support at an earlier stage. Special thanks to Judy Farrow, for helping me to navigate all the steps and paperwork to complete my doctorate.

Many people in Nicaragua participated in this project. Francisco Muñoz, with his first hand knowledge of birds, coffee and the reality of coffee farmers, was an invaluable assistant in the field. José Manuel Zolotoff, Osmar Arróliga and Juan I. Matamoros did an excellent job surveying birds and trees in Mombacho with the logistical support provided by Fundación Cocibolca. Joseph Wunderle, Jr. and Wayne Arendt helped in the design of the ornithological component of this project, training and surveying. Gerry Bauer (U.S. Forest Service) and Margaret Harritt (U.S. Agency for International Development) were instrumental in securing funding for research in Mombacho. The Wildlife Conservation Society provided initial research funds.

Rosario Sáenz gave invaluable assistance through her Fundación Nicaragüense para el Desarrollo Sostenible in Managua. Miguel Angel Castellón, from Instituto para el Desarrollo Rural, facilitated many institutional contacts. In the Northern highlands, Corina Picado, George and Liliana Duriaux, Octavio and Lidia Vílchez and many other families offered their hospitality while visiting coffee farmers. Merling Preza (PRODECOOP, Estelí), Carlos Sánchez (CLUSA, Managua), Fernando López (UCAFE, Dipilto), Fernando López (UCAFE, Jalapa) and Fátima Ismael Espinoza (SOPPEXCCA, Jinotega) provided contacts and valuable information to access technicians and farmers in the Nicaraguan highlands.

In Seattle, Laurie McCullem offered her friendship and invaluable support organizing information from the surveys. My sister Paloma and her husband Cass Avery rescued and fed me more than once while working long days at the Department of Biology. I thank my mother in Madrid for her lifelong faith in me.

And last but not least, to my wife Loretta Garden, for her patience, understanding and endurance during our separation and her continued support and encouragement throughout a very long doctoral journey.

DEDICATION

To Loretta,

for everything

CHAPTER 1: DOES ORGANIC CERTIFICATION INFLUENCE TREE COVER COMPOSITION IN COFFEE PLANTATIONS?

INTRODUCTION

Many believe that coffee grown under shaded conditions and organically cultivated (without the use of synthetic chemical inputs) is the most environmentally sound approach to coffee production (Bray et al. 2002; Dietsch 2005). Much has been written to describe the benefits of shade grown cultivation for biodiversity, as well as for development of high quality coffee (Perfecto & Snelling 1995; Perfecto et al. 1996; Greenberg et al. 1997; Calvo & Blake 1998; Wunderle 1999; Johnson 2000; Rojas et al. 2001; Carlo et al. 2004; Pineda et al. 2005; Gleffe et al. 2006; Philpott et al. 2006; Dietsch et al. 2007). However, very little attention has been paid to the role of organic production in fostering biodiversity conservation. Beyond the benefits of eliminating the use of synthetic chemicals on coffee farms, no one has considered the biodiversity impacts of management practices used in organic coffee production.

Most highland coffee (*Coffea arabica* L.) is grown under a layer of trees that provide shade and ground cover, and, in most cases, fix nitrogen (Harrer 1963; Bornemisza, 1982; Rice 1999). The composition and structure of this shade tree layer ranges from a dense and diverse canopy to a few scattered, nitrogen-fixing trees (Toledo & Moguel 1997; Moguel & Toledo 1999). As a general rule, when farms are managed to achieve optimal growth rates and yields, the tree canopies tend to be less dense.

Also to maximize yields, typical coffee cultivation includes considerable inputs of fertilizers, pesticides and herbicides (Gobbi 2000; Campanha et al. 2004; Nestel 1995). Such cultivation practices can be costly both economically and ecologically, and currently there is a push to grow coffee in more sustainable ways, to minimize the impact of management on biodiversity associated with coffee plantations (Rice & Ward 1996; Rice & McLean 1999).

Organic cultivation practice is seen as an obvious improvement over the conventional practice of using synthetic chemicals to enhance yields. Yet no study has yet considered the potential impacts and tradeoffs of management activities that alter vegetation structure that organic coffee farmers may use to substitute for the chemical controls previously used to maintain healthy coffee plants. In this study, I seek to understand whether and how organic cultivation may influence overstory vegetation in coffee plantations, particularly as farmers seek to enhance yields while compensating for a lack of synthetic fertilizers or combating the impacts of fungal pathogens.

One means to compensate for the prohibition against using synthetic fertilizers is to rely more heavily on nitrogen-fixing trees to mitigate for post-harvest nitrogen losses (Bornemisza 1982). Thus, I predict that organic plantations should employ a greater density or diversity of nitrogen-fixing trees when compared with conventional counterparts.

Coffee yields can be reduced by fungal pathogens. American leaf spot, caused by a fungus (*Mycena citricolor* Berk & Curtis), is one of the most serious diseases in coffee plantations across Latin America (Buller 1934; Tewari et al. 1984). It causes extensive defoliation and, if left unattended, the fungal infection can spread to twigs and berries, causing berry drop (Rao & Tewari 1988). The disease is more prevalent in plantations with high humidity and above 1000 m, conditions typically associated with highland, top quality, arabica coffee (*Coffea arabica* L.)

Since organic coffee producers would lose their organic certification if they used fungicides, they have few options to limit the incidence of coffee leaf spot (Vargas 1984; Vargas 1996; As 1996). One option available to organic farmers is to modify the forest environment to increase the amount of sunlight that reaches the coffee bushes, thereby drying the environment and increasing UV incidence, which has been shown to be effective in reducing American leaf spot infections (Beer et al. 1998; Staver et al. 2001). The easiest and the most cost-effective approaches to increasing light levels to the coffee bushes are to 1) reduce the number of trees that shade the plantation, 2) change the composition of the shade-tree layer, or 3) prune the shade trees more radically (Guharay et al. 2000). Consequently, I expect that organic coffee plantations, especially those infested with certain fungal pathogens, should display lower shade levels than conventional ones.

Additionally, some studies found a significant negative correlation between infestation levels of the coffee leaf rust (*Hemileia vastatrix* Berk & Br.) and the number of shade strata (Soto-Pinto et al. 2002) in Mexican coffee plantations, suggesting that higher strata complexity may act as a barrier for fungal dispersal, mainly via reducing wind speed. Thus, I predict that organic plantations should have a higher number of strata than conventional plantations.

I analyzed whether the conversion of traditional shade-coffee plantations to organic production influences the structure and composition of the tree layer and the plantation itself. I expect organic plantations to have lower amount of shade, and more strata than traditional plantations. I also expect that the density of nitrogen-fixing trees will be higher in organic plantations, as the growers cannot apply commercial fertilizers. I do not expect other aspects of the vegetation, for example, the density of coffee trees, to differ between the two plantation types.

STUDY AREA AND METHODS

Study Sites

Conventional and organic coffee plantations were selected as study sites in the Nicaraguan Highlands (Figure 1.1). The study was conducted between March and May 2007. Nicaragua provides a convenient location to test our hypotheses because of the prevalent use of shade trees in both organic and conventional coffee plantations. Official figures indicate that 96% of the coffee is cultivated under some kind of shade (Magfor 2003). The number of farms that produce organic coffee is still small (less than 2%), but their numbers have been increasing steadily in the last decade.

The Northern Highlands account for 80% of the area under coffee cultivation and more than 90% of the production in Nicaragua (IICA 2004). Historically, coffee plantations have been established in an altitudinal belt between 800 and 1800 m, in areas that once were covered with cloud forest. The western part of this region, known as Las Segovias, has remarkably diverse vegetation, soils and climate. Pure stands of highland pine forest (*Pinus maximinoi* H.E. Moore and *Pinus tecunumanii* Eguiluz & J.P. Perry) dominate mountain ridges and areas with sandy soils in the north and western parts (Stevens et al. 2001). At lower elevations mixed pine (*Pinus* spp)-oak (*Quercus* spp) forest alternate with pure oak formations, except in valleys where a rain shadow (less than 500 mm/yr) favors more xeric vegetation dominated by acacias [*Acacia pennatula* (Cham. & Schltdl.)]. In the past, cloud forest covered most of the central and eastern part, where organic rich soils and wetter climate (2000 mm/yr) are commonly found. Today's landscape is dominated by coffee plantations and pastures, and cloud forests are relegated to the most rugged and wettest areas.

Field sites were selected according to the presence of certified organic plantations at elevations above 900 m and with minimum annual rainfall of 1500 mm. I chose these parameters because farmers with plantations under these environmental conditions are the most likely to use antifungal chemicals, or for those certified as organic, to be likely to manipulate their canopy cover to place their coffee bushes under light shade cover. I prepared a list of 50 potential farms to be visited that were of medium size, and which shared similar varieties of Arabica coffee (*Coffea arabica* L.). I selected 10 pairs, one of each farm certified as organic, the other a conventional farm growing coffee under shade. Farm pairs were of similar sizes and located within a short distance of each other. No other prior information was used in selecting the pairs.

All the plantations use trees for shade, ranging from rustic to polyculture in structure and composition (Moguel & Toledo 1999). At the landscape level, these plantations form part of a complex matrix of forest fragments in different successional stages, pastures and coffee plantations. Some of the largest forest fragments are located inside protected areas and adjacent to coffee farms. Selected plantations vary in size from 10 to 100 ha, and were located in four departments, Jinotega (2 farms), Estelí (4), Madriz (6), and Nueva Segovia (8) (Fig 1.2). Shade trees were an array of native species from the original forest as well as planted native and non-native species. Banana plants were also widely used.

Vegetation Sampling

Sampling was conducted in 25 m radius circular plots, evenly distributed within each plantation. Plots were spaced a minimum of 100 m apart, and at least 50 m away from the nearest forest patch. The exact number of plots sampled in each plantation was a function of the size of the plantation to avoid undersampling the diversity of larger plantations by using a fixed sample size. As a rule, a minimum of 5 and a maximum of 10 plots were surveyed in a single plantation.

Habitat variables measured at each plot included elevation, distance to the edge, canopy tree species richness, number of canopy trees, number of strata, coffee density, percent canopy cover, coffee yields and presence of fungal infestation (Table 1.1).

Farmer interviews

To understand what factors play an important role in the short and long-term management of these coffee plantations, owners and administrators of 16 of the 20 coffee plantations were interviewed using a standardized questionnaire. This is part of a separate research project on farmer's perspectives on the role of forest fragments in their plantations (Chapter 3), but it allowed us to gather information on farming practices and yields.

Statistical analyses

I use a randomized block ANOVA to compare vegetation variables between organic and conventional farms. This is a mix effect model where farms pairs are treated as a random effect, farming method (organic vs. conventional) is a fixed effect and canopy cover, coffee tree density, number of vegetation strata, tree abundance and Musaceae abundance are dependent variables. Variables measured at the farm level (annual coffee yields, percentage of forest fragments and tree diversity) were analyzed using Wilcoxon signed-rank test (for variables with non-normal distributions) or paired T-test (for variables with normal distributions). I used a nested ANOVA model to control for the variability at farm level (thereafter named Farm Name in the analysis) to compare shade levels between farms infested with *Mycena citricolor* and non-infested farms. Tree diversity was estimated using several indexes (Shannon, Simpson and Hill's), and results were compared using a two-tailed paired T-test or its non-parametric equivalent (Wilcoxon signed-rank test). I used Spearman's rank correlation analysis to explore relations between coffee plantation variables and tree canopy structure, and between plantation age and the size and density of the coffee trees.

RESULTS

Coffee stand structure and species richness

I identified 121 tree species in the 20 farms visited (Table 1.2), and all but 20 individuals were identified to species. Highest average values for tree richness and diversity were obtained in organic coffee plantations (Table 1.3), but the differences with conventional farms were not statistically significant (Paired T test, Shannon index, T=1.112, 9 d.f., p=0.295; Simpson index, T=1.2, 9 d.f., p=0.261; Hill's N_0, T=1.168, 9 d.f., p=0.273; Hill's N_1., T= 1.165, 9 d.f., p=0.274; Hill's N_2 , T=1.079, p=0.309). Further, average diversity in organic plantations becomes more similar to conventional farms when I remove from the analysis two farms established less than 10 years ago, one organic plantation grown under cloud forest (with 26 mostly native tree species) and a conventional farm established in an area of abandoned pastures and shrubs (with 30 tree species, but dominated by *Inga oerstediana*), indicating that the means were strongly affected by the two more extreme plantations.

Conventional coffee plantations have significantly higher densities of coffee bushes than organic ones ($F_{1, 9} = 7.085$, p=0.008). Furthermore, differences between farm pairs are statistically significant too ($F_{9, 179} = 41.32$, p<0.001), probably a reflection of different coffee growing traditions within Northern Nicaragua. The same heterogeneity is common in the distribution of coffee varieties, with some farms having up to three different varieties in a single plot. Caturra was the most prevalent coffee variety in all plantations (Table 1.4), in both organic (74%) and conventional (64%). Together, the conventional plots had more coffee varieties than their organic counterpart (a total of 8 for conventional vs. 5 in organic farms).

Organic farms were significantly older than their conventional counterparts ($F_{1, 9}$ = 13.83, p<0.001). They also exhibit significant differences between farm pairs ($F_{9, 179}$ = 15.94, p<0.001). Some of the most obvious differences in coffee tree height were associated with the age of the plantation and the variety of coffee under cultivation. Plantations over 50 years old had coffee bushes as large as 4 m in height and 20 cm in diameter at the base. Coffee tree height was strongly predicted by the age of the plantation, but only in organic farms (Organic plantations, Spearman's ρ = 0.498, P < 0.001; Conventional plantations, Spearman's ρ = - 0.043, P = 0.682).

Contrary to our predictions, there does not appear to be any reduction in shade levels in organic plantations compared with conventional plantations (Table 1.5). Average shade cover ranged widely among the 20 coffee plantations, from 9% to as high as 70% (Figure 1.3). Organic plantations scored the highest and lowest values on this range. However, there was no statistically significant difference in the shade cover between organic and conventional farms ($F_{1, 9} = 0$, p=.984). But differences were significant between farm pairs ($F_{9, 179} = 22.47$, p<0.001). In conventional plantations there is a significant inverse correlation between coffee tree density and shade, and more dense plantations tend to have less shade cover (Figure 1.4, Spearman's $\rho = -0.445$, $P < 0.001$). In contrast, coffee tree density and shade do not show any correlation in organic plantations (Spearman's $\rho = 0.102$, $P = 0.323$).

Overall, organic farms had significantly more strata than conventional farms ($F_{1,9} = 13.31$, p<0.001). To test if this could be an artifact of the pre-existing vegetation, I removed from the analysis two farm pairs containing two plantations established in the last 9 years (one organic farm in a cloud forest and a conventional in an open pasture). There was no difference in the number of strata between conventional and organic farms when I excluded these two recently established farms ($F_{1,8} = 3.39$, p=0.067), although differences between farm pairs remained significant ($F_{8,160} = 11.13$, p<0.001).

Organic and conventional farms were not significantly different in abundance of canopy trees ($F_{1, 9} = 0.98$, p=0.323) or bananas ($F_{1, 9} = 1.67$, p=0.198), although variation between farm pairs was significant.

Infestation with American Leaf Spot (Mycena citricolor)

Most farms surveyed had little or no infestation with *M. citricolor*. The only plantations affected (4 organic and 3 conventional) were those located in the eastward side of the study area, in the Jinotega and Nueva Segovia Highlands (Figure 1.2). These plantations are located in areas where high humidity is prevalent over most of the year. Fungal infestation was mainly concentrated in plots where the hybrid coffee variety known as "Catimor" (a cross between leaf-rust-resistant Timor and Caturra coffee) had been planted, although other varieties were also affected.

Shade levels were not different between organic and conventional farms infested with *M. citricolor* (Nested ANOVA; Effect Test, Infestation w/ *M. citricolor* $F_1 = 0.004$, $p = 0.952$; Farm name [Infestation w/ *M. citricolor*] $F_{53} = 33.31$, $p < 0.001$).

When comparing farms infested with *M. citricolor* vs. non-infested farms, regardless of farming method, I found that farms that were not infested with *M. citricolor* had significantly higher shade levels (Nested ANOVA; Effect Test, Infestation w/ *M. citricolor* $F_1 = 6.021$, $p = 0.022$; Farm name [Infestation w/ *M. citricolor*] $F_{21} = 7.534$, $p < 0.001$). As a whole, farms infested with *M. citricolor* had an average shade level of 38%, while non-infested farms averaged 62%.

Some differences emerge when the analysis was performed within farming method. In conventional farms, infested plots averaged 40% shade cover, versus 60% in non-infested plots, although these differences are not statistically significant when I control for variation at the farm level (Nested ANOVA, Effect Test, Infestation w/ *M. citricolor* $F_1 = 1.299$, $p < 0.276$; Farm name [Infestation w/ *M. citricolor*] $F_{10} = 6.362$, $p < 0.001$). However, within organic farms, infested plots average 37% shade cover, while non-infested plots score 64%, and these differences are statistically significant (Nested ANOVA; Effect Test, Infestation w/ *M. citricolor* $F_1 = 5.149$, $p < 0.048$; Farm name [Infestation w/ *M. citricolor*] $F_9 = 10.082$, $p < 0.001$). These differences remained even when the farm recently established within a cloud forest fragment was included in the analysis**.**

The role of Nitrogen fixing trees

Nitrogen fixing trees from the Mimosaceae and Fabaceae families comprise an average of 56% of the shade trees in organic plantations and 69% in conventional farms, but these differences were not statistically significant (Paired T test, T=1.038, d.f. 9, p=0.326). Nevertheless, there was a considerably wider variation in the ratios of N fixing/non-fixing trees within conventional (Mean = 2.89 ± 0.84) than within organic (Mean = 1.76 ± 0.39) farms.

Forest fragments

All farms infested with *M. citricolor* (7 in total) have embedded forest fragments and, in some cases, have more area covered with forest than with coffee (Table 1.6). In contrast, the remaining non-infested farms (13) have less forest (no more than 34% of the farm area) or no forest at all (8 farms, Table 1.6). Farms affected by *M. citricolor* have significantly more area covered with forest than those unaffected by the disease ($T= 2.77$, d.f. 7.32, $p < 0.026$). I found no significant difference in the proportion of forest left between organic and conventional farms (Wilcoxon signed-rank test, $Z=1.68$, $p=0.093$) although organic farms tend to have twice as much area in forest (27.9%) than their conventional counterparts (12.8%).

One of us (JCMS) interviewed the owners of 16 of the 20 farms surveyed. A detailed analysis of the interview protocol and results is described elsewhere (Chapter 3). When asked whether forest fragments may act as refuge for coffee pests, only 2 responded affirmatively, indicating that most farmers don't perceive a relation between coffee pests and the presence of forest ($T = 4.30$, d.f. 2, $p = 0.02$). The responses of organic and conventional farmers were alike. When asked whether forests fragments help their coffee plantation, all the farmers responded positively, including those that responded earlier that forest may act as a refuge for coffee pests ($T = 4.30$, d.f. 2, $p = 0.01$). However, a specific statement linking coffee production to the presence of nearby forest fragments ("Forest fragments increase coffee yields") gave more mix results: Eight farmers responded affirmatively, 6 negatively and 2 didn't know. In this case, no clear differences emerged between organic and conventional farmers or those with forest vs. those who don't have any forest left in their farms.

Coffee Yields

As reported by farm owners, coffee yields ranged from a low 195 kg/ha to more than 2210 kg/ha. Some of the farms exhibited 3-fold oscillations in annual yields, probably a consequence of age and poor nutrition of coffee plants or inadequate pruning practices. This variation affected organic and conventional farms alike, but organic farms had yields that were on average 23% lower than conventional ones (Table 1.7). Nevertheless, this difference was not statistically significant (T test, T=-1.335, 13 d.f., $p = 0.205$).

DISCUSSION

Does organic certification influence tree cover composition in Nicaraguan coffee plantations? I don't think so. Shade levels and tree composition, diversity and abundance were similar among the plantations I surveyed, although levels of these variables varied more widely within organic farms. Contrary to our predictions, organic farms do not make a greater use of nitrogen fixing trees than conventional farms, even though conventional farmers must rely on farm trees to a greater extent to incorporate nutrients into the soil (Bornemisza 1982).

One reason that organic and conventional farmers may have similar tree diversity, density, and shade levels, may be that the incentives to use shade trees are substantial for both groups. Nitrogen fixing trees should reduce fertilizer costs among conventional farmers, as well as compensate for the lack of such fertilizers among organic farmers. Further, trees and other tree-like plants (such as plantains and bananas) serve multiple roles beyond shading coffee plants. For small farmers especially, shade trees can provide a complementary income and represent economic security (Méndez et al. 2001; Albertin & Nair 2004). Trees add organic matter to the soil via mulching of decaying leaves, branches and trunks, and decaying leaves form a protective layer that acts as a natural herbicide (Romero-Alvarado et al. 2002). Their deep root systems reduce soil erosion and compaction, and reduce water run-off during severe storms (Jiménez-Avila et al. 1982). Shade trees increase relative humidity in coffee plantations and act as a buffer for daily and seasonal changes in temperature (Perfecto 1996). By creating a more stable microclimate, trees also regulate ripening and maturation of coffee fruits and significantly increase the lifespan of coffee trees (Salazar 1999; Muschler 2001). All of these benefits should motivate both organic and conventional growers alike, and thus perhaps it is not surprising to find no systematic difference between these types of farms regarding their use of shade trees. However, in plantations where fungal infestation is a problem, the advantages of having a diverse and dense shade tree layer maybe compromised.

I expected to find a greater number of vegetation layers in organic than conventional farms, but probably for the wrong reason. A more plausible explanation for the higher number of vegetation layers in organic plantations is the greater age of organic farms, and the tradition of organic farmers in Nicaragua of minimizing labor costs associated with tree pruning and overall vegetation management.

Organic and conventional plantations did differ in other aspects. Organic farms had older plantations, more area covered with forest, and possibly lower yields than conventional farms. Age of coffee plants might in part be responsible for these lower yields. Because replanting is costly, most farmers pruned coffee trees several times over the lifespan of the plants. Organic farmers may be using this technique more extensively to invest fewer resources in renovating their coffee plantations. Given that organic farmers had lower yields than the conventional farmers, such cost savings may be particularly necessary for these farmers.

The single most important factor affecting shade cover in organic and conventional farms was the presence of *M. citricolor*. Farms affected with *M. citricolor* were all located in the eastern part of the study region, were humidity is typically highest (Fig. 2). Under those circumstances, some farmers appear to have reduced the number of shade trees to increase solar radiation reaching the coffee plants. I were unable to confirm whether this is a general trend because only 7 of the 20 farms visited were affected with the disease, and there was a considerable variation in shade levels among organic coffee plantations. Nevertheless, if differences in shade levels between infested and non-infested farms are an indication of farmers' response to fungal infestation, organic farms were more severely affected. To confirm this possible relationship, further research should be carried out focused in coffee plantations infested with *M. citricolor*, especially in areas where microclimatic conditions (high relative humidity) favor the development of the fungal disease. Further, the ways in which vegetation management might impact the incidence of this particular fungal infection is poorly studied, so it is difficult to generalize what practices might decrease its incidence in coffee plantations (Zúñiga Pereira 2000). More research is needed to look at infestation patterns within farms in relation to multiple factors, such as coffee variety, soil type, shaded tree density, topography, wind exposure, and distance to nearby forest areas.

All farms affected by *M. citricolor* had relatively large forest fragments, regardless of farm size. Organic farms tended to have twice as much area in forest than conventional farms. Although I have no conclusive evidence linking forest cover and infestation with *M. citricolor*, this remains a possibility. It is also possible that because the farms infested with *M. citricolor* occur in wetter, higher elevation sites in the eastern portion of the study area, this correlation simply reflects a coincidence with the location of the few remaining forest fragments. Certainly, I strongly urge that forest fragments be preserved, and if possible expanded in this region to support watershed services and biodiversity conservation.

Our results could challenge the conventional view that shade grown is always the most environmentally-friendly way for growing coffee, at least in areas where infestation with *M. citricolor* is a problem. Under those circumstances, it may be more feasible to grow coffee with low shade levels and applying the correct amount of chemical fertilizers to balance yearly loses of N and K (van der Vossen 2005) if, in exchange, part of the farm can be set aside for conservation. Forest fragments are needed for biodiversity conservation because it is unlikely that shaded plantations alone will provide feeding resources and the structural habitat complexity demanded by many species, for example, large avian frugivores that undertake complex altitudinal migrations (Powell & Bjork, 2003). Our on-going research explores this link by looking at the composition and structure of bird communities in organic and conventional coffee plantations (Chapter 2).

Unfortunately, the argument that areas with remaining forest are of marginal value for agriculture expansion (Gorenflo & Brandon 2005) does not discourage farmers from converting remaining forest patches into coffee plantations, especially when the coffee prices are high (O'Brien & Kinnaird 2003). Perhaps biodiversity conservation would be better accomplished via directing our efforts to developing a comprehensive accounting mechanism for all the environmental services that remaining forest patches provide to both the nearby coffee plantations and, to a certain extend, the local communities.

In this region of Nicaragua, organic farmers received a premium price for their coffee that ranged from 15 to 20% above the regular market price. In some exceptional cases, coffee roasters paid an additional 40% premium to farmers for protecting forest and setting aside part of the farm as a protected area. While not all the farmers have enough land to set aside areas for conservation, this is an interesting initiative that goes beyond the organic/conventional debate, and has important implications for preserving the last cloud forest fragments in the region.

In summary, I found few differences between the overstory vegetation in organic and conventional farms, and little evidence that organic farmers are manipulating their overstory more than conventional farmers. In contrast, I found that organic plantations have more area covered with forest fragments than conventional farms, even though they are getting lower yield per ha of planted coffee. However, I did find differences among individual farms that provide a cautionary lesson. One of the organic farms I visited that exhibited a dense tree canopy was covered with cloud forest as recently as 9 years ago. In contrast, I found a 6 year old conventional farm established in an abandoned and highly degraded pasture. While this latter farm was not very diverse, it was structurally much more diverse than nearby pastures – and thus represented a substantial improvement for biodiversity conservation. Obviously, the conversion of cloud forest should be discouraged, while the reclamation of degraded pasture lands should be encouraged, but none of the certification agencies or local organizations working in the coffee sector are paying attention to this issue. Economic incentives should be paid for restoring degraded lands, and not for degrading the last cloud forest fragments. These findings, along with our observations regarding the impacts of fungal infestation and forest cover, lead us to believe that certification strategies that provide incentives for maintenance of a forested landscape mosaic may best support biodiversity, and should be promoted even more strongly than organic standards.

FIGURES

Figure 1.1. Map of Nicaragua with the general location of the study farms.

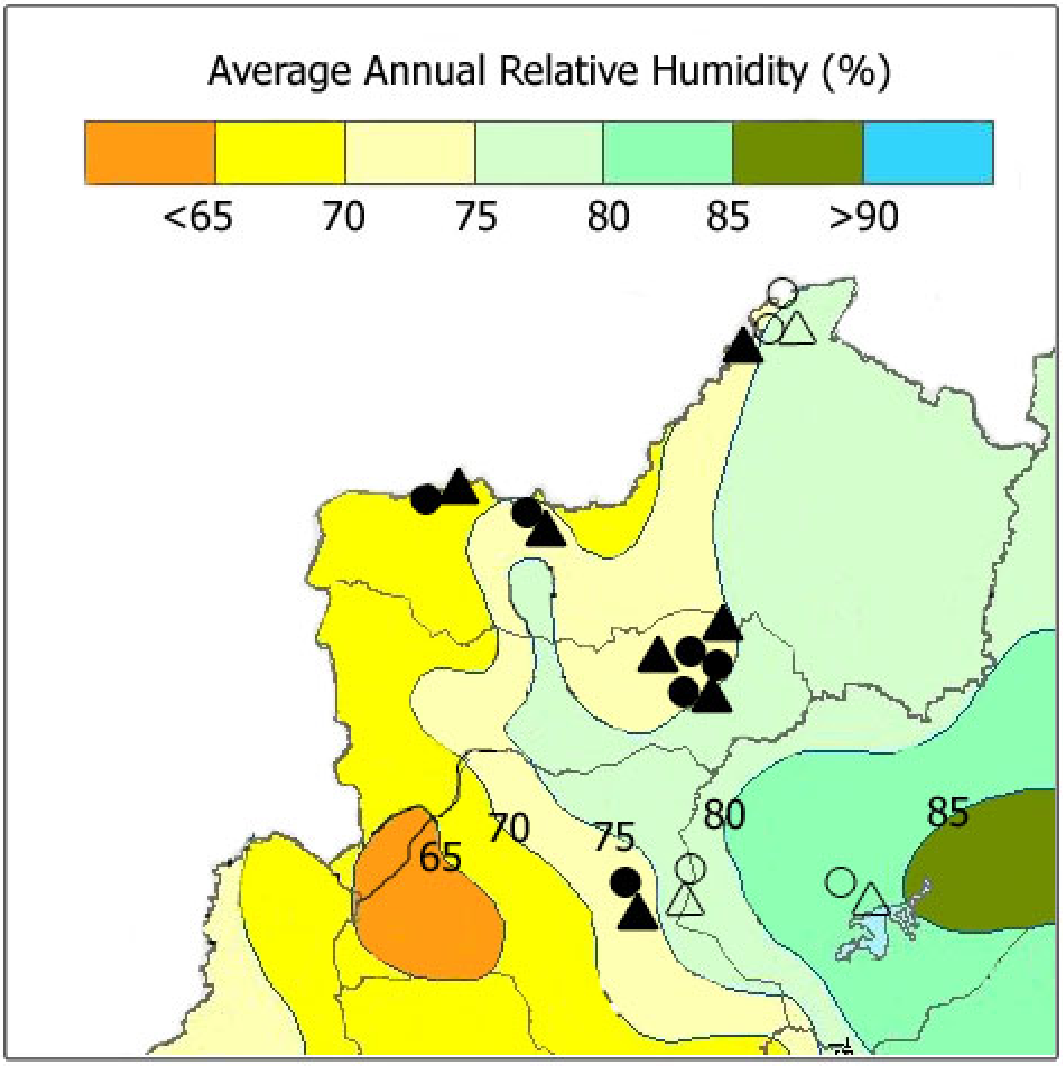


Figure 1.2. Location of selected plantations and relative humidity.

Organic farms infested (open circles) vs. not-infested (solid circles) with *M. citricolor*; conventional farms infested (open triangles) vs. not-infested (solid triangles) with *M. citricolor*.

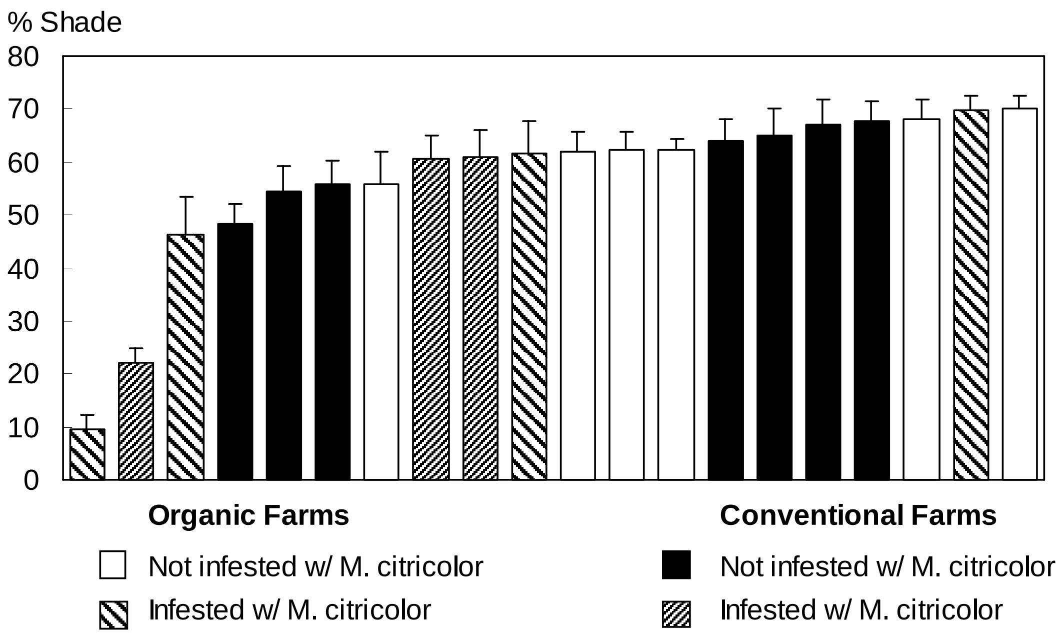


Figure 1.3. Shade levels in organic and non-organic farms.

Shade levels in organic (white) and conventional (black) farms, infested with *M. citricolor* (hatched) and non-infested (solid).

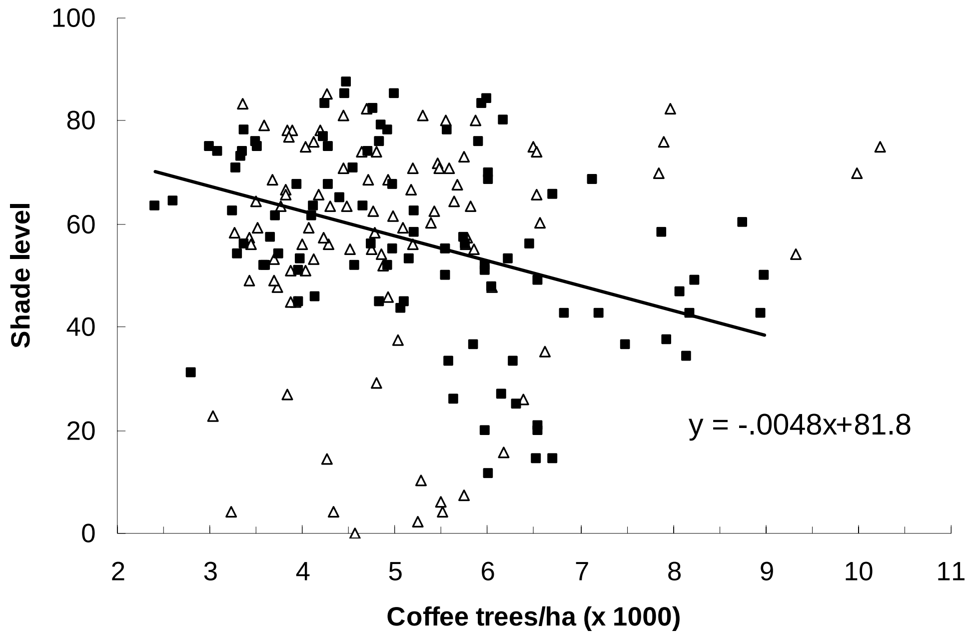


Figure 1.4. Shade level vs. coffee tree density.

Black squares, conventional plantations; white triangles, organic plantations. Regression line represents relationship between shade levels and coffee density in conventional farms.

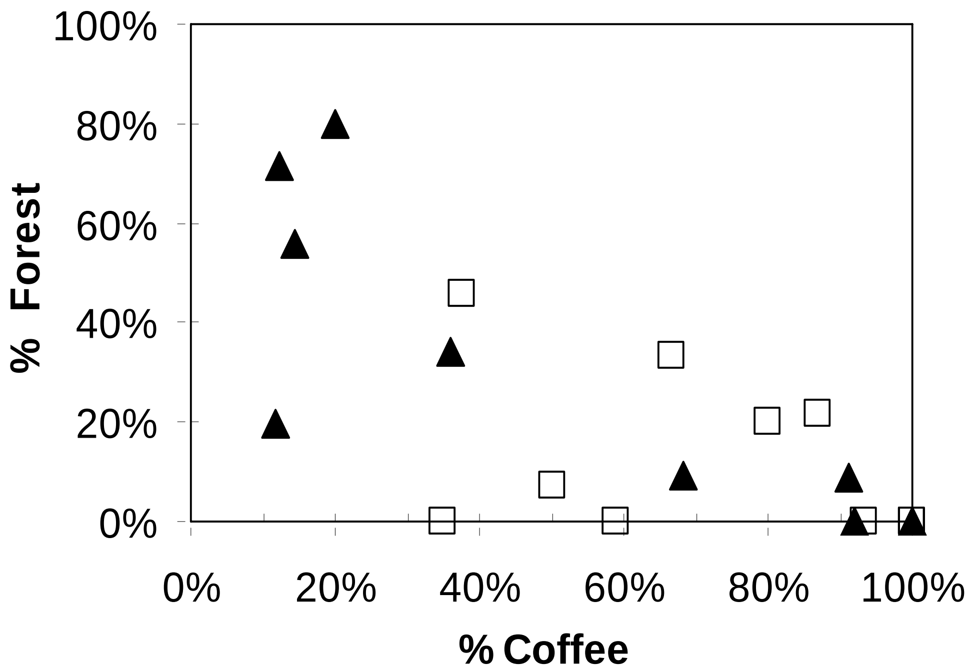


Figure 1.5. Proportion of land use in forest versus coffee.

Land use in organic (triangles) and conventional (squares) farms as percentage of the total area covered in forest vs. active coffee plantation; pastures and other crops are excluded from this analysis.

Table 1.1. List of variables measured on each plot.

1. Elevation, measured in meters with an altimeter at the center of the plot.
2. Age of the coffee plot, provided by the farm owner or plantation manager.
3. Total number of species of canopy trees ≥ 10 cm DBH, including bananas and plantains.
4. Total number of canopy trees ≥ 10 cm DBH.
5. Number of strata. The number of vegetation strata formed by trees ≥ 10 cm DBH, other than coffee. Vegetation on each plot, as a whole, was visually assigned to one or more of the following height classes: Understory (< 5 m), Intermediate (between 5 and 10 m), canopy (≥ 10 and < 20 m) and emergent (≥ 20 m). The presence of a single tree within a strata class mean that the entire plot scored for that level. Values ranged from 1 (a single strata present) to 4 (maximum number of strata present).
6. Coffee density, measured by recording the distance from a selected coffee tree to each of its nearest neighbour coffee trees (one on each side of the same planting row and one on each adjacent row). Three observations were recorded on each transect (N, S, W, W) starting at the closest coffee tree 5 m from the center plot and at approximately 8 m intervals thereafter.
7. Percent canopy cover, measured by looking straight to the overstory through an ocular tube, 50 mm in diameter, and recording the presence or absence of foliage within the visual field. Canopy cover was simplified by counting cover in four categories: 0, 25, 50, 75 or 100%. Six observations were recorded on each transect (N, S, E, W) starting at 1 m from the center plot and at 4 m interval. Average canopy cover for each plot is the average of the observations.
8. Average coffee yields based on estimates provided by the plantation manager over the last 3 years.
9. Presence of fungal infestation with *M. citricolor*.

Table 1.2. Tree species recorded in coffee plantations.

No	Scientific Name	Local Name	Other names	Family
1	*Mangifera indica*	Mango		Anacardiaceae
2	*Spondias mombin*	Jocote	Jocote Jobo	Anacardiaceae
3	*Spondias purpurea*	Jocote Ciruela	Jocote Corona	Anacardiaceae
4	*Tapirira mexicana*	Trotón		Anacardiaceae
5	*Anona reticulata*	Anona		Annonaceae
6	*Scheelea rostrata*	Corozo		Aracaceae
7	*Eupatorium (daleoides?)*	Matorral	Muñeco	Asteraceae
8	*Perymenium nicaraguense*	Tatascán		Asteraceae
9	*Carpinus tropicalis*	Cuero de Toro	Sauce, Saucillo	Betulaceae
10	*Bixa orellana*	Achiote		Bixaceae
11	*Cordia alliodora*	Laurel		Boraginaceae
12	*Bauhinia sp*	Pata de Paloma		Caesalpiniaceae
13	*Tamarindus indica*	Tamarindo		Caesalpiniaceae
14	*Crateva tapia*	Matasanillo	Manzana de Playa	Capparaceae
15	*Cecropia peltata*	Guarumo		Cecropiaceae
16	*Licania platypus*	Sonzapote	Zapote "unaco"	Chrysobalanaceae
17	*Calophyllum brasiliense*	María		Clusiaceae
18	*Terminalia oblonga*	Guayabo	Guayabón, Guayabillo	Combretaceae
19	*Lonchocarpus oliganthus*	Chaperno		Euphorbiaceae
20	*Ricinus comunis*	Higuera		Euphorbiaceae
21	*Albizia adinocephala*	Gavilán		Fabaceae
22	*Albizia saman*	Genízaro	Miligüiste	Fabaceae
23	*Cassia grandis*	Cárao		Fabaceae
24	*Dalbergia cubilquitzensis*	Granadillo		Fabaceae
25	*Diphysa americana*	Guachipilín		Fabaceae
26	*Erythrina berteroana*	Elequeme	Gualiqueme	Fabaceae
27	*Erythrina fusca*	Coralillo		Fabaceae
28	*Erythrina poeppigiana*	Búcaro		Fabaceae
29	*Gliricidia sepium*	Madreado	Madero Negro	Fabaceae
30	*Hymenaea courbaril*	Guapinol		Fabaceae
31	*Pterocarpus officinalis*	Sangredrago		Fabaceae
32	*Senna sp.*	Vainilla		Fabaceae
33	*Quercus cortesii*	Lisakí	Masica, Pimienta	Fagaceae

Table 1.2. (continue)

No	Scientific Name	Local Name	Other names	Family
34	*Quercus sapotifolia*	Roble Encino	Encino	Fagaceae
35	*Quercus segoviensis*	Roble		Fagaceae
36	*Casearia arborea*	Comida de Culebra	Chilillo	Flacourtiaceae
37	*Casearia corymbosa*	Huesillo	Huesito	Flacourtiaceae
38	*Homalium racemosum*	Areno		Flacourtiaceae
39	*Liquidambar styraciflua*	Liquidambar		Hamamelidaceae
40	*Alfaroa williamsii*	Cogollo Colorado	Variedad de Aguacate	Juglandaceae
41	*Beilschmiedia riparia*	Aguaslipe		Lauraceae
42	*Cinamomum sp*	Aguacate Blanco		Lauraceae
43	*Nectandra sp*	Aguacate Canelo	Canelo	Lauraceae
44	*Ocotea cf. veraguensis*	Canelo		Lauraceae
45	*Ocotea helicterifolia*	Aguacate Posán		Lauraceae
46	*Ocotea sp 1*	Aguacate Morado		Lauraceae
47	*Ocotea sp 2*	Aguacate Pachón		Lauraceae
48	*Ocotea sp 3*	Aguacate Colorado		Lauraceae
49	*Ocotea veraguensis*	Aguacate Sabanero		Lauraceae
50	*Persea americana*	Aguacate Comestible	Aguacate de Castilla	Lauraceae
51	*Persea caerulea*	Aguacate Mico	Aguacate Negro, Aguacatillo	Lauraceae
52	*Yucca guatemalensis*	Espadillo		Liliaceae
53	*Byrsonima crassifolia*	Nancite	Moco	Malpighiaceae
54	*Cedrela odorata*	Cedro Real		Meliaceae
55	*Acacia pennatula*	Carbón	Espino	Mimosaceae
56	*Inga oerstediana*	Guaba Colorada	Guaba Blanca, G. Pachona	Mimosaceae
57	*Inga paterno*	Guaba Paterna	Guaba Extranjera	Mimosaceae
58	*Inga punctata*	Guaba Negra		Mimosaceae
59	*Inga vera*	Guaba Cuajiniquil		Mimosaceae
60	*Lysiloma sp.*	Quebracho		Mimosaceae
61	*Brosimum alicastrum*	Ojoche		Moraceae
62	*Castilla elastica*	Palo de Hule		Moraceae
63	*Ficus obtusifolia*	Higuerón	Matapalo	Moraceae
64	*Ficus sp 1*	Chilamate	Lechoso	Moraceae
65	*Ficus sp 2*	Higo		Moraceae
66	*Juglans olanchana*	Nogal		Moraceae

Table 1.2. (continue)

No.	Scientific Name	Local Name	Other names	Family
67	*Ardisia costaricensis*	Cuya de Montana		Myrsinaceae
68	*Ardisia revoluta*	Cujia	Cuya	Myrsinaceae
69	*Eugenia esteliensis*	Saray		Myrtaceae
70	*Psidium guajava*	Guayaba Común		Myrtaceae
71	*Syzygium jambos*	Manzana Rosa		Myrtaceae
72	*Cespedesia spathulata*	Lengua de Vaca	Tinajera, Mierda de Gallina, Vara Blanca, Tabacón	Ochnaceae
73	*Piper aduncum*	Cordoncillo		Piperaceae
74	*Rupala montana*	Orín de Chancho	Zorrillo	Proteaceae
75	*Karwinskia calderonii*	Miligüiste	Genízaro	Rhamnaceae
76	*Eriobotrya japonica*	Ciruela		Rosaceae
77	*Genipa americana*	Jagua		Rubiaceae
78	*Casimiroa sapota*	Matasanos		Rutaceae
79	*Citrus cinensis*	Naranja		Rutaceae
80	*Citrus limon*	Limón	Limón Real, Limón Tahiti	Rutaceae
81	*Citrus paradisi*	Toronja		Rutaceae
82	*Citrus reticulata*	Mandarina		Rutaceae
83	*Zanthoxylum caribaeum*	Cabalonga	Quiebramuela, Chinche	Rutaceae
84	*Cupania cinerea*	Cacahuillo	Cola de Pava, Guacamaya	Sapindaceae
85	*Sapindus saponaria*	Limoncillo		Sapindaceae
86	*Sapindus saponaria*	Pacón	Jaboncilllo	Sapindaceae
87	*Chrysophyllum cainito*	Caimito		Sapotaceae
88	*Pouteria sapota*	Zapote		Sapotaceae
89	*Sideroxylon portoricense ssp. minutiflorum*	Zapotillo		Sapotaceae
90	*Syderoxilon capiri ssp. tempisque*	Tempisque		Sapotaceae
91	*Simarouba amara*	Acetuno	Aceituno	Simaroubaceae
92	*Acnistus arborescens*	Güitite		Solanaceae
93	*Brugmansia suaveolens*	Huelenoche		Solanaceae
94	*Solanum wrightii*	Cuernavaca		Solanaceae
95	*Guazuma ulmifolia*	Guácimo	Guácimo de Ternero	Sterculiaceae

Table 1.2. (continue)

No.	Scientific Name	Local Name	Other names	Family
96	*Styrax argenteus*	Alamo		Styracaceae
97	*Heliocarpus appendiculatus*	Majagüe	Majagua	Tiliaceae
98	*Luehea candida*	Molenillo	Guácimo de Molenillo	Tiliaceae
99	*Trema micrantha*	Capulín		Ulmaceae
100	*Urera sp*	Chichicaste		Urticaceae
101	*Lippia myriocephala*	Mampás		Verbenaceae
102		Caballo Blanco		
103		Cáñamo		
104		Mancharropa		
105		Montón		

Table 1.3. Tree diversity indexes in surveyed plantations.

	Shannon (H)'		Simpson λ		Hill's N_0		Hill's N_1		Hill's N_2	
Farm pair	Organic	Non-org	Organic	Non-org	Organic	Non-org	Organic	Non-org	Organic	Non-org
1	1.756	2.023	0.298	0.227	12	17	5.787	7.561	3.356	4.412
2	2.837	1.351	0.092	0.385	38	18	17.056	3.862	10.812	2.598
3	1.346	1.883	0.392	0.293	10	17	3.841	6.575	2.553	3.411
4	2.626	1.956	0.117	0.245	31	27	13.822	7.071	8.523	4.074
5	1.553	2.526	0.278	0.121	16	25	4.726	12.500	3.604	8.258
6	1.835	2.413	0.294	0.134	23	25	6.267	11.168	3.405	7.465
7	2.575	1.396	0.117	0.328	33	11	13.131	4.041	8.545	3.049
8	2.012	1.741	0.227	0.269	27	19	7.476	5.701	4.413	3.720
9	1.970	1.640	0.288	0.412	28	30	7.169	5.157	3.476	2.425
10	2.499	0.928	0.148	0.647	26	18	12.174	2.529	6.780	1.546
MEAN	2.101	1.786	0.225	0.306	24.4	20.7	9.145	6.617	5.547	4.096

Table 1.4. Distribution of coffee varietals per plot.

Percentages have been rounded to the nearest unit. Note that totals do not match total plot number because several plots have more than one varietal.

Variety	Organic	%	Conventional	%
Caturra	74	66	67	63
Catuai	24	21	10	10
Borbon	8	7	4	4
Arabica	0	0	1	1
Maracaturra	4	4	3	3
Maragojipe	0	0	6	6
Catimor	2	2	4	4
Paca	0	0	9	9
	112	100	104	100

Table 1.5. Comparison of vegetation and plantation characteristics.

Variable	Mean ± SE	
	Organic	Conventional
Shade level (%)	56.49 ± 2.21	56.45 ± 1.87
Tree strata	3.01 ± 0.09	2.65 ± 0.09
Plantation age (yrs)	13.92 ± 0.91	10.69 ± 0.67
Total trees	24.49 ± 1.41	26.12 ± 1.46
Total Musaceae	35.21 ± 3.7	40.86 ± 4.03
Coffee height	1.99 ± 0.06	2.04 ± 0.04
Coffee density	5231 ± 173	5622 ± 183

Table 1.6. Relation between forest cover and *M. citricolor* infestation.

Forest cover as percentage of total farm size and infestation with *M. citricolor*.

Percentage (%) of Forest Cover	
Not infested with *M. citricolor*	Infested with *M. citricolor*
34.3	80
33.2	71.4
20.5	56
19.5	45.8
9.1	21.7
0	8.8
0	7.3
0	
0	
0	
0	
0	
0	

Table 1.7. Average yields (kg/ha) for the last three harvest seasons.

Data provided by the farm owners via personal interviews.

	Organic Farms	Conventional Farms
	916.8	581.0
	387.4	1536.5
	1026.5	1401.0
	755.4	1329.9
	652.1	1175.0
	1239.6	1310.6
	1065.2	471.3
	968.4	
Average	876.4±95	1115.0±158

CHAPTER 2: THE ROLE OF ORGANIC CULTIVATION ON BIRD DIVERSITY AND ABUNDANCE IN SHADE COFFEE PLANTATIONS.

INTRODUCTION

There is growing recognition that parks and protected areas are not keeping pace with the biodiversity crisis (Terborgh 1999; Bruner et al. 2001) and that more attention should be devoted to enhancing the conservation potential of areas used for agricultural production (Murniati et al. 2001; Vandermeer & Perfecto 2007; Bhagwat et al. 2008). Criteria for assessing successful management differ for parks and agricultural lands. Areas devoted to conservation are considered successful when species and biological processes are preserved with a minimum human intervention. Considerable effort is devoted to isolate these areas from the market forces in a globalized economy (Redford 1992, Peres 2005; Kramer et al. 1997). In contrast, land used for agricultural or timber extraction is basically at the mercy of these very same market forces (Hecht & Saatchi 2007), and government policies are usually designed to promote trade (Nagendra et al. 2003). This is especially the case for agricultural commodities produced in developing countries (Niesten et al. 2004). Coffee is, by far, the most important agricultural commodity, both in economic terms and in the number of producers, traders and consumers involved (Pendergrast 1999). Furthermore, it provides a pertinent example of how market forces influence agricultural landscapes, and the attendant consequences for biodiversity conservation worldwide (O'Brien & Kinnaird 2003).

In the last decade a growing number of publications have emphasized the importance of shade coffee plantations as a refuge for biodiversity in agricultural landscapes (Perfecto & Snelling 1995; Perfecto et al. 1996; Greenberg et al. 1997; Calvo & Blake 1998; Wunderle 1999; Johnson 2000; Rojas et al. 2001; Carlo et al. 2004; Pineda et al. 2005; Gleffe et al. 2006; Philpott et al. 2006; Dietsch et al. 2007). These studies compare diversity levels of birds and other taxa in sun coffee, plantations that grow coffee without using trees for shade, with shade grown coffee, plantations using trees for shade. Some comparisons are among plantations with different types of shade structure and composition. Shade trees add one to several extra layers of vegetation complexity to this agricultural landscape. In general, the more complex the structure and composition of the shade layers, the higher the number of bird species found in the plantation (Moguel & Toledo 1998). All these studies corroborate the widely established fact that habitat structural complexity and diversity, provided in this case by a multi-species tree layer, is closely matched by a parallel diversity of other terrestrial taxa (Orians 1969).

Parallel to this interest in the environmental role of coffee plantations has been a growing demand for certified coffee, that is coffee grown under a new set of rules intended to enhance the role of coffee plantations as biodiversity friendly areas (Rice and Ward 1996). Perhaps the best known and more widely accepted of all certification schemes is the organic seal. Its core set of rules demands zero use of synthetic products when growing a particular crop. In the case of coffee, this implies that pests are controlled using native (or introduced) predators or parasites, fungal infections are dealt with using naturally-occurring rock additives and managing shading to control humidity levels, and weeds are controlled using habitat enhancement techniques (shading , mulching, etc) or manually removal (Staver et al. 2001). The expenses of growing coffee organically, plus the cost of certification are paid by the farmer. In exchange, the organic seal allows the farmer to get a premium price for the coffee, usually about 10 to 20% higher than current market prices for non certified coffee. Eventually, this premium price is passed to a consumer willing to pay the difference for a variety of reasons. In general, organic products are perceived as healthier (Gil et al. 2000), tastier (Fillion and Arazi 2002) and overall better for the environment, the farmer and workers than conventional alternatives (Ferraro et al. 2005). However, shade is not a requirement for organic certification. Indeed, the largest certified organic coffee plantation in Nicaragua has very few trees for shade (JC Martinez-Sanchez, pers. obs.). So, the perception of the benefits of organic coffee for biodiversity conservation has been based on contrasting shade versus sun coffee plantations, and not by actually comparing organic versus non organic farms.

How can we assess the environmental benefits of organic coffee? Are organic farms more species rich than neighbour conventional plantations? Do they support a more abundant fauna or flora? We have very little data on how much organic practices (zero use of agrochemical inputs) enhances biodiversity, particularly in the already species rich shade coffee plantations. By measuring the environmental benefits of organic coffee plantations I can evaluate if consumer perception is supported by scientific evidence, at least in this particular aspect.

Studies of the effects of organic agriculture on terrestrial biodiversity are relatively rare. Most of them have been carried out in Europe for annual crops. Piha et al. (2007) studied the effect of organic agriculture on birds at the landscape level, and found that landscape structure and agricultural land use were the principal determinants for bird diversity and species richness, not organic cultivation per se. Other studies conducted on particular species, such as skylarks *Alauda arvensis* in the Netherlands found significantly more birds nesting in organic fields (Kragten et al. 2008), but this experiment did not control for significant differences in crop density (higher in organic farms) and uneven sample sizes. A comparison of bird populations on organic and conventional farm systems in Britain found very few significant differences in bird density outside the breeding season. Individual species tended to be more strongly associated with other habitat variables than with organic management, and organic farms had more trees and significantly greater proportion of higher and wider hedges than conventional farms (Chamberlain et al. 1999). These differences could very well explain the higher number of birds in organic farms. In a review of papers published on the effect of organic agriculture on biodiversity, Bengston et al. (2005) noted that 53 out of 63 studies showed higher species richness in organic agricultural systems, but these authors also acknowledged that many studies comparing organic and conventional farming systems were poorly designed, and did not control for important variables both at the farm (i.e., vegetation structure and composition) and at the landscape level (Bengston et al. 2005). I know of no studies comparing organic and conventional farms in any tropical environment.

Bird diversity has been widely used to assess habitat quality (Cronquist & Brooks 1991; Hughes et al. 2002; Gregory et al. 2003; Mas & Dietsch 2004). They are probably the best known taxon in tropical mountain forests, and one of the most commonly studied in coffee plantations in the Neotropics (Wunderle & Latta 1996; Greenberg et al. 1997; Calvo & Blake 1998; Jones et al. 2002; Komar 2006; Raman 2006; Dietsch et al. 2007). Many species have specialized diets (i. e, insectivores) that can make them particularly vulnerable to changes in food resources (Wunderle & Latta 1998; Perfecto et al. 2004), poisoning via direct food consumption (Balcomb et al. 1984; Mineau 2005) or bioaccumulation (Hill & Mendenhall 1980; Peakall & Bart 1983; Pimentel et al. 1992). For this reason, I expect that populations of insectivores and top predators in general should be depressed in coffee plantations using insecticides.

Granivore birds feeding on the seeds of ground weeds may be disproportionably affected in plantations that regularly use herbicides (Santillo et al. 1989). I are not aware of any study on the impact of agrochemicals on nectar feeding birds, but since most nectar feeders consume a considerable amount of small insects for their protein requirements they could be affected similarly to insectivorous birds. The same sorts of predictions are not so evident for fungicides. The direct or indirect toxicity of fungicides for birds has not been clearly established, either for synthetic products or the mineral-base compounds (e.g., Bodeaux mixture, a solution of cooper based salts) used in organic farms (OCIA 2007).

This study compares bird diversity and abundance between organic and conventional shade coffee plantations. Firstly, I analyze for differences in the structure and composition of the canopy tree layer, since this could be a confounding factor in our analysis. I compare entire bird communities as well as specific trophic guilds and resident versus migratory species. I predict that insectivorous birds should be disproportionably affected because insecticides should significantly reduced prey availability and they may also suffer detrimental effects of bioaccumulation. Reduction on insect prey could also affect nectarivorous birds because insects play an important role in their diets. Birds feeding on small seeds produced by ground weeds should be affected in farms using herbicides. Birds using the coffee tree level should also be disproportionably affected, because it is at this level that all the pesticides are applied in conventional farms. If pesticides do not explain the differences in bird diversity and abundance in shade coffee plantations, I will test whether the structure and composition of the tree component does.

STUDY AREA AND METHODS

The study was conducted in coffee plantations adjacent to the Volcán Mombacho Natural Reserve, an isolated mountain (1345 m a. s. l.) located 10 km south of the city of Granada in the Pacific slope of Nicaragua (11°50' N, 85° 59'). This massive volcano creates its own highly seasonal, microclimate (Fig. 2.1). Annual rainfall (1800-2200 mm) falls mainly during 6 months, June through November. Rains during the dry season, (January through April) are brief and infrequent. Northeast trade winds are prevalent from December through February, speeding up the seasonal decline in the plantation's relative humidity (INETER unpublished data).

For the purpose of this study, I selected 10 plantations, 4 certified organic (referred thereafter as "Organic"), 4 that use chemicals (referred thereafter as "Conventional") and 2 transition plantations (farms that have adhered to organic standards in the last 2 years and are in the process of being certified as organic), all located between 400 and

800 m above sea level (Fig. 2.2). Organic farms were all certified under the same standards established by the Organic Crop Improvement Association (OCIA International) under a project implemented by the Cooperative League of the United States of America (CLUSA). Even though these farms had been certified organic within the last 3 years, they have been organic “de facto” for much longer, as a consequence of the economic hardships of the Contra War (1980-1990) and subsequent changes in land tenure. Conventional farms use a common set of inputs to control insect pests, weeds and in some cases fungal infections. Table 2.1 summarized the main agrochemical inputs use in these plantations, based on data provided by farm managers through informal interviews carried out at the beginning of the study. I made no further attempt to characterize the chemicals used in these farms. As a general rule, herbicides and insecticides were applied twice a year, mainly to control infestation of coffee berry borer *Hypothenemus hampei* Ferr (Coleoptera: Curculionidae), and fungicides three to four times a year, depending of the degree of infestation with coffee leaf rust *Hemileia vastatrix* Berk, and Br. (Basidiomycota: Pucciniales). Fertilizer was applied twice per year, in the form of N/P/K mixture or regular urea ($CO(NH_2)_2$ at 46%). Most applications of pesticides and fertilizer were during the rainy season (June through November). Coffee in Mombacho is harvested from December to late February.

Selected plantations ranged in size from 21 to 300 ha. At the landscape level, coffee plantations dominate the 400 to 800 m altitudinal belt, while higher elevations are covered by cloud forest. Remaining patches of semi-deciduous forest extend between coffee plantations in areas covered by deposits of basalt and other pyroclastic rocks (Atwood 1984). All plantations had many shade trees, ranging from rustic to polyculture in structure and composition (Moguel & Toledo 1999), although the structure and composition of the shade layer varied between plantations.

Three elements characterize the vegetation in these plantations, the coffee plantation itself, the tree layer shading the coffee plants, and the landscape surrounding these farms (Fig. 2.2). While all coffee plantations in our study site are from a similar variety of highland arabica coffee (*Coffea arabica* L.), they differ in use of chemical inputs, age of coffee trees and plantation density. Thus, I measured these variables on each 0.2 ha (25 m radius) plot as follow:

1. Farming system. Each farm was identified as certified organic (referred hereafter as “organic”), transition to organic (“transition”), and conventional.
2. Coffee density, estimated along four 24 m transects running in the cardinal directions centered within the 0.2 ha circle. Coffee density was measured by counting all coffee stems (< 3cm) touched by an observer’s outstretched arms

or chest as he/she walked the length of a transect (Wunderle 1999). This measure was standardized beforehand for all observers.

3. Coffee height, measured by recording the height of the four tallest coffee trees along each of the 4 transects.

The tree layer was characterized by the following variables:

1. Total number of species of canopy trees in the circle, excluding bananas and plantains.
2. Canopy tree height. Overstory trees, excluding coffee, were measured for maximum height with a 7 meter pole or a clinometer for high trees. Bananas and plantains were excluded because they were rarely used within the plantation.
3. Total leaf volume. I used tree height to separate trees into 4 strata (< 10 m, 10-20 m, 20-30 m, > 30 m), and weight tree density at each strata to estimate total leaf volume (< 10 m= density × 1; 10-20 m = density × 2; 20-30 m = density × 3; > 30 m= density × 4 (Philpott et al 2007).
4. Percent canopy cover, measured by looking straight to the overstory through an ocular tube, 50 mm in diameter, and recording the presence or absence of foliage within the tube's visual field. To meet the criteria for foliage presence, at least 25% of the tube sighting area had to be covered by foliage. Possible values were 0, 25, 50, 75 or 100%. Twelve observations were

recorded on each cardinal direction starting at 1 m from the center plot and at 2 m intervals. The observations were averaged to obtain an average canopy cover for each plot.

Two general landscape variables completed the profile of each plot:

1. Elevation, measured in meters with an altimeter at the center of the plot.
2. Distance from the center of the plot to the edge of the nearest forest patch, pasture or any annual crop.

To have a better idea of the overall importance of coffee plantations in relation to other land uses in Mombacho I mapped forest, coffee plantations, and other crops using recent (1995) ortho-photomaps, scale 1:10,000 from Instituto Nicaragüense de Estudios Territoriales (INETER). Three field crews covered approximately an area of 50 km^2 using hand-held gps units to map vegetation boundaries between forest and coffee plantations (Fig. 2.2).

Birds were censused using two complementary techniques: Fixed (25 m) radio point counts and mist netting transects (Ralph et al. 1996). A total of 200 points were selected, 83 distributed in 4 farms certified as organic, 54 in two transitional farms and 63 points in 4 conventional farms. Censuses were conducted between 6:00 am and 10:30 am. Birds were recorded for a 10 minute period using both visual and auditory clues. All birds detected were recorded, but for the final analysis I excluded individuals detected beyond the 25 m radius, as well as birds that flew over the point. Each point was censed 5 times over a period of 16 months, from November 1997 through April 1999 by a team of four ornithologists.

Additionally, I mist netted in 8 of the plantations (4 organic, 2 transition and 2 conventional) with 5 repetitions over the same time period. In every netting pulse between 15 and 19 nets (12 m long, 30 mm mesh size) were used simultaneously over a 2-day period. Mist netting sites were more than 0.5 km apart. Nets were placed in areas of varying coffee densities and routinely set to a maximum of 2.5 m height to obtain as complete a sample of birds as possible. Variables recorded were species, sex and age (when possible). Table 2.2 summarized the dates for both point counts and mist net sampling.

The primary diet of each species was classified into five categories: small arthropods (SA), large arthropods, small reptiles and birds (LARB), fruits and large seeds (FLS), small seeds (SS) and nectar (N). To account for species feeding on more than one food type, I weighted each category from 1 (occasional in the diet), 2 (regular food) or 3 (exclusive food). This allowed me to split diets into two (1 and 2, or 1.5 and 1.5) or three trophic categories (1, 1, 1), or assigned a single one (3). I analyzed potential differences in bird trophic guilds among farming methods in two ways. First, I compared at the species level and subsequently use their relative abundance to weight their contribution to one or more trophic guilds. Assignment of diet and habitat preferences was based on information from the literature (Stiles & Skutch 1989) and our own knowledge

Statistical Analysis

I carried out a series of preliminary tests to confirm that farms were similar in vegetation structure and composition. Canopy cover, coffee tree densities and number of tree strata were compared between farming methods (organic and conventional) using nested analysis of variance (ANOVA). This design, where farms were nested within corresponding farming practice, allowed us to incorporate differences at the farm level while comparing farming practices. When data distribution violated parametric assumptions I used square root transformation or ran non-parametric tests (Mann-Whitney U or Kruskal-Wallis sign test).

I used sample-based rarefaction analysis (Gotelli & Graves 1996) to assess the reliability of our point counts in recording tree and bird species richness and to control for different sampling effort (James & Rathbun 1981). I ran 1000 simulations using EcoSim v. 7 software (Gotelli & Entsminger 2001). Based on the results of our vegetation sampling I set the maximum number of individual trees to 900, allowing us to compare tree species richness among organic, transition and conventional plots.

Conversely, I did the same rarefaction analysis for the birds by setting the maximum number to 1500 individuals.

I estimated the overall canopy vegetation similarity using the Bray-Curtis coefficient, $C_N = 2N_j \big/ (N_a + N_b)$ where N_a and N_b are the total number of individuals in site A and B, and N_j is the sum of the lower of the two abundances recorded for species found in both sites (Magurran 2004). Coefficient values range from 0, for totally dissimilar communities, to 1 when they are identical. These values were clustered using a single-linkage nearest neighbor method that is based on Euclidean distance using the software package Biodiversity Pro version 2.0 (McAleece 1997). The same analysis was performed to estimate bird community similarity between farming methods. In all statistical analyses a probability of committing a Type I error was placed at the 0.05 level of significance. Means are given with ± one standard error.

I explore whether individual characteristics of the tree layer predicted bird species richness using linear regressions. I follow a stepwise multiple linear regression with backward selection of 6 vegetation variables: Total number of trees, tree richness, percent canopy cover, mean canopy tree height, number of canopy tree strata and total leaf volumes. These were the independent variables and bird species richness and abundance were dependent variables. Data for canopy tree height and total leaf volumes were log transformed. Data for bird abundance were square-root transformed.

I analyze data from mist net captures separated from those of point counts because our relative sampling effort among farming practices was different on both cases.

RESULTS

Vegetation analysis

I recorded a total of 119 tree species, plus 17 morpho-species that I were unable to identify. Tree species richness was similar among the plantation types, even after adjusting for the unequal sampling effort (Fig. 2.3; single factor ANOVA, $F_{2, 9} = 0.422$, $p = 0.667$). There was considerable variation in vegetation among coffee plantations, but farms did not cluster together according to farming method (Fig. 2.4). One tree species, *Inga oerstediana,* dominated all plantations, accounting for half of the total trees (Table 2.3).

Shade levels range from 43% to 79% (Table 2.4) and were differed significantly among individual farms (Nested ANOVA, $F_{7, 190} = 14.33$, $p < 0.001$), but did not differ by farming method (Nested ANOVA $F_{2, 7} = .217$, $p = 0.81$). Furthermore, both organic and conventional farms exhibit similar ranges in shade levels (Table 2.4).

Coffee tree density was on average 10% higher in conventional plantations, but this difference was produced by a single organic farm (San Joaquín) with an unusually low coffee tree density. Otherwise there was no statistical difference among plantation types (Effect test, farming method $F_{2, 7} = 0.256$, $p = 0.781$; farm name (farming method) $F_{7, 190} = 10.05$, $p < 0.001$). A similar trend was observed for other vegetation variables, such as number of shade trees, canopy height and number of tree strata. As a group, conventional farms have more tree strata than organic counterparts (an average of 3.21 m ± 0.09 layers in conventional versus 2.81 m ± 0.07 in organic). They are also taller (14.42 m ± 0.43) than those in organic farms (12.69 m ± 0.36). Nevertheless, inter-farm variation superseded any difference associated with farming practices. Summarizing, organic and conventional farms in Mombacho are alike in composition and structure of tree canopies, as well as their coffee plantations.

Bird diversity and abundance

I recorded a total of 4,478 individuals of 92 bird species (72 residents and 20 Neotropical migrants) with our point counts. Twenty five additional species were captured in mist nets but not recorded our point counts. Overall species richness was similar among farms grouped together by farming method and ranged from 61 in transitional farms to 74 species in conventional ones. I combined the results of the 5 censuses and constructed rarefaction curves with 6 resampling points at intervals of

250 individuals Estimated species richness, as determined by rarefaction analysis, confirmed these results (Figure 2.5: note overlap of the confidence intervals). Furthermore, bird communities did not cluster together by farming method (Fig. 2.6).

Organic and conventional farms were very similar in bird species composition (Table 2.5). These farms shared 8 out of the10 most commonly recorded species. Two migrants, *Vermivora peregrina* (ranking 1) and *Dendroica petechia* (ranking 3) and one resident wren (*Thryothorus pleurostictus*, ranking 2) were the most common birds in conventional farms, while *Thryothorus pleurostictus* and *Dendroica petechia* and *Euphonia hirundinacea* ranked alike in organic farms.

The number of birds recorded in our point counts varied widely, from as high as 40 birds to no birds at all in 12% of our point counts. Conventional farms averaged almost 5.17±0.29 birds per plot and census, while organic and transition farms averaged 4.19±0.20 and 4.03±0.26 respectively. To reduce the bias of having too many missing values I combined the results of the five censuses before testing for differences between farming practices. Nevertheless, these differences were not statistically significant (Effect test, farming method $F_{2, 7} = 0.751$, $p = 0.507$; farm name (farming method) $F_{7, 190} = 10.05$, $p < .001$). To sort out the effect of resident and migratory birds, I conducted separate tests for each group. In both cases, conventional farms scored higher, but the results were more pronounced for the migrants, with an average of 1.44±0.18 birds per plot in conventional farms versus 0.83±0.09 in organic ones. The low number of migrants prevented us from running a nested ANOVA.

I performed a one-way ANOVA to test for differences between censuses conducted on different dates in farms under the same farming practices. I excluded the 4^{th} census from analysis of Neotropical migrants because they were absent at that time (late July- early August). Farms showed significant differences in abundance of resident birds between censuses (Effect test, Organic $F_4 = 14.72$ $p < 0.001$; Transition $F_4 = 13.25$ $p < 0.001$; Conventional $F_4 = 11.30$ $p < 0.001$). Bird abundance peaked in conventional and transition farms in the third census (July), while in organic farms it peaked earlier (February). For migrants, differences between censuses were not significant, although their numbers were slightly higher in the 4^{th} census (November 1998) under all farming practices.

If farming practice (e.g., pesticide use) is having an impact on the bird community I expected it to be strongest at the crop level, in our case, around the coffee bushes. The average number of birds was almost identical between organic (0.90±0.06) and conventional farms (0.93±0.08) (Kruskal-Wallis ANOVA, H=1.42, 2 d.f., p = 0.49). Resident birds followed a similar patterns (Kruskal-Wallis ANOVA, H=1.10, 2 d.f., p

= 0.58). Migrant numbers at the coffee tree level were too low (a mere 16 birds in 800 point counts) for any meaningful statistical analysis.

I analyzed my data of resident birds in the canopy layer adding the results of the 5 surveys and using a square root transformation. There was no statistical difference in the numbers of birds recorded in the canopy tree layer between conventional (2.80±0.18) than organic farms (2.46±0.15), as the numbers between farms of each type ranged more widely than differences between farm types (Effect test, farming method $F_{2, 7} = 0.586$, $p = 0.582$; farm name (farming method) $F_{7, 190} = 8.68$, $p < .001$). Migrants at the canopy layer behave in a similar fashion (Effect test, farming method $F_{2, 7} = 0.483$, $p=0.636$; farm name (farming method) $F_{7, 190} = 7.97$, $p < .001$).

Species not recorded in a particular group of farms (organic, transition or conventional) were usually recorded in very low numbers in general. *Euphonia affinis* was the only species with more than 10 records in organic and transitional farms that was never recorded in conventional farms.

Trophic guilds

At the species level, there were no differences in bird species feeding on arthropods, small reptiles or birds, fruits or seeds (SA, LARB, FLS and SS) between organic, transition and conventional farms. Nevertheless, conventional farms had more species of nectar feeders than organic and transition farms (Effect test, farming method $F_{2, 7} = 6.952$, $p = 0.02$; farm name (farming method) $F_{7, 190} = 10.05$, $p= 0.005$). However, when I ran the same analysis for weighted values of nectar feeders, these differences became non-significant (Effect test, farming method $F_{2, 7} = 2.07$, $p = 0.2$; farm name (farming method) $F_{7, 190} = 7.40$, $p< 0.001$).

Mist netting results

I captured 1840 birds of 79 species (50 residents and 29 Neotropical migrants) with an estimated effort of 10,069 net hours. Captures averaged 18 birds per 100 net-hr, but ranged widely between farms. There was an eight fold range in capture rates, from 5.57 birds/100 net-hr in a transition farm to 40.3 birds in Cutirre, a conventional farm (Table 2.6). Hummingbirds comprised the majority of birds netted in all farms, accounting for more than half of total captures (Table 2.7).

I found more birds in conventional farms than in organic ones, even though our sampling effort was half as great. Nevertheless, interfarm variation was by far more significant, and our statistical analysis confirmed that total number of birds, residents and migrant alike, were not statistically different between farming methods. Birds grouped by trophic guild show no differences either. Table 2.8 summarizes these results.

Bird-habitat relationships

Our regression model failed to predict overall bird abundance from all but one variable, average canopy tree height ($t = 1.967$, d.f. 2, 199, $p = 0.051$). However, when I analyzed residents and migrants separately, the model predicting resident bird abundance included tree abundance ($t = 2.464$, d.f. 2, 199, $p = 0.015$) and shade level ($t = 1.911$, d.f. 2, 199, $p = 0.057$), while migrant abundance was predicted only by tree abundance ($t = -1.978$, d.f. 1, 199, $p = 0.049$). The regression model predicting bird richness included tree richness ($t = -3.338$, d.f. 2, 199, $p = 0.001$) and total leaf volumes ($t = 3.691$, d.f. 2, 199, $p < 0.001$). This is also the case for the model predicting resident bird richness [tree richness ($t = - 3.426$, d.f. 2, 199, $p = 0.001$) and total leaf volumes ($t = 3.875$, d.f. 2, 199, $p = 0.001$)], but for migratory bird richness the regression model included only canopy tree height ($t = 2.227$, d.f. 2, 199, $p = 0.027$)

DISCUSSION

Our results show that bird diversity and abundance are not influenced by whether or not chemicals are used to control undesirable pests or weeds in shade coffee plantations. Instead, bird diversity and abundance appear to be directly related to the structure and composition of the tree canopy. In this regard, our results agree with the growing body of evidence that demonstrates the importance of shade trees in coffee plantations (Perfecto & Snelling 1995; Greenberg et al. 1997; Calvo & Blake

1998; Wunderle 1999; Johnson 2000; Carlo et al. 2004; Gleffe et al. 2006; Philpott et al. 2006; Dietsch et al. 2007).

I did not measure the amount of chemical inputs and the timing of pesticide application that were used in our conventional farms, so it is impossible to evaluate how typical are these plantations in that regard. Nicaraguan farmers usually complain that chemical inputs cost here between 30 to 40% more than in neighbouring countries. According to a commercial distributor of these products, Nicaraguan coffee growers spent on average between 40 to 50% less per hectare in pesticides than farmers in Costa Rica or Guatemala do, and distributors import lower volumes of these products but at a higher cost. Nicaragua has the lowest wages in the region – in fact, many Nicaraguan workers travel to Costa Rica or El Salvador during the coffee harvest to earn better wages – meaning that in many cases it probably costs less to pay laborers to manually cut weeds, or apply compost as fertilizer, than buying herbicides and fertilizers.

It remains to be seen if our results are applicable to other coffee growing regions, such as the Northern highlands of Nicaragua, where high humidity levels forces farmers to maintain more open tree canopies and to use more chemical inputs.

Another element to consider is the instability of these farming practices when they are at the mercy of the market forces. Two of the conventional farms I surveyed are now being certified by Rainforest Alliance as sustainable coffee, a seal that does not completely ban pesticide and fertilizer use in agriculture but helps farmers to optimize their use while at the same time pays attention to other environmental issues, like management of forest patches and shade tree diversity. On the other hand, three of the organic farms I studied were sold and are being subdivided to build vacation residences, a change in land use that could have by far a more detrimental effect on biodiversity conservation than any amount of pesticide use.

Coffee plantations in Mombacho show remarkable differences in canopy tree structure and composition, but these differences are not associated with farming practice. It is interesting to note that even plantations own by the same individual and under the same technical management can be rather different.

Tree richness is remarkably high in these coffee plantations, even in farms dominated by introduced *Inga* species (Bandeira et al 2005). These coffee plantations are among the oldest in the country, dating back to the end of the XIX century. Therefore, future research should look at recruitment and population dynamics of these tree species, since there is evidence that natural succession and gap dynamics are severely impaired in other agricultural systems using trees with a similar purpose (Rolim & Chiarello 2004).

Bird diversity in Mombacho plantations is relatively low, compare with similar farms in Southern Mexico and Guatemala (Calvo & Blake 1998; Greenberg et al. 1997; Cruz-Angón & Greenberg 2005). Mombacho is an isolated volcano that has suffered at least three major collapses in historical times (Sea et al. in press). The cloud forest in the highlands was never colonized by many of the frugivores (*Pharomachrus mocinno*, *Aulacorhynchus prasinus*, *Euphonia elegantissima*, *Chlorophonia* spp, *Chlorospingus opthalmicus*, *Buarremon brunneinucha, Ortalis* spp), nectarivores (*Diglossa* spp) and army ant followers that are so common in the nearby forest of Guanacaste and the Northern Nicaraguan highlands. Today, it is an island of forest surrounded by agriculture and cattle farms. Not surprisingly, birds at these coffee plantations are a subset of generalists from an avifauna dominated by generalist species.

The main differences observed between plantations were due to the resident avifauna using the tree layer. Here is where differences between farms are more obvious, regardless of the farming method under management. In contrast, the resident avifauna using the coffee tree substratum is almost identical among plantations, further evidence that current levels of pesticide application in conventional farms are not having a detrimental effect on the bird population. If anything, a dense and diverse canopy probably keeps most of the birds away from the coffee layer, thereby acting as refuge from pesticide poisoning. In that sense, the workers applying these pesticides are probably at a far greater risk than any bird. Nevertheless, I did not find any bird carcasses during our days in the field over a two year period nor did I receive any report of human poisoning. Further research should be conducted in coffee plantations under more intense cultivation, lower and less diverse shade levels and higher pesticide applications. Multiple point counts should be conducted, before and after pesticides are applied. Ideally, a control should be established within the same plantation to minimize differences between farms.

The absence of many resident bird species in coffee plantations has always been linked to lack of suitable habitat and no research has explored a potential connection between pesticide sensitivity and rarity among tropical resident birds. Nor I am aware of any publication documenting pesticide bioaccumulation in tropical land birds. In this regard there is a lot we need to do to prove a cause-effect relationship between pesticide use and survival and fitness of resident and migratory birds.

The presence of Neotropical migrants in such low numbers may have nothing to do with the management of these coffee plantations and more to do with the presence of more suitable habitat in the nearby forest. Mombacho appears to be off the main route for Neotropical migrants heading south and may be an added factor explaining the lack of Neotropical migrants. Preliminary data from two monitoring station in Mombacho support this hypothesis (Fundación Cocibolca, unpl. records).

Another factor of concern is the scale of our natural experiment. It is quite possible birds are using these plantations as suboptimal habitats and that their territories and food resources spread over areas covering several plantations, even forest patches. This may be the case for some of the migrants, and could explain why they are less sensitive to certain vegetation parameters of the tree canopy, like shade levels and tree richness. I have anecdotal evidence that many resident forest birds embark in seasonal altitudinal movements, moving to higher altitudes during the dry season. That could explain the changes in bird numbers I observed between censuses.

It is likely that the differences observed in certain trophic guilds between plantations are the result of subtle differences in the structure and composition of the canopy tree layer, or the presence of forest fragments within these farms. Studies in Puerto Rico shade coffee plantations found similar levels of reproductive activity and productivity between birds nesting in shade coffee plantations and secondary forest (Gleffe et al. 2006). Forest fragments in coffee plantations may play a more crucial role in preserving bird species than organic agriculture, especially when they are protecting critical habitat, such as stream banks ("arroyos") or water holes (Warkentin et al 1995).

Abundance and diversity of resident and migratory birds were not explained by the same vegetation attributes. This may be related to differences in food and habitat requirements. A tall canopy may be important for some species, but for many nectar feeders the presence of *Inga* spp with their year round supply of nectar may be far more important. That may explain why tree abundance is a better predictor of bird abundance for resident species than tree height or tree species richness. These results also highlight how variable individual coffee plantations are, even when they are located close to each other or managed by the same owner. The variance among farms presents a serious challenge for certification programs that have to set objective rules applicable worldwide, especially when birds are the flagship taxa.

Smithsonian's Bird-friendly coffee, Audubon's Shade-Grown coffee and American Birding Association's Songbird Coffee use bird conservation as the main argument for certification. Bird-friendly certification requires all coffee to be certified organic prior to any further inspection (SMBC 2000, 2002). It is not clear whether this is the case for all Audubon's shade grown coffee, since they use two separate certification standards, one for organic (OCIA), and another (Rainforest Alliance) for the shade component (http://www.auduboncoffeeclub.com/shop). Songbird coffee is, at least for the shade component, self-certified by the coffee trader that buys the coffee and it does not require its shade coffee to be organically grown (http://www.thanksgivingcoffee.com/justcup/songbird). For a coffee and bird lover it is not easy to figure out what is the best choice of coffee. The real benefits of shade are buried under a better known certification seal (organic), even though it is the shade that really matters.

Our results indicate that priority should be given to encourage farmers to grow coffee under a diverse shade, and that organic production should not be a prerequisite to certify coffee as bird-friendly. More attention should be devoted to both the composition of the tree layer and especially the preservation of forest fragments within and around plantations (Raman 2006). The canopy layer of coffee plantations could be easily improved as bird habitats with introduction of specific tree species attractive to birds (Carlo et al. 2004). Nevertheless, criterion for bird-attractive tree species remains vague for all three bird-related coffee certifications or endorsements, and it is even less clear when dealing with forest fragments.

In conclusion, encouraging shade coffee plantations to become organic may not help bird diversity and abundance. We should focus our efforts into better understand the role of individual species of shade trees as food resources for birds. Furthermore, forest fragments, at the farm level and beyond, may be critical for conservation of multiple taxa. A wise tradeoff could be to increase yields by 20% or more applying the right amount of fertilizer while at the same time freeing 20% of the land for conservation. Could this become the new biodiversity coffee ®?

FIGURES

Figure 2.1. Location of Mombacho Volcano, Nicaragua.

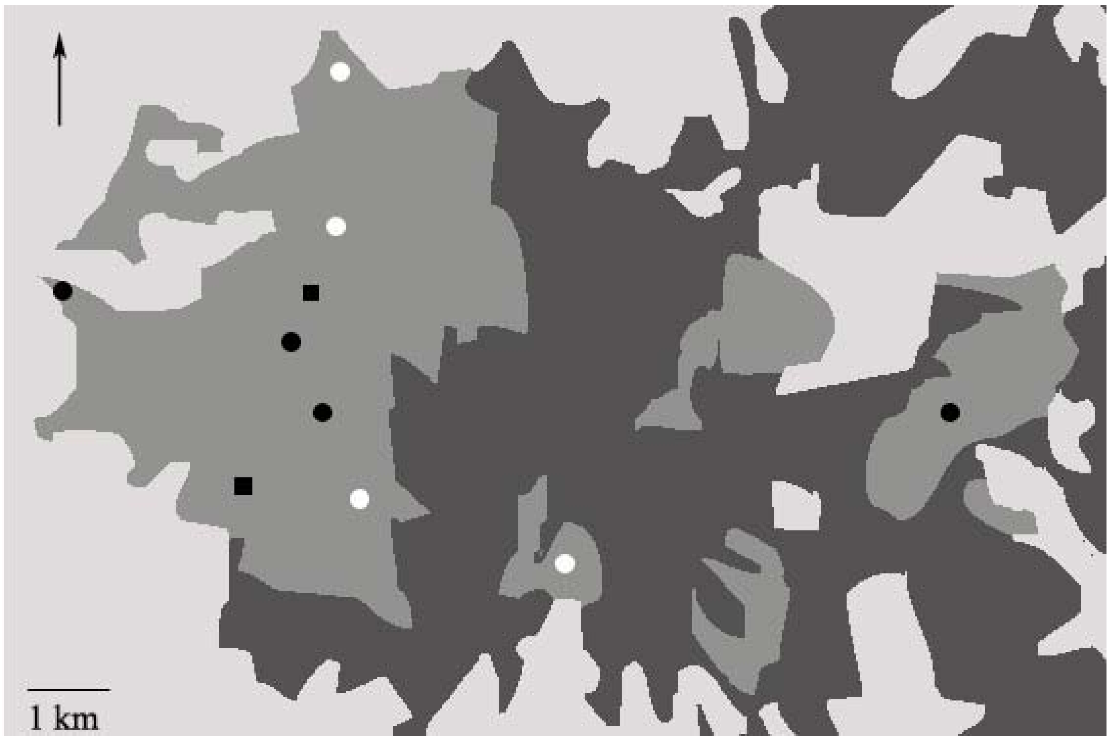


Figure 2.2. Distribution of coffee plantations in Mombacho, Nicaragua.

Distribution of organic (open circles), conventional (solid circles) and transition (squares) coffee plantations in relation to forest (dark grey), pastures and crops (light grey) and the overall coffee area (medium grey).

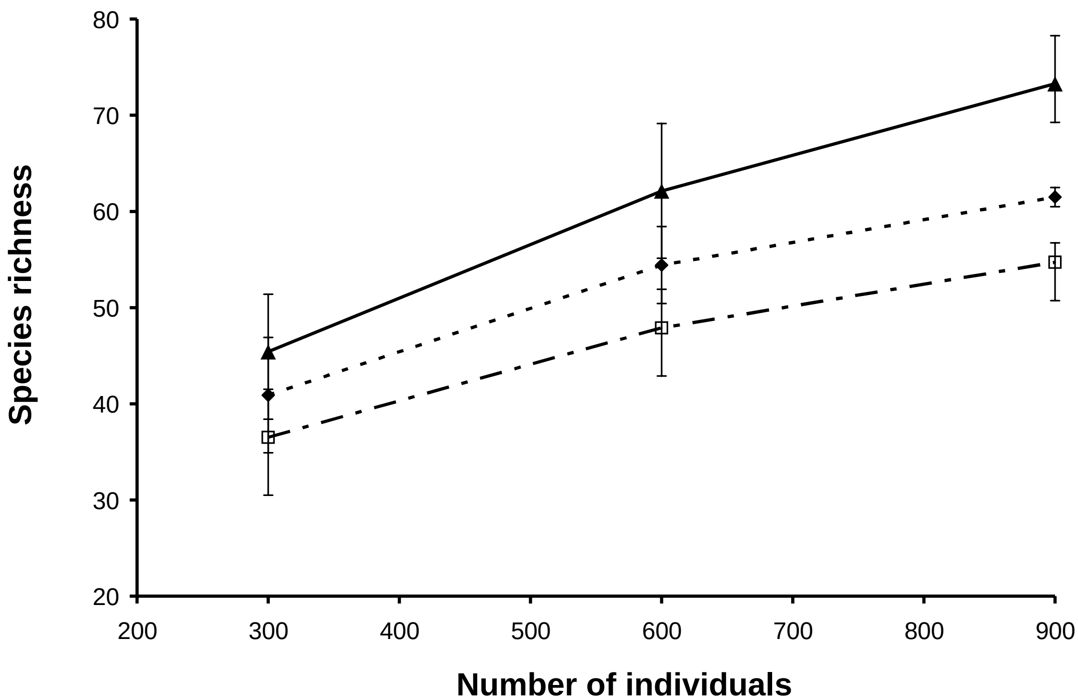


Figure 2.3. Rarefaction curve for tree species.

Trees in coffee plantations at Mombacho, Nicaragua managed under different farming methods (conventional, squares; organic, triangles; transitional, diamonds). Data points are mean expected richness at three points of individual resampling and bars represent 95% confidence intervals.

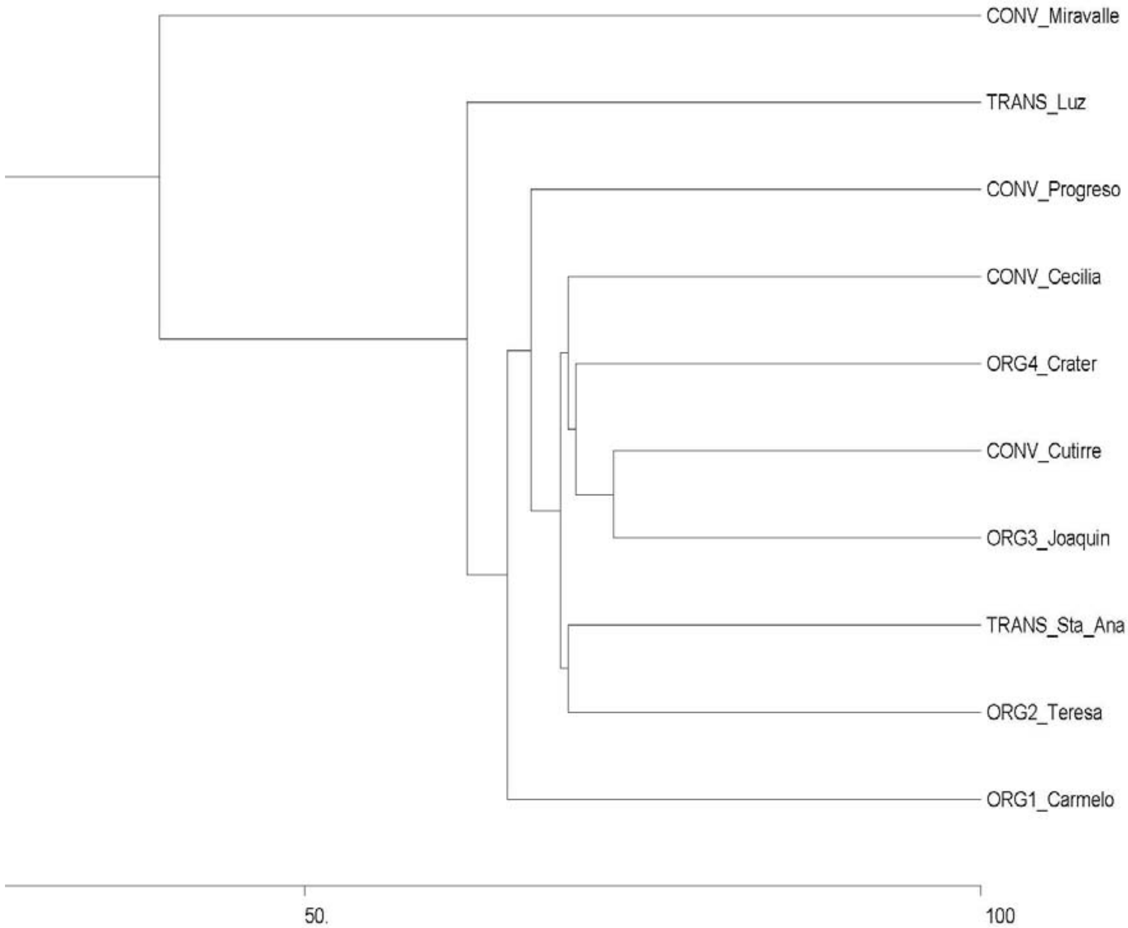


Figure 2.4. Cluster analysis of tree canopies

Cluster analysis, based on Bray-Curtis similarity index, of tree canopies of farms surveyed in Mombacho. Labels correspond to farming method acronyms (CONV, conventional; TRANS, transition and ORG for organic) followed by the farm name.

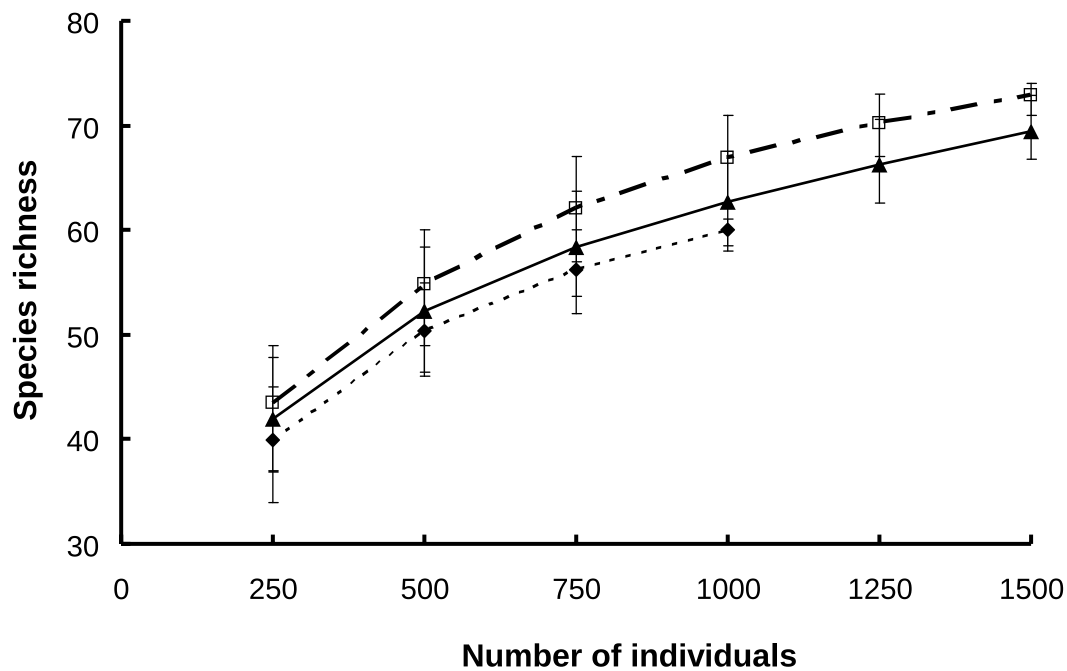


Figure 2.5. Rarefaction curve for bird species.

Birds in coffee plantations at Mombacho, Nicaragua managed under different farming methods (conventional, squares; organic, triangles; transition, rhombs). Data points are mean expected richness at six points of individual resampling and bars represent 95% confidence intervals.

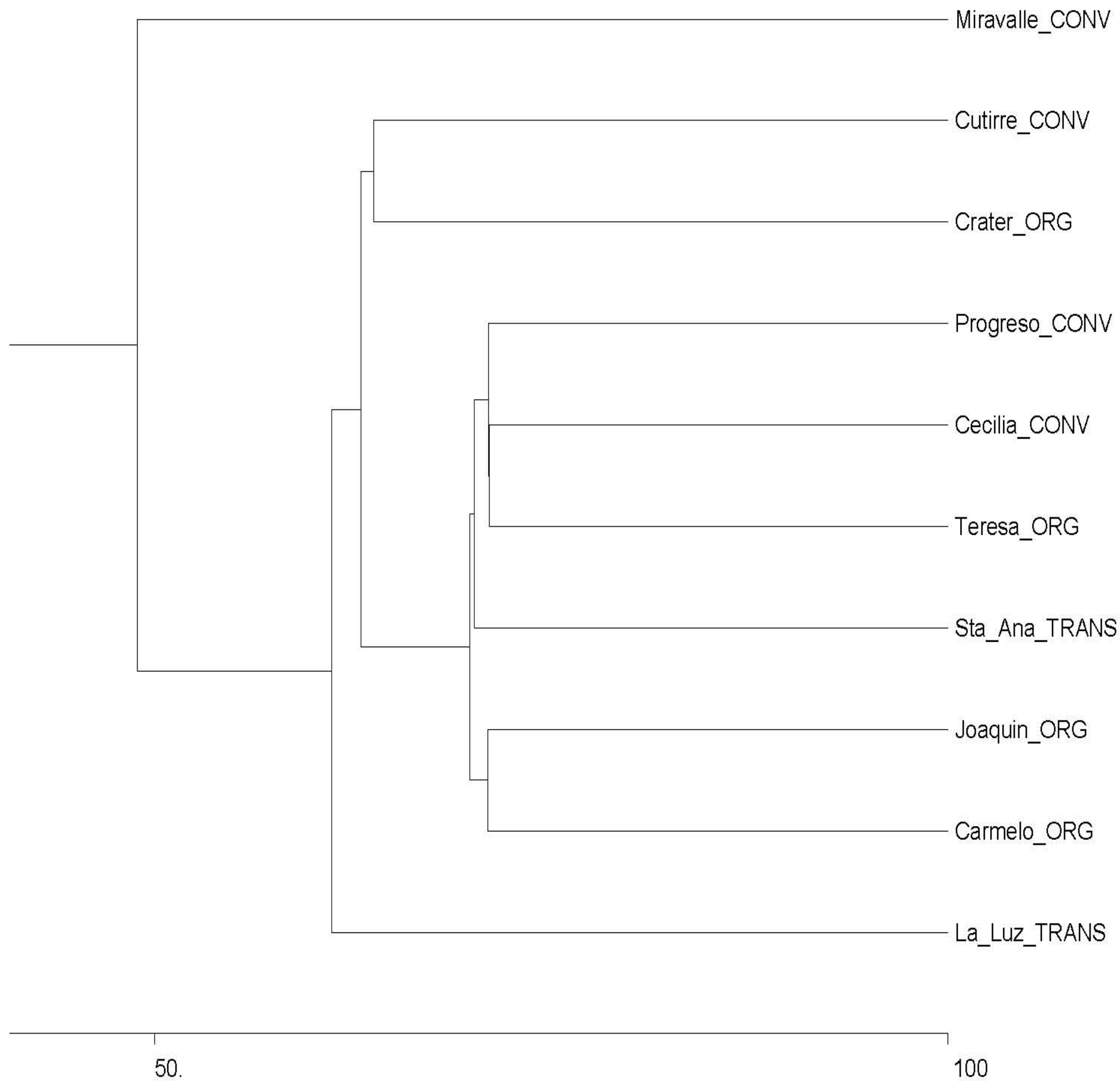


Figure 2.6. Cluster analysis of bird communities.

Analysis of bird communities in Mombacho coffee plantations, based on Bray-Curtis similarity index. Labels correspond to farming method acronyms (CONV, conventional; TRANS, transition and ORG for organic) followed by the farm name.

TABLES

Table 2.1. Use of chemical inputs in coffee plantation of Mombacho, Nicaragua.

	HERBICIDES	FUNGICIDES	INSECTICIDES	FERTILIZER
CONVENTIONAL				
El Progreso	Gramoxone[1]	Anvil[4]	Decis [5]	Urea, 18/5/15 (NPK)
Cutirre	Gramoxone[1]	Anvil[4]	Decis [5]	Urea, 18/5/15 (NPK)
Miravalle	Gramoxone[1]	Cobre Sandoz[6]	Lorsban[8]	15/5/15 (NPK)
Santa Cecilia	Gramoxone[1]; Round-up[2]; 2, 4-D; kamex	Oxicloruro de Cobre, Alto 100SL[3]: Anvil	None	Urea, 18/5/15 (NPK)
TRANSITION				
La Luz	Manual cutting	Cooper	None	Urea, 15/5/15 (N/P/K)
Santa Ana	Round-up, manual (since 1993)	Champion[7], Cobre Sandoz	None	Urea
ORGANIC				
El Carmelo	Manual cutting	Cooper	None	Compost from coffee pulp
Sta. Teresa	Manual cutting	Cobre Sandoz, solution with *Gliricidia sepium* leaves	none	Compost from coffee pulp, chicken manure,
San Joaquin	Manual cutting	none	none	Compost from coffee pulp
El Crater	Manual cutting; goats	Cooper	none	Compost from coffee pulp

[1] Paraquat; [2] Glyphosate; [3] Ciproconazole; [4] Hexaconazole; [5] Deltamethrin (Pyrethroid); [6] 56% CuO, 1% SO_4Mn, 1% SO_4Zn; [7] 77% Cooper oxide; [8] Chlorpyrifos (organophosphate)

Table 2.2. Summary of sampling dates.

Coffee plantation	Farming Method	1997	1998	1998	1998	1999
				Mist Netting pulses		
La Luz	Transition	Nov. 4 - 5	April 22 - 24	Sept. 17 - 18	Dec 16 - 17	March 16 - 17
Carmelo	Organic	Dec. 11 - 12	March 24 - 25	Sept. 8 - 9	Nov. 26 - 27	March 5 - 6
Santa Ana	Transition	Dec. 30 - 31	March 17 - 18	Sept. 1 - 2	Dec. 1 - 2	Feb. 20 - 21
Santa Teresa	Organic	Dec. 18 - 19	March 19 - 20	Sept. 10 - 11	Dec. 3 - 4	April 14 - 15
Cutirre	Conventional	Nov. 6 - 7	March 31-April 1	Aug. 30 - 31	Nov. 24 - 25	March 3 - 4
San Joaquin	Organic	Dec. 4 - 5	April 7 - 8	Sept. 22 - 23	Dec. 18 - 19	March 18 - 19
El Cráter	Organic	Nov. 24 - 25	April 2 - 3	Aug 18 - 19	Dec. 22 - 23	Feb. 16 - 17
Miravalle	Conventional	Nov. 13 - 14	March 12 - 13	Aug. 25 - 26	Dec. 10 - 11	Feb. 18 - 19
				Point Count		
La Luz	Transition	Oct. 25 - 26, Nov 4	Feb. 26 - 27	July 24	Nov 17	March 16-17, April 14
Carmelo	Organic	Nov. 2	Feb. 28	July 28	Nov 17	March 27 - 28
Santa Ana	Transition	Oct. 27 - 28	Feb. 25 - 26	July 23	Nov 12	March 25
Santa Teresa	Organic	Oct. 30	Feb. 26	July 28	Nov 18	March 26
Miravalle	Conventional	Oct. 27	Feb. 25	July 22	Nov 10	March 23
El Cráter	Organic	Nov. 1	March 1	Aug 5	Nov 19	March 30
Progreso	Conventional	Oct. 28 - 29	Feb. 25	July 22	Nov 13	March 31
Cutirre	Conventional	Oct. 31	Feb. 28 - March 1	Aug. 4	Nov 21	March 27
San Joaquin	Organic	Nov. 20	Feb. 27	July 30	Nov 11	March 24
Santa Cecilia	Conventional	Nov. 21	Feb. 27	July 29	Nov 10	March 23

Table 2.3. Ranking of the ten most recorded trees.

Vegetation plots at Mombacho coffee plantations, grouped by farming practice.
( ) total number of trees.

Rank	Organic	Transition	Conventional
1	*Inga oerstediana* (463)	*Gliricidia sepium* (292)	*Inga oerstediana* (422)
2	*Gliricidia sepium* (267)	*Inga oerstediana* (193)	*Gliricidia sepium* (167)
3	*Ficus obtusifolia* (84)	*Cedrela odorata* (107)	*Ficus obtusifolia* (76)
4	*Cedrela odorata* (57)	*Ficus obtusifolia* (49)	*Cecropia peltata* (72)
5	*Cecropia peltata* (43)	*Cecropia peltata* (38)	*Cordia alliodora* (43)
6	*Luehea candida* (34)	*Cordia alliodora* (34)	*Cedrela odorata* (33)
7	*Guazuma ulmifolia (24)*	*Enterolobium cyclocarpum* (22)	*Albizia guachapele* (21)
8	*Cordia alliodora* (23)	*Guazuma ulmifolia* (21)	*Enterolobium cyclocarpum* (17)
9	*Cordia gerascanthus* (23)	*Albizia saman* (12)	*Erythrina berteroana* (15)
10	*Albizia lebbeck* (22)	*Diphysa americana* (9)	*Terminalia oblonga* (14)

Table 2.4. Summary of vegetation variables

	Plots	Total Trees	Total Tree spp	Trees/plot	Tree spp/plot	% N fixing trees	% Shade	Coffee trees/plot	Coffee tree height	Canopy height	No. of tree strata	Total leaf volumes
CONVENTIONAL												
Progreso	20	389	30	19.45±1.58	4.25±0.32	77.29±3.83	47.15±3.51	155.55±11.32	2.02±0.12	13.64±0.72	3.05±0.15	35.00±2.16
Miravalle	10	136	19	13.60±2.94	6.30±0.88	61.05±5.89	67.20±4.97	204.20±16.00	2.95±0.18	15.43±1.02	3.10±0.21	23.90±3.05
Sta. Cecilia	13	220	22	16.92±1.39	5.38±0.37	62.24±4.08	43.00±4.36	137.69±14.04	1.69±0.15	12.25±0.90	3.15±0.18	28.92±2.68
Cutirre	20	294	28	14.70±0.79	6.60±0.33	52.08±4.65	72.45±3.51	120.25±11.32	2.39±0.12	16.35±0.72	3.55±0.15	31.35±2.16
Sub-total	63	1039										
TRANSITION												
Sta. Ana	24	458	37	19.00±1.40	5.1±0.49	71.23±4.25	62.54±3.21	162.67±10.33	2.07±0.11	12.10±0.66	2.92±0.13	31.83±1.87
La Luz	30	468	47	15.60±1.17	6.53±0.39	47.83±3.76	67.40±2.87	107.70±9.24	1.99±0.10	12.04±0.59	2.93±0.20	25.13±1.76
Sub-total	54	926										
ORGANIC												
Carmelo	20	389	47	19.45±1.91	7.56±0.59	57.52±4.68	79.35±3.51	156.45±11.32	2.80±0.12	12.08±0.72	3.00±0.15	30.80±2.16
Sta. Teresa	20	325	32	16.25±0.97	5.25±0.36	61.12±3.73	47.75±3.51	172.60±11.32	2.10±0.12	10.31±0.72	2.30±0.15	24.35±2.16
San Joaquin	23	321	25	13.96±0.75	5.43±0.34	56.41±3.77	47.91±3.28	87.39±10.55	2.44±0.18	13.02±0.67	2.96±0.14	25.30±2.01
El Crater	20	270	34	13.50±1.01	4.70±0.55	69.02±5.11	64.30±3.51	128.65±11.32	2.63±0.12	15.36±0.72	3.00±0.15	26.10±2.16
Sub-total	83	1305										
TOTAL	200	3270										

* Numbers show mean ± standard error and letters indicate significant differences ($p < 0.05$) within a variable

Table 2.5. Most recorded bird species.

Ranking of the ten most recorded species in point counts at Mombacho coffee plantations, grouped by farming practice.
( ) total number of birds.

Rank	Organic	Transition	Conventional
1	*Thryothorus pleurostictus (203)*	*Thryothorus pleurostictus (199)*	*Vermivora peregrina* (209)
2	*Dendroica petechia* (176)	*Dendroica petechia* (116)	*Thryothorus pleurostictus* (186)
3	*Euphonia hirundinacea* (132)	*Vermivora peregrina (116)*	*Dendroica petechia* (178)
4	*Calocitta formosa* (129)	*Calocitta formosa* (69)	*Psarocolius montezuma* (98)
5	*Psarocolius montezuma* (110)	*Psarocolius montezuma* (65)	*Amazilia saucerrottei* (87)
6	*Chiroxiphia linearis* (108)	*Brotogeris jugularis* (48)	*Euphonia hirundinacea* (80)
7	*Thryothorus modestus* (101)	*Melanerpes hoffmannii* (46)	*Thryothorus modestus* (65)
8	*Amazilia saucerrottei* (97)	*Chiroxiphia linearis* (43)	*Calocitta formosa* (60)
9	*Vermivora peregrina* (97)	*Thryothorus modestus* (35)	*Hylophilus decurtatus* (60)
10	*Melanerpes hoffmannii* (54)	*Vireo flavoviridis* (28)	*Amazona albifrons* (56)

Table 2.6. Summary of mist netting captures.

Farm name	Farming Method	nets	Hours	Net x hours	Birds total	Birds/100 net hours	Residents	Migrants	spp total	spp residents	spp migrants
El Carmelo	Org	15	82	1230	286	23.25	238	48	34	23	10
Sn. Joaquín	Org	15	81	1215	128	10.53	119	9	14	9	5
Sta. Teresa	Org	15	80	1200	158	13.17	95	63	22	15	7
El Cráter	Org	17	76	1292	99	7.66	81	18	24	18	6
La Luz	Trans	19	68	1292	72	5.57	61	11	15	10	5
Sta. Ana	Trans	15	79	1185	347	29.28	232	115	37	20	17
Miravalle	Conventional	15	87	1305	206	15.79	166	40	28	19	9
Cutirre	Conventional	15	90	1350	544	40.30	459	85	45	29	16
TOTAL				10069	1840	18.27	1451	389	79	50	29

Table 2.7. The ten most capture bird species.

Ranking of the ten most frequently captured species in mist nets at Mombacho coffee plantations, grouped by farming practice.
( ) total number of birds.

RANK	TRANSITION	ORGANIC	CONVENTIONAL
1	*Amazilia saucerrottei* (49)	*Chlorostilbon canivetti* (102)	*Amazilia saucerrottei* (124)
2	*Chiroxiphia linearis* (44)	*Amazilia saucerrottei* (72)	*Hylocharis eliciae* (106)
3	*Thryothorus pleurostictus* (41)	*Hylocharis eliciae* (69)	*Chiroxiphia linearis* (71)
4	*Chlorostilbon canivetti* (30)	*Chiroxiphia linearis* (64)	*Chlorostilbon canivetti* (65)
5	*Hylocharis eliciae* (30)	*Amazilia rutila* (53)	*Thryothorus pleurostictus* (54)
6	*Archilocus colubris* (26)	*Thryothorus pleurostictus* (42)	*Amazilia rutila* (49)
7	*Dendroica petechia* (26)	*Tolmomyias sulphurescens* (34)	*Vermivora peregrina* (43)
8	*Empidonax flaviventris* (22)	*Archilocus colubris* (30)	*Phaethornis striigularis* (33)
9	*Thryothorus modestus* (17)	*Dendroica petechia* (28)	*Tolmomyias sulphurescens* (20)
10	*Vermivora peregrina* (17)	*Vermivora peregrina* (28)	*Archilocus colubris* (19)

Table 2.8. Summary of Nested ANOVA test for mist netting data.

Variable	Conventional Mean±SD	Transition Mean±SD	Organic Mean±SD	d.f	Farming Method	p	Farm Name (Farming Method)	p
Bird abundance	75.10±55.79	42.20±37.43	35.50±28.44	2,5	1.286	.354	4.40	.004
Resident abundance	63.00±53.48	32.10±25.61	26.95±25.47	2,5	1.842[*]	.252	4.377[*]	.004
Migrant abundance	12.10±10.10	10.10±12.81	6.40±8.39	2,5	.748[*]	.520	2.905[*]	.028
Bird species	16.40±6.06	11.30±5.75	9.75±4.47	2,5	1.143	.390	11.726	<.001
Resident species	11.90±3.573	8.10±4.01	7.80±3.62	2,5	.900	.464	12.322	<.001
Migrant species	4.50±2.84	3.20±2.20	2.25±1.83	2,5	1.093	.404	4.885	.002
Trophic weight SA	50.10±33.36	46.10±45.62	26.55±29.16		N/A		N/A	
“ LARB	6.90±4.16	4.00±6.19	4.25±5.75		N/A		N/A	
“ FLS	39.40±33.09	21.10±30.80	17.25±15.25		N/A		N/A	
“ N	126.80±161.59	48.00±59.36	63.80±86.55	2,5	1.855	.250	.878	.507
“ SS	1.80±3.82	6.8±12.59	.70±1.59		N/A		N/A	

[*] / data is square root transformed
N/A / unequal variances, test not applicable

CHAPTER 3: THE ROLE OF COFFEE PLANTATIONS IN BIODIVERSITY CONSERVATION: ATTITUDES AND PERCEPTIONS FROM NICARAGUA.

INTRODUCTION

In the last 20 years demand for coffee (*Coffea arabica* L.) produced under more environmentally and socially friendly conditions has been growing. Several initiatives have been developed to promote best environmental and/or social practices. Environmental standards that have been promoted include requiring a protective shade layer (Rice & Drenning 2003; Fishersworring 2002; Larson 2003), prohibiting the use of synthetic pesticides and fertilizers (IFOAM 1996; Rice & Ward 1996; Rice 2001; Bray et al. 2002) or a combination of practices designed to mitigate environmental impacts of this crop (Willie 2004; Sustainable Agriculture Network 2005a,b).

In a parallel and sometimes complementary effort, groups concerned with social issues and poverty alleviation developed a series of certification programs to pay farmers a minimum price for their coffee (The Fairtrade Foundation 2002; Murray et al. 2003). While environmental certification schemes have been developed without stipulation as to farm size or land tenure issues, social standards have focused on supporting family-run farms and cooperatives.

Environmental and social certification programs pay premium prices for coffee grown under the rules and regulations of their respective seals. Apart from this direct incentive, certification allows farmers to find a preferential market niche for their product (Ponte 2002) and secure long term contracts.

Growing coffee under shade has numerous advantages relative to sun-grown coffee, which can be grouped into social/economic and agroecological benefits. Social and economic benefits stem from a more diversified income from sales of fruits, herbs, and timber products (Michon et al. 1986; Siebert 2000), lower application of external inputs (fertilizers, herbicides and insecticides), and longer production life of the coffee trees (Beer et al. 1998; Staver et al. 2001; Siebert 2002). Agroecological benefits include pest control, mitigation of climate fluctuations, erosion control, and biodiversity conservation (Perfecto et al. 1996).

Proponents of organic coffee production give priority to zero use of synthetic inputs rather than the presence of trees or other non-traditional crops. So far, the use of trees for shading is not a requirement to obtain organic certification (OCIA 2007). While most products grown under organic standards provided certain health benefits for the producer as well as the consumer of the product, in the case of coffee only the producer (or his/her workers) benefit by avoiding pesticide exposure, since roasting the coffee beans effectively destroys any chemical resides that could reach consumers. The environmental benefits of organic production are evident when it is compared with non-organic production methods under identical conditions. However, most organic farms tend to produce 20-25% lower yields and require more labor for manual weed control and multiple applications of organic fertilizers than their non-organic counterparts (Lyngbæk et al. 2001; van der Vossen 2005).

To compensate for lower yields and/or higher production costs, producers of shaded and organic coffee receive a basic premium over the conventional price in the international market when they are able to certify their coffee (Perfecto et al. 2005). Consumers are the driving force behind these initiatives, since they are the ones that ultimately pay the price premium. On the other hand, producers may be motivated to use some of these techniques - e.g., keeping trees for shade or using organic fertilizers - not because of the premium prices they can fetch, but because it allows them an upfront reduction of costs associated with synthetic fertilizers and pesticides, or for cultural reasons we may not fully understand (Segura et al. 2004). In small coffee plantations organic farmers compensate for the extra labor needed using family labor. But what are the limitations of these systems? Are they applicable to farms of all sizes or just to small family-run properties? How will the farmers compete with their relative low yields and/or higher production costs? How sustainable are these practices when coffee prices go up or down?

Farmers are faced with a variety of decisions that influence how much of the land area is cultivated, what species of trees and how much shade cover they retain on their plantation. These decisions are influenced by the size of their plantation, their access to labor, as well as the stability of and changes in coffee prices (Bennett & Godoy 1992). Lower coffee prices may push farmers to search for alternative income by cutting trees to produce firewood or timber (Flores et al. 2002), while others may neglect basic maintenance practices in the plantation, or reduce chemical inputs (Valkis et al. 2004). Dietsch et al. (2004) argue that price drops may result in worker layoffs on large farms or land conversion on small farms, contributing to forest clearing. The picture is even more confusing when coffee prices go up. Some argue that this creates a clear incentive to boost production, and deforestation increases accordingly in those areas where forest fragments are intermixed with coffee plantations and pastures, or pushes farmers into protected forests to establish new plantations (O'Brien and Kinnaird 2003, 2004).

In Nicaragua, the area under coffee cultivation almost doubled from 1990 to 2000 (Magfor 2003). Whether this expansion was achieved by restoring abandoned coffee plantations or through encroaching on remaining forest fragments is unknown. Opinion surveys are a tool that can shed light on these contentious issues, and can provide a valuable insight on how rules and regulations of different certification programs are viewed on the farm. If farmers do not understand the intended consequences of environmental practices it is unlikely they will apply them when there are insufficient economic incentives. On the other hand, if certification agencies do not understand farmers perceptions it is also unlikely their environmental standards will achieve their intended goals.

While many farmers are aware of the importance of coffee quality, the need to mitigate watershed pollution, or the benefits of shading coffee, very few have ever heard about the environmental services provided by the forest fragments in their coffee plantations or the importance of respecting the integrity of nearby protected areas. For example, studies in Brazil, Costa Rica and Panama showed how bees alone, especially stingless bees that are native to these forests, can increase coffee quality and yields by between 10 and 20% when they pollinate coffee flowers (Klein et al. 2003; Ricketts et al. 2004; Roubik 2002). However, it is not clear that most coffee growers are aware of the pollination services provided by these bees.

Farmer's decisions are influenced by agronomists and other professionals that provide them with advice and training. These professionals are responsible for disseminating official policies that influence farmers' access to credit, as well as which regions are chosen for initiation of special projects to assist farmers. Traditionally, technicians overemphasized the importance of using substantial amounts of agrochemical inputs and the removal of trees to obtain a pest-free harvest and high yields (Le Pelley 1973;

Rice 1990; Wesphal 2002). However, in the last 10-15 years there has been a radical shift in the message, as more and more technicians received training and salaries from international agencies and organizations that promote the use of Integrated Pest Management practices, planting of shade trees, and minimal use - or no use at all - of chemical inputs (Guharay et al. 2000). For all these reasons it is important to understand the role technician's opinions play in management decisions taken by farmers.

As coffee is the most important agricultural commodity in many developing countries, governments devote considerable energy and resources to promote its cultivation. Experts and policy advisors play a crucial role shaping national policies for the coffee sector and their opinion influence how international agencies and national governments allocate resources to promote sound practices. Because of that, their opinions may foresee trends in the coffee sector.

One of the tools frequently used to assess agricultural trends in land use and public perception are surveys. In agriculture they have been use to assess the acceptability of agricultural technology transfer, government policies and market trends. In the coffee sector, surveys have been used to understand farmers perceptions of pests (Segura et al. 2004), knowledge of shade trees (Albertin & Nair 2004; Grossman

2003; Bentley et al. 2004), and strategies for coffee production of small-scale farmers (Westphal 2002).

Information gathered by surveys can be used to assess how perceptions among coffee growers, technicians, and policy makers may influence current and future agricultural practices in coffee plantations and the conservation of remaining forest fragments. In this case, I are particularly interested in evaluating the impact of the specialty coffee industry (organic, shade-grown, fair trade, and high quality coffee) on the conservation of forest fragments in and around certified coffee plantations.

Some of the questions I sought to answer in surveys were:

1. How do coffee prices influence farmers' land management decisions?
2. Is there a correlation between farm size and farmers perceptions regarding the use of trees for shade and willingness to preserve forest fragments?
3. Do farmers and agronomists share the same perceptions about the desirability and use of shade trees, and the role of forest fragments?
4. Do farmers believe that current certification schemes are adequate to fulfill their needs? Do they feel they are they fair?
5. Are farmer's advisors and technicians encouraging forest conversion to increase profits for the farmer?

6. Why do farmers keep forest fragments in their farms? What are the perceived benefits/costs? Are they kept regardless of coffee prices?
7. What kind of shade trees do farmers prefer? Are shade trees selected simply for utilitarian values, or are aesthetic, environmental or cultural factors involved?
8. How do farmers perceive the role of non-pest wildlife in their coffee plantation?
9. How do organic and conventional farmers compare in their environmental perceptions, including the use of or proper disposal of agricultural waste?
10. Are yields different in organic and traditional farms?
11. What is the relation between yields and farm size?
12. How are protected areas perceived by agronomist and policy makers when coffee is cultivated inside their boundaries?
13. What are the trends in coffee production nationwide?
14. What is the Government policy towards to coffee sector? Does it promote environmentally sound practices? Does it encourage higher yields or expansion of the coffee growing areas?

STUDY AREA AND METHODS

All surveys were conducted by the senior author (JC Martinez-Sanchez) in Nicaragua, a typical coffee growing country with a well developed specialty coffee sector and with numerous highland areas designated as nature reserves (La Gaceta 1983, 1991). A number of these protected areas are located in coffee producing regions, mainly in the Northern Highlands. Table 1 provides a list of protected areas located in coffee producing regions.

In Nicaragua, 96% percent of coffee is cultivated under some kind of shade (Magfor 2003), although these official figures seem high compared to neighbor countries, and contradict data from other sources (Perfecto et al. 1996). Most of the coffee grown in the country comes from *Coffea arabica* varieties and are cultivated in the highlands, between 600 and 1800 m elevation. A significant proportion of the coffee produced in the country is certified as organic, Fair Traded or both. Nicaragua is the third largest producers of Fair Trade coffee worldwide (TransFair USA 2007). For the 2005/2006 harvest coffee exports reached a record of $200 million dollars, making it by far the most important cash crop in the country (Valkis et al. 2004).

Study sites

Farmer interviews focused on individuals from two coffee growing regions in the Northern Highlands, Las Segovias and Jinotega. JCMS contacted managers of coffee cooperatives located in departmental capitals of Jinotega, Estelí and Ocotal, as well as the towns of Jalapa and Dipilto to request access to interview them. Interviewees were asked at the end of the interview to introduce the interviewer (JCMS) to other technicians and experts in the coffee sector for a potential interview. They also provided names of many local farmers, affiliated or not with their cooperatives. Most of the interviews with owners of small to medium size plantations were conducted at their farms.

I actively sought to include an even balance of organic/ conventional farmers. To minimize any bias towards farmers affiliated to cooperatives or small farmers, I actively contacted the largest coffee growers in the region, making use of personal contacts and connections made through farmers interviewed earlier in the study.

In Managua, the capital, JCMS interviewed policy makers, experts and government officials. Many new contacts were found through those interviewed. I also used my own knowledge of the local government and non governmental organizations to approach potential interviewees. In only a few cases (three farmers, three policy makers and 2 agronomists) was our request for an interview declined, and this was usually due to scheduling conflicts.

Our selection criteria did not pretend to be representative of the entire coffee sector in Nicaragua, but it gives a sense of local opinions on the questions I asked. Logistic constraints did not allow inclusion of groups, such as small farmers unaffiliated with any cooperative with farms in regions without road access.

All interviews were confidential as to the informant and the information provided. Each interview was taped and notes taken, but before analysis identifying information was removed. Each interviewee was given a consent form approved by the Human Subjects Division at the University of Washington (Grant 06-3751-E/C 01) and given an opportunity to opt out of the interview. All parties who granted an interview signed the consent form.

The interview was a survey with a combination of multiple choice and open questions (Appendices A for farmers, B for technicians, and C for policy makers). A minidisc recorder was used to record each interview while, at the same time, the interviewer (JCMS) took notes on a blank questionnaire. A number of questions asked for responses on a Likert scale. I limited the use of this format to 6 questions in the farmers' survey, 9 in the agronomists' survey and 16 in the survey for policy makers. I suspected that some farmers could feel more constrained in their responses if I used this format extensively in the survey, especially for those not familiar with this format. Conversely, this should not be an issue for agronomists and policy makers who are probably more used to being interviewed, and thus I made greater use of this format in surveys customized for them.

The primary survey for farmers (Appendix A) was modified slightly to interview technicians and extensionists that provide technical advice and training to farmers (Appendix B). This survey group included coffee certifiers and field technicians working in agricultural projects related to coffee to get a better understanding of the similarities and differences between their ideas and those of the farmers' on the role of shade trees and forest fragments in the management of coffee plantations. By comparing responses of the technicians and farmers, similarities between the groups were explored, to give insights into future national trends in the coffee sector.

A third survey was administered to decision makers and government officials in charge of the coffee sector (Appendix C). These include managers of certification agencies, coffee grower associations and officials from the Ministry of Agriculture and Forestry (Magfor) and the Ministry of Industry. These decision makers are responsible for policy design and implementation, oversight of certification schemes, and coordination with donor agencies that provide the resources needed to implement these policies. Accordingly, this survey incorporated a number of specific questions for this group alone. Most of these interviews of decision makers were conducted in Managua following the same techniques used to interview farmers on their farms.

Prior to beginning the survey, I explained my institutional affiliation with the University of Washington to our interviewee, and also that I were not affiliated with any coffee trader, the Nicaraguan government, or any certification agency. Each interview lasted between 45 and 120 minutes and usually ended with a friendly talk about coffee or other aspects of the research. When requested, a copy of the questionnaire was provided to the subject.

Survey design for farmers

The survey was designed in 14 sections, each with a dominant theme. The general types of questions are described here, and the entire survey is available in Appendix A. The first section recorded general information on farm location, farm size and the extension of different land uses within the farm.

Farmers were asked to report the type and extent of trees in the coffee plantation, and their perceived benefits or costs of having trees within the plantation. I also asked about desirable characteristics for shade trees, ranging from the shape and size, origin and complementary uses. Farmers were asked only to choose between having shade trees with an additional use (timber production, firewood or fruit, each explore one at a time), not having that use, or having a combination of trees with and without that specific use. I also asked respondents to name the best five tree species for the success of their farm.

One section of the interview explored questions about the availability of forest fragments on the farm, their perception of the utility of such fragments, and the motivation that influenced the farmer to choose that particular location to grow coffee. If farmers had forest fragments on their land, they were asked their opinions (on a six-level Likert scale) of different alternative uses of forest fragments. All farmers, regardless of whether or not they had forest fragments on their land, were asked whether they believed forest fragments helped or hindered their coffee plantations, and what where the relationships between the presence of forest fragments and pests or pollinators. I asked several questions about the role of forest fragments that were intentionally designed to be redundant with other sections of the survey, so I could evaluate internal consistency in the responses across the entire survey.

A portion of the survey focused on plantation management, including questions on farm waste and how farmers handle it, fertilizer use, and whether the area under cultivation had increased or decreased in the last 5 years. Some questions explored whether and how farmers might change their management practices given hypothetical changes in coffee prices (exploring both alternatives of becoming high or low). These questions were to explore how price fluctuations influence farmer's decisions on land use.

I also explore what factors influence yields and quality. I explore farmer's knowledge of pollination, and the relationship between pollination quality and yields and bean quality. Farmers also were asked what they would like to do to increase yields and the quality of their coffee.

The final section explored the farmer's perception of the future and how s/he would like to see the farm in 5 years time. The interview typically ended in an informal talk about coffee and farm management.

Survey design for coffee technicians and agronomists

Most of the sections in this survey were identical to the survey for farmers, but the questions were presented in the format of asking the technician or agronomist about the types of professional advice they offer to farmers (See Appendix B). For example, one question asked "What do you recommend should be done with forest fragments in a coffee farm?" In addition, I had specific questions for agronomists about their perceptions regarding coffee and biodiversity, their knowledge of different certification programs, and their opinion about growing and certifying coffee planted inside protected areas.

The section about how price oscillations influenced farmer's decisions had two parts. First, I asked about the type of advice they offered farmers. Later, I asked what they though farmers did when coffee prices are high or low. In another shift in wording, for these specialists, I specifically used the word pollination when asking about what conditions favor pollination ("What are the environmental conditions that are the most favorable for the best pollination of coffee flowers?").

The interview concluded with a question about their conception of an ideal coffee plantation. I provided the choice of different certification regimens, shade versus sun grown coffee and only coffee versus a diversified farm. If they preferred a diversified farm, then they were presented with an array of 17 possible products and services to choose from. At the end, the interviewee was given a chance to express their opinion on the survey or simply talk about coffee in general.

Survey for policy makers and experts

This survey focused on policy issues, with a section on the new coffee law (La Gaceta 2001) and government response to price oscillations. Sections on coffee certification and coffee and forests were very similar to those presented to agronomists (see Appendix C). On the issue of coffee and protected areas, I added a specific question asking if they had knowledge of coffee plantations located within specific protected areas. For this group of respondents only, there was a section of questions asking their opinions about the desirability of expanding coffee growing areas, as well as whether coffee should or should not be cultivated in certain departments or regions.

The survey ended with a series of questions about their predictions for future changes in the coffee sector (expansion of coffee areas, changes in yields and quality, changes in coffee cultivation, etc).

Statistical analysis

Respondents were aggregated by type of respondent (coffee grower, technician, policy maker) and by size of farm, but no identifying information was included in any analyses.

Because coffee growers with different sized farms might have different views, and respond to different pressures, I grouped coffee grower responses into those holding three size classes of farms, representing small (< 10 ha), medium (10-100 ha) and large (>100 ha) land holding coffee growers.

I used basic descriptive statistics to present our results. I compared the attitudes of coffee growers and technicians using single factor ANOVA. When our data distribution violated parametric assumptions, I used square root transformations or ran non-parametric tests (Mann-Whitney U, Friedman's or Kruskal-Wallis sign test). I explored relationships between variables using linear logistic regression. The level of significance to commit a type I error was set at 0.05 for all our tests. Means are provided with ± standard error.

RESULTS

Profiles of interviewees

I interviewed 83 coffee growers, 52 agronomists and agricultural technicians, and 20 experts and policy makers. Their coffee plantations are in San Juan del Río Coco and Quibuto (Department of Madriz, 31%), Dipilto and Jalapa (Dep. of Nueva Segovia, 29%), Miraflor and Sontule (Dep. of Estelí, 6%) and San Rafael del Norte and Asturias (Dep. of Jinotega 22%). Most coffee growers were interviewed either in their farms or in nearby towns.

Coffee growers were 49.3±1.5 years old on average. Most (72%) had some formal education (Fig. 3.2), and had owned their farms for an average of 24.9±2.6 years. Technicians were 40.7±1.3 years old, 91% had a university degree (Fig. 3.3), and were working in the coffee sector on average for more than a decade, working with the government or the private sector (Fig. 3.4). They were based in 4 departments, Nueva Segovia (44.4%), Jinotega (24.1%), Estelí (14.8%) and Managua (16.7%).

All the experts and policy makers (age 46.4±2.2) had university degrees, were working on coffee issues for an average of 18 years, and were affiliated with the government and organizations of the private sector (Fig. 3.5). Experts and policy makers were also in the same departments, but in different proportions, with the highest number located in the capital, Managua (40%).

Most of the coffee growers and agronomists (89%) and policy makers (80%) were males.

Farm profiles

Together, the interviewed coffee growers own a total of 5557.1 ha, %. Table 1 gives a summary of the different land uses reported by the interviewees, grouped by farm size. As a group, these farms had large proportion of their land covered with forest, although this pattern was seen only in the medium and large farms (Fig. 3.6). These farms were significantly different in proportion of the farm devoted to coffee under production (Kruskal-Wallis' test, χ^2 = 23.706, d.f. 2, P< 0.001, n=83), pasture (χ^2 = 16.452, d.f. 2, P< 0.001, n=83) and forest (χ^2 = 25.636, d.f. 2, P< 0.001, n=83).

Changes in coffee growing area

Most coffee growers reported that they had more coffee planted now than 5 years ago (72%), while 11% reported having less. These results are similar among all farm sizes.

Characterization of the tree layer

Respondents believed trees were beneficial to the coffee plantation. Furthermore, when asked whether coffee production increased or decreased under a tree layer, 94%, coffee growers responded it increased. Coffee growers preferred short (< 5 m, 30.5%) than tall (> 5 m, 19.5%) trees for shade, although as many chose a canopy with a combination of both short and tall trees (32%).

Coffee growers varied considerably in what they gauged to be the optimal level of shade for their farms (20 to 80% shade cover). Coffee growers with small land holdings preferred higher shade levels than those with medium and large farms, and those with medium sized farms chose higher levels than those with the largest farms (Fig. 3.7; One-way ANOVA, $F = 5.48$, d.f. 2, 78, $p = 0.006$). A similar analysis was performed comparing shade level preferences between organic and non organic coffee growers, which showed that as a group, organic coffee growers preferred higher density levels than their non organic peers (One-way ANOVA, $F = 5.59$, d.f. 1, 79, $p = 0.02$). However, shade levels between small organic and conventional farms were very similar (One-way ANOVA, $F=1.019$, d.f. 1, 33, $p = 0.32$). In contrast, shade levels reported by owners of medium farms were significantly different, with organic coffee growers reporting shade levels 10% higher than conventional coffee growers (One-way ANOVA, $F = 5.769$, d.f. 1,35, $p = 0.02$). This was also the case for large farms, with owners of organic plantations preferring almost double the amount of shade than their conventional peers (One-way ANOVA, $F = 14.253$, d.f. 1, 7, $p = 0.007$).

Most coffee growers (96%) preferred trees with a wide canopy over narrow shaped trees. Trees with big leaves were preferred by 37.6% of the respondents, versus 14.6% that chose small leaves, and 41.5% that expressed no preference for either. Nearly all respondents (95%) prefer trees that shed lots of leaves. Similarly, ease of pruning was chosen as desirable by most coffee growers (85.4%).

Coffee growers gave a diversity of responses regarding the importance of selecting shade trees for multiple uses, such as timber, firewood, or fruit production. Half of the coffee growers considered that it important to select trees that generate useful timber, while 13.4% preferred not to use timber producing trees for shade, and 24.4% said it did not matter. A large proportion of coffee growers considered using fruit trees for shade important (48.1%), but 21% did not want to have fruit trees to avoid problems with workers stealing fruit or damaging coffee trees while picking up fruits. Most coffee growers (80.5%) preferred to use trees for shade that can produce firewood.

Many shade trees in coffee plantations produce leaves all year round, and nearly all coffee growers (95.1%) responded that this characteristic was important in their selection of tree species to use in the shade layer. The majority of coffee growers (79.3%) preferred trees from the same area, while 20.7% did not consider the origin of the tree (local vs. introduced) a relevant factor.

Favorite trees

Coffee growers' tree of choice was *Inga* spp. Species identity is not clear because common names can refer to different species, and the same species can be referred to by more than one common name. Coffee growers make a distinction between local Inga species (Guaba Negra, Guaba Roja, Guaba Blanca, Guaba Verde, etc) and what they called "Guaba Extranjera" o "Paterna" (probable *Inga paterno*). *Inga* spp was the most popular group of trees as a first, second and third (23%) choice for coffee growers (Fig. 3.8). In contrast, the introduced Búcaro (*Erythrina poeppigiana*) was mentioned only a handful of times. Bananas and plantains were a medium priority choice, and wild avocados were mentioned consistently in the responses (Fig. 3.8). Surprisingly, domestic varieties were only mentioned twice. Citrus trees in general were a low priority. I did not attempt to estimate the total number of species mentioned by coffee growers because of potential problems matching a variety of local names with scientific names.

Agronomists' choices of trees mirrored those of coffee growers. *Inga* spp were the most popular trees as first, second and third choices (Fig. 3.9). Agronomists mentioned citrus trees more often than coffee growers, but with a similar low priority. Wild avocados were also chosen a number of times, while bananas and plantains were barely mentioned (Fig. 3.9).

Role of forest fragments

A majority of coffee growers (63%, particularly those with medium and large farms) held significant patches of forest on their lands. These coffee growers, plus an additional 14% that do not have any forest left in their properties, indicated that it was useful to leave some forest areas on the farm. To be sure that this was not confused with the use of shade trees, I intentionally used the word "montaña," that in Nicaraguan Spanish means forest. Several explanations were given, mainly related to conservation of water sources, biodiversity conservation and microclimate preservation (Fig. 3.10).

All but two coffee growers that held significant area of forest on their property responded that they chose to have these areas as forest, rather than leaving it as forest due to lack of resources to convert the land to other uses, or because the land was useless for agriculture. Coffee growers (60%) expressed that they did not get any direct economic benefit from the forest portion of their lands. When asked why they had not converted these forest fragments into coffee plantation or pasture, most respondents rejected the idea stating they were not interested in converting it to coffee or to pasture (Fig. 3.11). When asked similar questions as a statement on a Likert scale, most coffee growers disagreed with converting forest to coffee plantation, to pasture, or to other crops (Fig. 3.12). Coffee growers also agreed with the statement “it will be better to expand the area covered with forest,” and, to a lesser extend, “forest fragments in my farm increase my coffee yields” (Fig. 3.13).

Coffee growers in general do not think forests serve as a refuge for coffee pests. Those responding affirmatively (12.2%) mentioned coffee berry borer *Hypothenemus hampei* Ferr (Coleoptera: Curculionidae), American leaf spot, *Mycena citricolor,* and coffee leaf rust *Hemileia vastatrix* Berk, and Br. (Basidiomycota: Pucciniales). Agronomists tended to agree with coffee growers in this regard, and 76% disagree or strongly disagree with the statement “Forest serves as a refuge to coffee pests”. In the case of policy makers and coffee experts, however, the results were more divided, with 55% disagreeing and 35% agreeing that forest patches act as refuge for coffee pests. Specifically, forests in humid regions were singled out as refuges for fungal agents, such as American Leaf Spot.

The role of birds and insects

Coffee growers perceive birds as either beneficial or non-important for the coffee plantation (Fig 3.14). I asked the same question for insects that were not pests, and the results were similar. The majority (66%) of agronomists considered birds beneficial, and insects elicited an even more positive attitude, with 75% of agronomist considering them beneficial, while 25% considered them as non important.

Management of agricultural waste

Coffee pulp is the most widely recycled agricultural waste, used by coffee growers through composting or applying it directly to the coffee trees after letting it dry (Fig. 3.15). In contrast, coffee husks are barely used because de-husking is carried out in large “beneficios” far from coffee plantations. Agronomists recommended converting pulp into compost and, to a lesser extent, to apply pulp directly around coffee plants (Fig. 3.16). In the case of coffee husks, agronomists were split evenly in their preferences between composting, using it as cattle folder, processing husks into cooking bricks, or disposing as waste with no further use (Fig. 3.16).

Managing wastewater is a major problem for most farms. Most coffee growers build basic sink holes where they discharge waste water, although many acknowledge that the size of these filters can only handle a fraction of the waste water they produce (Fig. 3.15). Only a minority of coffee growers reused waste water as fertilizer, and still a significant number either discharge it directly to a nearby stream or let it run freely off the farm (Fig. 3.16).

Organic and non-organic coffee growers differed somewhat in their management of agricultural waste. All coffee growers who acknowledged discarding wastewater into streams or letting it run freely own conventional, non-organic farms, however none of the organic coffee growers carried out such practices. In total, one in four conventional coffee growers follow these practices. In addition, the majority of coffee growers using coffee pulp as fertilizers were organic coffee growers, whereas four of the five coffee growers that indicated that they do not use coffee pulp as fertilizer have non-organic farms.

Changes in farm management

Coffee prices oscillate dramatically worldwide and I wanted to know how those price oscillations affected farm management. I presented an open question, allowing multiple choices per respondent: "How will you invest your money if you receive a good price for your coffee?" Coffee growers stated that they would choose to improve infrastructure, usually the wet processing facilities, or to establish new plantations (Fig. 3.17).

An opposite scenario was presented, one very well known by all coffee growers: "What will you do to save money when coffee sells at a low price?" Three responses ranked the highest, with most coffee growers stating that they would give overall less maintenance to the coffee plantation, while many fewer indicated that they would do nothing different, and a smaller group stated that they would abandon the plantation altogether (Fig. 3.17).

Yields, quality and pollination.

To improve the quality of their coffee, coffee growers indicated that improving wet processing facilities would be most useful, followed by applying more fertilizer, and renewing old plantations (Fig. 3.18). To improve their yields, coffee growers preferred to use more fertilizer and renew plantations (Fig. 3.18).

In this context I asked, as an open question, “What makes coffee flowers turn into good quality beans?” I wanted to measure the level of awareness of the role of bees in coffee pollination. I received 119 responses, with the most common response being “apply enough fertilizer”, followed by “receive the right amount of rainfall” and “timely fumigation”. Bees as pollination agents were only mentioned once (Fig. 3.19).

I compared reported annual coffee yields from 3 harvest cycles, 2004/05, 2005/06 and 2006/07 and found significant differences between years (Friedman’s test, χ^2 = 12.116, d.f. 2, P=0.002, n=72). Owners of small, medium and large farms reported annual yields on 3 consecutive harvest cycles that were significantly different (Kruskal-Wallis’ test, cycle 2004/05, χ^2 = 7.969, d.f. 2, P=0.019, n=72; cycle

2005/06, χ^2 = 12.106, d.f. 2, P=0.002, n=72; cycle 2006/07, χ^2 = 10.376, d.f. 2, P=0.006). Owners of larger farms consistently reported the highest yields, while differences were less pronounced between medium and small size farms (Fig. 3.20).

Yields in Organic vs. conventional farms

Conventional farms reported higher yields for three consecutive years (Fig. 3.21), although these differences were statistically significant only for 2005/06 (Kruskal-Wallis' test, χ^2 = 10.563, d.f. 1, P=0.001, n=72) and 2006/07 (Kruskal-Wallis' test, χ^2 = 4.178, d.f. 1, P=0.041, n=72). However, yields reported for large farms were mostly responsible for these differences. Small sized organic and conventional farms did not differ in their 3-year average yields, and the same was true for medium size farms. For large farms our sample was too small to perform this analysis.

Land use in organic vs conventional farms

Our sample contained 43 certified organic farms and 40 conventional, including 9 working with Starbucks. I compared total area and different land uses, as reported by their owners, to explore potential differences among these two groups. Conventional farms were on average more than twice the size of organic farms (Mann-Whitney U, H=647, Z=-1.942, p=0.052). Furthermore, non-organic farms have significantly more area planted with coffee (H=630.5, Z=-2.093, p=0.036) and more area under coffee production (H=601, Z=-2.363, p=0.018). However, they do not have significant differences in the amount of forest cover (H=840, Z=-0.191, p=0.849), pasture (H=768, Z=-2.363, p=0.343) or secondary vegetation (H=802, Z=-0.733, p=0.463), nor in the number of farms that has planted more coffee in the last 5 years (H=839, Z=-0.244, p807).

Agronomist's perceptions on the role of trees and desirable tree characteristics

I asked our interviewees their opinion about how to achieve higher coffee yields, with trees (shade coffee) or without them (sun coffee). The response was nearly unanimous, with 90.6% responding that having shade trees led to higher yields. Three technicians responded that coffee without trees was the ideal choice, but complained that coffee growers were, nevertheless, not willing to spend the money needed to grow coffee that way. Only two respondents chose "it depends" with the explanation that although yields could be higher without trees, the environmental and economic costs of this option made it unsustainable.

Agronomists expressed a preference for use of a combination of short and tall trees for shade (Fig. 3.22), and considered between 30 and 50% the most appropriate shade level for optimal coffee yields (Fig. 3.23). Preference for wide canopy trees was almost unanimous, while opinions on leaf size characteristics were split evenly among all categories (large leaves, small leaves, and a mix of leaf sizes). There was a more uniform opinion about trees and mulch production, with most agronomists preferring trees that produce lots of leaves for mulching (Fig. 3.22).

Permanence of leaves all year around was considered an important attribute for a shade tree, as well as ease of pruning. Most agronomists also preferred shading coffee with locally available species of trees (Fig. 3.22).

The Role of forest fragments in coffee plantations

I asked agronomists if keeping forest fragments is useful for the coffee plantation. I asked this twice, first as an open question and later in the interview as a statement they needed to rate using a Likert scale. In both cases their responses were very similar, with all but one interviewee either agreeing (88.7%) or strongly agreeing (3.8%) that keeping forest fragments is useful for coffee plantation. Responses of policy makers were very similar, with 90% agreeing that forest fragments help coffee plantations in general.

I asked for an estimate of how much area should be devoted to forest in a typical 20 to 100 ha coffee plantation. Most agronomists recommend leaving between 20% and 50% of the farm under forest. When the same question was asked to policy makers they recommended similar levels (Fig. 3.24).

I also asked coffee growers an open question regarding where they feel forest patches should be located. Most agronomists mentioned more than one location, but they favorite place was near water holes and streams to protect water sources. Highland areas were also considered important, as well as steep slopes (Fig. 3.25). Note that these responses are not mutually exclusive and most interviewees mentioned more than one location.

The next sets of questions were presented as statements to rate on a Likert scale. These were: “Is it better to convert forest fragments into coffee plantations?”, “Is it better to convert forest fragments into pastures?”, and “Is it better to convert forest fragments into other crops?” Most agronomists disagree with converting forest fragments to coffee plantations, pastures, or other crops (Fig. 3.26). Responses of policy makers were quite similar to those of agronomist in this set of questions, and most of them disagree with the notion of replacing forest fragment with coffee plantations, pastures or other crops (Fig. 3.27).

Two additional statements followed during the interview: “It will be better to expand the area covered with forest” and “presence of forest increases coffee yields”. In the first case, most agronomists agreed. On the statement linking forests and coffee yields the results were more divided, but still the majority of agronomist agreed (Fig. 3.26). Policy makers agreed that these forest fragments should be expanded, although only 50% agreed with the statement that forest fragments help to increase coffee yields (Fig.3.27).

Coffee and protected areas

When asked their level of agreement with the statement “Coffee produced inside protected areas should not be certified,” most agronomists responded with disagreement (79.2%) or strong disagreement (2%). When asked to elaborate, most respondents acknowledged the fact that coffee plantations already exist in many protected areas, and certification could allow a mechanism to control them better. Several agronomists suggested the creation of a specific certification seal (“denominación de origen”) with the dual purpose of setting strict rules for growing coffee and to give coffee and added value, for example as conservation coffee. Several respondents suggested demanding all plantations inside protected areas use no agrochemicals (adopting organic methods). Other argue that shade coffee plantations do not degrade protected areas, and to the contrary, act as a buffer against more destructive farming practices, such as annual crops or pastures. Still other agronomists responded that coffee plantations should only be established to restore areas currently deforested and should never be established inside forest.

When asked to provide their level of agreement with the statement “Establishment of new coffee plantations in protected areas should be allowed,” the interviewees either disagreed (83%) or strongly disagreed (3.7%) with this statement. Among reasons given was that agricultural practices should not expand at the expense of forest areas, and that water sources could be negatively affected. Other respondents mentioned the importance of mountain forest for biodiversity conservation.

Certification and production

Half of the farms I visited were certified as Fair trade and Organic. Two farms were only certified as organic because they were too big to be fair trade certified. Most of the largest farms (8 out of 10) were selling coffee to Starbucks and their owners called their farms “certified” because of the large number of requirements they need to fulfill to get preferential status with that company.

I asked certified coffee growers, including those selling coffee to Starbucks, to rate their satisfaction with the price premiums they received on a scale ranging from “fair,” “more or less fair,” to “unfair”. Our interviewees split their responses evenly among these three choices, regardless of their farm size.

Yields, quality and changes in farm management

I asked three questions in this section: a) “In your opinion, what should be done in the Nicaraguan coffee sector to improve bean quality?” b) “In your opinion, what should be done in Nicaragua to increase yields?” c) “What are the condition most favorable to get coffee flowers well pollinated?" These were open questions and most agronomists provided more than one answer. A large number of responses were to improve bean quality (86) or to increase yields (89). For improving bean quality, agronomists recommended improving wet processing facilities, followed by using more fertilizer and using new varieties (Fig. 3.28). To increase yields, they recommend using more fertilizer, pruning coffee trees, increasing plant densities, and renewing plantations (Fig. 3.28).

On the question about pollination ("What are the environmental conditions that favor a good pollination of coffee flowers?"), there were multiple responses per interviewee. Most agronomist mentioned bees as pollination agents, but this question elicited a wide range in the responses. Those include plant nutrition, right precipitation, and right humidity level (Fig. 3.29). Self-pollination and hummingbirds (as pollination agents) were mentioned a handful of times. Policy makers/experts also mentioned bees more often, followed by plant nutrition. However, 20% of the respondents could not provide any explanation (Fig. 3.29).

The ideal coffee farm

I asked agronomist to choose the most desirable characteristics of their ideal farm. All but one preferred a farm with diversified production. I presented a list of 17 possible activities to combine with coffee production. The number of responses, 316 in total, gives an idea of the abundance and diversity of farming activities they chose. Ranking first was fruit trees, followed by environmental services, timber trees and ecotourism (Fig. 3.30).

Impact of the Coffee Law and the National Coffee Council (CONACAFE) according to Policy Makers.

Opinions expressed by policy makers and coffee experts were very descriptive in nature, and here I summarize the main points raised by our interviewees. The original questions were a) what is the most valuable aspect of the current Coffee Law? b) What is the least useful aspect of the Coffee Law? c) What is the most important achievement of CONACAFE? d) What changes would you recommend to make CONACAFE more effective?

There is a strong level of skepticism among all interviewees about the usefulness of the Coffee Law, but the creation of CONACAFE was mentioned as the most valuable contribution of the law so far. Most elements of the law are not well known because they have not been implemented, such as certain fiscal incentives for improving social conditions and environmental conservation.

Most interviewees mention more negative than positive aspects of both the Coffee Law and CONACAFE. They complained about the lack of bylaws to make

CONACAFE operative, and lack of a clear government policy towards the coffee sector. A common complaint was that this is a fiscal law to collect more taxes from coffee growers, instead of supporting them. Policy makers also felt that the law limits participation of many sectors, particularly small to medium size coffee growers. The law was perceived as very bureaucratic and the elements to regulate coffee taxation have not been implemented.

For most respondents, the biggest achievement of CONACAFE is the creation of the national registry of coffee producers, traders, and exporters. Other experts mentioned better projection of the sector to new open markets. Although the National census of the coffee sector may be useful to provide better services to coffee growers, the overall opinion is that, so far, there are few concrete results.

Lack of adequate representation in the current CONACAFE is a major concern among respondents. A better mechanism to select representatives was mentioned repeatedly. Small and medium size coffee growers should be represented according to the specific weight they have in the coffee sector. Changes in the CNC composition should be introduced to truly provide services mentioned in the coffee law to all coffee producers, and participation should be expanded at all levels, but especially in coffee growing regions. Overall, CONACAFE is not widely accepted among coffee growers.

Government policies and price oscillations

All interviewed policy makers, including those working for the current Government, concurred that there are no policies to respond to price oscillations. The goal is to implement a retention mechanism when coffee prices are above $100 /QQ and use these funds when needed to support coffee growers when coffee prices drop below an unspecified benchmark.

Certification and yields

Policy makers were familiar with several certification seals. Ranking on top was organic, mentioned by all respondents, followed by Rainforest Alliance (78%), and Bird-friendly (28%) certifications. Even though there was a clear disparity in the number of certification seals they knew, I asked all of them whether yields change when coffee production goes from conventional to organic, shade-grown, Fair-trade, Rainforest Alliance, and Starbucks. Most interviewees expressed that yields decrease when plantations convert to organic, and to a lesser extend when converting to shade-grown (Fig. 3.31). For the later, a number of respondents expressed the opposite (yields increase when production switches to shade-grown), especially over the lifespan of the coffee plant. For Fair-trade, no change was the prevalent choice, while there was no clear pattern in the opinions about Rainforest Alliance coffee (Fig. 3.31). As many interviewees though that production will increase as those who did not know. For Starbucks, most respondents considered that yields increase (Fig. 3.31). Agronomists' opinions on certification and yields were similar to those expressed by policy makers (Fig. 3.32).

Coffee and protected areas

Most policy makers and coffee experts agreed that there are coffee plantations established inside the boundaries of protected areas. When asked to mention what specific protected areas have coffee plantations, a total of 17 areas were mentioned, an average of 3 per interviewee. Reserva Natural Datanlí-El Diablo (Jinotega) was mentioned the most (8 times), followed by R. N. Volcán Mombacho, Granada (6), Bosawás, Jinotega and RAAN (5) and R. N. Cordillera Dipilto Jalapa, Nueva Segovia (5). Nearly all (90%) of the policy makers disagreed with the statement "Coffee plantations inside protected areas should not be certified". Instead, they suggested either to create a specific certification of origin seal, or to use any of the current certification schemes to enforce environmental standards of these seals. Certification was not perceived as a foe, but as an ally in the preservation of these protected areas. In response to the next question, "What should be the government policy towards growing coffee within the boundaries of protected areas?" interviewees recommended allowing only already established coffee plantations.

Improving coffee quality and yields

Policy makers were asked the same questions I gave to agronomists and coffee growers about how to improve yields and coffee quality. Policy makers ranked first "apply more fertilizer to increase yields," followed by "plantation renovation," and "adequate pruning" (Fig. 3.33). When asked how to improve bean quality, two post-harvest activities ranked on top, "improving wet processing facilities" and "drying and storage in dry processing facilities" (Fig. 3.33).

Trends in coffee production

Should we plant more coffee in Nicaragua? I posed this and other questions to our policy makers to have a better understanding of future trends in the coffee sector. Most of them disagreed (75%) with the idea of expanding coffee cultivation or giving incentives to expand coffee production (75%). Nevertheless, there was no clear agreement on whether there was a tendency to increase coffee plantation area nationwide. Although, policy makers expressed the sense that nationwide there is a trend toward producing more shade grown coffee (75%), no one expressed an expectation that production of sun coffee would increase. Most policy makers were of the opinion that there is a national trend toward increasing organic production (65%), improving coffee quality, and increasing yields.

When policy makers were asked about specific regions with the greatest potential to expand coffee cultivation and those where it is not profitable to grow coffee, 50% responded with names and locations of specific regions. Areas with potential to expand coffee cultivation were all located in the highlands, in departments such Jinotega, Matagalpa and Nueva Segovia. The argument was expressed that these are the best areas to grow highland coffee, also know SHG (Strictly High Grown) and SHB (Strictly Hard Bean) in the specialty coffee sector. Conversely, areas mentioned were it is not profitable to grow coffee were all situated at less than 800 m above sea level in the Pacific Region. The coffee variety considered in all cases is highland arabica coffee, since Nicaragua does not have commercial plantations of lowland coffee varieties.

Five year projection on coffee plantations.

I asked coffee growers to look into the future and imagine how they would like to see their farms, five years from now. Most of them envisioned their farms with higher yields and more areas planted with coffee (Fig. 3.34).

DISCUSSION

Our surveys, albeit limited in coverage and representativeness, detected several important patterns among Nicaraguan coffee growers. First and foremost, they use trees for shade, regardless of farm size and certification, because they consider shade trees useful for the coffee plantation particularly for providing better and more stable yields (Boa et al. 2000; Soto-Pinto et al. 2000). Nevertheless, there is an inverse trend between farm size and reported shade levels, with smaller coffee growers reporting higher levels of shade, regardless of certification status. Organic certification influenced reported shade levels among medium and large farm owners, with organic coffee growers reporting denser shade levels.

Coffee growers preferred to shade with wide canopy trees that shed leaves but maintain foliage all year and are easy to prune. They value variable tree heights and tree types, although fruit trees were disliked by a significant number of coffee growers (22%) because of illegal picking by farm workers. However, none of the small farmers (<10 ha) dislike having fruit trees. Trees that can be used for firewood are favored mainly because many fix nitrogen (e.g., *Inga* spp). Even though coffee growers preferred trees that can be pruned easily I suspect that very few small and medium coffee growers actually regulate shade in their plantations, and that could also explain why small farms reported higher shade levels.

Local trees were preferred over introduced species, and their list of five favorite trees confirmed that. Guaba Extranjera (probably *Inga paterno*) and Búcaro (*Erythrina poeppigiana*) were the only non local trees mentioned by coffee growers. A number of Guaba species (*Inga* spp.) dominated their choice of shade trees. Interestingly several species of non domestic avocados (*Ocotea* spp. among others) were preferred over fruit trees. The main reason given to keep them as shade was to attract birds. I tallied Bananas (*Musa* spp.) as trees because for many coffee growers they play a similar role to trees. Nevertheless, they were not chosen as a good shade species for most coffee growers, although there is also the possibility that some coffee growers did not mention them because they are not trees.

Agronomist's choices and opinions about shade trees and levels of shade were very similar to those of coffee growers. They tended to choose more fruit (oranges) and timber trees with highly price timber for shade, such as Cedro Real (*Cedrella odorata*), Granadillo (*Dalbergia cubilquitzensis*), Laurel (*Cordia alliodora*), and Nogal (*Juglans olanchana*). Agronomists were not concerned with potential allelopathic effects of any shade trees, as evidenced that was never mentioned.

When it comes to coffee grower preferences regarding the preservation of forest fragments, farm size matters. This is not surprising, considering that small coffee growers have limited choices when it comes to land uses. There was only a 6% difference in percentage of the farm devoted to forest between medium and large farms, suggesting there is a threshold in farm size to achieve a balance between coffee production and forest preservation. In fact, large farms have nearly as much land devoted to pasture as they have to forest, while in medium size farms forest cover is higher than pasture cover by 9%. Cattle in Nicaragua are used by many coffee growers as alternative to savings account to get cash on demand. That may explain why medium size farms keep a significant area under pasture, even though the coffee growers could earn several orders of magnitude more money from expanded coffee production. Dairy cows allow a constant cash flow for the coffee grower. In this regard, coffee is more like gold; you receive your money when you sell it, usually just a few times per year. More attention should be devoted to understanding what factors drive coffee growers' decisions on alternative land uses.

Our comparison of land use between conventional and organic farms indicated that these farms are not different in land use when farm size is considered. Only owners of small conventional farms reported significantly more coffee under renovation than their organic equivalents. Regardless of farm size, converting to organic cultivation does not appear to have an effect on other land uses. Coffee growers' opinions of the role of forest fragments are similar. The only aspect of farm management where these two groups may differ is in their use of agricultural waste, with a significant number of conventional coffee growers improperly disposing of pulp and wastewater. Only a minority of coffee growers takes advantage of nutritional capabilities of wastewater or coffee husks. This is an area that deserves more attention. The idea of simply filtering wastewater in sink holes is a recommended standard by all certification seals, including organic, Rainforest Alliance, and Starbucks, but they do not offer specific guidelines to reuse wastewater in the coffee plantation. More should be done to teach coffee growers the advantages of proper composting of farm waste, and certification agencies should develop more strict protocols in this regard. Needless to say I found an abundance of good role models in our farm visits.

Yield differences were very pronounced between years, and this may be an indication that most farms are not properly fertilized either with chemical or organic products. I did not include in our survey a set of questions about use of fertilizers, but it was part of the informal conversation when I engaged coffee growers in an analysis of yields for the last 3 years. Finding an organic coffee grower that could fertilize all his coffee plants on a regular basis was exceptional. Only one farmer bought and transported chicken manure from distant farms for fertilizer. Most farms with cattle did not take advantage of cow manure because they have free-range cattle and collecting their manure was impractical. One conventional coffee grower used bat guano as fertilizer and his reported yields were among the highest and most stable.

Only large coffee growers pay for soil analysis to have reliable information on the right fertilizer to use. Organic coffee growers did not use soil analysis because they mostly relied on using fertilizer they produced via compost, bocashi or "lumbrihumus" (worm compost).

Larger farms reported higher yields. This is not surprising, since owners of these farms probably spend more per ha of planted coffee in inputs and labor. I did not find significant differences in yields between organic and conventional farms of comparable size. Apparently many coffee growers were still suffering the consequences of the recent crisis in coffee prices and this may also explain the wide range in yields reported. Our sample size also prevented us from conducting a more robust analysis of differences among farm subgroups.

Coffee growers are not aware of the role of bees as coffee pollinators. Conversely, they did not link the presence of forest fragments with better pollination services, even though they perceive forests helped coffee production in several other ways (water conservation, microclimate, etc). Agronomists and policy makers were more aware of the role of bees, but again failed to connect bees with the presence of forest fragments. Given the considerable interest that this issue generated in our informal conversations after conducting the survey, I suggest understanding pollination services when training coffee growers by certification agencies should be a priority. Furthermore, certification agencies and coffee traders that claim environmental benefits should pay more attention to the presence of forest fragments as a key element for certification of environmentally friendly coffee, because there is a synergy of benefits to the coffee grower and biodiversity conservation in general.

Most coffee growers consider birds and non-pest insects as beneficial or neutral to the coffee harvest. A handful of coffee growers were aware of the role of birds as insect predators, although some of the roles assigned to birds were questionable (hummingbirds as pollination agents or birds in general as providing natural fertilizer with their droppings). I did not explore in detail the level of awareness of coffee growers regarding integrated pest management techniques.

Most coffee growers reported having more coffee than 5 years ago, regardless of farm size and farming method. I suggest taking these results with caution, because a number of coffee growers reported having more coffee if they have coffee under renovation. I did find, however, that high coffee prices are a strong incentive to establish new coffee plantations, and our own observations and information provided in informal talks support this. One of the policy makers I interviewed suggested that high coffee prices paid to winners of recent Cup of Excellence contests was the driving force behind new coffee plantations in the Municipality of Dipilto, Nueva Segovia. In addition, high coffee prices represent a challenge for cooperatives selling certified coffee, because coffee growers find it more attractive to sell their coffee directly in the local market than through their cooperatives.

There is no evidence that lower coffee prices are driving coffee growers to either cut trees from remnant forest or from the shade layer in the plantation (Dietsch et al.

2004). Coffee growers declared that first they will give less overall maintenance to the plantation and stop buying inputs, and eventually will abandon the farm before selling it or changing to other crops. Coffee growers I interviewed have owned their farms for an average of 25 years, and they are probably among the most stable landholders in the country, considering the dramatic events in recent Nicaraguan history.

Agronomists' opinions mirrored those of coffee growers in most issues, including appreciation for shade plantations, forest fragments and use of agricultural waste. They are more aware of the role of bees, although we must interpret this result with caution. I mentioned the word "pollination" when I asked my question ("What are the environmental conditions that are the most favorable to obtain the best pollination of coffee flowers?") and this could have biased our respondents. The fact that they did not connect the presence of forest fragments with favorable conditions for pollinators suggests they may not see this correlation. When this very same question was asked to policy makers and coffee experts they responded in a very similar manner.

Perhaps the most interesting aspect of our survey is the perception that agronomists and policy makers have about growing coffee inside protected areas. Their opinion about certifying coffee plantations inside protected areas clearly defies current standards of any certification seal. However, it seems to us that this is a very logical approach. If you want to avoid deforestation inside protected areas you need to certify existing crops and give coffee growers a good incentive to manage plantations in a sustainable way. Certification becomes a tool to develop an accurate land use registry in ecologically sensitive areas, such as the last remnants of cloud forest in the Nicaraguan highlands. Furthermore, neither agronomists nor policy makers supported certifying new plantations or to allow new plantations inside protected areas. Nevertheless, I found numerous examples of farms being certified inside protected areas, and certification agencies are not even aware of park boundaries. This is a sensitive issue, and one I could not explore any further because I did not want to compromise the confidentiality of participants in this survey.

Nicaraguan coffee plantations are probably among the most diverse and densely shaded in the world, regardless of farm size. Interestingly the official figures on percentage of coffee grown under shade (96%, according to MAGFOR 2003) matches our coffee growers' perception that coffee production increases under a tree layer (94% of the respondents). Currently, we are in a cycle of high coffee prices and that, combined with low national wages for farm workers, give coffee growers a substantial economic boost. But this situation is far from stable, and lack of government policies to support coffee growers during times of crisis forces coffee growers to rely on themselves and their cooperatives to survive (Bacon 2005). More work is needed to explore ways to stabilize yields without compromising ecological integrity of these plantations, especially on how fertilizers, both synthetic and organic, are used (Perfecto et al. 2005). Certification agencies, especially those working with organic standards, should move beyond specific crop certification and look at farms as ecological units that require more than zero use of fertilizers to be environmentally friendly.

FIGURES

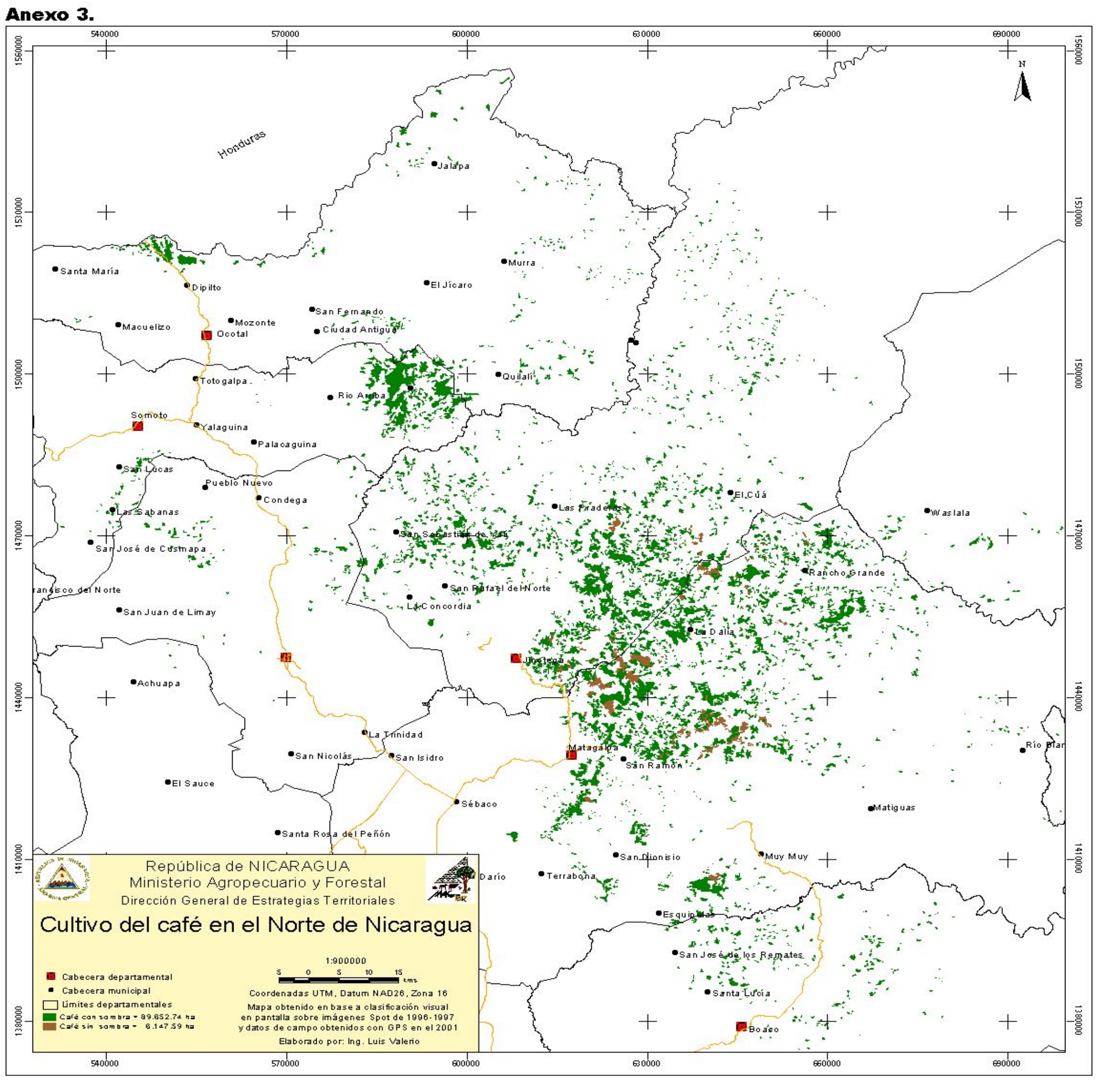


Figure 3.1. Coffee plantations in the Northern Highlands of Nicaragua.

(after Valerio 2000).

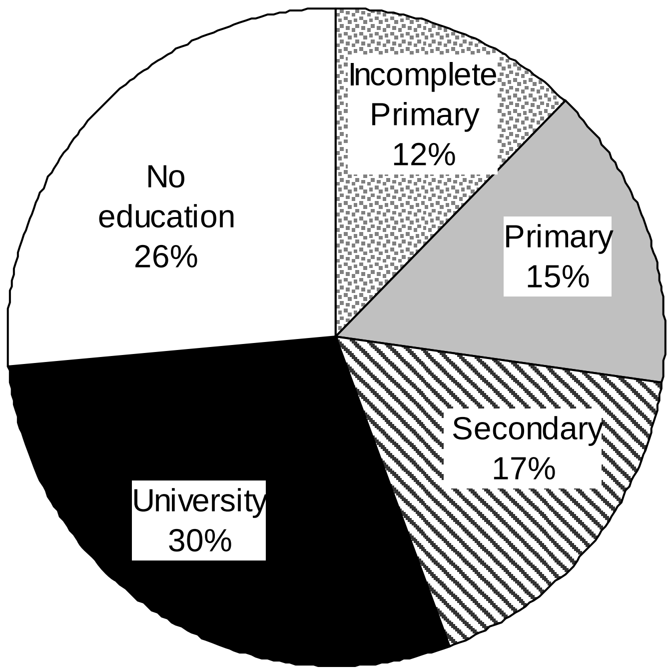


Figure 3.2. Education among interviewed coffee growers.

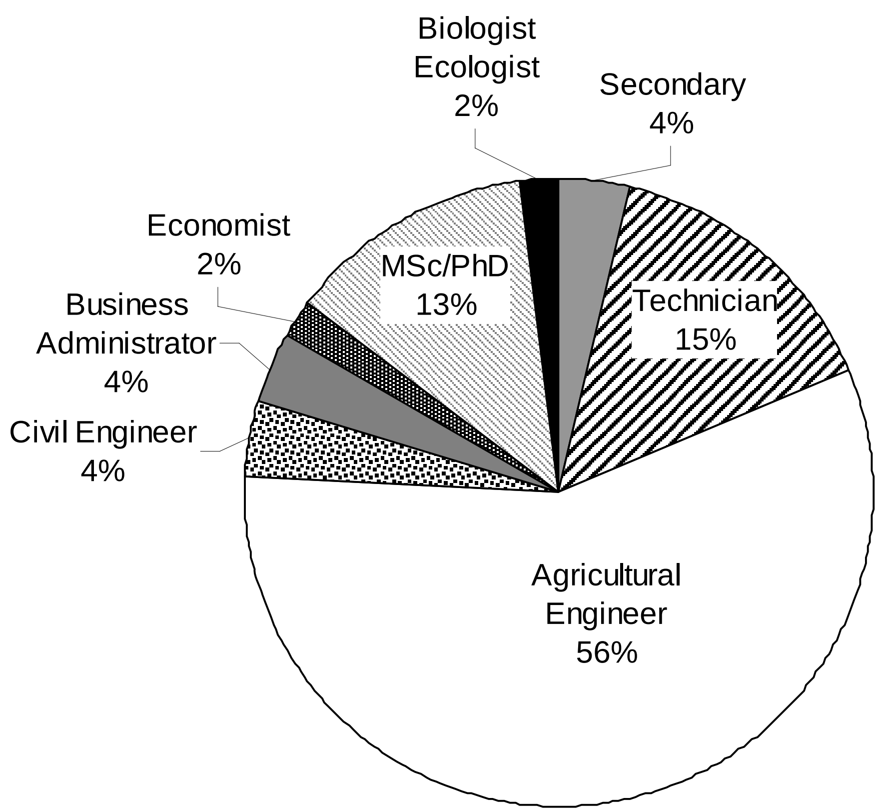


Figure 3.3. Education among interviewed technicians.

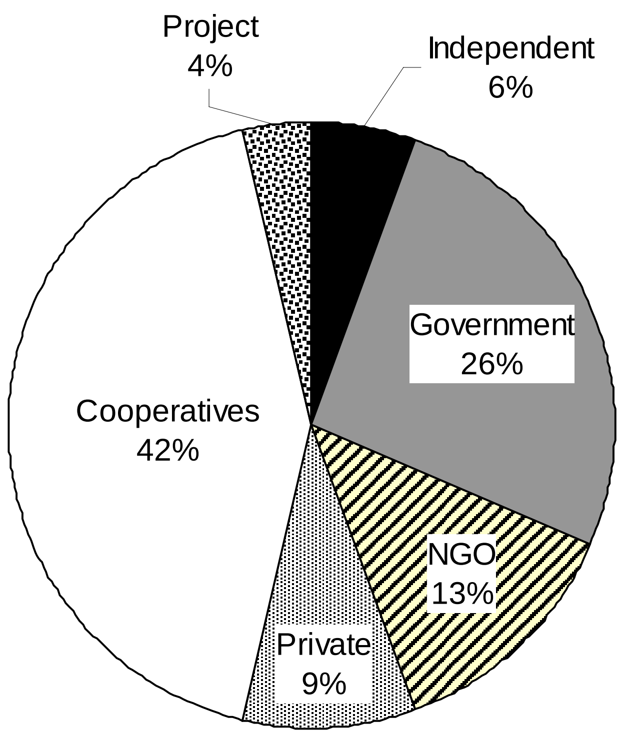


Figure 3.4. Work affiliation among interviewed technicians.

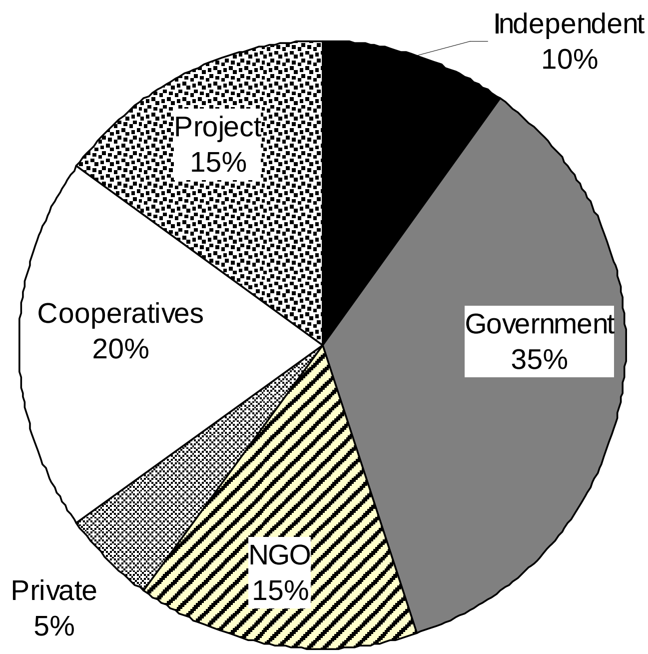


Figure 3.5. Work affiliation among interviewed policy makers and experts.

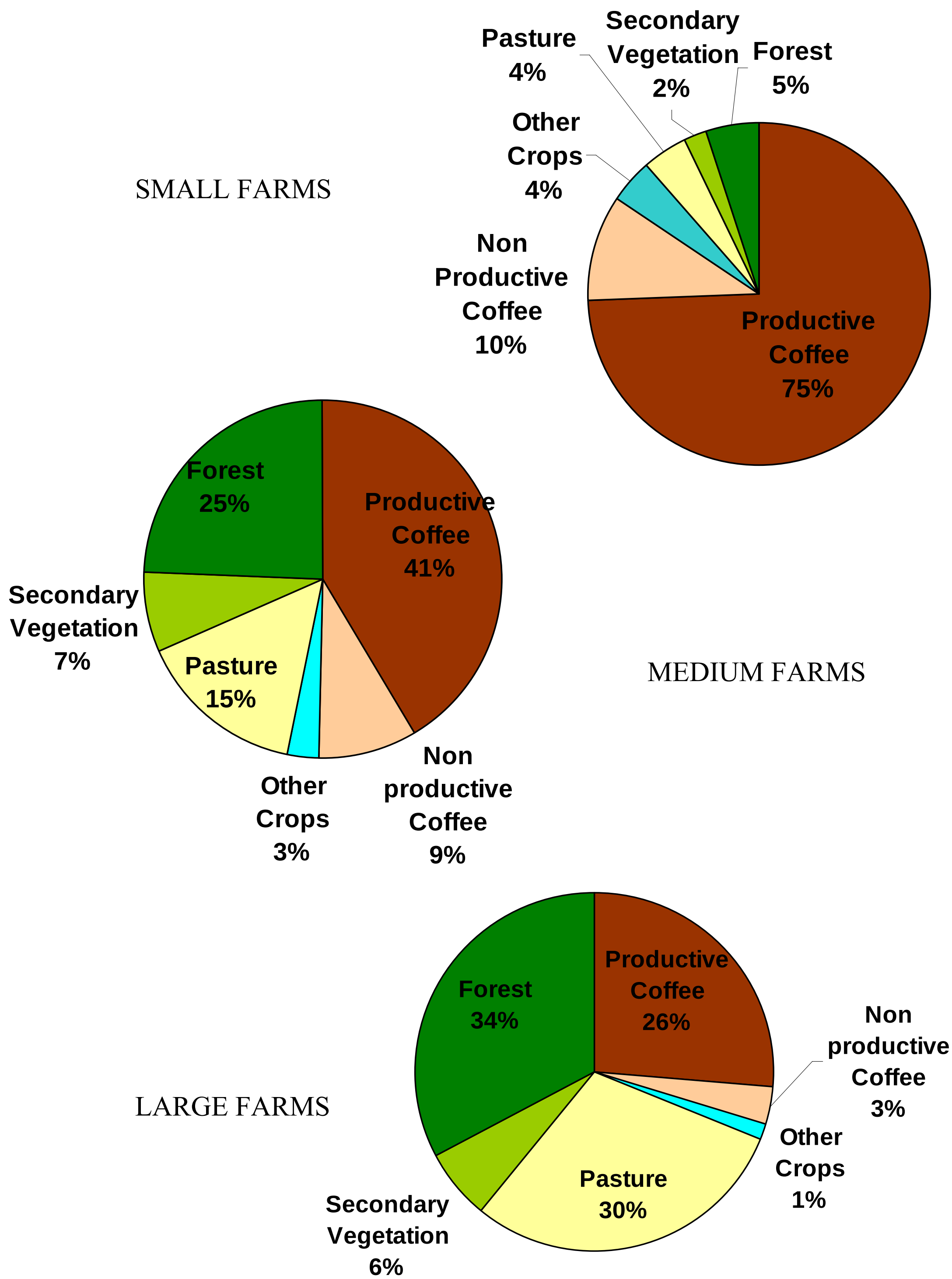


Figure 3.6. Land use and farm size.

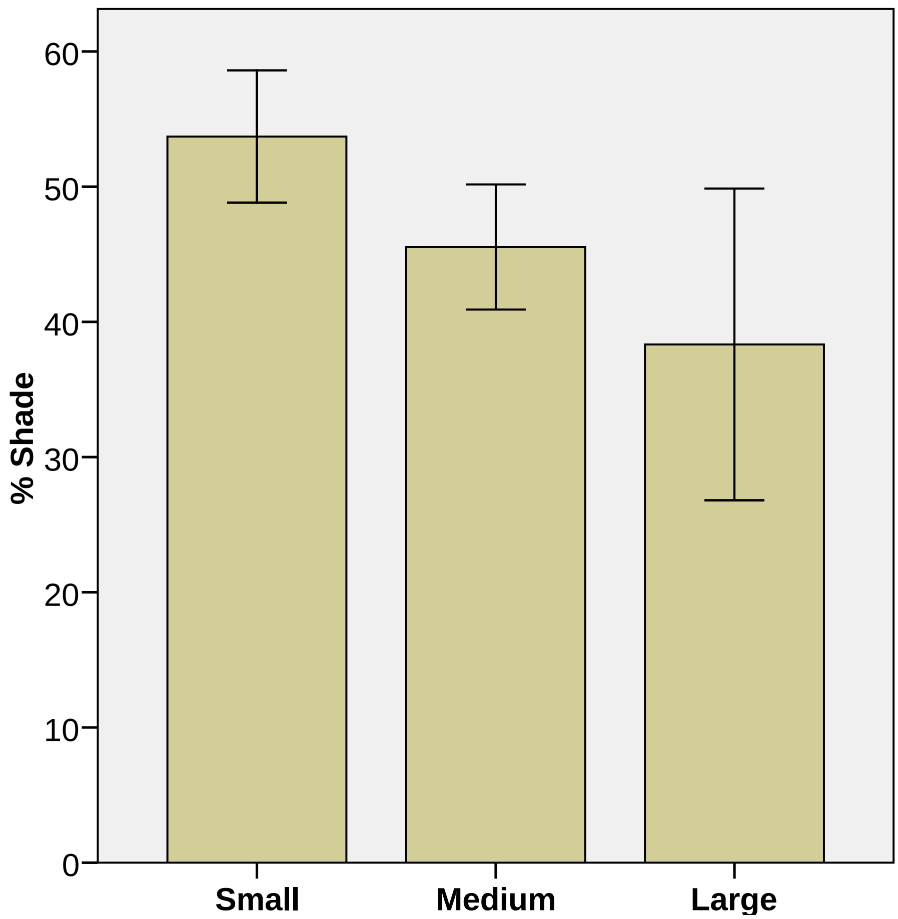


Figure 3.7. Shade levels and farm size.

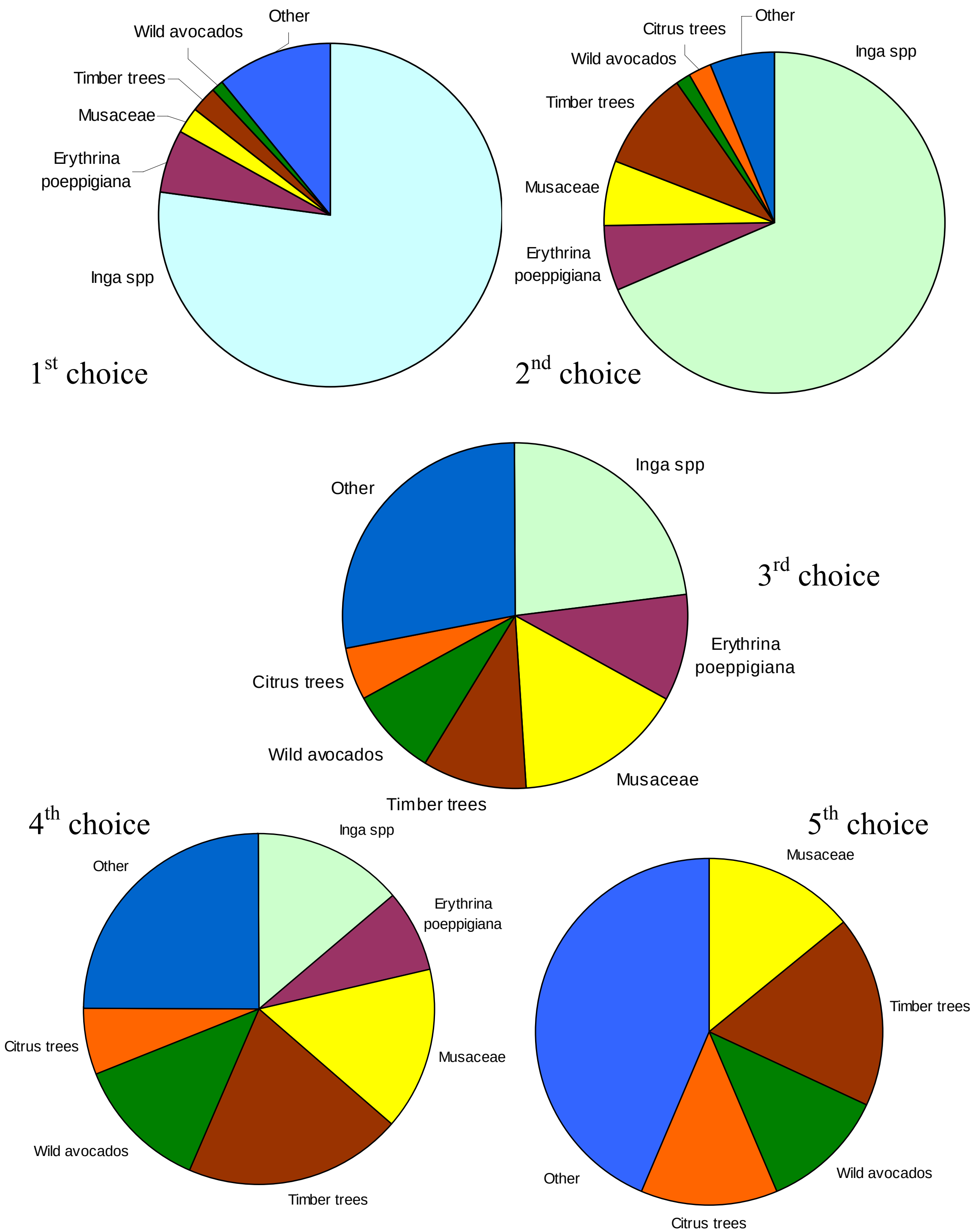


Figure 3.8. Best 5 trees in coffee plantation according to coffee growers.

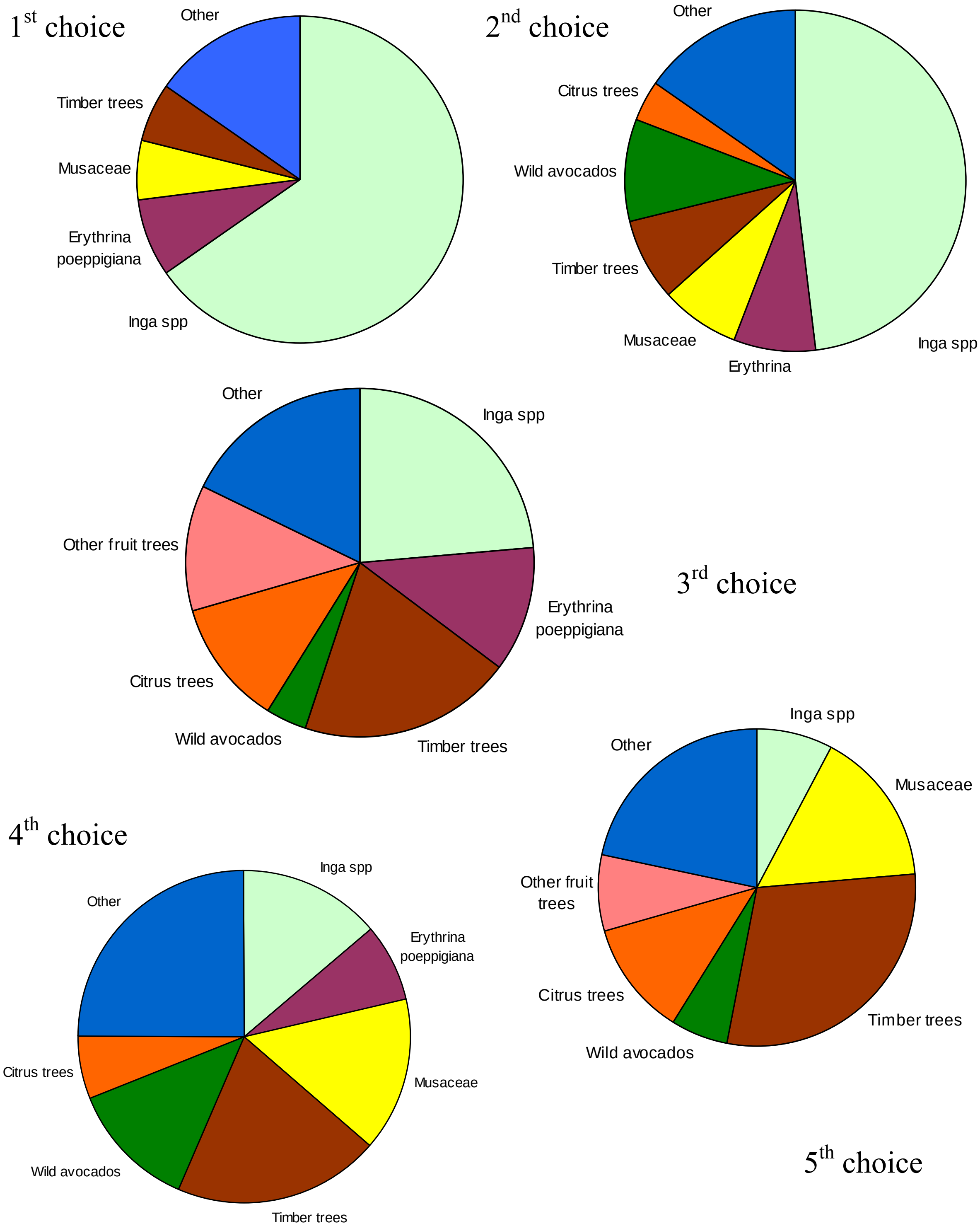


Figure 3.9. Best 5 trees in coffee plantation according to agronomists.

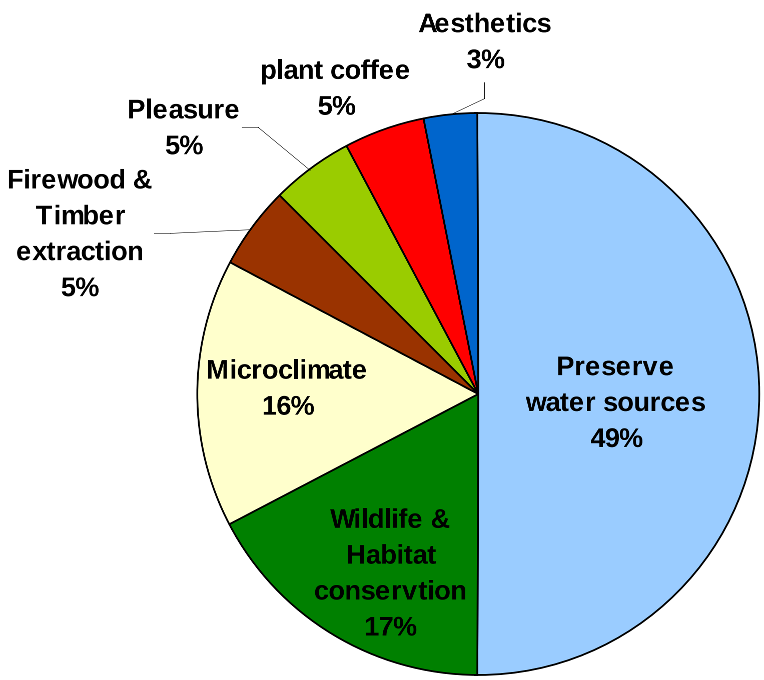


Figure 3.10. Reasons given by coffee growers to keep forest fragments.

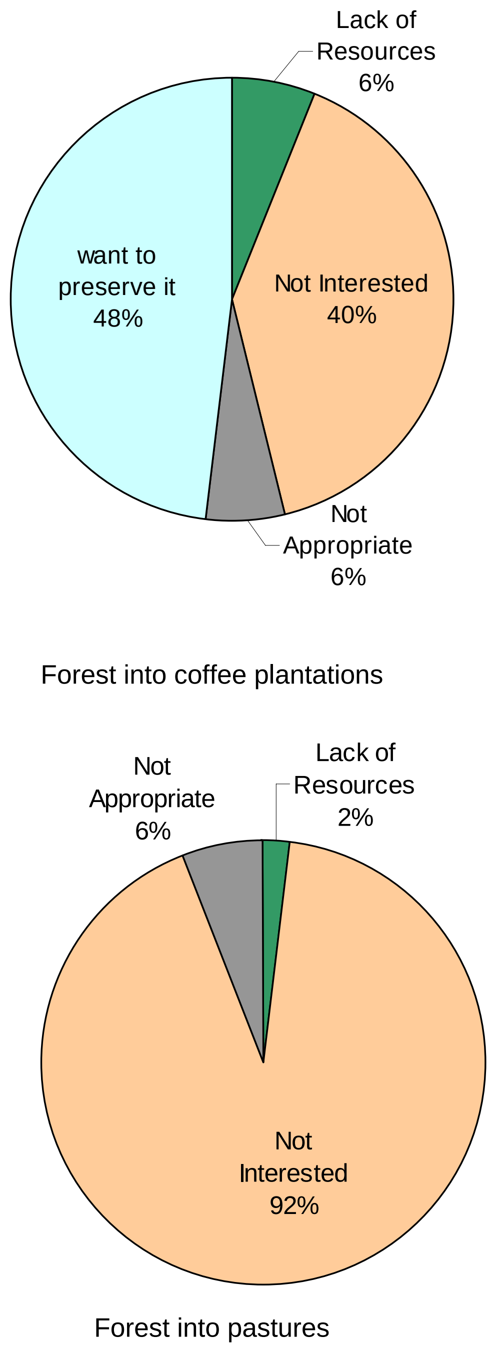
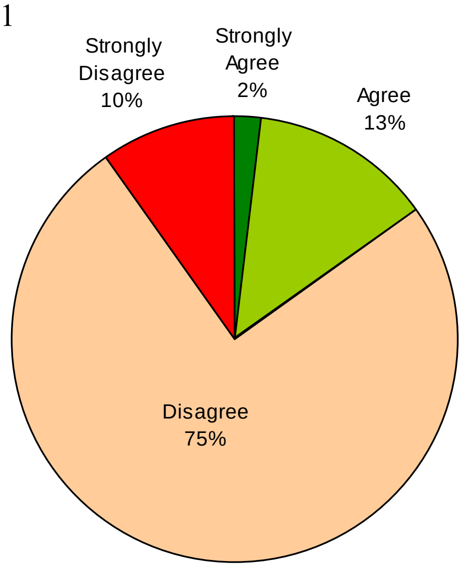
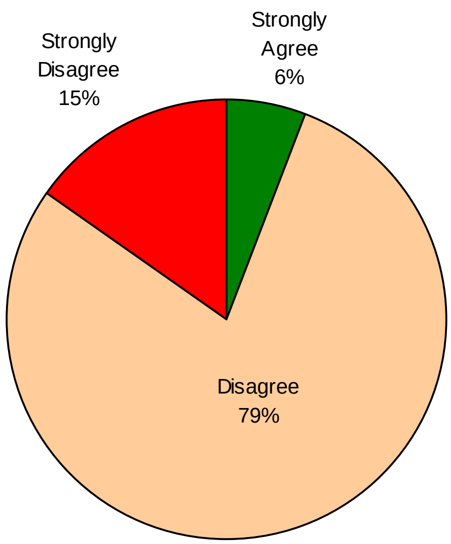


Figure 3.11. Coffee growers' opinions on converting forest fragments.

Forest in the farm should be
converted into coffee plantations



Forest in the farm should be
converted into pastures



Forest in the farm should be
converted into other crops

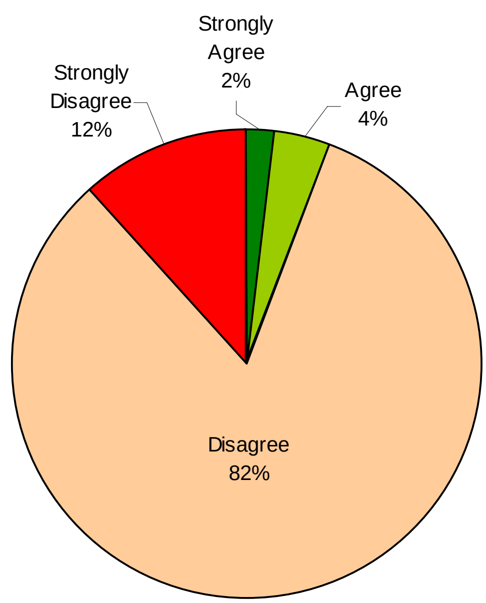
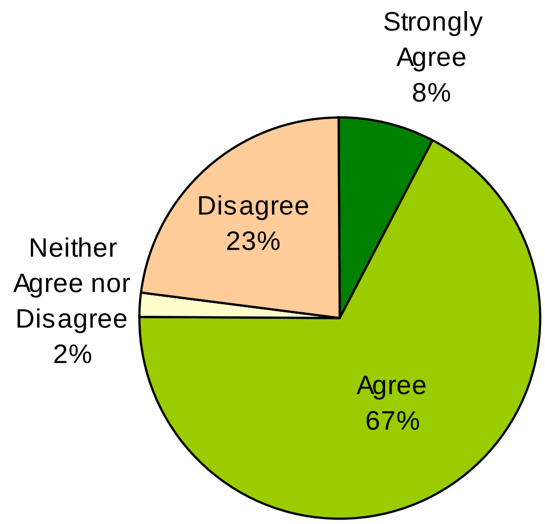
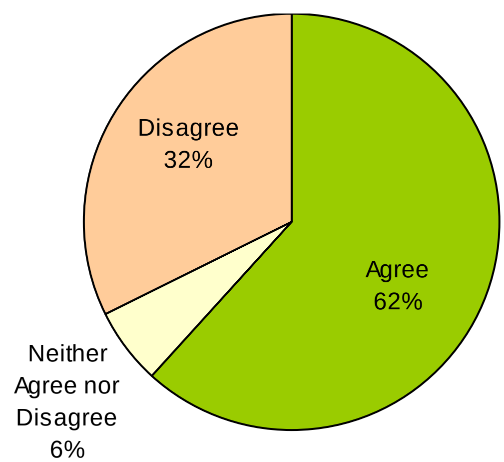


Figure 3.12. Coffee growers' agreement with statements about forest conversion.

Responses were measured on a 5 point Likert scale (ranging from strongly agree to strongly disagree).



Forest in the farm should be expanded



Forest increase coffee yields

Figure 3.13. Coffee growers' agreement with statements about forest expansion.

Responses were measured on a 5 point Likert scale (ranging from strongly agree to strongly disagree).

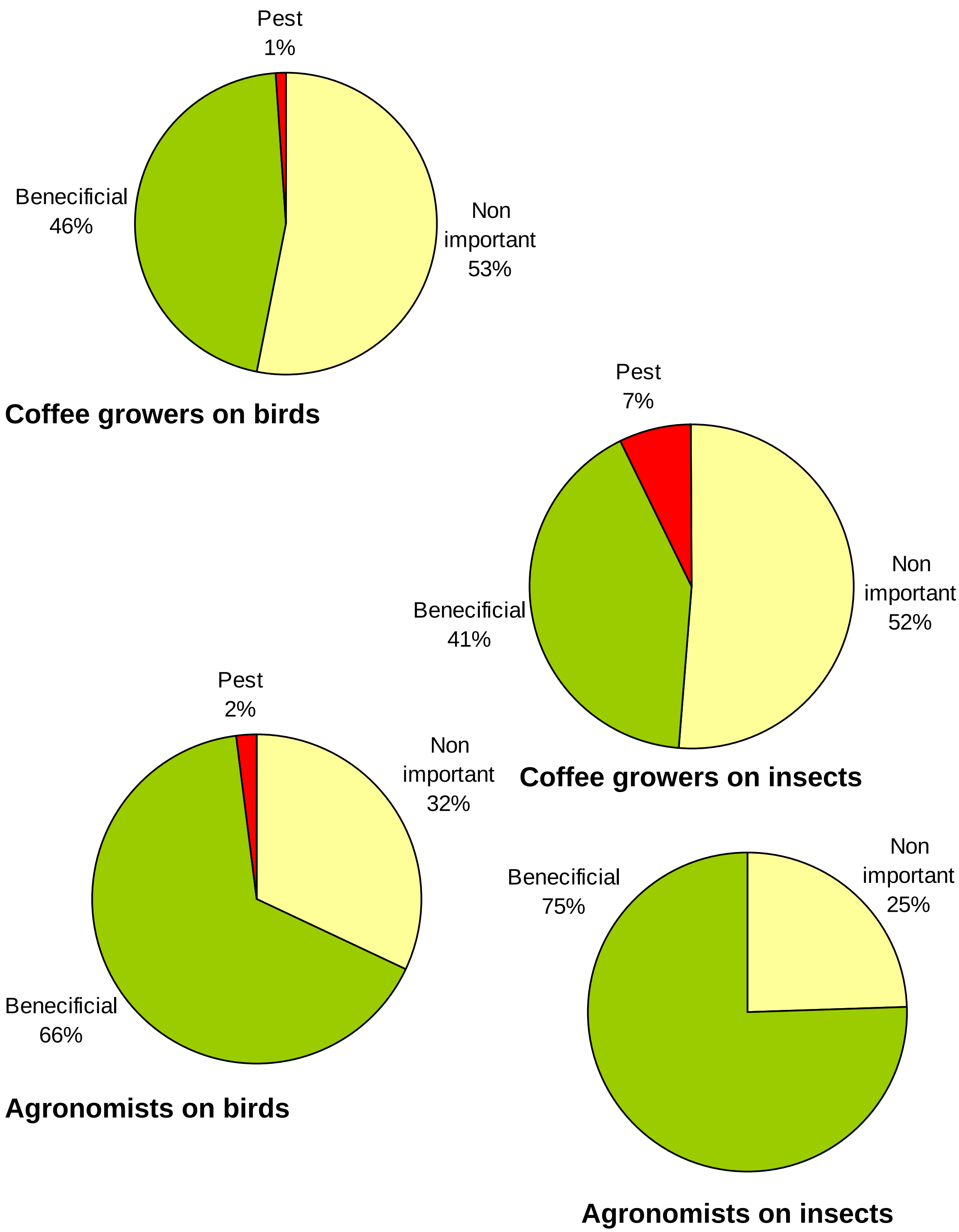


Figure 3.14. Perceptions of coffee growers and agronomists on birds and insects.

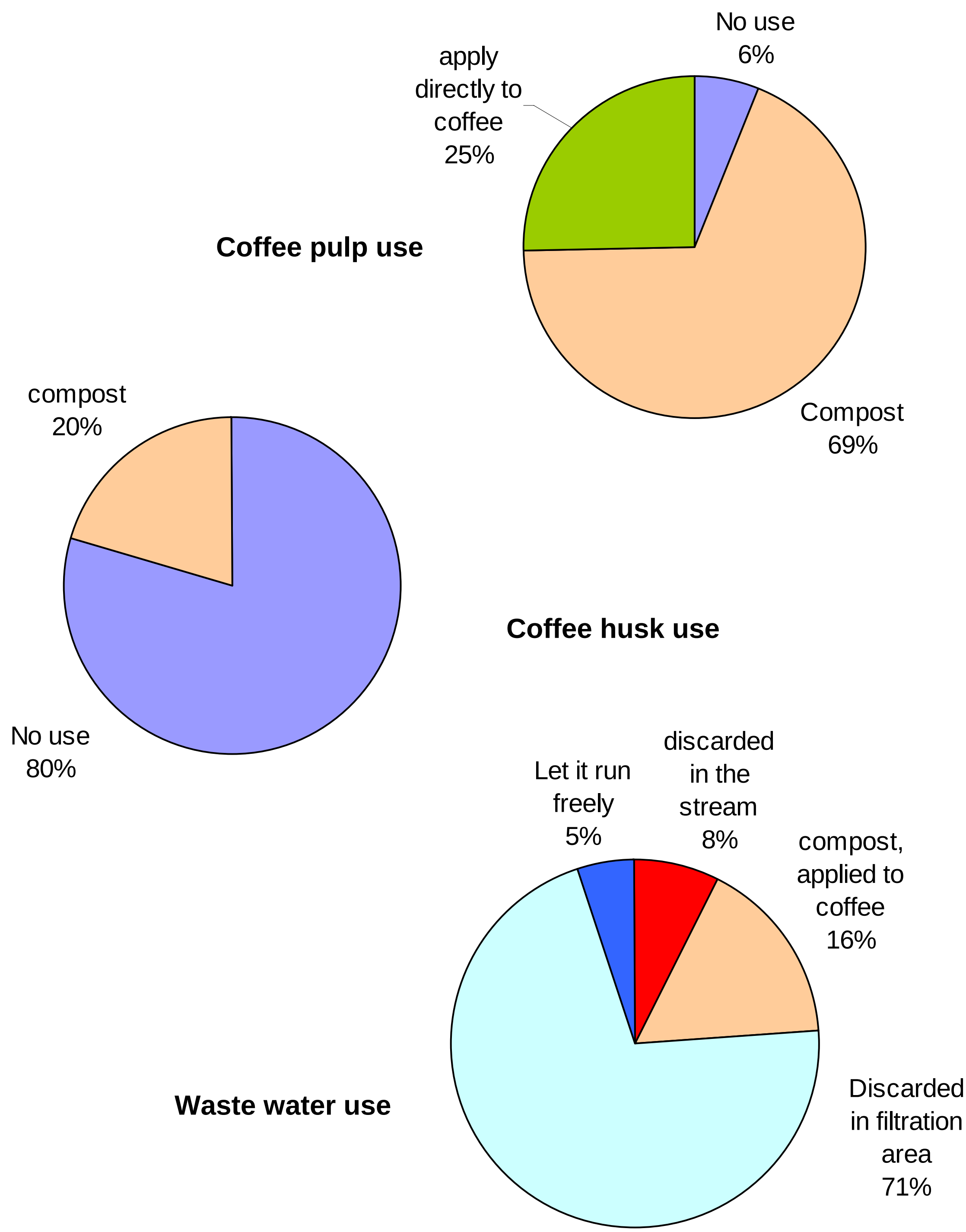
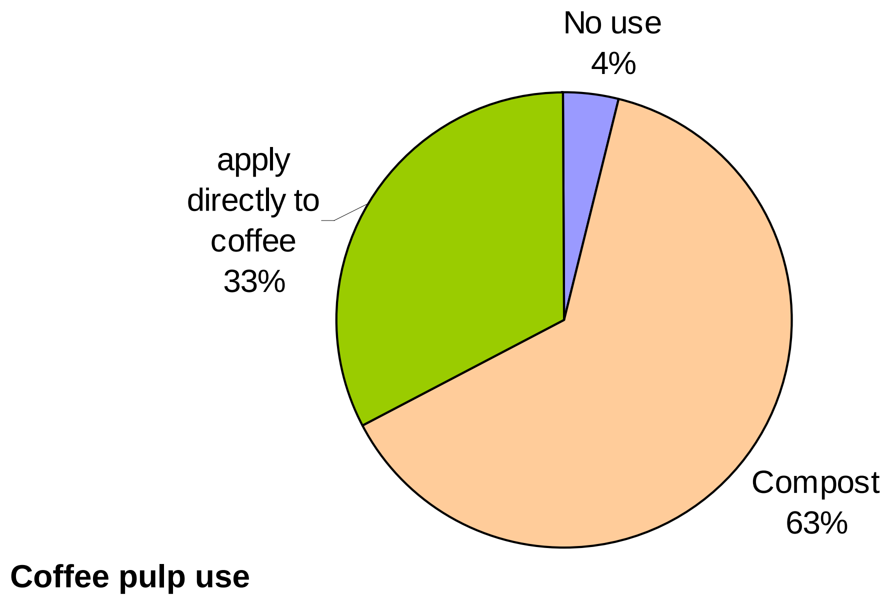


Figure 3.15. Coffee growers' opinions on use of agricultural waste.



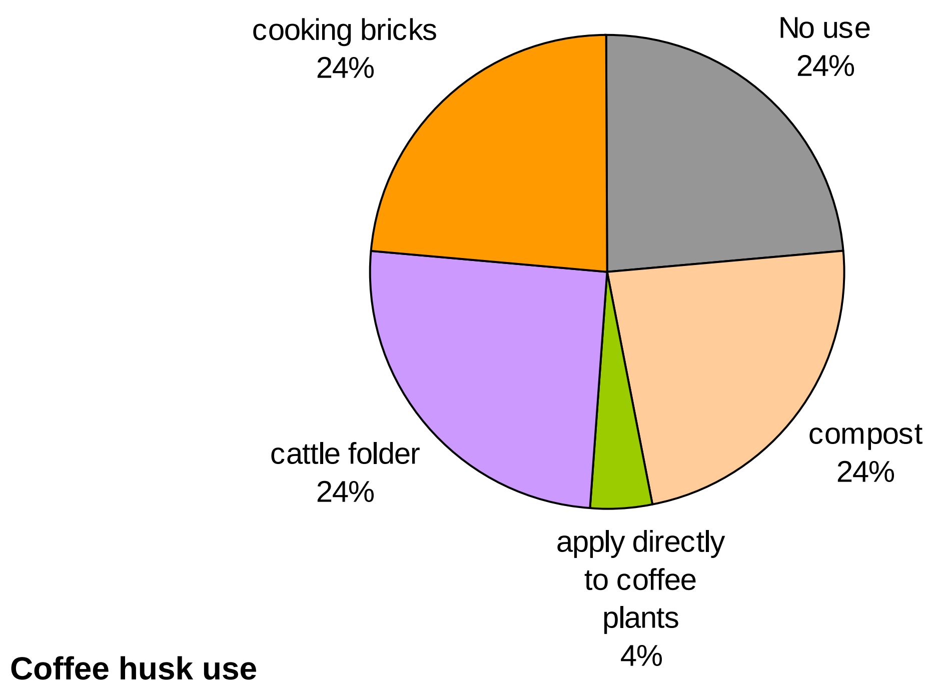


Figure 3.16. Agronomists' recommendations on use of agricultural waste.

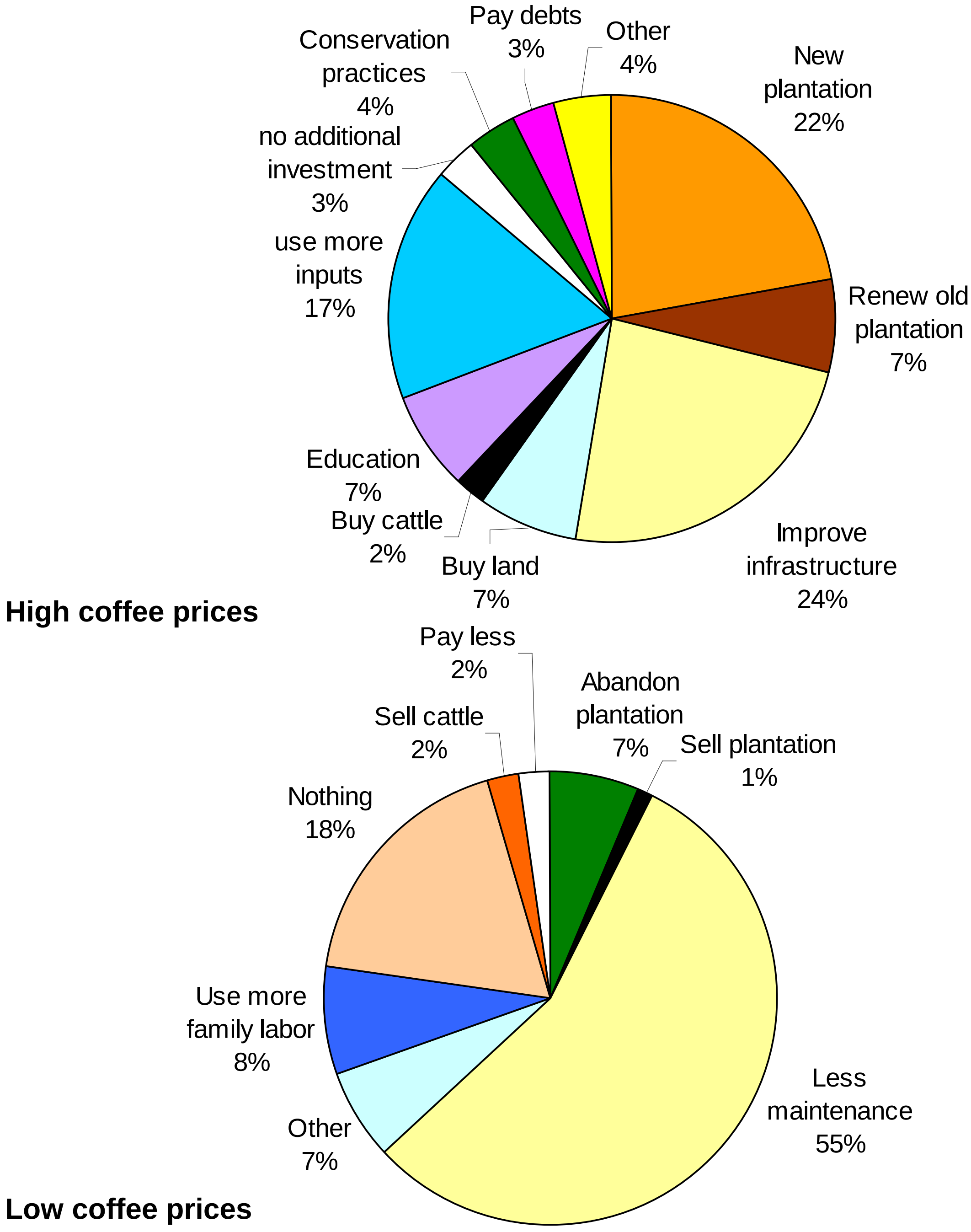


Figure 3.17. Coffee growers, coffee prices and farm management.

Coffee growers' description of how price would influence farm management.

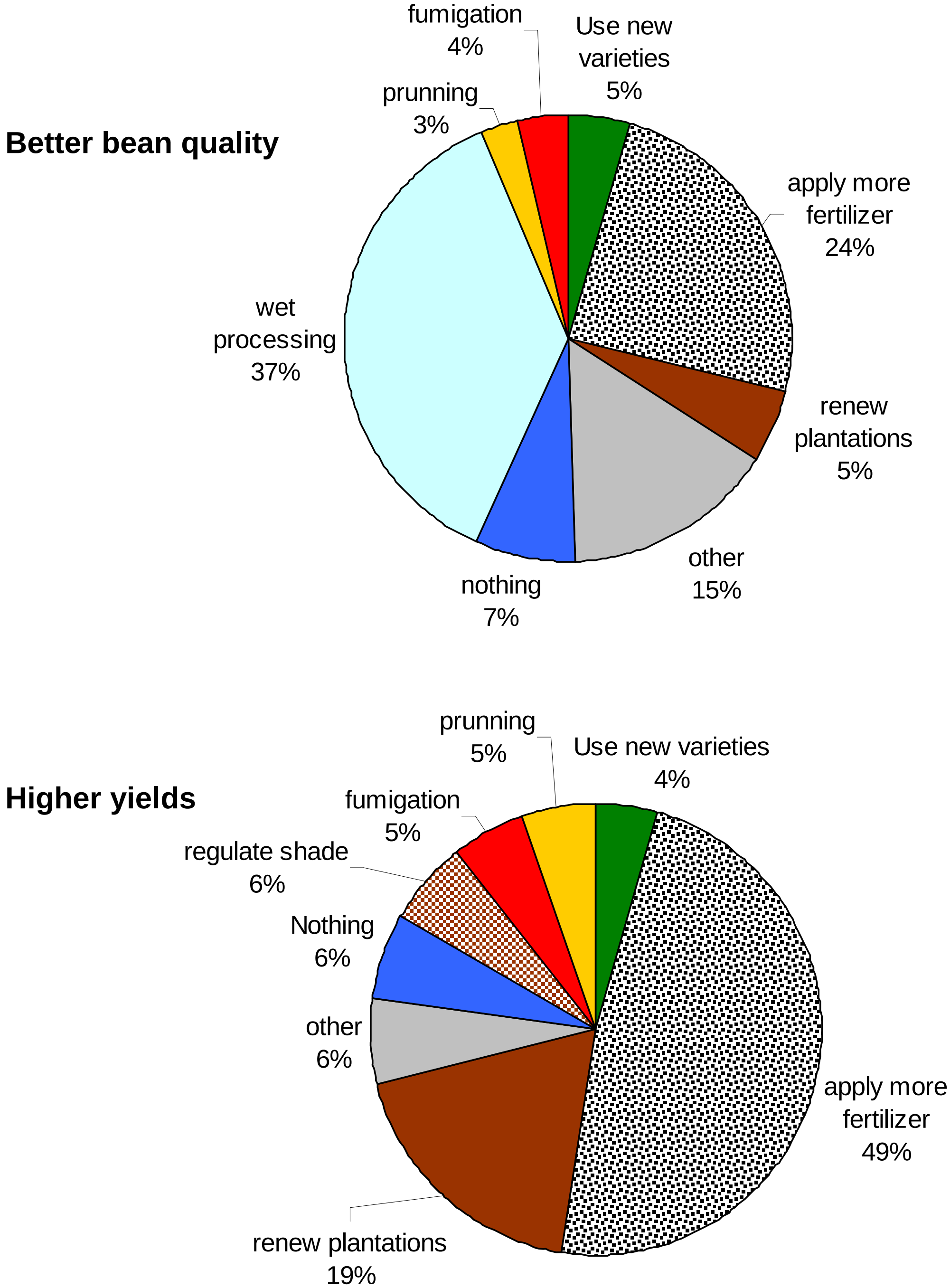


Figure 3.18. Coffee growers, bean quality and yields.

Management actions to increase bean quality and yields

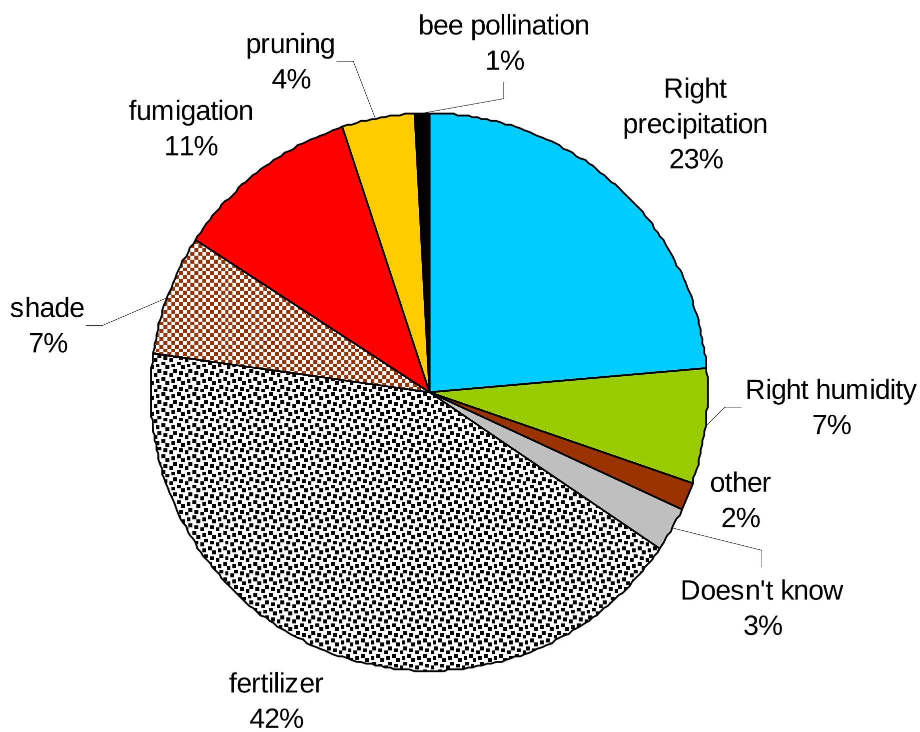


Figure 3.19. Coffee flowers and beans.

Coffee grower opinions on conditions that favor transformation of flowers into good quality beans.

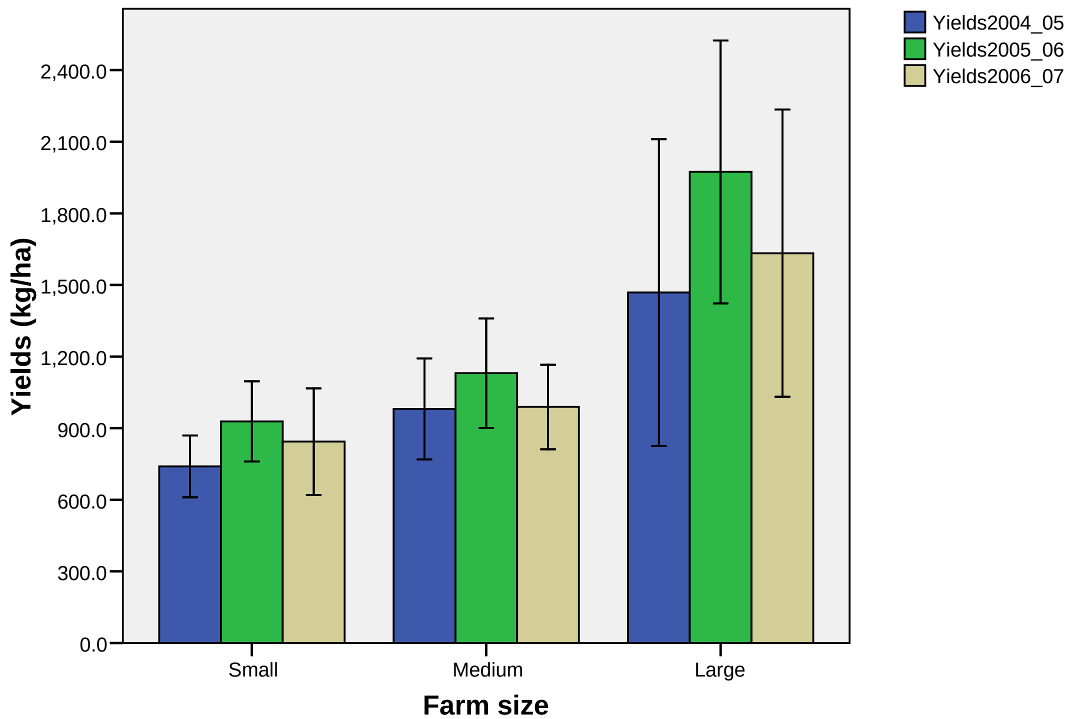


Figure 3.20. Self-reported yields in coffee plantations over three years.

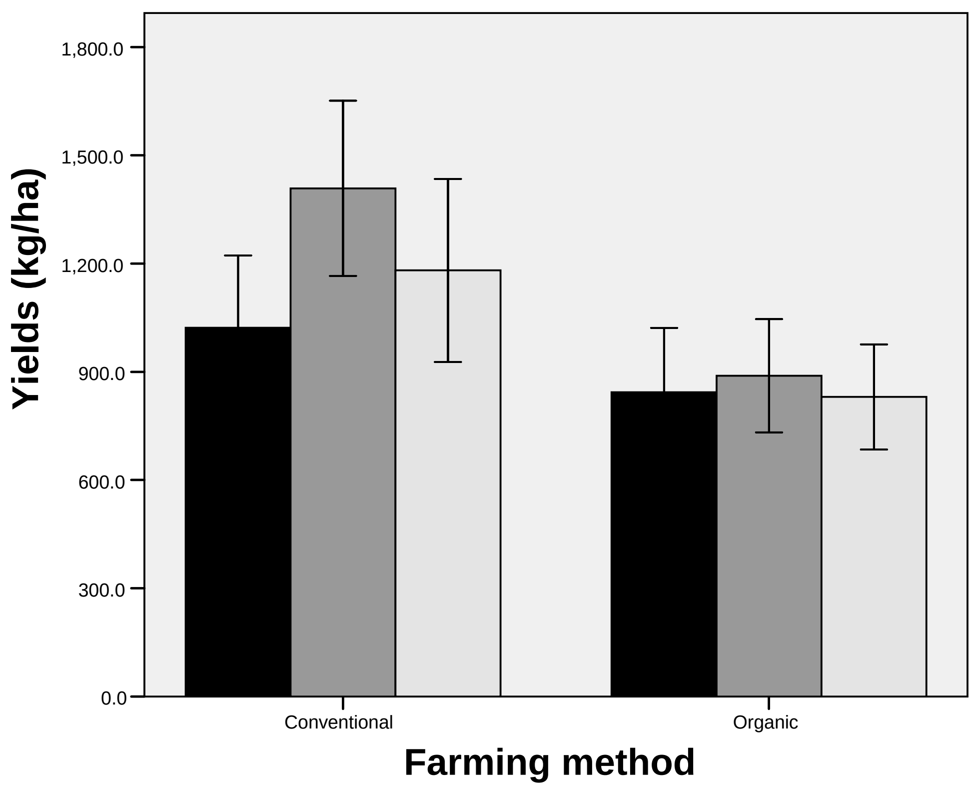


Figure 3.21. Self-reported yields for conventional and organic farms.

Each bar corresponds to a different harvest cycle (Black, 2004/05; grey 2005/06; white 2006/07)

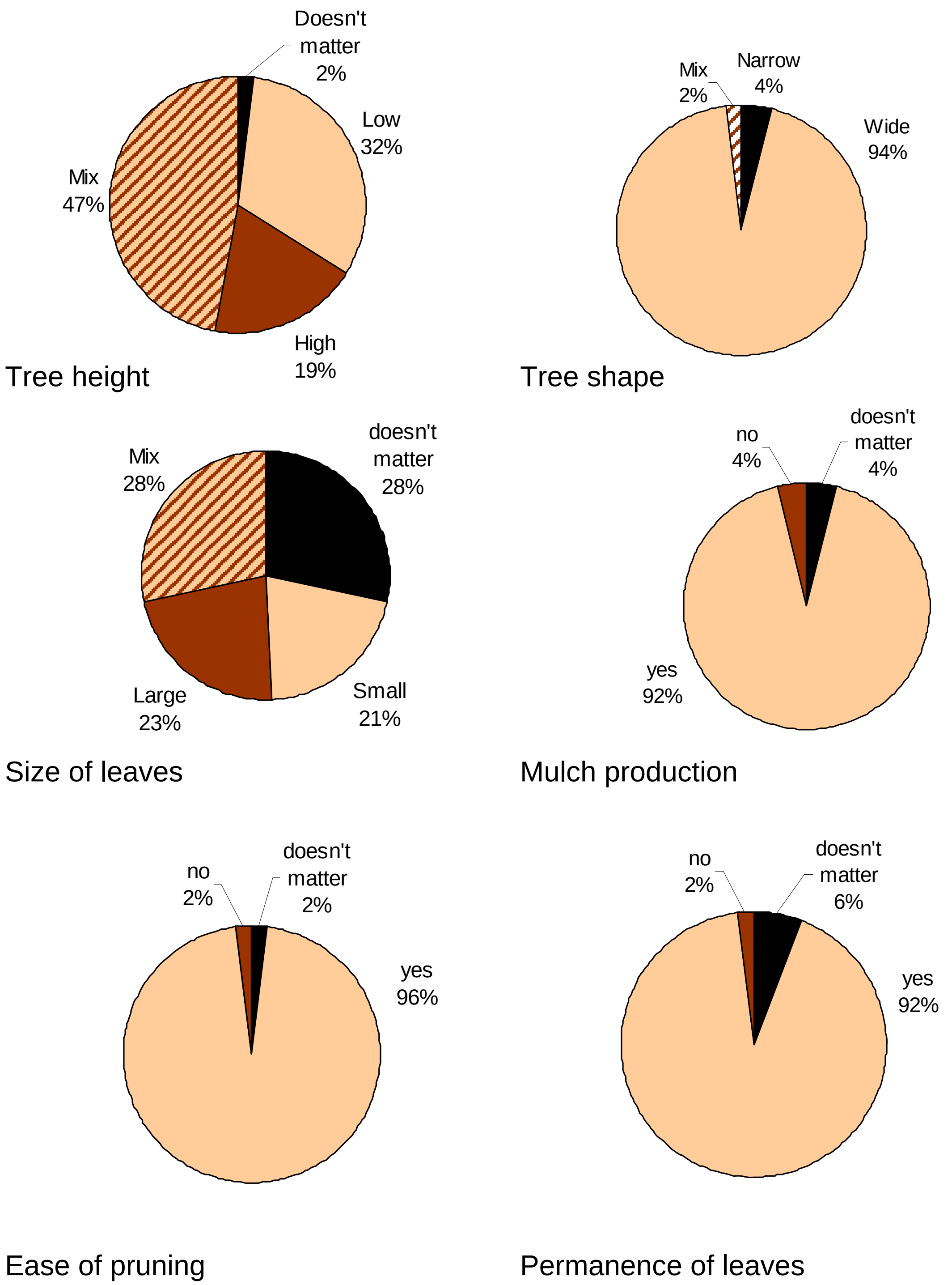


Figure 3.22. Shade tree characteristics preferred by agronomists.

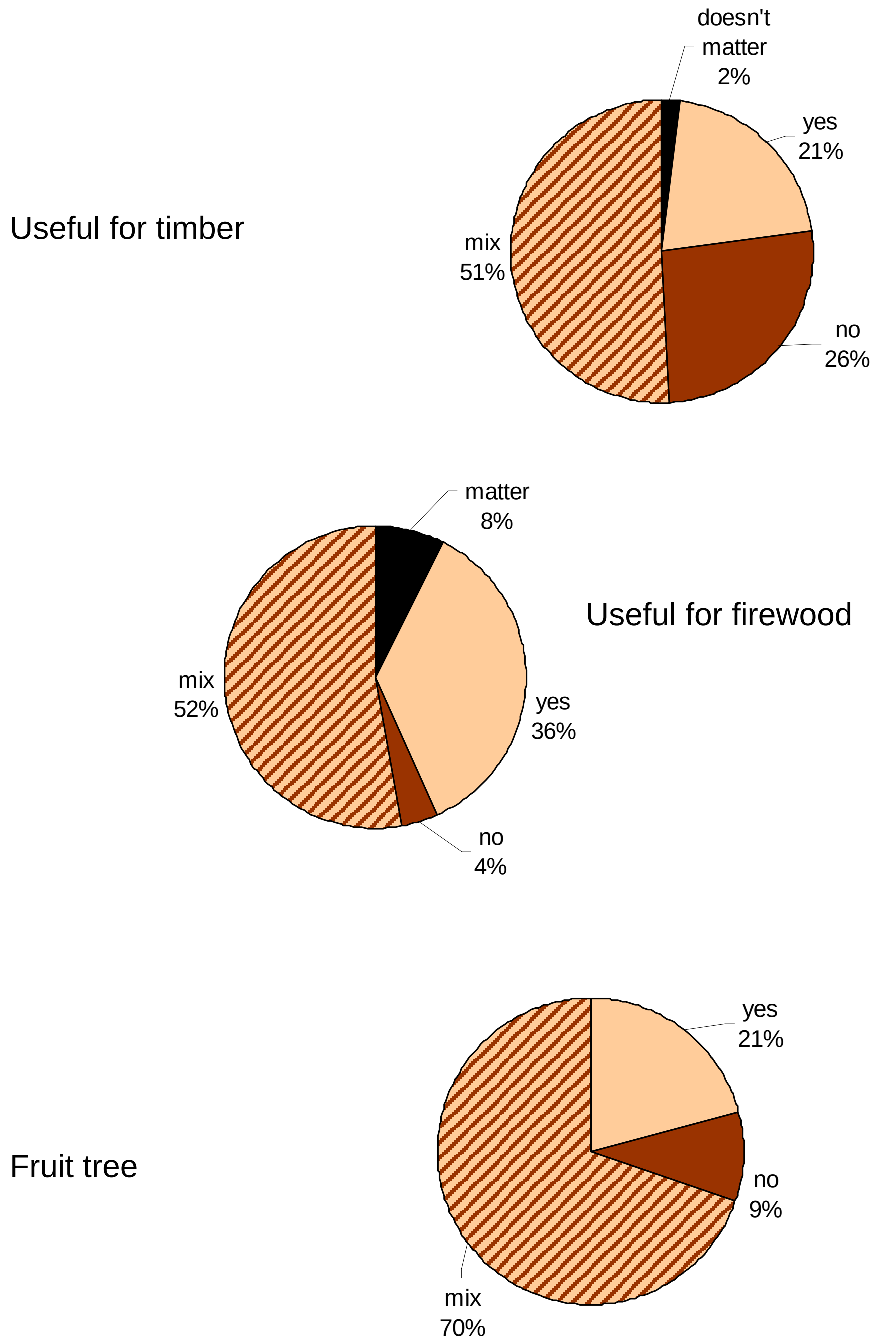


Figure 3.22 (cont.) Shade tree characteristics preferred by agronomists.

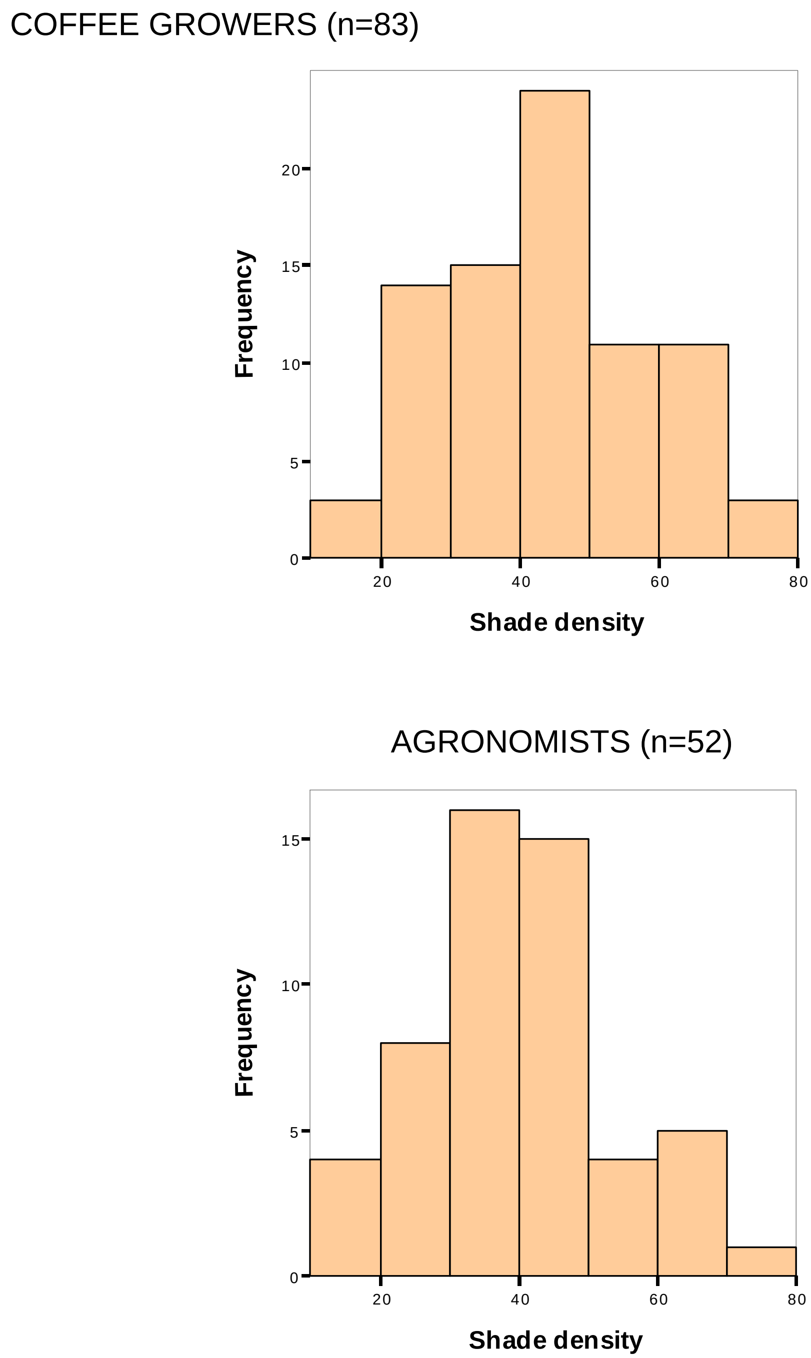
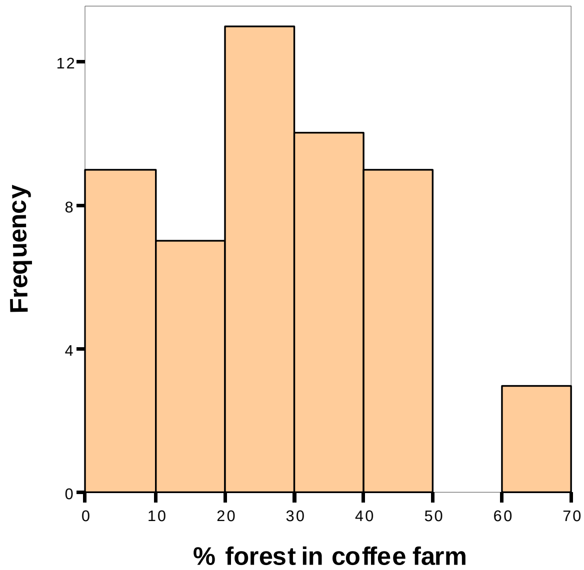
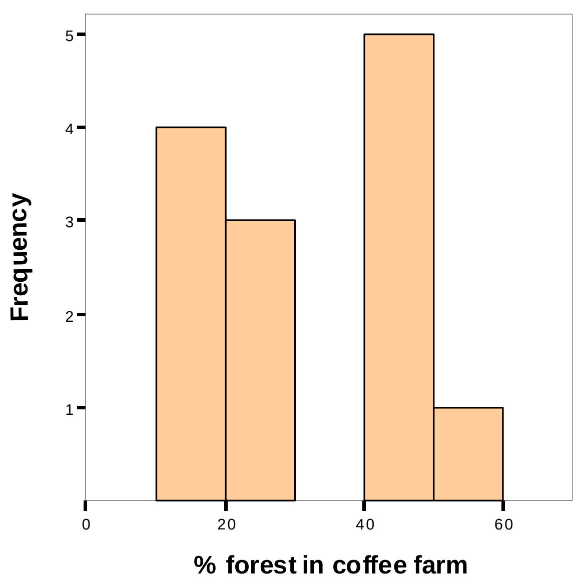


Figure 3.23. Shade levels preferred by coffee growers and agronomists.



Recommended by Agronomists (n=52)



Recommended by Policy Makers (n=20)

Figure 3.24. Ideal proportion of forest fragments in coffee plantations. Recommendations by agronomists and policy makers.

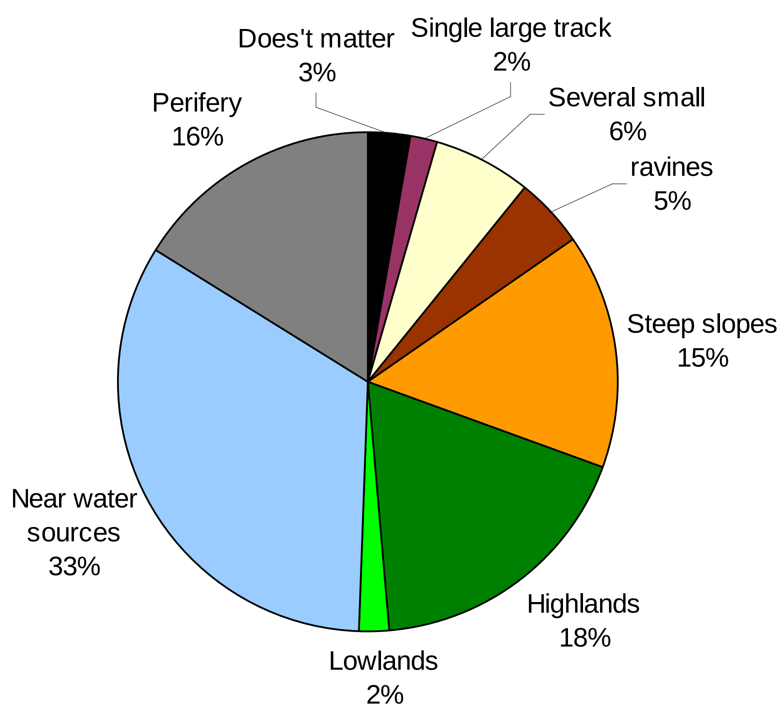
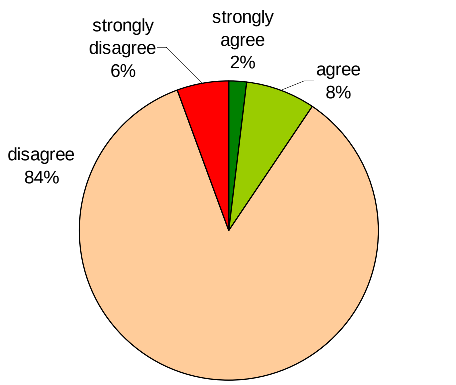
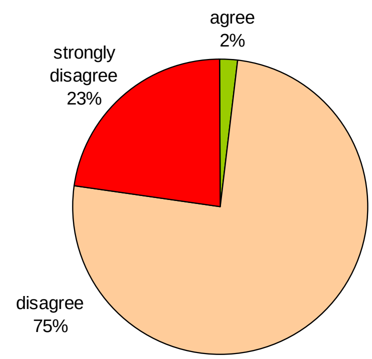


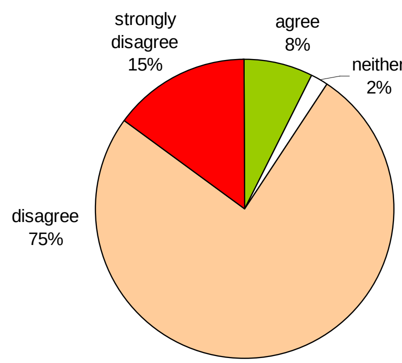
Figure 3.25. Agronomists' preferred location of forest fragments.



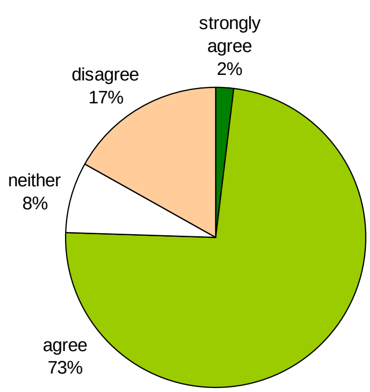
Better convert forest to coffee plantation



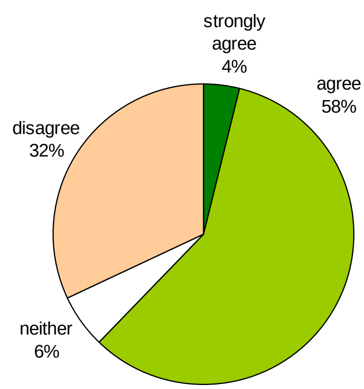
Better convert forest to pastures



Better convert forest to other crops



Forest increases coffee yields



Better to expand forest area

Figure 3.26. Agronomists' and the role and best use of forest fragments.

Agronomists' agreement to statements regarding proposed best uses of forest fragments in coffee farms. Responses ranked on a 5 point Likert scale (ranging from strongly agree to strongly disagree).

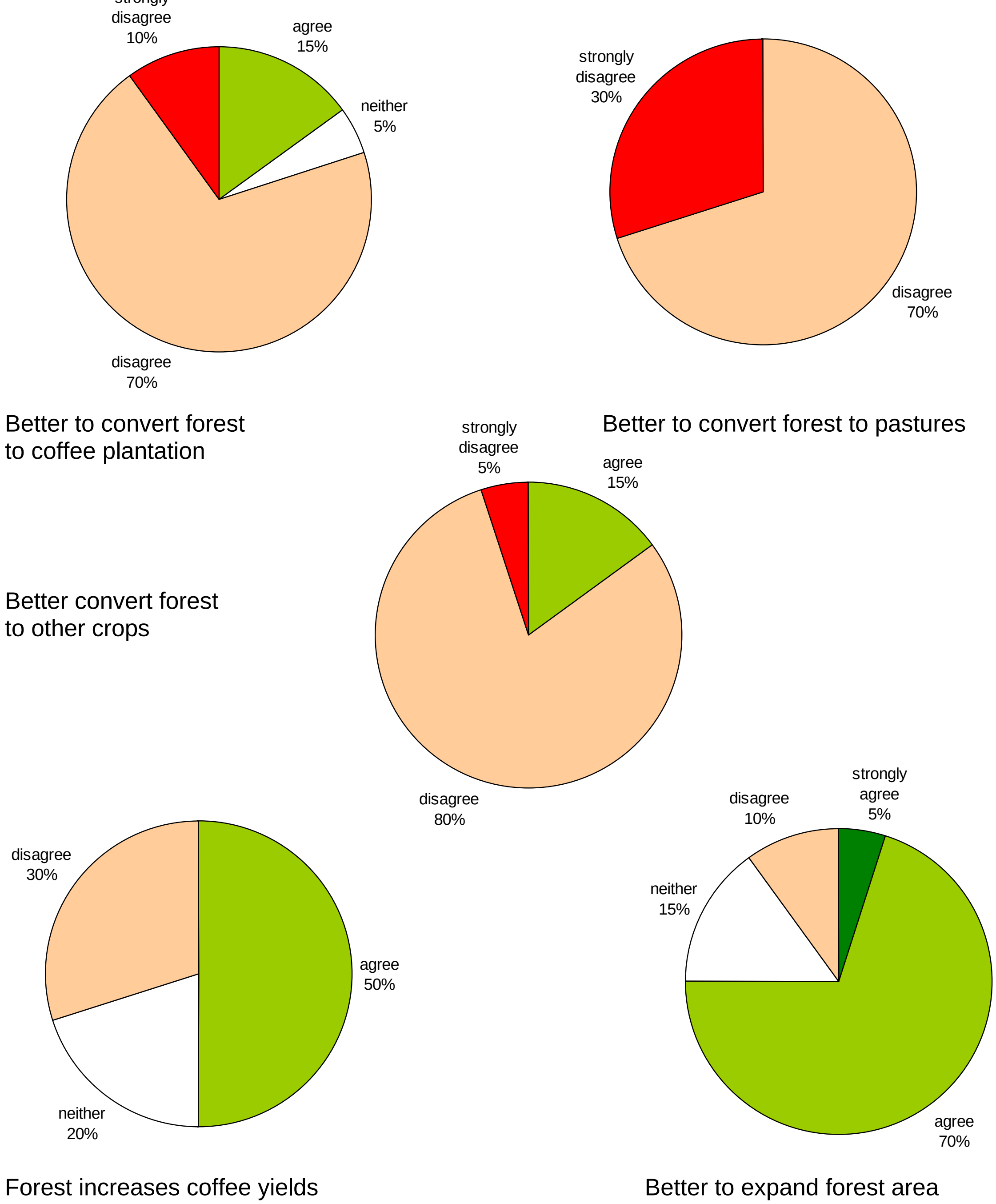


Figure 3.27. Policy makers and forest conversion in coffee farms.

Policy makers' agreement to statements regarding proposed best uses of forest fragments in coffee farms. Responses ranked on a 5 point Likert scale (ranging from strongly agree to strongly disagree).

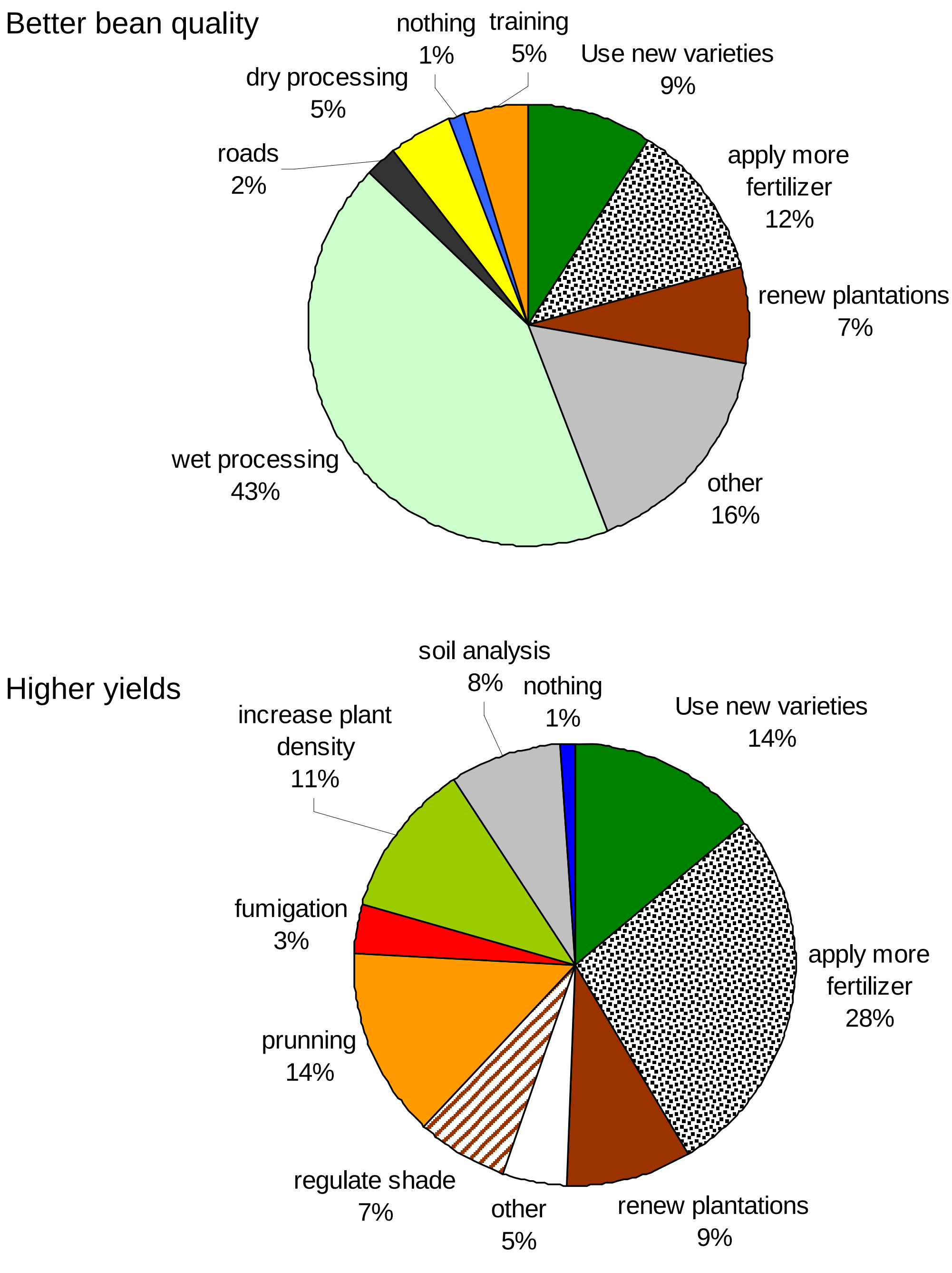


Figure 3.28. Agronomists, bean quality and yields.

Agronomists' recommendations on management actions that improve bean quality and yields.

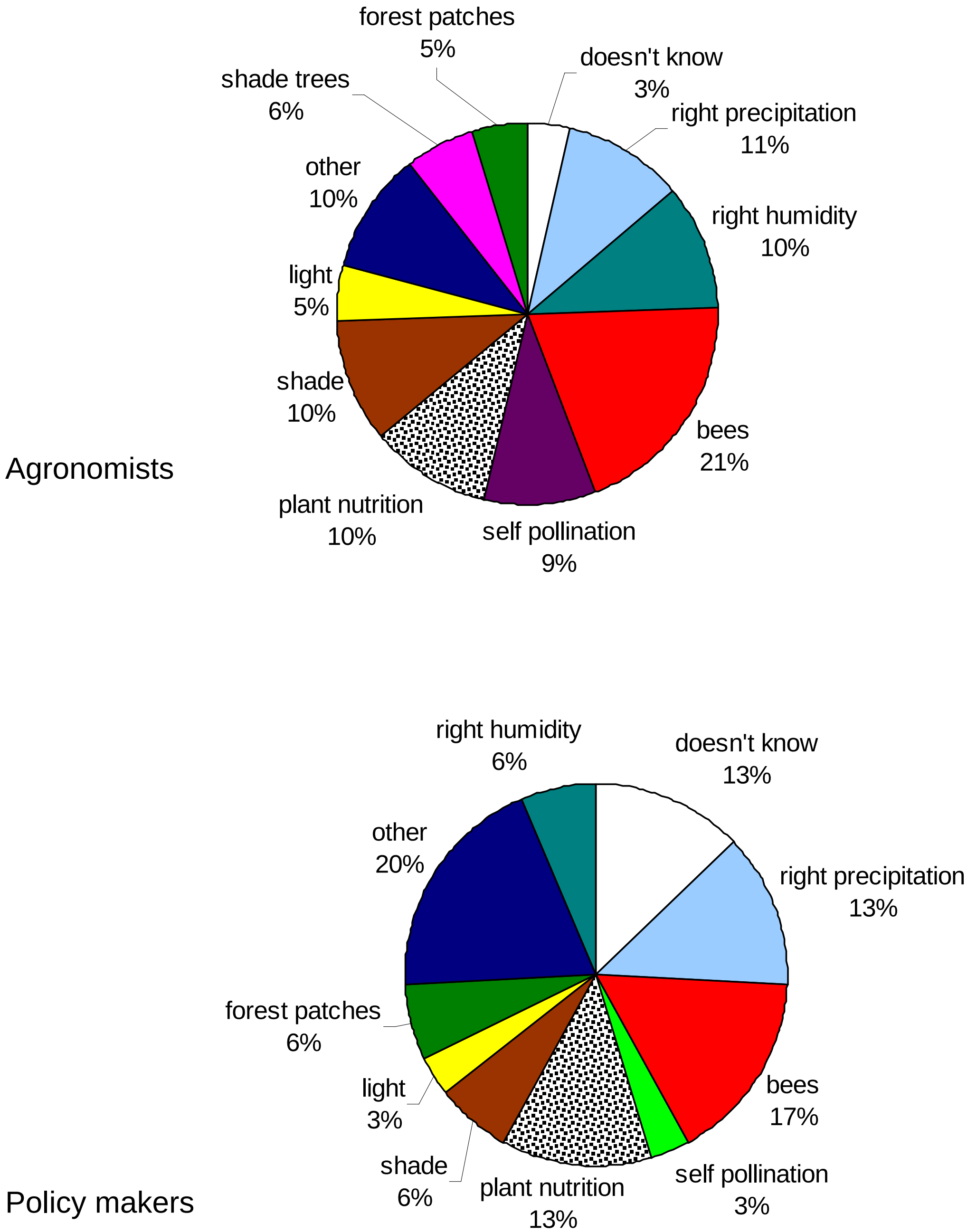


Figure 3.29. Pollination and coffee.

Agronomist and policy maker's responses on what causes pollination of coffee flowers.

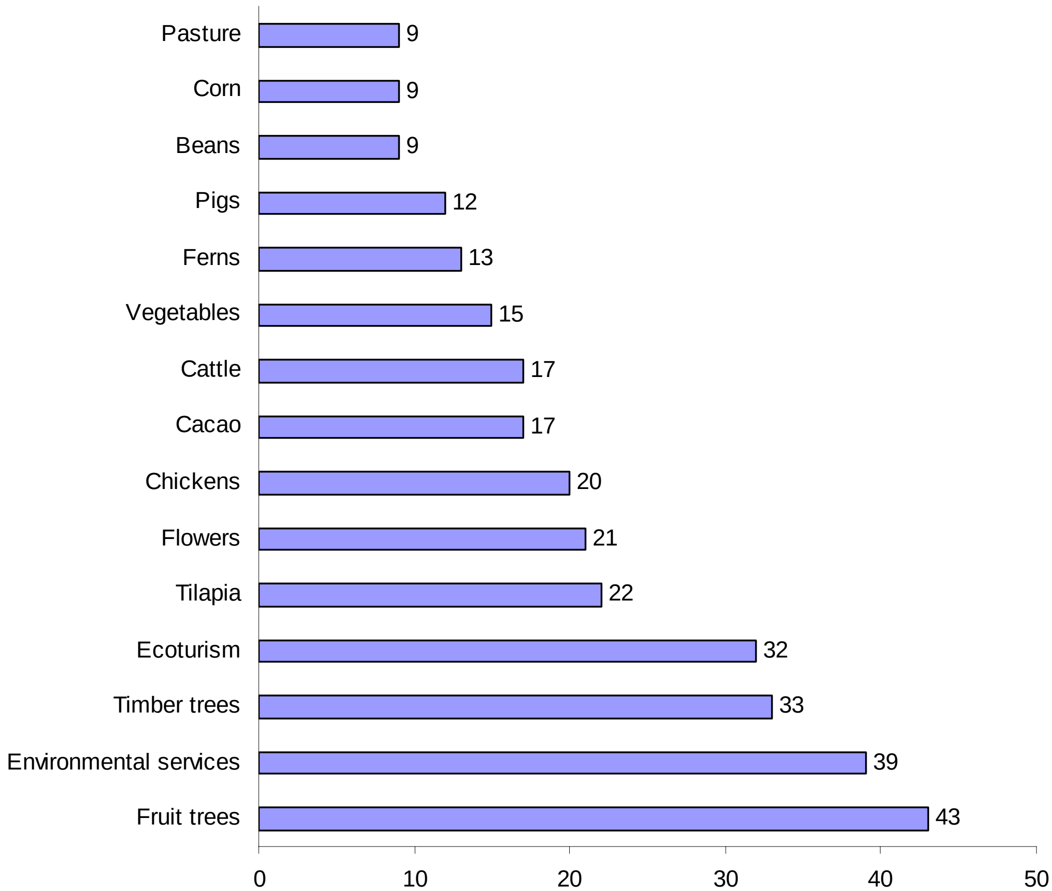


Figure 3.30. Agronomists' ideal coffee farm.

Agronomists' recommendations of activities that would promote an ideal coffee farm. Bars represent the number of times a particular activity was chosen.

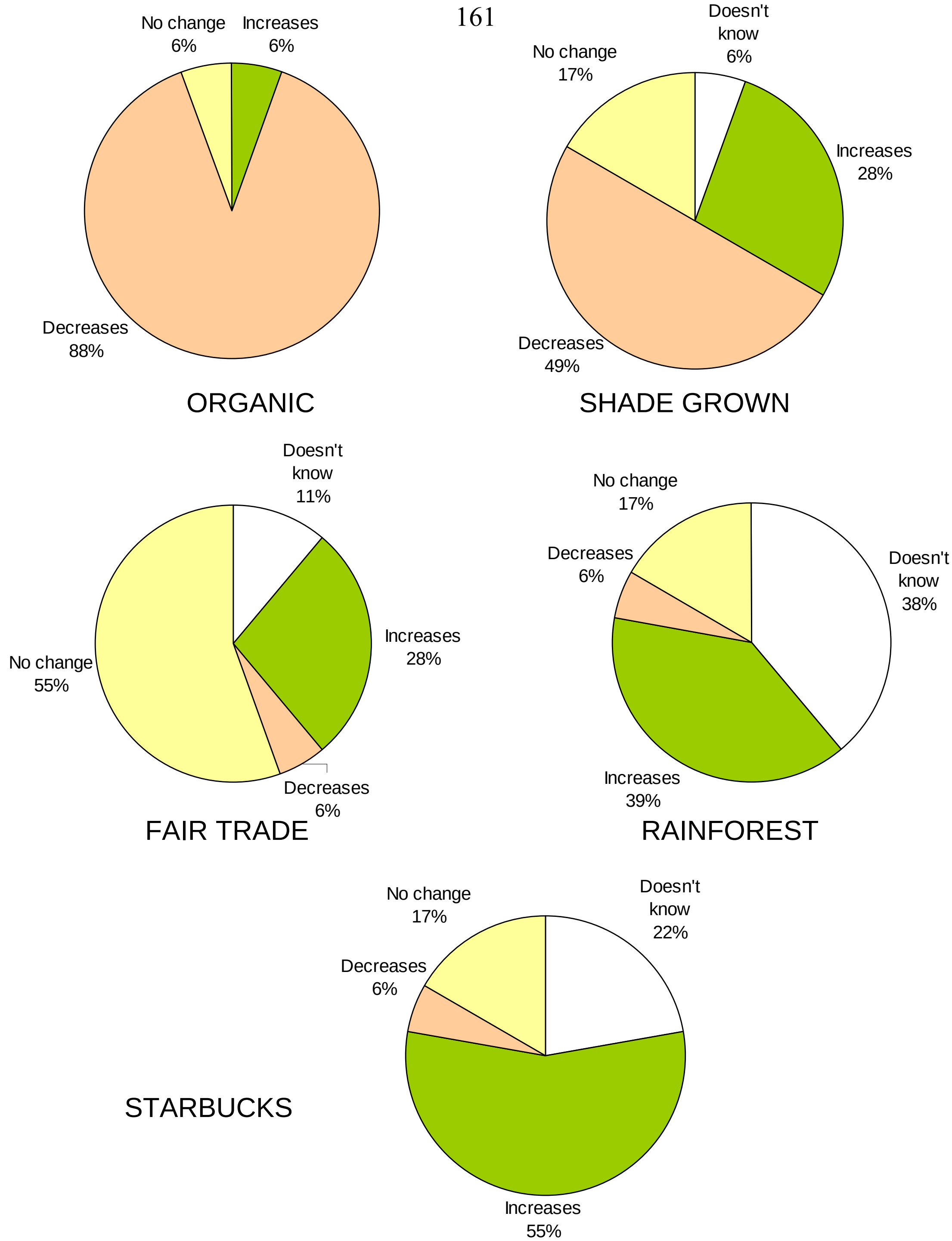


Figure 3.31. Policy makers, certification and yields.

Policy makers expectations on how certification affects yields.
Responses represent how yields are expected to change after certification.

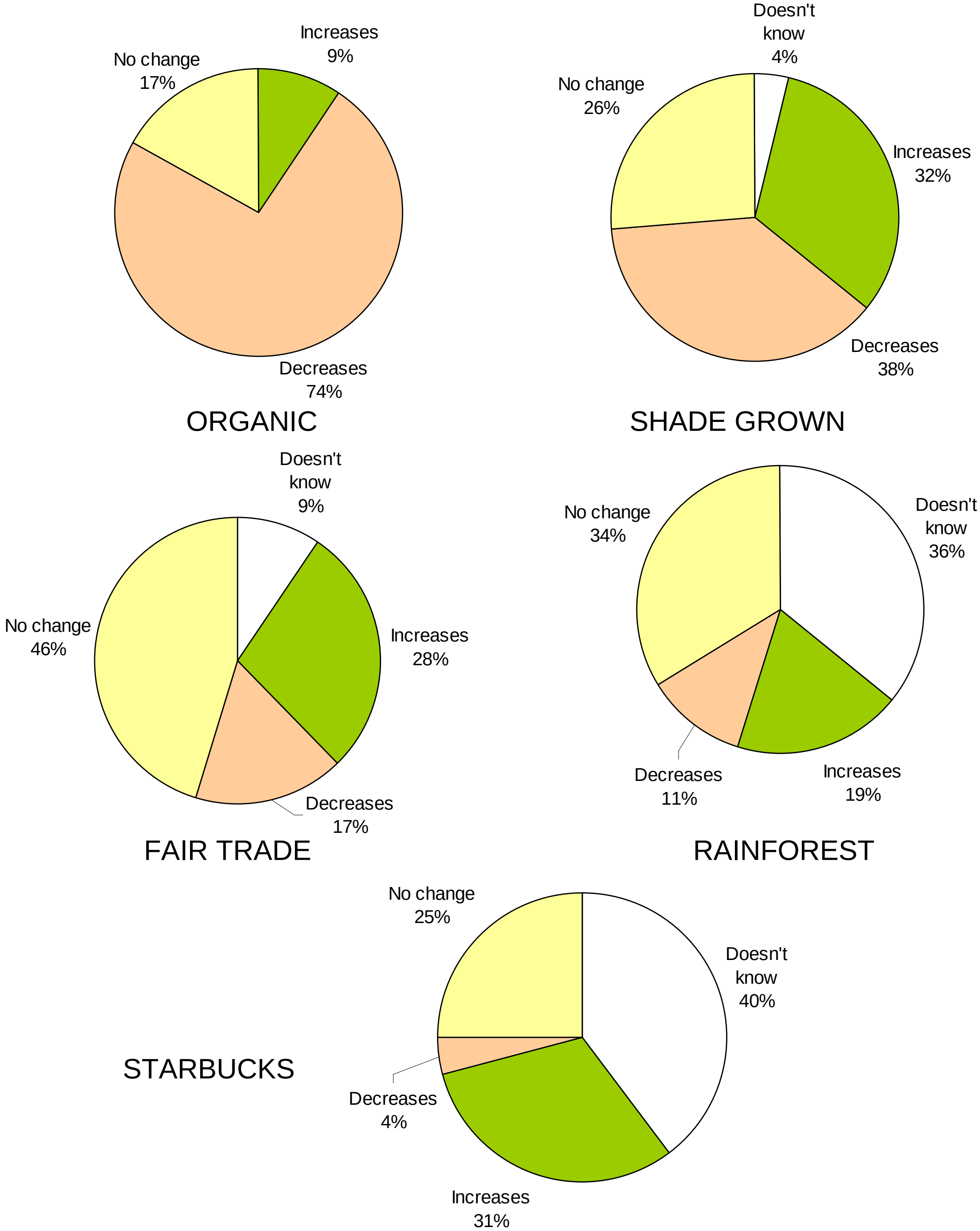


Figure 3.32. Agronomists, certification and yields.

Agronomists' expectations on how certification affects yields.
Responses represent how yields are expected to change after certification.

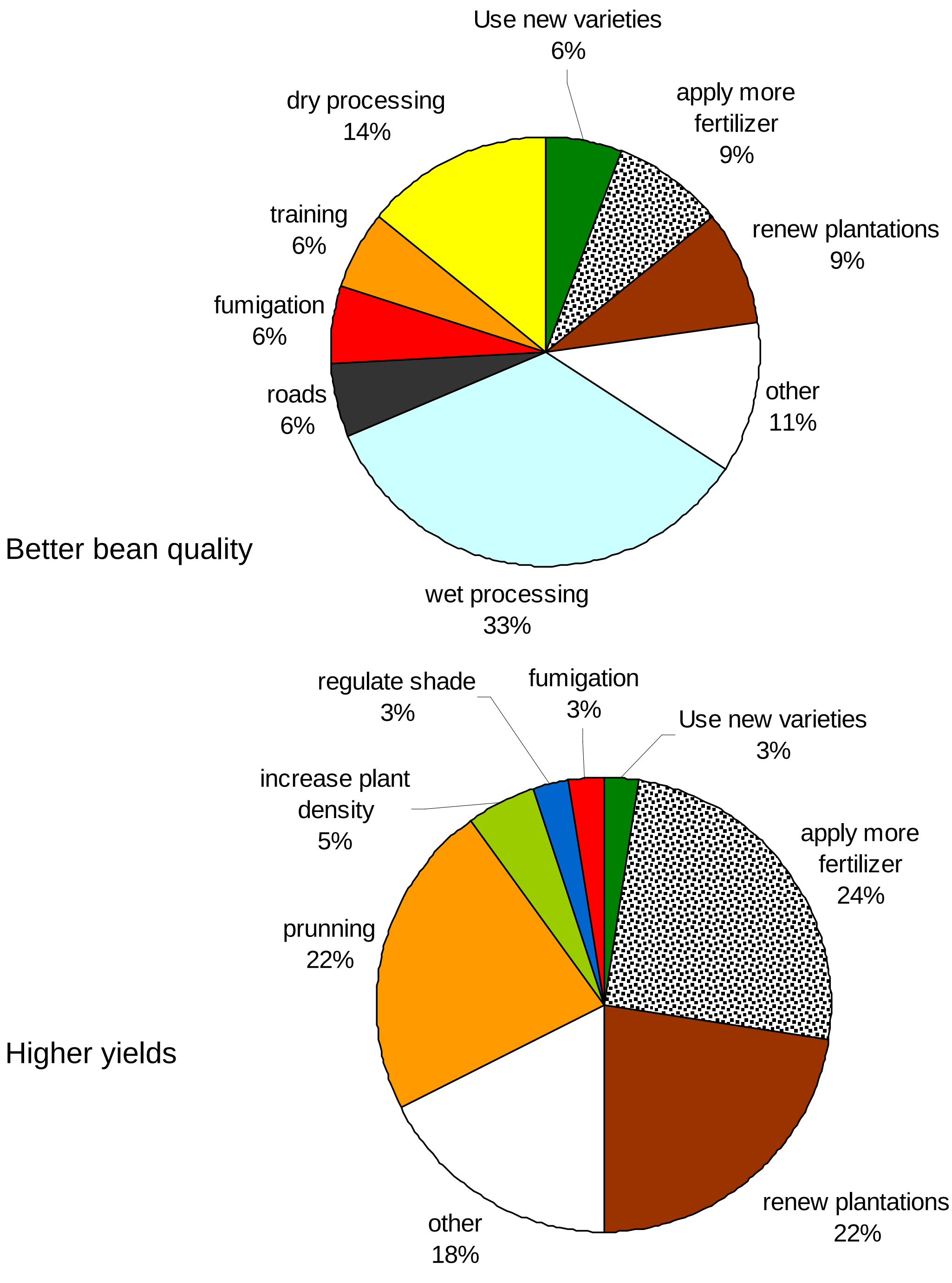


Figure 3.33. Policy makers, bean quality and yields.

Policy makers' recommendations on management actions to improve bean quality and yields.

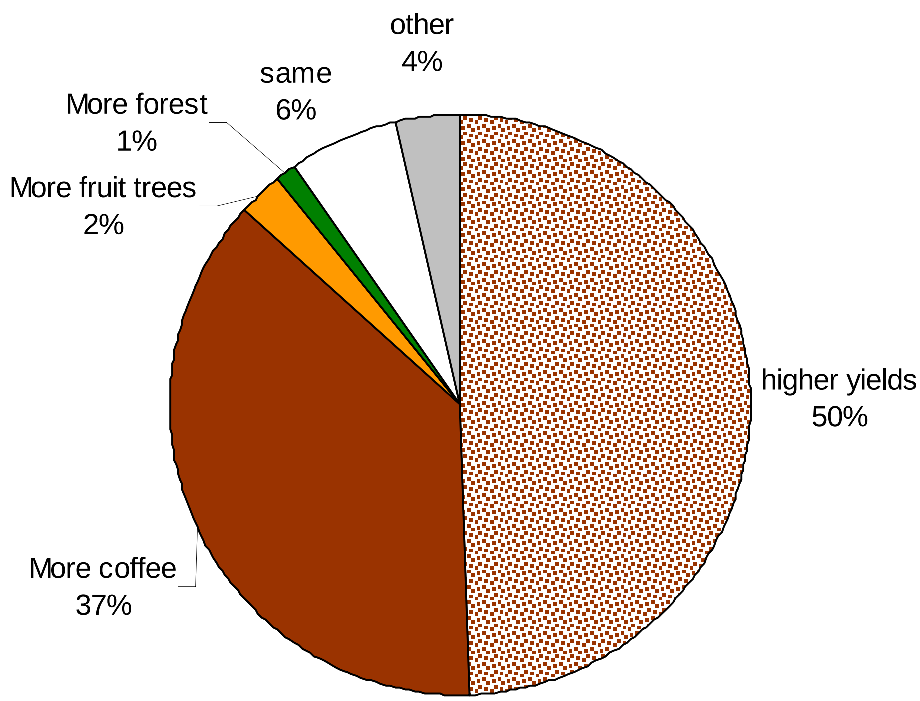


Figure 3.34. Farm changes, 5 years from now.

Coffee grower' expectations for how they will change their farms over the coming 5 years.

Table 3.1. List of Protected areas with coffee plantations in Nicaragua.

Total extension of coffee plantations in Nicaragua is estimated in 116242.32 ha (after Valerio 2000).

Area Protegida	**Con sombra**	**Sin sombra**	**Total**	%	**% Nacional**
Cerro Apante	760.56		760.56	4.91	0.65
Cerro Cumaica - Cerro Alegre	362.84		362.84	2.34	0.31
Cerro Datanlí-El Diablo	986.40	211.40	1197.80	7.74	1.03
Cerro Arenal	156.28		156.28	1.01	0.13
Cerro Kilambé	266.81		266.81	1.72	0.23
Cerro Kuskawás	1761.78		1761.78	11.38	1.52
Cerro Mombachito-La Vieja	120.12		120.12	0.78	0.10
Cerro Musún	141.17		141.17	0.91	0.12
Cerro Pancasán	114.99		114.99	0.74	0.10
Cerro Quiabuc	46.33		46.33	0.30	0.04
Cerro Tisey-Estanzuela	9.79		9.79	0.06	0.01
Complejo Volcán San Cristóbal	870.03		870.03	5.62	0.75
Cordillera Diplito-Jalapa	288.80		288.80	1.87	0.25
Chocoyero-El Brujo	24.38		24.38	0.16	0.02
Cerro Frío-La Cumplida	1125.21	455.05	1580.26	10.21	1.36
Fila Masigüe	50.26		50.26	0.32	0.04
Guabule	1084.56	578.13	1662.69	10.74	1.43
Macizo de Peñas Blancas	1610.59	333.91	1944.50	12.57	1.67
Mesa Moropotente	363.42		363.42	2.35	0.31
Miraflor	578.07		578.07	3.74	0.50
Salto Río Yasica	39.43	1.44	40.87	0.26	0.04
Sierra Quirragua	148.33		148.33	0.96	0.13
Tepesomoto-Pataste	496.61		496.61	3.21	0.43
Víctimas del Huracán Mitch	12.08		12.08	0.08	0.01
Volcán Mombacho	16.42		16.42	0.11	0.01
Volcán Yalí	1221.62		1221.62	7.89	1.05
Yúcul	985.43	252.79	1238.22	8.00	1.07
Total	13642.31	1832.72	15475.03	100.00	**13.31**
%	88.16	11.84	100.00		
% Nacional	12.45	27.36	13.31		

Total extension of coffee plantations in Nicaragua is estimated in 116242.32 ha (after Valerio 2000).

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APPENDIX A: ORIGINAL INTERVIEW TO COFFEE FARMERS IN NICARAGUA

Entrevista para dueños de cafetales en Nicaragua

Página de Cubierta (para despegar y guardarla en un archivo aparte)

Nombre ____

Correo electrónico ____

Edad ________________ Sexo ______________

Nivel escolar ____

Nombre de la finca ____

Relación con la finca

Dueño ____

Socio de cooperativa propietaria ______________________________

Mandador ____

Administrador ____

Si no es el dueño, nombre del dueño ___________________________________

Permiso del dueño para que el Mandador o el Administrador sean entrevistados dado en la fecha ____________________

Datos Generales de la Entrevista

1.1. Fecha

Departamento ____________________

1.2. Municipio ____________________

1.3. Comunidad / Comarca

____

1.4. Lugar de la entrevista

____

1.5. Hora de iniciar

1.6. Hora de terminar

2. Características de la Finca.

2.1. Tamaño de la finca ______________

2.2. Área de café ______________

2.3. Bajo producción ______________

2.4. Bajo resiembra ______________

2.5. En descanso ______________

2.6. Área para otros cultivos______________

2.7. Área de potreros ______________

2.8. Área de bosque ______________

2.9. Tipo de café ____

2.10. Desde cuándo tiene la finca ____________________________________

2.11. Qué le hizo escoger este lugar para cultivar café?

____

3. Manejo del Café.

3.1. Tiene más o menos café que hace 5 años?

MAS	MENOS

3.2. Cuándo fue la última vez que decidió ampliar el cafetal?

3.3. Cuándo fue la última vez que redujo el área con café?

3.4. Qué aspectos considera cuando decide si va a sembrar, abandonar o eliminar un área de café? ____

3.5. Sirve para algo dejar una parte de la finca con montaña (bosque)? Por qué? ____

4. Asistencia Técnica.

4.1. Recibe ayuda o asesoría de algún organismo?

SI	NO

4.2. En que consiste la ayuda que recibe?

1 Préstamo	2 Asistencia Técnica	3 Insumos	4 Otra

4.3. Considera que la ayuda que recibe es…

1	Muy útil, resuelve mis problemas
2	Sirve para resolver algunos problemas
3	No sirve para resolver problemas
4	No recibo ayuda

4.4. Dónde se puede acudir para recibir ayuda?

1	Oficina del gobierno
2	Cooperativa
3	Banco
4	Asociación de productores
5	Organismo no gubernamental
6	Centro de acopio
7	Casa comercial
8	Otra

---

5. Certificación.

5.1. Tiene certificado su café?

SI	NO

5.2. Qué tan complicado le resultó conseguir que le certifiquen su café?

1	2	3	4	5
MUY FACIL	FACIL	MAS O MENOS	DIFICIL	MUY DIFICIL

5.3. Ha logrado que le paguen mejor por el café certificado?

SI	NO

5.4. Cuánto más le han pagado por el café certificado? ______________

5.5. Cree que el sobreprecio que se paga por el café certificado es justo?

1	2	3	4	5
MUY JUSTO	JUSTO	MAS O MENOS	INJUSTO	MUY INJUSTO

5.6. Está satisfecho con la agencia certificadora?

SI	MAS O MENOS	NO

5.7. Por qué razón no tiene certificado su café?

1	Costos muy altos
2	Papeleo engorroso
3	No sirve para mucho
4	No sabe por donde empezar
5	Tiene miedo que baje el rendimiento de la finca
6	Otras razones

5.8. Dónde vende su café?

1	Lo vendo en la finca
2	Lo llevo a la cooperativa, que es la que lo vende
3	Lo llevo directamente a la agencia
4	Otro

6. Presencia de árboles.

6.1. Tiene árboles dentro de su cafetal?

SI	NO

6.2. Si no tiene, cuales son los perjuicios que ocasiona tener árboles mezclados con el café?

1	Baja el rendimiento
2	Aumentan las enfermedades
3	Compiten con el café
4	Aumentan los costos
5	Otros problemas

6.3. Si tiene, cuáles son los beneficios de tener árboles mezclados con el café?

1	Aumenta el rendimiento
2	Menos enfermedades
3	Protege al café del calor
4	Producen leña
5	Producen madera
6	Producen fruta
7	Dan sombra
8	Otros beneficios

6.4. Como piensa que produce más café un cafetal, mezclado con árboles que dan sombra o a pleno sol?

1 Con árboles	2 Sin árboles

6.5. Por qué produce más con árboles?________________________________

6.6. Por qué produce más a pleno sol? ______________________________

6.7. Cuáles son las características más importantes de la sombra para lograr el mejor rendimiento en su cafetal?

6.7.1. Altura de los árboles de sombra

1	Más de 5 m de alto
2	Menos de 5 m de alto
3	Una combinación de árboles altos y bajos
4	La altura de los árboles no importa

6.7.2. Tipo de sombra

1	Sombra rala
2	Sombra densa
3	Una mezcla de sombra densa y rala
4	No importa si es densa o rala

6.7.3. Forma de los árboles

1	Copa estrecha y espigada
2	Copa con forma de sombrilla
3	Una mezcla de copas estrechas y anchas
4	La forma de la copa no importa

6.7.4. Tamaño de las hojas

1	Pequeñas
2	Grandes
3	Una mezcla de hojas grandes y pequeñas
4	No importa

6.7.5. Producción de hojarasca

1	Árboles que boten muchas hojas
2	Árboles que boten pocas hojas
3	Una mezcla de los dos tipos
4	No importa la cantidad de hojas que boten

6.7.6. Producción de madera

1	Importante que sean árboles maderables
2	No importa si son maderables o no

6.7.7. Producción de leña

1	Importante que sirvan para leña
2	No importa si sirven o no

6.7.8. Producción de fruta

1	Importante que produzcan fruta
2	No importa si sirven o no

Otros usos que le da a los árboles que tiene en su cafetal

____

6.7.9. Facilidad de poda

1	Árboles que se poden fácilmente
2	No importa la facilidad con que se poden

6.7.10. Permanencia de las hojas

1	Árboles que mantienen las hojas todo el año
2	Árboles que botan la hoja en el verano
3	No importa que los árboles mantengan o boten sus hojas

6.7.11. Origen de los árboles

1	Que sean de la zona
2	Traídos de afuera
3	No importa de donde sean

6.7.12. El producto de los árboles de la finca…

1	Lo utiliza para autoconsumo
2	Se lo vende a los vecinos
3	Lo saca a vender al mercado

6.8. Indique los nombres de las cinco especies de árboles más importantes para su finca y el por qué.

Especie	Leña	Madera	Postes	Fruta	Sombra	Otro
1.						
2.						
3.						
4.						
5.						

6. Manejo de los fragmentos de bosque.

6.1. Por qué mantiene esa parte de la finca con bosque?

1	Por gusto, quiero conservarlo así
2	No tengo dinero para ponerla a producir
3	No me sirve para sembrar nada
4	Otro

6.2. Qué provecho le saca?

1	No le saco nada
2	Protege el cafetal
3	Me da leña y madera
4	Me gusta tenerlo así
5	Otro

6.3. Por qué no lo ha convertido en un cafetal?

1	Falta de recursos
2	No me interesa
3	Quiero dejarlo así
4	No es apropiado
5	Otro

6.4. Por qué no lo ha convertido en otro cultivo o en un potrero?

1	Falta de recursos
2	No me interesa
3	No tengo ganado
4	No es apropiado
5	Otro

6.5. Cree que el bosque sirve de refugio para plagas? SI NO

Cómo? ______________________

6.6. Cree que el bosque ayuda al cafetal SI NO

Cómo? ______________________

6.7. El bosque que me queda en la finca….

6.7.1. Lo mantengo así para mientras

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

6.7.2. Estaría mejor convertido en cafetal

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

6.7.3. Estaría mejor convertido en potrero

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

6.7.4. Estaría mejor convertido en otros cultivos

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

6.7.5. Estaría mejor ampliarlo

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

6.7.6. Hace aumentar la cosecha

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Cómo? ____

____

7. Beneficiado del café.

7.1. Proceso el café en mi finca

SI	NO

7.2. Tipo de beneficio?

HUMEDO	SECO

7.3. Si beneficia en su finca, qué hace con la pulpa del café?

1	La quemo
2	La dejo que se descomponga
3	Hago abono para el cafetal
4	La hecho en la quebrada
5	Otro

____

7.4. Si beneficia en su finca, que hace con la cascarilla del café?

1	La quemo
2	La dejo que se descomponga
3	Hago abono para el cafetal
4	La hecho en la quebrada
5	Otro

____

7.5. Si beneficia en su finca, que hace con las aguas mieles?

1	Las boto en la quebrada
2	Las utilizo para hacer abono
3	Las hecho en una pila de filtración
4	Otro

____

8. Establecimiento de nuevas parcelas de café

8.1. Cómo le gustaría a usted establecer nuevas parcelas de café.

1	Hacer una "socola" dejando los árboles más altos para que me sirvan de sombra
2	Sacar primero los árboles más grandes, hacer una socola y dejar árboles pequeños para sombra.
3	Botar todos los árboles, limpiar el terreno y establecer nueva sombra con estacas de árboles útiles
4	Botar todos los árboles, limpiar bien el terreno y establecer una sombra de
5	Sin sombra
6	Otra

8.2. Hay alguna diferencia en la manera de establecer un plantío entre una variedad de café y otra?

SI	NO

Explique ____

9. Biodiversidad asociada.

9.1. Las aves silvestres

1	Son beneficiosas para el café
2	Son dañinas para el café
3	No tienen importancia

9.2. Los insectos que no son plaga

1	Son beneficiosos para el
2	Son dañinos para el café
3	No tienen importancia

9.3. Qué otros animales, aparte de las plagas, son dañinos para el cafetal?

____

En qué manera? ____

9.4. Qué otros animales son beneficiosos para el cafetal?

____

En qué manera?____

10. Los cambios en la finca.

10.1. En que invertiría sus ganancias si le pagaran un buen precio por su café?

1	Ampliar el cafetal
2	Aplicar más insumos
3	No invertiría mas de lo normal en el café
4	Comprar animales
5	Mejorar la infraestructura de la finca
6	Reforestar con árboles útiles
7	Otros cultivos (maíz, frijol, etc.)
8	Otros gastos

10.2. Qué haría en su finca para ahorrar dinero si le pagan mal la cosecha?

1	Quitaría el cafetal para sembrar algo que sea más rendidor
2	Abandonaría una parte del cafetal
3	Vendería la finca
4	Le doy menos mantenimiento a todo el cafetal
5	No gasto en abono
6	Vendo parte de la leña
7	Vendo algo de madera
8	Otro

11. Rendimiento y calidad.

11.1. Ha logrado que le paguen mejor por su café por ser de buena calidad? Cuánto más? ________

SI	NO

11.2. A su juicio, cuáles son los cambios más importantes que a usted le gustaría implementar en su finca para mejorar la calidad del grano?

____

11.3. A su juicio, cuáles son los cambios más importantes que a usted le gustaría implementar en su finca para mejorar el rendimiento de los cafetales? ______________________________________

11.4. Cuáles son las condiciones que más favorecen que las flores del cafeto se desarrollen en granos de calidad? ______________________________

12. Mirando hacia el futuro.

12.1. Como le gustaría ver a su finca en unos 5 años?

1	Con nuevas áreas de café sembrado
2	Con más árboles frutales
3	Con más bosque
4	Sin café, con otro uso
5	Con los mismos cafetales pero más rendidores

13. Las necesidades del caficultor.

13.1. En lo económico ______________________________

13.2. En lo técnico ______________________________

13.3. En lo social ______________________________

13.4. Recibe algún tipo de apoyo del gobierno?	SI	NO
13.5. Recibe algún tipo de apoyo de asociaciones de productores?	SI	NO
13.6. Ha recibido apoyo para financiar esta cosecha?	SI	NO

Con qué tasa de interés? [ ]

13.7. Cuál es el mayor reto que afronta el sector cafetalero? _______________

____

14. Comentario Final

____

____

____

____

____

____

____

La entrevista se completa con dos listas de árboles: Una con las especies que ha plantado el caficultor y la otra con los árboles que el caficultor, a propósito, ha dejado en pié en la finca.

Árboles que el caficultor ha dejado en pie	Árboles que ha sembrado
1.	**1.**
2.	**2.**
3.	**3.**
4.	**4.**
5.	**5.**
6.	**6.**
7.	**7.**
8.	**8.**
9.	**9.**
10.	**10.**

APPENDIX B: ORIGINAL INTERVIEW TO AGRONOMISTS

Entrevista para técnicos y extensionistas agrónomos en Nicaragua

Página de Cubierta (para despegar y guardarla en un archivo aparte)

Nombre ____

Correo electrónico ____

Teléfono ______________(oficina) ________________ (celular)

Edad ____________Sexo ____________

Nivel escolar ____

Cargo ____

1. **Datos Generales de la Entrevista**

   1.1. Fecha

   1.2. Departamento ____________________

   1.3. Municipio _____________________

   1.4. Comunidad / Comarca ____

   1.5. Lugar de la entrevista ____

   1.6. Hora de iniciar

   1.7. Hora de terminar

2. **Experiencia con café.**

   2.1. Años de trabajar con café

   2.2. Años de trabajar como técnico

   2.3. En que consiste su trabajo? ____

   2.4. Cuántos productores atiende?

3. **Sombra en café.**

   3.1. Cómo piensa que produce más café un cafetal, mezclado con árboles que dan sombra o a pleno sol?

CON ARBOLES	SIN ARBOLES

   3.2. Por qué?____

   ____

   3.3. Cuáles son las características más importantes de la sombra para lograr el mejor rendimiento en un cafetal?

   3.3.1. Altura de los árboles de sombra

1	Más de 5 m de alto
2	Menos de 5 m de alto
3	Una combinación de árboles altos y bajos
4	La altura de los árboles no importa

3.3.2. Cantidad de sombra

	%

1	Sombra rala
2	Sombra densa
3	Una mezcla de sombra densa y rala
4	No importa si es densa o rala

3.3.3. Forma de los árboles

1	Copa estrecha y espigada
2	Copa con forma de sombrilla
3	Una mezcla de copas estrechas y anchas
4	La forma de la copa no importa

3.3.4. Tamaño de las hojas

1	Pequeñas
2	Grandes
3	Una mezcla de hojas grandes y pequeñas
4	No importa

3.3.5. Producción de hojarasca

1	Árboles que boten muchas hojas
2	Árboles que boten pocas hojas
3	Una mezcla de los dos tipos
4	No importa la cantidad de hojas que

3.3.6. Producción de madera

1	Importante que sean árboles maderables
2	No importa si son maderables o no
3	Mezcla maderables y no maderables
4	Sin árboles maderables

3.3.7. Producción de leña

1	Importante que sirvan para leña
2	No importa si sirven o no
3	Mezcla de árboles que sirven para leña con otros que no sirven
4	Sin árboles que sirvan para leña

3.3.8. Producción de fruta

1	Importante que produzcan fruta
2	No importa si sirven o no
3	Mezcla de frutales y no frutales
4	Sin árboles frutales

3.3.9. Facilidad de poda

1	Árboles que se poden fácilmente
2	No importa la facilidad con que se poden

3.3.10. Permanencia de las hojas

1	Árboles que mantienen las hojas todo el año
2	Árboles que botan la hoja en la época seca
3	No importa que los árboles mantengan o boten sus hojas

3.3.11. Origen de los árboles

1	Que sean de la zona
2	Traídos de afuera
3	No importa de donde sean

Otros usos que se le da a los árboles del cafetal

____

____

3.4. Indique los nombres de las cinco especies de árboles más importantes para la finca cafetalera y el por qué.

Especie	Leña	Madera	Postes	Fruta	Rompevientos	Sombra	Medicinal

Otro

____

4. Bosque y cafetales.

4.1. Tiene algún sentido mantener parches de bosque entremezclados con los cafetales?

SI	NO

Por qué?

____

4.2. Si piensa que el bosque le ayuda al cafetal, cuánto bosque hay que mantener entremezclado con el café para que sirva de ayuda?

%

4.3. Dónde hay que mantener el bosque?

	En la periferia del cafetal
	En una sola parcela
	Repartido en varias parcelas
	Protegiendo fuentes de agua
	En laderas con fuerte pendiente
	La ubicación no importa

Por qué?

____

14.1. Cree que el bosque sirve de refugio para plagas:

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

Cómo? ____

14.2. Cree que el bosque ayuda al cafetal

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

Cómo? ____

14.3. El bosque que me queda en una finca….

14.3.1. Estaría mejor convertido en cafetal

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

14.3.2. Estaría mejor convertido en potrero

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

14.3.3. Estaría mejor convertido en otros cultivos

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

14.3.4. Estaría mejor ampliarlo

1 MUY DE ACUERDO	2 DE ACUERDO	3 NO SE	4 EN DESACUERDO	5 MUY EN DESACUERDO

14.3.5. Hace aumentar la cosecha

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Cómo?

____

____

15. Biodiversidad asociada.

15.1. Las aves silvestres

1	Son beneficiosas para el café
2	Son dañinas para el café
3	No tienen importancia

15.2. Los insectos que no son plaga

1	Son beneficiosos para el café
2	Son dañinos para el café
3	No tienen importancia

15.3. Qué otros animales, aparte de las plagas, son dañinos para el cafetal?

____

En qué manera?

____

____

15.4. Qué otros animales son beneficiosos para el cafetal?

____

____

16. Manejo de residuos orgánicos.

16.1. Qué recomienda usted que se haga con la pulpa del café?

1	Quemarla
2	Dejarla que se descomponga
3	Hacer abono para el cafetal
4	Echarla en la quebrada
5	Otro

16.2. Qué recomienda usted que se haga con la cascarilla del café?

1	Quemarla
2	Dejarla que se descomponga
3	Hacer abono para el cafetal
4	Echarla en un río o quebrada
5	Otro

---

17. Certificación.

17.1. Cuántos tipos de certificación conoce?

	Orgánica
	Rainforest Alliance
	Amigable con las Aves
	Certificación Starbucks
	Certificación Comercio
	Otra(s)

17.2. Cuánto cree que le cuesta a un productor certificar su finca? ___________

17.3. Cuál es el sobreprecio que puede obtener un productor si su café está certificado? ____

17.4. El sobreprecio que se paga por el café certificado es justo.

1	2	3	4	5	6
MUY JUSTO	JUSTO	MAS O MENOS	INJUSTO	MUY INJUSTO	NO SABE

17.5. Por qué cree usted que algunos productores certifican su café y otros no?

____

____

17.6. Cree usted que el rendimiento de una finca cambia cuando

17.6.1. Se convierte a producción orgánica	SUBE	IGUAL	BAJA	NO SABE
17.6.2. Se convierte a café de sombra	SUBE	IGUAL	BAJA	NO SABE
17.6.3. Se certifica como Café de Comercio Justo	SUBE	IGUAL	BAJA	NO SABE
17.6.4. Se certifica con Rainforest Alliance	SUBE	IGUAL	BAJA	NO SABE
17.6.5. Se certifica con Starbucks	SUBE	IGUAL	BAJA	NO SABE

17.7. Qué deberían hacer las agencias certificadoras para conseguir que más productores certifiquen su finca?

	Abaratar los costos de certificación
	Brindar más asistencia técnica
	Visitar más a menudo a los productores
	No cobrar por la certificación
	No deberían hacer nada diferente
	Otra

17.8. El café que se produce dentro de áreas protegidas no se debería certificar

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por que?____

17.9. Se debería permitir el establecimiento de nuevas plantaciones de café en áreas protegidas

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por que? ____

____

18. Impacto de los precios.

18.1. Si a un productor le pagan un buen precio por su cosecha, en que le recomendaría usted invertir sus ganancias?

	Ampliar el cafetal
	Aplicar más insumos
	Diversificar finca
	Mejorar os cafetales que ya tiene
	No invertiría mas de lo normal en el café
	Comprar animales
	Mejorar la infraestructura de la finca
	Reforestar con árboles útiles
	Otros cultivos (maíz, frijol, etc.)
	Capacitación
	Otros gastos

18.2. Si a un productor le pagan un mal precio por su cosecha, en que le recomendaría usted invertir sus ganancias?

	Quitar el cafetal para sembrar algo que sea más rendidor
	Abandonar una parte del cafetal
	Vender la finca
	Dar menos mantenimiento a todo el cafetal
	No gastar en abono
	Vender parte de la leña
	Vender algo de madera
	Otro

____

18.3. En su opinión, qué suelen hacer los productores con la finca cuando los precios del café están bajos? ______________________________________

____

18.4. En su opinión, qué suelen hacer los productores con la finca cuando los precios del café están altos? ______________________________________

____

18.5. Cree usted que el tamaño de la finca afecta estas decisiones de cambio de uso relacionados con los precios del café?

SI	NO

Por que?

____

____

18.6. Cuál cree usted que es el precio justo que debe recibir un productor por un café de buena calidad ____

19. Rendimiento y calidad.

19.1. A su juicio, cuales son los cambios más importantes que necesitan darse en la caficultura Nicaragüense para mejorar la calidad del grano?

____

19.2. A su juicio, cuáles son los cambios más importantes que necesitan darse en la caficultura Nicaragüense para mejorar el rendimiento de los cafetales?

____

19.3. Cuáles son las condiciones ambientales que más favorecen una buena polinización de la flor del café

____

19.4. Cómo cree usted, con sus conocimientos, que puede ayudar a un cafetalero para que logre certificar de su finca?

____

____

20. La finca ideal.

20.1. Cómo recomienda usted que se establezcan las nuevas parcelas?

	Haciendo una "socola" dejando los árboles más altos para que me sirvan de sombra
	Sacando primero los árboles más grandes, hacer una socola y dejar árboles pequeños para que se desarrollen como sombra
	Botando todos los árboles, limpiando el terreno y estableciendo nueva sombra con estacas de árboles útiles
	Botando todos los árboles, limpiando bien el terreno y estableciendo una sombra de chagüite para proteger los nuevos cafetos
	Otra

20.2. Cómo debería ser para usted la finca ideal?

1	Con sombra
2	Sin sombra
3	Certificada orgánica
4	Certificada de sombra
5	Certificada Comercio Justo
6	Sin certificación
7	Certificada Starbucks
8	Certificada Rainforest
8	Solo con café
9	Diversificada

20.3. Qué otras cosas le gustaría que se produjera en una finca cafetalera?

1	Hortalizas
2	Flores
3	Helechos
4	Cacao
5	Frijoles
6	Maíz
7	Pastos
8	Frutales

9	Tabaco
10	Tilapias
11	Pollos
12	Cerdos
13	Ganado
14	Árboles maderables
15	Ecoturismo
16	Servicios Ambientales
17	Otros

21. . Comentario Final

____

____

____

____

____

____

APPENDIX C: ORIGINAL INTERVIEW TO POLICY MAKERS.

Entrevista para asesores y tomadores de decisiones en Nicaragua

Página de Cubierta (para despegar y guardarla en un archivo aparte)

Nombre ____

Correo electrónico ____

Teléfono _________________(oficina) ________________ (celular)

Edad _____________ Sexo _____________

Cargo ____

1. Datos Generales de la Entrevista

1.1. Fecha

1.2. Departamento ____________________

1.3. Municipio ____________________

1.4. Comunidad / Comarca

____

1.5. Lugar de la entrevista

____

1.6. Hora de iniciar

1.7. Hora de terminar

2. Experiencia con café.

2.1. Años de trabajar con café

2.2. Años de trabajar en su cargo

2.3. En que consiste su trabajo?

____

3. Impacto de la Ley del café.

3.1. Cuál es el aspecto más valioso de la actual Ley del Café?

____

Cuál es el aspecto que considera menos útil de la Ley del Café?

____

4. Impacto de la Consejo Nacional del Café.

4.1. Cuáles han sido, en su opinión, los principales logros del Consejo?

____

4.2. Qué cambios cree usted que son necesarios para que el Consejo sea más efectiva?

____

5. Política hacia el sector durante ciclos con precios bajos.

5.1. Existe alguna política oficial del Gobierno cuando los precios internacionales del café están bajos? ______________________________

____

5.2. Existe alguna política oficial del Gobierno cuando los precios internacionales del café están elevados?

____

6. Certificación.

6.1. Cuántos tipos de certificación conoce?

	Orgánica
	Rainforest Alliance
	Amigable con las Aves
	Certificación Starbucks
	Certificación Comercio Justo
	Otra(s)

____

6.2. Cuánto cree que le cuesta a un productor certificar su finca? _________

6.3. Cuál es el sobreprecio que puede obtener un productor si su café está certificado? ____

6.4. El sobreprecio que se paga por el café certificado es justo.

1	2	3	4	5	6
MUY JUSTO	JUSTO	MAS O MENOS	INJUSTO	MUY INJUSTO	NO SABE

6.5. Por qué cree usted que algunos productores certifican su café y otros no?

____

____

6.6. Cree usted que el rendimiento de una finca cambia cuando

6.6.1. Se convierte a producción orgánica	SUBE	IGUAL	BAJA	NO SABE
6.6.2. Se convierte a café de sombra	SUBE	IGUAL	BAJA	NO SABE
6.6.3. Se certifica con Comercio Justo	SUBE	IGUAL	BAJA	NO SABE
6.6.4. Se certifica con Rainforest Alliance	SUBE	IGUAL	BAJA	NO SABE
6.6.5. Se certifica con Starbucks	SUBE	IGUAL	BAJA	NO SABE

6.7. Qué deberían hacer las agencias certificadoras para conseguir que más productores certifiquen su finca?

1	Abaratar los costos de certificación
2	Brindar más asistencia técnica
3	Visitar más a menudo a los productores
4	No cobrar por la certificación
5	No deberían hacer nada diferente
6	Otra

____

7. Café y áreas protegidas.

7.1. Cree usted que en la actualidad hay cafetales establecidos dentro de los límites de áreas protegidas?

SI	NO

____

7.2. En qué áreas protegidas cree usted que hay cafetales? ________________

____

7.3. El café que se produce dentro de áreas protegidas no se debería certificar

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por que?

____

____

7.4. Cuál cree que debe ser la política del gobierno sobre la producción de café dentro de los límites de áreas protegidas?

____

____

8. Bosque y cafetales.

8.1. Tiene algún sentido mantener parches de bosque entremezclados con los cafetales?

SI	NO

Por qué? ____

8.2. Si piensa que el bosque le ayuda al cafetal, cuánto bosque hay que mantener entremezclado con el café para que sirva de ayuda?

	%

8.3. Dónde hay que mantener el bosque?

	En la periferia del cafetal
	Repartido entre los cafetales
	Protegiendo fuentes de agua
	en laderas con fuerte pendiente
	En el centro del cafetal
	La ubicación no importa

Por qué?

____

8.4. El bosque sirve de refugio para ciertas plagas del café

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Cómo? ____

8.5. Estaría mejor convertido en cafetal

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

8.6. Estaría mejor convertido en potrero

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

8.7. Estaría mejor convertido en otros cultivos

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

8.8. Estaría mejor ampliarlo

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

8.9. Hace aumentar la cosecha

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Cómo? ____

____

9. Iniciativas para mejorar la calidad del grano.

9.1. A su juicio, cuáles son los cambios más importantes que necesitan darse en la caficultura Nicaragüense para mejorar la calidad del grano?

____

9.2. Cuáles son las condiciones ambientales que más favorecen una buena polinización de la flor del café?

____

10. Iniciativas para mejorar el rendimiento por ha.

10.1. A su juicio, cuáles son los cambios más importantes que necesitan darse en la caficultura Nicaragüense para mejorar el rendimiento de los cafetales?

____

11. Expansión del área cafetalera.

11.1. Se necesita expandir el área cafetalera

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

11.2. Debe haber incentivos para ayudar a la expansión del área cafetalera

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

____

11.3. Cuáles son las regiones que tienen un mayor potencial para expandir el área cafetalera?

	Chinandega-León		Meseta de los Pueblos		Jinotega
	Sierras de Managua		Isla de Ometepe		Nueva Segovia
	Volcán Mombacho		Matagalpa		Estelí
	Madriz		Río San Juan		RAAN
	Boaco		Chontales		RAAS

Por qué? ____

11.4. Cuáles son las regiones en donde, a su juicio, no es rentable que se produzca café?

	Chinandega-León		Meseta de los Pueblos		Jinotega
	Sierras de Managua		Isla de Ometepe		Nueva Segovia
	Volcán Mombacho		Matagalpa		Estelí
	Madriz		Río San Juan		RAAN
	Boaco		Chontales		RAAS

Por qué? ____

12. Mirando hacia el futuro.

12.1. Usted cree que la tendencia de caficultura Nicaragüense para los próximos años será incrementar el área sembrada de café

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

____

12.2. La tendencia de caficultura Nicaragüense para los próximos años será aumentar la proporción de café que se produce bajo sombra.

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

____

12.3. La tendencia de caficultura Nicaragüense para los próximos años será aumentar la proporción de café que se produce sin sombra

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

12.4. La tendencia de caficultura Nicaragüense para los próximos años será aumentar la proporción de café certificado orgánico.

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

12.5. La tendencia de caficultura Nicaragüense para los próximos años será aumentar el rendimiento por ha.

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

12.6. La tendencia de caficultura Nicaragüense para los próximos años será mejorar la calidad del grano.

1	2	3	4	5
MUY DE ACUERDO	DE ACUERDO	NO SE	EN DESACUERDO	MUY EN DESACUERDO

Por qué? ____

13. Comentario Final

____

____

____

____

Appendix D: Original consent form to interview coffee farmers.

FORMULARIO DE CONSENTIMIENTO DE LA UNIVERSIDAD DE WASHINGTON

El Papel de los Programas de Certificación del Café en la Conservación del Bosque Tropical: Un caso de Estudio en Nicaragua.

Nombre: Martha Groom	Afiliación Académica:	UW College of :
Juan C. Martínez-Sánchez	University of Washington	Arts and Sciences

Teléfono: **206-718-1463**

Cell: **(505)428-0555**

DECLARACIÓN DE LOS INVESTIGADORES

Por este medio le estamos solicitando su participación en una investigación. El objetivo de este Formulario de Consentimiento es darle la información que necesita para decidir si quiere participar o no en esta investigación. Por favor, lea este formulario detenidamente. Usted puede hacer preguntas sobre el propósito de esta investigación, qué le vamos a pedir que haga, los posibles riesgos y beneficios, sus derechos como voluntario, y cualquier otra cosa sobre la investigación o este formulario que no esté clara. Cuando todas sus preguntas hayan sido contestadas, usted puede decidir si quiere o no participar en este estudio. Este proceso se denomina "consentimiento informado."

PROPÓSITO DEL ESTUDIO

Nosotros queremos entender mejor los puntos de vista de los caficultores sobre los factores que afectan la rentabilidad de sus fincas, así como la influencia de estas sobre la biodiversidad. Estamos interesados en investigar los factores que influyen en los cafetaleros a la hora de decidir como cultivar su tierra, tales como el uso de árboles de sombra, el papel que juegan los fragmentos de bosque en la periferia de los cafetales y la viabilidad a largo plazo de sus cafetales. Nos gustaría entrevistar a caficultores sobre sus experiencias en el cultivo del café.

PROCEDIMIENTOS DEL ESTUDIO

Si Usted decide participar en este estudio, me gustaría entrevistarle sobre sus experiencias como productor de café. La entrevista dura entre 30-45 minutos, y estará enfocada sobre la forma que usted maneja sus cafetales. Por ejemplo, yo le preguntaré: "Qué hace con sus cafetales cuando se cae el precio del café" y "Como cree usted que un cafetal produce más, con árboles o sin árboles?" Usted no está obligado a responder a todas las preguntas.

Me gustaría grabar la entrevista para así tener un registro más preciso. Solo los miembros del equipo de investigación tendrán acceso a las grabaciones, que permanecerán guardadas en un archivo bajo llave. La grabación de su entrevista será transcrita en las próximas 10 semanas, le asignaremos un código y destruiremos la grabación.

RIESGOS, ESTRÉS O MEOLESTIAS

Algunas personas sienten que dar información para investigaciones es una invasión de privacidad. Yo he tomado en cuenta estas preocupaciones sobre privacidad en las siguientes secciones. Algunas personas se sienten conscientes de si mismas cuando se graba su voz.

BENEFICIOS DEL ESTUDIO

Esperamos que los resultados de este estudio nos sirvan para entender mejor las percepciones de los caficultores sobre cual es la mejor forma de manejar sus fincas a largo plazo. Asimismo, deseamos que nuestro estudio sirva para llenar el vacío entre las percepciones de los diversos actores que trabajan en el sector del café. Usted puede que no reciba un beneficio directo por participar en esta investigación.

OTRA INFORMACION

Su información es confidencial. Yo estaré encargado de codificar la información de este estudio. Guardaré la clave entre su nombre y el código asignado en un lugar seguro y diferente al de las entrevistas hasta Mayo del 2012. En esa fecha destruiré esta clave. Si los resultados de este estudio se publican o se presentan en público, no usaremos ninguna cita de su entrevista, al menos que usted nos de permiso para hacerlo.

Dado que trabajo para una universidad de los Estados Unidos, necesito informarle que las autoridades de la universidad a veces revisan estudios como este para estar seguros que se llevan a cabo de forma segura y legal. Si se llevara a cabo una revisión de este estudio, su registro podría ser examinado. Los revisores respetarán su privacidad. Los registros de esta investigación no se usarán para provocarle daño legal alguno.

Es posible que necesite volver a contactarle para aclarar información sobre la entrevista. En ese caso, le telefonearé o le visitaré para acordar una cita para poder hacerle las preguntas adicionales estrechamente relacionadas con la entrevista original. Por favor, hágame saber si usted me da permiso para contactarle para este propósito. Este permiso no le obliga en forma alguna.

POSIBILIDAD DE INVESTIGACIÓN EN UN FUTURO

Finalmente, es posible que decida llevar a cabo un estudio sobre cambios en prácticas o actitudes en el cultivo del café. Le gustaría que volviera a contactarle dentro de 5-10 años para hacerle nuevas preguntas? Que me de permiso no le obliga en forma alguna a participar.

____

Firma del investigador   Nombre del investigador   Fecha

DECLARACIÓN DEL PARTICIPANTE.

Me han explicado en que consiste esta investigación. Yo estoy de acuerdo en participar en ella. He tenido la oportunidad de hacer preguntas. Si más adelante tengo preguntas sobre la investigación puedo preguntar a uno de los investigadores que se mencionan. Si tengo preguntas sobre mis derechos como participante de esta investigación, puedo llamar a la División de Participantes Humanos de la Universidad de Washington al (206) 543-0098. Doy permiso para que los investigadores graben mi entrevista tal como se describe en este formulario de consentimiento. Yo recibiré una copia de este formulario de consentimiento.

Yo doy permiso para que el investigador pueda usar citas textuales de mi entrevista.
Sí _______   No _______

Yo doy permiso para que el investigador pueda volver a contactarme para aclarar información.
Sí _______   No _______

Yo doy permiso para que el investigador pueda volver a contactarme para participar en una futura investigación.

Sí _______   No _______

____

Firma del participante   Nombre del participante   Fecha

CC: Archivo, Participante.

Vita

Juan Carlos Martínez-Sánchez' interest in biology began as a young child exploring nature in the Sierra de Madrid, Spain. Binoculars in hand, he enjoyed all moving creatures alike, and took special care to share this enjoyment with his family by bringing an array of wild visitors to his home. Determined to be a biologist, he received his undergraduate degree in Environmental Biology from the Universidad Autónoma de Madrid. Following his dream to explore the tropics, he volunteered for the literacy campaign in Nicaragua and discovered the need for conservation of the last standing rainforests.

During the turbulent decade of the 1980s, Dr. Martínez-Sánchez was instrumental in establishing the foundation for conservation in Nicaragua. His accomplishments include designing environmental interpretation for Masaya Volcano National Park, establishing the first vertebrate collection in the country, and serving as the first director of Bosawas, which a decade later would become one of the largest biosphere reserves in Central America.

Dr. Martínez-Sánchez began his doctoral studies at Virginia Tech in 1990 and transferred to the University of Washington a year later. Upon completion of his general exam, he returned to Nicaragua to undertake his dissertation. While collecting data at one of his field sites, he encountered the rapid destruction of cloud forest on Mombacho Volcano. He took advantage of a unique opportunity to lead a newly formed coalition of stakeholders that convinced the Nicaraguan government to turn over the management of this protected area. This served as a model for management of protected areas around the country. Over the next five years he trained a diverse team of field biologists, interpreters and park managers who later assumed responsibility for conservation around the country. He published a book on biodiversity in Nicaragua, and researched and compiled data on Nicaraguan birds.

Dr. Martínez-Sánchez began new research for his dissertation on the role of organic coffee plantations in biodiversity conservation. This dissertation builds on his experience as an ornithologist and his knowledge of the interface between agricultural land and protected areas.