Factors influencing adoption of conservation practices on coffee farms.

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**Abstract:** To enhance existing governmental efforts to conserve habitat on coffee farms and identify barriers that constrain farmers’ participation in conservation initiatives, we conducted a survey of 89 coffee growers in Puerto Rico. We asked farmers if they currently grew coffee under the shade tree canopy or under direct sun, about their participation in local and federal incentive programs, and openness to conservation and agroforestry practices. The results of open-coding revealed four factors influencing adoption of conservation practices. First, some farmers perceived that local agricultural incentives required sun farming to be eligible for state incentives which conflicts with conservation practices. Second, farmers’ definition and implementation of conservation practices, namely shade coffee, differed from the ones advocated by environmental agencies, particularly in the percentage and type of shade tree cover. Third, farmers highlighted the need of financial incentives to support shade method. Lastly, farmers expressed concerns over loosing land management autonomy in case they decide to participate in a conservation initiative. We recommend that increased involvement of farmers in the design of conservation initiatives and use of financial incentives would help to address these barriers.

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**Introduction**

Agriculture constitutes one of the main sources of ecosystems disturbance and loss of habitat. In response to these negative effects, recent efforts in agricultural research focus on practices that could sustainably combine agricultural and ecological objectives. In coffee growing countries, one such practice is shade coffee, a system where coffee is grown under a canopy of shade trees. Its potential to provide environmental benefits received considerable attention from scholars and conservation organizations (Cerdán et al., 2012; Jha et al., 2011). Some of the benefits provided by the shade trees include reduced coffee pests and diseases (Lopez-Bravo et al., 2012), enhanced soil fertility, improved water quality (Cerdán et al., 2012), and nutrient retention (Trujillo, 2001).

However, while shade farming method might represent an advantageous alternative for conservation organizations, it might have an opposite effect on coffee growers. Shade method is associated with lower yields, and coffee growers have been transitioning towards more conventional methods by eliminating tree cover and growing coffee under direct sun. In Puerto Rico, the Department of Agriculture (PRDA) has encouraged farmers to adopt sun farming method since 1960s to help revive declining industry and increase yields (Borkhataria et al., 2012). The exact number agricultural farms converted to sun production Puerto Rico is not available, but the data from United States Department of Agriculture (USDA) Census of Agriculture (2012) shows a stable increase in number of sun plantations between 1982 and 2012 .

The transition towards sun method represents a major challenge to promoting the conservation of biodiversity and sustainable agriculture. Conservation organizations and governmental agencies have acknowledged some of these challenges and developed various tools in order to promote eco-friendly farming and incentivize conservation-oriented actions on private landholdings. In Puerto Rico, this includes a sun-to-shade joint program between federal agencies US Fish and Wildlife Service (USFWS) and USDA Natural Resources Conservation Service (USDA NRCS). As part of a Watershed Management Initiative, these agencies provide financial incentives to farmers who plant shade trees on their farms, along with other soil conservation practices (Guanica Bay Watershed Initiative, 2010).

However, participation in these programs remains low. Similar to conservation programs in continental U.S., these initiatives rely primarily on voluntary participation of farmers (Reimer et al., 2012). While numerous studies have discussed factors affecting farmers’ participation in conservation practices (Baumgart-Getz et al., 2012; Prokopy et al., 2008), research on coffee farmers remains limited. Previous findings highlight the economic factor as determining force behind farmers’ decision-making (Borkhataria et al., 2012; Greiner et al., 2009; Haggar et al., 2013). Others point to the role of policy in impacting the choice of farming methods and even decision whether to abandon farming altogether (Batz et al., 2005). In Puerto Rico, the most recent study on coffee farmers practices and attitudes towards conservation was conducted in 1999 (Borkhataria et al., 2012). Interestingly, the researchers used direct observations to compare how farmers identify their coffee growing methods with the scientific classification and found inconsistency between the two. To our knowledge, current studies on farmers decision-making are missing farmers’ definition of coffee growing methods and as a result, could be missing a valuable element.

A deeper insight on why farmers opt for a particular coffee growing practice, how they evaluate existing agricultural and conservation incentives and what they think of regional conservation initiatives can help understand the current coffee growing trends and reasons behind farmers participation or lack of participation in conservation initiatives. This information is also necessary for designing more efficient agricultural and conservation initiatives that can attract more landowners. This study seeks to address these knowledge gaps and aims at providing useful insights on how conservation programs can better adjust to farmers’ land-use needs and decision-making. Specifically, its goals are to document local farmers' current coffee growing methods, identify constraints in local conservation policies and analyze ways to strengthen participation of coffee growers in conservation initiatives.

**Methods**

***Study area and data collection***

Our study site was located in the western half of Puerto Rico, the area where coffee was one of the predominant agricultural crops. The area consisted of twelve municipalities: Ciales, Guayanilla, Jayuya, Juana Diaz, Yauco, Maricao, Las Marias, Lares, Adjuntas, Ponce, Sabana Grande and Utuado.

This study was part of a larger research project and the previous research team provided us with a sampling list. Using spatial data, the research team randomly selected coffee farms within the coffee growing region and conducted habitat assessment (species count) in those spots. The sampling list contained 126 GPS coordinates of coffee farms and 52 of those included farmer’s contact information.

Since we did not have contact information for all the farmers, we divided the fieldwork between two teams of two people. One team called the farmers for whom the contact information was available, briefly explained the purpose of the study and scheduled meetings with those who consented to meet. The second team had the task of visiting the remaining 74 locations and trying to obtain contact information of the person in charge of farming operations. If nobody was present at the site, the team left an information sheet with description of the project and our contact information. If the team was not successful in contacting a farmer after three on-site visits, we eliminated that location from the sample. This happened in 16 cases. Further, we identified that some farmers owned two or three farms from our sampling list which led to the exclusion of 10 more cases. Our final sample consisted of 100 prospective participants.

The research teams then proceeded with data collection. After obtaining written consent, we proceeded with the in-person questionnaire. One team member read the questions to the respondent, while the other wrote down the answers in the paper version of the questionnaire. We used a pre-tested questionnaire that included 56 closed and open-ended questions. The questions focused on farmers' coffee-growing practices, attitudes towards conservation initiatives, and factors that affect decisions to adopt and maintain conservation practices. Other topics covered by the questionnaire included farm’s land use profile, farmer’s experience with federal and state agricultural incentives, and socio-economic profile of the respondents. Further, we asked farmers to define two main coffee production systems (shaded and unshaded) and list benefits and disadvantages associated with each method.

***Data Analysis***

Data was stored using the Survey Monkey, online survey software. We first created a survey matrix in the software and included a line for entering a response to each question, followed by a line for entering observations and comments corresponding to each question. At the end of each fieldwork visit, we manually entered the responses into the matrix.

Qualitative and quantitative data were analyzed separately. Descriptive statistics were used to calculate frequency, means, and standard deviation. \*Jaime to add a few sentences on what he did, methods, software used\*

Qualitative data, obtained from open-ended questions, was analyzed by manually coding the most frequently used words of interest in the hard copies of questionnaires. \*Marysol and Angelica to add a few sentences on what they did\*

**Results**

We completed 89 in-person surveys (89% response rate), usually on the farm or in the farmer's house. The surveys took between 30 minutes and 2 hours to complete.

***Overview of the sample***

The majority of the respondents in the sample were owners (82%), followed by the farm’s administrator (8%), tenants (6%), or other (4%). Of the 89 respondents, 94% were male. The gender distribution is representative of gender distribution of farmers in Puerto Rico: farming is predominantly operated by male farmers (USDA 2012). The average age of the respondent was 59 years (SD=XX). Only 40% of the respondents had post-high school educational level, while 12% only completed elementary school. The annual income from farming varied from <10,000 to >70,000; however, 48% earned <10,000. When asked about the fairness of current coffee prices, 63% of respondents found the current coffee price unfair. Low incomes associated with farming represented a concern among coffee growers; 24 respondents (27%) said they were considering selling the land or abandoning farming altogether due to low profitability.

Farm plots included in this survey ranged from 2 to 728 acres with the mean size of 66 acres (SD=110). The average portion of farm land that farmers used for coffee farming comprised 51%, and only 12 % of respondents reported using all of their land for growing coffee. Only 10% of the farms were monoculture. In the polyculture (90%) farms, plantain was the second most commonly grown crop after coffee: 53% (n=75) of the respondents grew coffee intercropped with plantain. As respondents explained, the PRDA staff recommended intercropping plantains with coffee. The plantain provides partial shade to the growing coffee bush and serves as a cash crop until coffee starts to bear fruit.

Participation of farmers in government incentive programs varied across the research sample. Almost half (49%) of the respondents only received incentives from the PRDA, followed by 29% who received both federal and state incentives, 18% who did not participate in any incentive programs (18%), and 3% only received federal incentives (3%). Among the group that receives incentives (n=73), the most commonly received incentives were PRDA fertilizer subsidy (96%), PRDA salary subsidy (52%), PRDA new planting subsidy (49%) and the USDA NRCS shade coffee program (30%).

***Practices***

Coffee production systems varied within the study area. In addition to two pre-defined answer choices (“sun” and “shade”, 30% and 20% respectively), 33% of the respondents reported they had part of the land under sun, and part under the shade method. Farmers listed various reasons for having both sun and shade grown coffee on their lands, including transition to complete shade, comparative evaluation of what practice was more beneficial, concerns for the environment, and an effort to decrease maintenance. However, we did not ask farmers to specify the proportion of land they had under each method and thus it is not clear what farming method prevailed on the farm.

Interestingly, 17% of participants reported using a “semi-shade” method that they identified as distinct from traditional shaded method. The method was generally defined as a partial shade cover that let the sun in while also protecting the coffee. For shade cover, farmers used shade trees recommended by federal environmental agencies (*inga edulis and* *andira inermis*) and also citrus and avocado trees.

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| Method | Proportion  | Example of farmers’ definitions of methods |
| Part sun, part shade | 33% | “Part of the coffee farm in shade grown, part is sun grown.” |
| Sun | 30% | “Does not have shade, cleared out.”“Does not have trees and produces more.” |
| Shade | 20% | “Around 30 to 40% of shade cover.”“Trees like guama and moca are intercropped with coffee.” |
| Semi-shade | 17% | “Shade that protects coffee but also lets in the sun.”“Trees are planted from a certain distance from the coffee bush and provide partial shade.” |

Further, we asked the farmers to list benefits and disadvantages associated with sun and shade methods. The most commonly identified benefit of the sun growth was its high yields, mentioned by 74% of the respondents. On the other hand, 14% of farmers could not name any benefit associated with this practice. Amongst most commonly mentioned disadvantages of sun method were high maintenance, high demand for herbicides and fertilizers, shorter lifespan of the plant, and higher incidence of pest attacks.

Shade grown coffee was described as a practice with lower yields, but higher quality of the bean. Three most commonly identified advantages were better quality of the bean (51%), less maintenance (39%), and higher quality of the harvest (29%). Some expressed that even though shade-grown coffee had lower productivity, the beans’ quality compensated for quantity.

***Factors influencing adoption of conservation practices***

After open-coding the responses, we identified four common themes that affect adoption of conservation practices. First, some farmers perceived that PRDA policies impeded adoption of shade method and other conservation practices. They expressed strong perception that they needed to grow at least part of their coffee using sun method to be eligible for PRDA incentives.

Second, we noted that farmers’ definition of shade method differed from the one encouraged by the federal shade coffee program. Some farmers mentioned that not all types of shade trees provided by the federal agencies were suitable for farming, and on some occasions, they ended up removing them. Some farmers practiced “semi-shade” which has lower density of shade trees than the one suggested by the program. Further, some farmers used crop trees like avocado or citrus as “shade” but those trees do not necessarily provide ecological functions desired by the program.

Third, economic pressures conflict with adoption of shade method as farmers perceive this method as less profitable in the short term. Farmers emphasized financial compensation to secure their participation in conservations initiatives.

Forth, farmers expressed concern over the impact conservation practices might have on their land management autonomy. They were worried that participation in conservation scheme will limit their land decision-making. They expressed support towards a land-use scheme that balanced conservation and sustainable farming, but expressed doubts that PRDA would support these practices and questioned whether environmental agencies would end up imposing higher restrictions on farmers.

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| Factors | Example quote | Frequency of mentions |
| Perceived lack of support from PRDA  | “The PRDA forced us to switch to sun method. Here the work gets done under dictatorship. They give you fertilizer and seeds, but in exchange, you need to use sun method.” |  |
| Discrepancy in definitions of shade method | “They need to change the type of trees in order for the coffee to produce.” |  |
| Economic  | “Incentives. Without incentives, they can bring a thousand shade trees, nothing will happen.” |  |
| Private-public conflict | “The genuine part of the government, the one that wants to conserve, should be involved. It should not become a political play or just stay on paper.”  |  |
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**Discussion**

The results of qualitative analysis reveal four factors that farmers perceive as affecting adoption of shade method and other conservation practices.

Consistent with previous study (Borkhataria et al., 2012), our findings point out to a heavy reliance of coffee industry on governmental subsidies. Farmers also pointed out to the disharmony between federal and state subsidies: while federal programs incentivize sustainable agroforestry practices, state incentives favor sun growth. Conflicting policies weaken conservation objectives of the agencies and place farmers to choose between conservation and profitability. Unless there is a consistency between agricultural and environmental goals, substantial conservation goals will not be achieved.

The fieldwork revealed a higher complexity in coffee growing methods than a clear-cut dichotomy of sun versus shade commonly assumed by environmental and agricultural agencies. Farmers use a variety of tree species and density in order to create shade cover that is the most suitable for the characteristics of their farm. Several farmers identified a so-called “semi-shade” practice which has less tree density than the one encouraged by conservation agencies. We found that the way many farmers practiced shade growth was distinctive from the conservation-oriented purposes of conservation agencies. Some farmers expressed concern that they did not have an option of selecting tree species for shade canopy, but were given species identified by the agencies for environmental purposes, but not necessarily beneficial to the farmer’s production. Some farmers used fruit trees as shade cover; yet, for purpose of habitat and biodiversity this might not be the most desired choice of tree canopy. Although some farmers considered plantain as having a shade farm, from the conservation perspective it is not considered a shaded culture.

In general, farmers were widely aware of the benefits and importance of shade trees for conservation and sustainability; the majority of coffee growers used some form of shade canopy. However, economic factor prevailed in the land-use choice; although farmers acknowledged higher quality harvest in shade production, this did not prevail over high productivity of sun farming. It is a common understanding among the farmers that return to shade growth should be accompanied by financial incentives from the government. Almost half (48%) of the farmers in our sample made annually less than $10,000 from coffee production. It would seem that, in order to strengthen conservation efforts in the area, there is the need to look closely at the poverty trends in local communities and how they might be tackled by more economically sustainable production systems.

While farmers generally expressed support for conservation initiatives, they shared concerns whether these initiatives could threaten farmers’ ownership rights and limit their land use choices. To some, the initiative was regarded as an imposition of governmental agencies and environmental organizations. Thus, farmers accounts point to the need of revisiting the debate about the initiative and how it could harmonize with established agricultural practices within the region. Further work on promoting the initiative and explaining its principles to private landowners is necessary. Financial subsidies and decreased dependency of farmers on subsidies are necessary to ensure continuity of the initiative.

Based on our findings, we propose the following policy recommendations…

**Literature Cited**