Factors that influence participation of Puerto Rican coffee farmers in conservation programs

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Abstract
Sustainable, conservation-oriented agricultural practices like shade coffee and agroforestry can enhance conservation objectives in tropical landscapes. Adoption of these practices, however, is influenced by numerous factors. We conducted a survey of 89 coffee farmers in Puerto Rico to understand their farming practices, experience with existing incentives, and willingness to participate in conservation programs. Quantitative analysis showed that current farming practices, farm size, and annual income from farming were associated with willingness to participate in conservation programs. Qualitative results suggested that financial considerations, conflicting state and federal incentives, lack of information about conservation programs, distrust in government, and land use restrictions might hinder participation. Some farmers perceived that sun farming—a practice incompatible with sustainable conservation—was required to be eligible for state agricultural incentives. The way some farmers practiced shade farming differed from the way suggested for conservation purposes, particularly in the type of shade trees and their cover density. Farmers highlighted the need for financial incentives to encourage adoption of shade farming. They also expressed concerns that participation in conservation programs could limit their land management autonomy. We suggest that availability of financial incentives, reconciliation of institutional barriers, increased outreach, and involvement of farmers in design of conservation programs can increase adoption and retention of conservation practices.

KEYWORDS
agroforestry, coffee farming, conservation programs, incentives, model Forest, policy, Puerto Rico, shade coffee

1 | INTRODUCTION

Sustainable agriculture is becoming increasingly important to achieve conservation objectives (Garcia et al., 2010). Recent studies show that agricultural practices like agroforestry can support conservation and biodiversity without sacrificing agricultural production (Kremen & Merenlender, 2018). One such example is coffee agroforestry, or shade coffee farming—a practice of growing coffee under a structurally and floristically diverse canopy of shade trees.
A diverse shade tree overstory can support habitat for a wide range of species (De Beenhouwer, Aerts, & Honnay, 2013). Coffee farms are frequently located close to biodiversity hotspots and could enhance conservation objectives in those regions (Moguel & Toledo, 1999).

Shade farming, however, is associated with an important economic tradeoff—lower yields (Hernandez-Aguilera, Conrad, Gómez, & Rodewald, 2019). Many coffee growers have removed shade trees and transitioned to conventional sun farming to increase production (Rice, 1999). To encourage shade farming and compensate farmers for lower yields, government and environmental organizations have implemented numerous incentives, including price premiums for shade coffee and payments for ecosystem services (Williams-Guillén & Otterstrom, 2014). Participation in these programs tends to be voluntary; understanding factors that influence enrollment is key to recruitment and retention of coffee growers.

Numerous studies (e.g., Baumgart-Getz, Prokopy, & Floress, 2012; Prokopy, Floress, Klothtor-Weinkauf, & Baumgart-Getz, 2008) have discussed participation of farmers in conservation programs but studies on coffee growers are scarce. Previous research indicates that specifics of a policy, economic considerations, and experience with coffee farming practices play a role (Batz, Albers, Ávalos-Sartorio, & Blackman, 2005; Smith Dumont, Sassner, Agaba, Nansamba, & Sinclair, 2018; Wall, 2010). Literature further suggests that nonconservation incentives, interactions between multiple government institutions, and different ways that farmers practice shade farming might influence participation (Chazdon et al., 2009; Jacobson, Sieving, Jones, & Doorn, 2003) but few studies have assessed these factors empirically. We address this knowledge gap by examining coffee farming practices in Puerto Rico, one of the Caribbean hotspots for conservation priority (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000).

Although coffee farming in Puerto Rico has decreased following industrialization, it remains a dominant land use and a source of economic activity in the central part of the island (USDA, 2014). Most of the coffee farms in Puerto Rico are sun grown. The Puerto Rico Department of Agriculture (PRDA) provides agricultural incentives and subsidies to local coffee farmers but these mainly support sun coffee farming (PRDA, 1990). The federal agencies, the U.S. Fish and Wildlife Service (USFWS) and the USDA Natural Resources Conservation Service—Caribbean Area (NRCS), established a joint shade coffee program to encourage soil conservation and a return to shade farming. Funded by the NRCS Environmental Quality Incentives Program (EQIP), the program provides technical assistance with best management practices and financial incentives to plant shade trees on coffee farms (NRCS, 2018). At the state level, in 2014, Puerto Rico government passed the conservation-oriented Model Forest Law (num. 182; hereafter, MFP). The MFP designated over 150,000 ha of land in the western part of the island as the National Model Forest. The MFP established conservation and sustainable development as priorities for the west-central region of the island and encouraged voluntary adoption of sustainable agriculture and conservation practices in the region. Within the National Model Forest limits, almost half of the land is agricultural, mainly coffee farming (PR Planning Board, 2010).

Participation in these state and federal programs is voluntary. To the best of our knowledge, no previous study examined experience of U.S. coffee growers with the EQIP, and no research on participation in the MFP exists. Conservation research stresses the importance of local, context-specific research (Bose, Vira, & Garcia, 2016), yet the latest study on Puerto Rico coffee growers was conducted in 1999 (Borkhataria, Collazo, Groom, & Jordan-Garcia, 2012). Our research examines current coffee farming practices and farm characteristics in Puerto Rico. Through in-person surveys, we examine factors that affect willingness of coffee growers to participate in conservation programs. We asked coffee farmers to define elements that might help make a conservation program successful. Based on previous studies (e.g., Batz et al., 2005; Borkhataria et al., 2012), we suggest that institutional barriers and socio-economic considerations might influence the decision to participate in conservation programs.

2 METHODS

The study took place in the main coffee producing region of the island that had a total farming area of 7,100 ha and 2,301 coffee farms (USDA, 2014). Using landcover maps (Gould et al., 2008), we compiled a database of 126 randomly selected coffee farms across 12 municipalities: Adjuntas, Ciales, Guayanilla, Jayuya, Juana Diaz, Las Marias, Lares, Maricao, Ponce, Sabana Grande, Utuado, and Yauco (Figure 1). In the absence of a priori data, and because most questions required a binary response, we needed to conduct at least 88 surveys to have a power of 80% (type II error $\beta = 0.20$) at an alpha of 0.05. Of these 126 farms, we had contact information for 52. We called and asked to speak to the farm’s primary decision-maker, briefly explained the purpose of the study, and scheduled in-person meetings with those who consented to meet. We also visited 74 coffee farms that had no contact information. If nobody was present at the site, the research team left an information sheet with a description of the project and 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 discovered that some farmers owned multiple farms in our sampling pool which led to additional elimination of 10 farms. The final sample consisted of 100 prospective participants.

The fieldwork took place between June and December 2015. All participants gave written informed consent to participate in this study. We completed 89 in-person surveys, for an 89% response rate. We did not ask farmers why they declined to participate but some volunteered this information. Reasons differed, including lack of time, abandonment of farming, and not having a consent from farm’s owners to participate. We did not find evidence that we systematically excluded a particular group from this study.

We interviewed the primary decision-makers on a farm, usually on the farm or in the farmer’s house. After obtaining written consent, we administered the in-person survey. Surveys were conducted in Spanish and took between 30 min and 2 hr to complete. One team member read the questions to the respondent, while the other wrote down the responses. We used a pre-tested questionnaire that included 56 open and closed-ended questions (Appendix S1). Open-ended questions focused on coffee farming practices, willingness to participate in conservation programs, and elements that would make a conservation program successful. We asked farmers to define two main coffee farming practices—sun and shade—and list benefits associated with each practice. We asked farmers if they heard about the MFP. We briefly explained the policy to those unfamiliar with it. Closed-ended questions included socio-economic status, farm characteristics, and participation in federal and state agricultural incentives. When the interviews were conducted on a respondent’s farm, we conducted field observations of a prevailing coffee farming practice. We then compared our observations with coffee farming practice reported by the participants.

### 2.1 Data analysis

Data were stored using the Survey Monkey online software. We analyzed open-ended and close-ended questions separately. Two researchers manually open-coded the responses to open-ended questions, coding for the most frequently used terms and clustering them into themes. We considered that the responses constituted a theme if they were mentioned by at least two respondents (Ryan & Bernard, 2003). A third researcher cross-checked and validated these themes against the original transcripts (Patton, 2002). We used descriptive statistics to calculate frequencies of the responses.

We used descriptive statistics to analyze responses to closed-ended categorical questions. We summarized farm size as mean (±1 SD). We used chi-square tests to determine if there was an association between participation of a respondent and agricultural incentives (state or federal), their education level (university and high school or lower), or annual income from farming (<$10,000; $10,000–$30,000; or >$30,000).

We used Classification and Regression Tree Analyses (CART; De’ath & Fracricius, 2000) to determine which predictor variables grouped (classified) respondents most strongly with their willingness to participate in a
conservation initiative. CART is a nonparametric modeling procedure that can accommodate mixed continuous, ordinal, and categorical variables collected in this study, as well as data that might contain outliers or correlated data (VanEngelsdorp et al., 2010). The procedure recursively partitions data—in this case, willingness to participate in a conservation program—such that the populations of farmers within each partition became more and more class homogeneous. The response variable—willingness to participate—was categorized as yes, no, or undecided options. We included five predictor variables, based on previous literature and our fieldwork observations (Batz et al., 2005; Borkhataria et al., 2012; Smith Dumont et al., 2018; Wale, 2010). The variables were: annual farming income (<$10,000; $10,000–$30,000; >$30,000); current participation in incentive programs (yes or no); farm size (<84 ha or ≥84 ha); education level (high school or lower and university, which included associate degree and some college); and farming practice (shade [SH], sun [SU], or mix of sun and shade [SUSH]).

We had incomplete socio-economic data on four respondents, so we omitted them from the CART, reducing analysis to 85 respondents. The use of only complete cases avoids inference problems that might arise from missing data on one or more predictor variables (De’ath & Fracricius, 2000). For splitting criteria, we used the Gini Index (G²), a measure of impurity (entropy), such that nodes in a classification tree went from impure (mixing of classes among samples contained in the node) to less impure or more homogenous (smallest when the node contains only one class) (De’ath & Fracricius, 2000). To avoid overfitting a model, we used a 10-fold cross-validation (VanEngelsdorp et al., 2010), a procedure that divided data into 10 mutually exclusive subsets of approximately equal size. The tree with the minimum estimated error was identified, interpreted as the best estimated predictive single tree (De’ath & Fracricius, 2000). As model performance measures, we reported misclassification rates, the R² for a single model fit to all observations, and the receiver operating characteristic (ROC) values. Moreover, we reported the relative contributions of variables as predictors in the model, ranked by the proportion of the G² explained by a variable. We ran all analyses using JMP statistical software package (2016, ver.13.2.1, SAS Institute, Inc, Cary, North Carolina).

3 | RESULTS

3.1 | Overview of the sample

The majority of the respondents were farm owners (82%), followed by administrator (8%), tenant (6%), or others (4%) (Table 1). Of the 89 respondents, 94% were male. The gender distribution is representative of gender distribution of farmers in Puerto Rico: farming is predominantly a male occupation (USDA, 2014). The age of the respondents ranged between 23 and 86 years old, with the average age of 59 years. Educational attainment varied: 12% completed elementary school, 46% completed secondary education, 14% had some college or associate degree, and 28% completed bachelor’s degree or higher. 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 unfairly low. More than quarter of the respondents (27%) shared they were considering selling or abandoning the farm due to low profitability.

Farm plots included in this survey ranged from 0.81 ha to 294 ha with the mean size of 27 ha (SD = 44; 95CIs = 17–37). The average portion of farmland that farmers used for coffee farming was 51%, and 12% of respondents reported using all land for coffee farming. Only 10% of the farms were monoculture. In the polyculture farms, plantain was the second most commonly grown crop after coffee: 45% of polyculture farms had coffee intercropped with plantain. The majority (59%) reported they had nonfood trees and/or forested areas on their farm.

3.2 | Incentives

Participation of farmers in government incentive programs varied across the sample. Almost half (49%) received only state agricultural incentives, followed by 29% who received both state and federal incentives, 18% did not receive any, and 4% received only federal. Among those who received incentives (n = 73), the most common incentives were: PRDA fertilizer subsidy (96%); PRDA salary subsidy (52%); PRDA new crops subsidy (49%); and the NRCS shade coffee program (30%). When asked their opinion of incentives, farmers prevalingly described incentives in positive terms (e.g., “good” and “vital to survival of agriculture”). Criticism towards current incentives included excessive paperwork, delayed payments, and lack of funding. Several farmers (15%) shared they were not aware of federal incentives. Farmers learned about incentive programs through different means, including agency outreach (18%); personal visits to the agencies (13%); recommendations from fellow farmers (12%); and media (9%).

We found a strong association between income from farming and participation in incentives (Pearson χ² = 8.19; p = .02). Results indicated that 94% of farmers who made >$10,000 (n = 44) received incentives at the
time of the survey, as compared with 69% of those with an income of <$10,000 (n = 43). In contrast, there was no association between education level and whether farmers participated in incentive programs (Pearson $\chi^2 = 0.01; p = .92$).

### 3.3 Practices

The combination of practices (SUSH) was the most common farming practice in the sample, reported by 33% of the respondents. Farmers listed various reasons for using both practices, including transition to shade farming, environmental concerns, and an effort to decrease maintenance. We did not ask farmers to specify the proportion of land they had under each practice, and thus it was unclear which practice—sun or shade—prevailed on their farm. Sun farming was reported by 30% of the farmers, and 20% practiced shade farming. In addition, 17% of the respondents reported a semi-shade practice, an option that we did not originally consider. When asked to clarify the distinction between shade and semi-shade practices, farmers explained that semi-shade had a partial shade cover which allowed the sun in and protected the coffee. For the semi-shade, farmers used a variety of trees as canopy, including trees recommended by the NRCS (Inga laurina and Andira inermis), citrus, and avocado trees. This farming practice could be considered restored shade; thus, we grouped shade and semi-shade farmers for the CART.

We asked participants to list advantages associated with sun and shade practices. The most frequently mentioned advantage of shade farming was quality of the bean, named by 51%. Other reported benefits included less maintenance (39%), higher yield (29%), comfortable conditions for picking coffee (11%), and environmental

| Variable                              | Shade farming (SH) | Sun farming (SU) | Part sun, part shade (SUSH) | Semi-shade |
|---------------------------------------|--------------------|------------------|------------------------------|------------|
| Sample size                           | n = 18             | n = 27           | n = 29                       | n = 15     |
| Average farm size (ha)                | 59                 | 66               | 85                           | 48         |
| Farm tenure                           |                    |                  |                              |            |
| Owner (%)                             | 78                 | 100              | 79                           | 73         |
| Polyculture farms (%)                 | 67                 | 11               | 83                           | 87         |
| Gender                                |                    |                  |                              |            |
| Male (%)                              | 100                | 96               | 97                           | 93         |
| Average age                           | 56                 | 58               | 59                           | 62         |
| Annual farming income, (%)            |                    |                  |                              |            |
| <$29,000                              | 67                 | 78               | 69                           | 79         |
| $30,000–$59,000                       | 22                 | 11               | 14                           | 14         |
| >$60,000                              | 6                  | 11               | 17                           | 7          |
| Education level, (%)                  |                    |                  |                              | n = 26     |
| ≤high school                          | 61                 | 70               | 62                           | 47         |
| Some college/2-year degree            | 6                  | 15               | 10                           | 20         |
| 4-year college or higher              | 33                 | 15               | 28                           | 33         |
| Participation in incentives, (%)      |                    |                  |                              |            |
| Only federal                          | 6                  | 0                | 0                            | 0          |
| Only state                            | 33                 | 63               | 52                           | 33         |
| Both                                  | 44                 | 18               | 38                           | 33         |
| None                                  | 17                 | 19               | 10                           | 33         |
| Willingness to participate, (%)       |                    |                  |                              | n = 14     |
| Yes                                   | 70                 | 69               | 76                           | 57         |
| No                                    | 18                 | 12               | 10                           | 14         |
| Depends                               | 12                 | 19               | 14                           | 29         |
benefits (9%). Examples of environmental benefits included protection from extreme weather events like hurricanes and droughts: “Shade cover defends us. We have recently experienced a drought, but I have my coffee and it is of good quality” (shade farmer, Utuado). Some expressed a sense of environmental responsibility associated with shade farming: “Everything [farming practices] I do here affects the coast. I plant shade trees for environmental reasons; they improve well-being and aesthetics” (shade farmer, Yauco).

The most commonly mentioned advantage of sun farming, listed by 74% of the respondents, was high yields. Other mentioned benefits were easier maintenance (3%) and less pests (2%). Yet, 14% of the respondents, including those who practiced sun farming, could not identify any benefits from sun farming. Instead, farmers listed disadvantages, including costly maintenance (8%), lower quality of the bean (8%), and shorter lifespan of the plant (4%). One farmer shared that this practice “had no benefit and they were growing it because of the government” (sun farmer, Las Marias).

3.4 Factors influencing adoption of conservation practices

We found that 53% of the respondents had not heard about the MFP prior to our study. However, the majority of the respondents used in the CART (n = 85) expressed willingness to participate in existing or similar conservation programs: 69% said yes, 13% said no, and 18% responded as maybe (categorized as undecided). The generalized R² of the model was 46% using seven splits (Figure 2). The model had a misclassification rate of 0.27, and the receiving operating characteristic (ROC) ranged from 0.73 to 0.89. Farming practice was the best predictor, accounting for most of the variation (51%) in grouping farmers, followed by income (21%) and farm size (19%). Receiving incentives and education contributed 6 and 3%, respectively.

At the broadest level, farm size split farmers in two groups—those cultivating on small (<84 ha) and large (≥84 ha) farms. Large-scale farmers were split by farming practice (right-hand side of the decision tree; Figure 2). Farmers who practiced either sun or shade coffee had low willingness to participate (22%), compared with SUSH farmers (87%). Small-scale farmers were split by a greater number of predictors. Farmers that did not participate in incentive programs exhibited high willingness to participate in a conservation initiative (79%). Those farmers who received incentives (n = 34) were split by farming practice, education, and income. Farmers with university education level but <$10,000 income were more likely to participate (71%). Farmers with university education and higher income were more likely to be undecided (40%). Farmers with education level of high school and lower were more likely to participate if they cultivated shade (75%) or sun coffee (90%).

Five main themes emerged after we analyzed responses to what constituted a successful conservation program (Figure 3). Farmers listed education and outreach (27%); government commitment (18%); financial incentives (16%); land use (8%); and cooperation among coffee farmers (7%).
as essential elements. Four participants (4%) struggled to respond to this question.

Respondents most frequently stressed the need for increased outreach and education. This included education about conservation programs, as well as about the benefits of shade farming. Farmers noted that current conservation message “did not reach well” (sun-shade farmer, Yauco) and stressed the need to educate people about agricultural and ecological benefits of shade coffee. Farmers suggested various outreach venues for promoting conservation programs, including radio and newspaper announcements, workshops, visits from conservation agencies, and learning from peers.

The second theme centered around “sincere commitment from the government” (semi-shade farmer, Utuado). The farmers stressed the need for continuous supervision and involvement of different levels of the government in the implementation of conservation programs. Some expressed distrust in the state Model Forest policy, worrying it would become “yet another political play” (semi-shade farmer, Jayuya). They emphasized that the government should show “good faith” (shade farmer, Utuado) in their intention to promote sustainable agriculture.

The third theme focused on financial incentives. Farmers shared that conservation programs should include monetary incentives and free distribution of shade trees to be economically viable. The respondents also noted that they relied on state agricultural incentives but that those impeded shade farming. “The PRDA forced us to switch to sun method. Here the work gets done under dictatorship. They give you fertilizer, but in exchange, you need to practice sun farming” (sun farmer, Las Marias). It was a common perception among farmers that sun farming was a prerequisite for receiving state agricultural incentives. One farmer explained that he eliminated shade cover to be eligible for the PRDA incentives.

The land use theme focused on restrictions associated with conservation programs. Farmers were concerned that the programs did not reflect their preferences and that it limited land management autonomy at the farm level. Some felt left out from the design and implementation of MFP and expressed frustrations with the Policy: “They [the government] never dedicated time to speak with coffee growers. How will you, as an agency, make plans with my land without consulting me first?” (shade farmer, Adjuntas). Several farmers echoed the idea of finding a balance between farming and conservation, arguing for “a fair balance between sustainable farming and our ability to manage our land” (SUSH farmer, Maricao). Some farmers suggested that the government should divert conservation efforts to abandoned, rather than to active, agricultural lands, questioning “the need for turning a farm back into a jungle” (SUSH farmer, Adjuntas). Several farmers indicated discontent with the federal shade coffee program: the species of shade trees provided by the agencies required additional

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### FIGURE 3
Coffee farmers in this study discussed what made a conservation program successful. Five themes emerged when we qualitatively analyzed their responses:

| Theme (frequency, %) | Illustrative quote |
|----------------------|--------------------|
| Outreach and education (27%) | “Give people the information, so that they [the farmers] see that shade coffee works” (SUSH farmer, Utuado). |
| Government’s commitment (18%) | “The genuine part of the government, the one that wants to conserve, should be involved. It should not just stay on paper” (sun-shade farmer, Maricao). |
| Financial incentives (16%) | Without incentives, they can bring a thousand shade trees, nothing will happen” (shade farmer, Utuado). |
| Balanced land use (8%) | “I am a farm owner, but they do not grant me rights to cultivate the way I want. The two [conservation and agriculture] should go together, developing a custom of sustainable agriculture” (SUSH farmer, Jayuya). |
| Cooperation among farmers (7%) | “I believe in a community initiative 200%” (SUSH farmer, Maricao). |
maintenance, and some were not quite compatible with coffee farming. In some cases, farmers ended up replacing shade trees with citrus or avocado trees.

The fifth theme addressed cooperation among coffee farmers. A sun farmer from Maricao noted that for conservation programs to work farmers should "play their part". This notion of cooperation was supported by a SUSH farmer from Utuado, who shared that all farmers should reach an agreement on best farming practices because "shade coffee was much better". A SUSH farmer from Yauco commented that he could demonstrate the benefits of shade farming to other farmers.

4 | DISCUSSION

In this study, we explored factors that might influence participation of Puerto Rico coffee farmers in conservation programs. Political characteristics of Puerto Rico uniquely shape the role institutions play in participation. Data from the surveys suggest that state and federal incentives support conflicting farming systems. Many farmers perceived sun farming to be an eligibility requirement for state agricultural incentives. This might explain why a third of our sample practiced both sun and shade farming—this way, farmers could apply for a wider variety of incentives. The majority of the respondents received state agricultural incentives. If sun farming is associated with eligibility for incentives, this farming practice will continue to persist, hindering conservation objectives of shade coffee programs. Government agencies could collaborate on reconciling conservation and agricultural incentives to prevent farmers from having to choose one or the other (Ogg, 2019). Competitive economic incentives remain an important element of conservation programs (Moon & Cocklin, 2011), and policymakers could ensure that adoption of conservation practices does not jeopardize farmers' livelihoods (Wale, 2010). In addition to revising existing incentives for consistency, institutions could promote efforts to diversify livelihoods, including strategies like shade coffee certification, polycultures, and agricultural cooperatives.

The discussion of institutional barriers revealed another vital dimension of a successful conservation program—perceived commitment from the government. Although the role of trust and good governance is widely discussed in conservation scholarship (e.g., Bennett et al., 2019; Prokopy et al., 2019), its discussion in coffee farming is limited. Farmers in our sample expressed doubts that the Puerto Rico Department of Agriculture would support sustainable agricultural practices, favored by the state Model Forest Policy and the federal shade coffee program. The MFP itself was poorly communicated to farmers; the majority of the respondents had never heard of the policy. Further, farmers were suspicious of government’s commitment surrounding the policy. Their skepticism could be grounded: since its establishment, the government entity overseeing the policy has gone through numerous changes in leadership and organizational restructuring (Alvarado Leon, 2018). Perceptions of farmers towards a specific policy might affect their attitudes towards conservation in general (Bose et al., 2016). The perception that governmental initiatives lack the support for proper implementation might diminish the chances of success of current and future conservation programs. Institutions could direct their efforts to build trust with coffee growers and demonstrate their commitment to sustainable farming systems.

Our findings point to the need for increased outreach and availability of information about existing conservation programs. Many farmers in our study were not familiar with existing conservation programs, and only a small proportion participated in the federal shade coffee program. This may explain the high degree of indecisiveness about participation in some groups (i.e., university educated with higher income). Farmers also commented that they lacked training and English language skills to access the information and apply for federal incentives. The federal agencies NRCS and USFWS might benefit from additional outreach efforts and offering trainings on enrollment in programs like EQIP. Similar to coffee farmers in other countries (Gross, Erickson, & Méndez, 2014), farmers in our sample were largely aware of environmental benefits of shade coffee. Yet, they might be skeptical of its economic viability. Outreach efforts could address costs and profitability of shade farming, rather than only focusing on its environmental advantages. Perhaps, environmental agencies could recruit some of the shade coffee growers in the region to act as model landowners (Niemiec, Willer, Ardoin, & Brewer, 2019) who could demonstrate to fellow farmers the functionality of shade coffee system.

Field observations suggest that some farms reported as shade did not necessarily meet the ecological characteristics of a shade farm. Some farmers used plantains as shade cover, but plantains provide limited habitat for species (Schroth & Harvey, 2007). Some farmers shared that shade trees provided by the federal shade program, usually Inga laurina and Andira inermis, were not always compatible with their preferences, and farmers ended up replacing these trees with citrus and avocado. The fruit trees, however, might be less preferable for conservation objectives (Miranda-Castro & Padron, 2005). This incompatibility in preferences might result in the removal of shade trees as soon as the terms of the conservation program expires (Irizarry, Collazo, Pacifíci, Reich, & Battle,
Our study indicates that farmers might define and practice shade farming differently than what is suggested by environmental agencies. Conservation programs need to examine these differences and incorporate them into the design of incentives. Some farmers in our sample advocated for a conservation scheme that balanced conservation and agriculture. Perhaps, a conservation program that encourages a shade coffee system with a partial cover—or semi-shade, as some farmers in our sample reported—could help reconcile these objectives (Moguel & Toledo, 1999). These partially-shaded farms can be profitable for farmers (Jezeer, Verweij, Santos, & Boot, 2017) and provide important ecosystem services like pollination and habitat conservation (Irizarry et al., 2018; Prado, Collazo, & Irwin, 2018).

Our findings echo previous research in Puerto Rico and other coffee growing countries. Financial incentives represent a universal element that farmers and researchers identify as central to conservation programs (Bravo-Monroy, Potts, & Tzanopoulos, 2016; Iverson et al., 2019). Socio-economic characteristics of farmers associate differently with participation. Consistent with previous research (Shinbrot, Jones, Rivera-Castañeda, López-Báez, & Ojima, 2019), educational level of the respondents was not a good predictor. Farming practice, farm size and economic considerations, including current income from farming, strongly influenced willingness to participate. Large-scale farmers might have more land use flexibility to participate. Large-scale farmers might have more land use flexibility to participate (Batz et al., 2005), although some small-scale farmers in our sample also reported willingness to participate.

Our findings revealed a high willingness to participate in conservation programs among several groups of farmers. These results should be taken with caution—willingness does not always lead to actual participation (Floress et al., 2018). Future research could explore the relationship between willingness to participate and variables beyond socio-economic characteristics, for example, environmental attitudes or awareness. Inferences from this kind of study might be further improved by increasing the sample size and distributing the sample more evenly among municipalities. These two modifications would likely help identify stronger predictors of willingness to participate and determine if there are spatial patterns. Municipalities in the remote, mountainous parts of the island might not get the same visitation rates from field agents as municipalities nearby the coast and main roads. Future studies could further explore differences in willingness to participate among farmers within and outside of the MFP boundaries.

Our findings can be used to inform the design of conservation programs in Puerto Rico and other coffee growing countries. The complexity of factors that shape decision-making is not unique to Puerto Rico (e.g., Gross et al., 2014), but our study demonstrates the importance of local, context-specific research to understand participation. Researchers and practitioners need to examine if there are institutional barriers or policy inconsistencies that might hinder adoption. Conservation agencies could assess whether their outreach efforts actually reach prospective participants. To ensure conservation programs align with farmers’ needs and preferences, conservation agencies should involve farmers in all stages of the process, from design to implementation. Particular attention could be paid to integrating perspectives from small-scale farmers as they are often excluded from conservation considerations (Méndez, Bacon, Olson, Morris, & Shattuck, 2010). Regular checks on farmers’ perceptions and evaluation of conservation programs can provide timely feedback on a program’s performance (Bennett, 2016). Coupled with economic incentives, these interactive, bottom up approaches to conservation programs might foment and maintain enrollment.

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CONFLICT OF INTEREST
The authors declare no potential conflict of interest.

AUTHOR CONTRIBUTIONS
All authors were involved in conceiving the idea and designing the study. T.G., A.R., M.M. collected the data. T.G., J.C., A.R., M.M. analyzed the data. T.G. and J.C. led the writing of the manuscript with support from A.T.

DATA AVAILABILITY STATEMENT
Due to possible sensitivity of human subjects’ data, interview files and transcriptions are only accessible to the authors.

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**SUPPORTING INFORMATION**

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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