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Shade-grown coffee in Puerto Rico: Opportunities to preserve biodiversity while reinvigorating a struggling agricultural commodity

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ABSTRACT

Shade-grown coffee contributes to biodiversity conservation and has many ecological benefits. We reviewed historical trends in coffee production and interviewed 100 coffee growers in 1999 to determine current management practices and attitudes toward the cultivation of sun and shade coffee in Puerto Rico. We discuss the outlook for the coffee industry in the 21st century and implications for biodiversity conservation, hoping lessons from Puerto Rico will apply to the international coffee industry. Throughout the 20th century, government intervention, including subsidies and technical assistance, supported coffee farming in Puerto Rico. In an effort to modernize coffee production and increase yields, the conversion from shade to sun coffee plantations was encouraged. Despite government support, the amount of land devoted to this once dominant agricultural commodity declined markedly between 1982 and 2007 (84%), due to labor shortages, low income, and catastrophic hurricanes. We found that a return to shaded plantations would be embraced by most farmers. Growers of shaded coffee were generally happier with their cultivation practices (89.3% satisfied) than growers of sun coffee (60.9% satisfied), valued biodiversity, and were willing to cultivate coffee under shade if given similar incentives to those received for farming sun coffee. The future of the coffee industry in Puerto Rico may depend on government programs that capitalize upon emerging markets for sustainably produced, shade-grown coffee. We conclude that where governments have close ties to the coffee industry, they should strive to wed economic development with the conservation of biodiversity and associated ecological services by providing support and incentives for the production of shade coffee.

1. Introduction

Coffee cultivation in Puerto Rico has a long history of government involvement beginning with the establishment of labor laws in the 1830s compelling landless peasants to work on farms (Wells, 1969) and continuing in the form of subsidies and set prices today. Coffee was introduced to Puerto Rico in 1736, was a major commercial crop by the early 1800s, and had replaced sugar as Puerto Rico's leading agricultural commodity the end of the 19th century (Carrion, 1983). However, its dominance declined precipitously in the aftermath of a series of catastrophic hurricanes that occurred at the turn of the century (1899) and subsequently in 1928 and 1932 (Garcia, 1937). Many farms never recovered, and those that did were undermined by labor shortages and low average yields per hectare (Vicente-Chandler et al., 1968a,b; Serra et al., 1971).

The persistence of the coffee culture in the island can be attributed, in large part, to governmental support. Support for it over the 20th century included high local farm prices relative to world prices, the prevention of imports by a high tax, crop insurance, help from agricultural extension agents, and direct government payments (Vicente-Chandler et al., 1968a,b). A pivotal development to re-invigorate the struggling coffee industry stemmed from the University of Puerto Rico's Agricultural Experiment Station. Aiming to modernize coffee production and to increase yields, researchers at the Station established that higher yields could be achieved by eliminating shade trees (Arrillaga and Gomez, 1942; Abruna et al., 1959), and that intensive coffee management had the potential to increase yields from approximately 220 kg per hectare to 1680–2240 kg (Abruna et al., 1959; Vicente-Chandler et al., 1969). Accordingly, farming coffee without shade (sun coffee) has been encouraged since the late 1960s, with farmers paid to destroy low-yielding coffee trees and to apply more modern cultivation techniques on their farms (Vicente-Chandler et al., 1968a,b). Despite this new governmental effort, the practice

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of intensive coffee production without shade was slow to catch on and promotion of sun coffee cultivation practices remained a concern throughout the 1970s (Gonzalez-Villafane and Zapata-Acosta, 1981). Indeed, widespread conversion to sun coffee did not occur until the latter half of the 1980s. Notable among the changes in the remaining "shaded" coffee farms was that most farmers adopted the government's recommendation of using widely spaced shade trees (*Inga vera*, Inga laurina, or Andira inermes), or bananas and plantains (*Musa* spp.) with total shade not exceeding 25–30% (Vicente-Chandler et al., 1968a,b; Estacion Experimental Agricola, 1999).

This emphasis on sun coffee has occurred despite the deleterious effects of conversion from shade to sun coffee on biodiversity. A multitude of studies have shown that biodiversity elements, including plants (Nir, 1988; Mendez et al., 2007; Philpott et al., 2008a; Correia et al., 2010), insects (Perfecto et al., 2003; Mas and Dietsch, 2004; Gordon et al., 2009; Jha and Vandermeer, 2010), reptiles (Lenart et al., 1997; Borkhataria, 2001; Macip-Rios and Munoz-Alonso, 2008), birds (Parrish and Petit, 1995; Petit et al., 1999; Naidoo, 2004; Tejeda-Cruz and Sutherland, 2004; Estrada and Coates-Estrada, 2005; Gleffe et al., 2006; Greenberg et al., 1997a, others), and some mammals (Daily et al., 2003; Harvey and Villalobos, 2007) are higher in shaded than in unshaded coffee. Furthermore, the conservation of biodiversity may provide ecological services to farmers in the form of pest control; studies have shown that ants, birds, and lizards can decrease the abundance of insect pests in coffee (Perfecto et al., 2004; Borkhataria et al., 2006; De la Mora et al., 2008; Philpott et al., 2009).

Here we discuss the trajectories of sun and shaded coffee culture in Puerto Rico since 1982 and the results of a survey of farmer attitudes regarding the conversion from shaded to sun coffee. We also address the perceived challenges to the coffee industry as indicated by growers and agricultural extension agents surveyed in 2000, the role of governmental programs on the persistence of the industry in the 21st century, and the implications for biodiversity conservation.

2. Methods

2.1. Agricultural statistics

We used the U.S. Department of Commerce (USDC) and U.S. Department of Agriculture (USDA) Census of Agriculture to compile statistics on changes in coffee culture since 1982. The Census was conducted in 1982 (USDC, 1984), 1987 (USDC, 1989), 1992 (USDC, 1994), 1998 (USDC, 2004), 2002 (USDC, 2004), and 2007 (USDA, 2009) and contains statistics on both sun and shaded coffee. We converted land units from cuerdas to hectares (1 cuerda = 0.393 ha). All statistics are from the census for the corresponding year unless otherwise noted.

2.2. Surveys

Farmers were surveyed in 3 Puerto Rican municipalities, Ciales, Utuado, and Jayuya (Fig. 1). We selected names of farmers randomly from lists kept by the Department of Agriculture. We surveyed 100 farmers and also surveyed 5 agronomists from the Puerto Rico Department of Agriculture, the Agricultural Extension Service of the University of Puerto Rico, and the USDA's Natural Resources Conservation Commission to gain additional insight into coffee cultivation practices and government incentives.

The survey instrument for the coffee growers contained 53 questions, which focused on 6 broad themes: background information; descriptions of agricultural practices and land use; assistance provided by the government; use of sun versus shaded coffee cultivation; obstacles to coffee production (e.g. hurricanes, pests, soil erosion); and attitudes toward the conservation of wildlife.

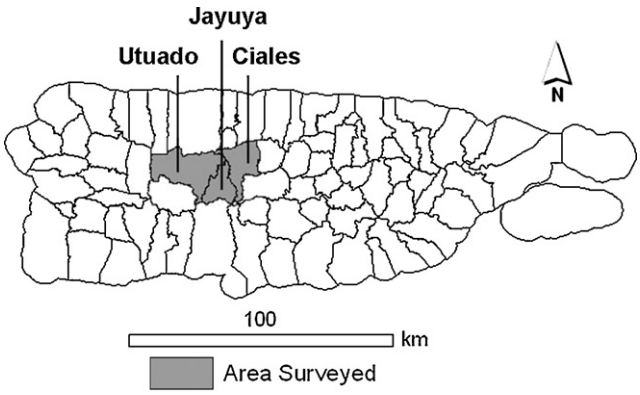

Fig. 1. Map of municipalities included in survey of coffee farmers.

To determine whether farmers practiced sun or shaded coffee cultivation, we asked the question: do you consider your farm to be a sun plantation or a shaded plantation? The surveyor independently placed the farm into one of five categories with a priori designations of shaded or unshaded: (1) coffee trees only (unshaded); (2) coffee with a few bananas, plantains, or other very sparse trees (unshaded); (3) coffee under the shade of bananas, plantains, citrus, or other sparse shade trees (unshaded); (4) coffee primarily under the shade of *Inga vera* (shaded); (5) or coffee under the shade of various types of trees, including native trees, forming a dense canopy of shade (shaded).

We addressed the challenges to coffee production faced by coffee farmers by asking them to use a scale of 1–3 (1 equals "no importance," 2 equals "little importance," and 3 equals "very important") to rate the importance of the following occurrences: erosion, damage caused by insects, nutrient deficiencies, fungus, lack of capital, lack of workers, and hurricane damage. We also asked them to rate the conservation value of the different taxa that occur in coffee (plants, birds, fish, amphibians, reptiles, mammals, invertebrates, and microorganisms) and the attributes they found important for deciding whether to conserve a species. The importance accorded to the problems facing farmers and to the conservation of the various taxa was compared using standard 2-tailed *t*-tests to make pairwise comparisons with Bonferroni alpha-adjustments (Zar, 1996).

3. Results

3.1. Agricultural statistics

According to USDC and USDA Censuses, coffee was the most economically important crop in Puerto Rico from 1982 to 1998, accounting for 24.6–32.0% of total market value. The importance of coffee declined after 1998, however, possibly in response to Hurricane Georges in September, 1998, which caused widespread destruction in the coffee region. In 2002, coffee had declined to only 16.81% of total market value, but increased slightly to 19.11% in 2007. The total value of coffee to the Puerto Rican economy peaked in 1992 at approximately $56.8 million and had declined to approximately $42 million by 2002. In 2007 it was valued at approximately $41.8 million. Coffee was replaced in economic importance by horticultural crops and plantains.

The total number of coffee farms also peaked in 1992 at 11,263 farms. The number of coffee farms in Puerto Rico decreased by approximately 46% between 1998 and 2007, from 10,441 to 5678 (Fig. 2). The average amount of money generated per farm from coffee increased steadily between 1982 and 1998, declined slightly in 2002, but increased by approximately 59.4% between 2002 and 2007.