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Article

Political Ecology of Shade Coffee: Perspectives from Jamaican Blue Mountain Farmers

Wendy C. Willis and Matthew D. Johnson

Current Affiliation: American Bird Conservancy, The Plains, Virginia, USA

Research Undertaken at: Humboldt State University, Arcata, California, USA

Corresponding author. E-mail: wendy_c_willis@hotmail.com

Abstract

Jamaica's Blue Mountains are heralded as one of the world's premier coffee growing regions. Previous ecological research in Jamaica has demonstrated that shade-grown coffee practices provide beneficial ecosystem services for farmers, yet most coffee farms in the Blue Mountains have very little shade. The socio-ecological factors that influence coffee cultivation choices in Jamaica have not been analysed. Using chains of explanation, the aim of this project was to unearth the political, economic and ecological drivers and constraints that inform and influence farmers' decisions for intercropping shade trees amongst their coffee plants. Semi-structured interviews were conducted on farm-sites in the three parishes of the Blue Mountains: Portland, St. Andrew, and St. Thomas. Results from this project reveal that the human-environment interactions of coffee producers are impacted by the interplay of on-farm, on-island, and global forces. This necessitates reframing the value of ecosystem services provided by shade trees into a cohesive argument that resonates with Jamaican coffee industry specialists and the specific regional socio-ecological needs of Blue Mountain coffee farmers. Priorities for change should include: encouraging communities to re-learn the benefits and applications of organic soil fertility and the values of shade trees while exposing farmers to marketing research and strategies for pursuing conservation of coffee niche markets.

Keywords: Shade Coffee, Political Ecology, Social Ecology

INTRODUCTION

In some tropical regions where the volume of coffee production is comparatively low, sparse information is available; in particular, the historically marginalised mountain landscapes of the Caribbean have been mostly overlooked. In Jamaica, several deductive and mainly ecological inquiries have assessed the economic benefits of ecosystem services in shaded coffee farms (Johnson 2000; Kellermann et al. 2008; Johnson et al. 2010; Railsback and Johnson 2014; Davis et al. 2017), yet many coffee farmers in the Blue Mountains fail to adopt shade tree cultivation practices.

Blaikie and Brookfield (1987) developed the political ecology framework known as 'chains of explanation' for analysing the disparities associated with land degradation and the marginalisation in global south communities. This theory can be applied to analyse the interconnected local, regional, and global factors that affect smallholder decision-making processes. In this paper, we use the framing of chains of explanation to analyse how the ecological, socio-economic, and political drivers and constraints faced by farmers in Jamaica's Blue Mountains affect shade tree cultivation in their coffee farms.

Coffee is a tropical plant with enormous socio-ecological impacts ranging from local to global scales. This perennial

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plant can only be grown in moist, frost-free tropical and sub-tropical ecosystems (Wickizer 1951). *Coffea arabica* originated in the mountainous terrain of Ethiopia and the Boma Plateau of Sudan (Wrigley 1988) and evolved to grow within a shaded understory (Wintgens 2004). As demand for coffee increased, coffee cultivators discovered that with addition of agrochemicals it was possible to increase short-term production of the *arabica* varietal without shade trees by growing them in full sun (Willson 1985). This process of agricultural intensification and subsequent deforestation (Perfecto et al. 2009) has led to fewer farms worldwide with shade trees and poses a threat to biodiversity (Rice 1999).

Much research has focused on the ecological merits of shaded coffee cultivation systems, which continue to be threatened by conversion to simpler 'sun coffee' monocultures (Jha et al. 2014). Given the wealth of information about beneficial ecosystem services for humans and the environment, through the inclusion of more trees in tropical agricultural landscapes (Perfecto et al. 1996; Johnson 2000; McNeely and Schroth 2006; Kellermann et al. 2008; Perfecto, et al. 2009; Railsback and Johnson 2014, Vandermeer and Perfecto 2015), why aren't more coffee farmers readily adopting shade cultivation practices?

Authors studying shaded coffee ecosystems recognised the disconnect between information disseminated in the academy and farming practices of coffee growers. This led to integrating qualitative methods and social science frameworks to understand factors that influence a coffee farmer's land use decisions for including or excluding shade trees (Sinclair and Walker 1998; Berkes, et al. 2003; Bacon et al. 2008; Mendez 2008; Jha et al. 2011, 2014).

Nonetheless, relatively little research has focused on micro and macro-level factors that influence a coffee farmer's adoption or retention of shade practices (Blackman et al. 2007; Mendez 2008; Westphal 2008; Aguilar-Støen et al. 2011; Jha et al. 2011; Borkhataria et al. 2012). Instead, social scientists investigated the impact of coffee farmers' local ecological knowledge of trees and how this shaped their tree selection criteria and farming practices. Albertin and Nair (2004) examined the attributes farmers used to select tree species alongside their perceptions of shade tree roles. These preferences were then juxtaposed with socioeconomic data to create a demographic typology that compared income with cultivation choices. Similarly, Muleta et al. (2011) measured Ethiopian farmer perspectives about shade trees by focusing on their levels of traditional knowledge and perceived beliefs about socioeconomic benefits of shade trees. Valencia et al. (2015) assessed the role of knowledge sources and transmission amongst coffee farmers to better understand its role for agroforestry management practices in Chiapas, Mexico. Cerdán et al. (2012) assessed smallholder's local ecological knowledge of tree cover impacts on ecosystem service provisions in Costa Rica.

When authors employed a mixed methods approach for studying coffee systems, their predominant focus tended to centre around a shade plant inventory combined with a socioeconomic benefits perspective (Soto-Pinto et al. 2007; Jha et al. 2011; Muleta et al. 2011; Toledo and Moguel 2012b). Jeezer et. al (2018) analysed the economic performance of small-scale coffee farms in Peru to determine the effects of shade trees and input management on coffee production. Collectively, these authors also couch their arguments by surmising that socioeconomic pressures are the primary variables affecting coffee cultivation practices (Albertin and Nair 2004; Soto-Pinto et al. 2007; Muleta et al. 2011). These findings began to illustrate the complexity of attempting to explain some of the socioeconomic causal mechanisms for farmer shade-management preferences but tended to overlook the interconnected political and ecological barriers affecting shade coffee cultivation.

Borkhataria et al. (2012), Westphal (2008) and Mendez (2008) applied socio-political and socioeconomic frameworks to survey farmer perceptions of shade. Borkhataria et al. (2012) conducted semi-structured interviews with Puerto Rican farmers within the context of a 'post-technification' environment and applied mixed methods to investigate coffee farmer attitudes about converting their sun-cultivated coffee to agroforestry systems while simultaneously quantifying attitudes about conservation values. Their results reveal that farmers are interested in growing shade coffee and that farmer-government dependency influences the type of cultivation practice employed in the field. Westphal (2008) utilised the integration of social, economic and political drivers for investigating cultivation choices on Nicaraguan coffee farms to assess how institutions and structures affect livelihood strategies, which in turn influence associated tree choices on individual farms. Mendez (2008) utilised political ecology and agroecology frameworks to examine multi-scalar attributes affecting shade-tree management choices and soil quality on smallholder farms in El Salvador.

The socio-political history of ecological context of Jamaica makes it a useful case for examining farmers' use of shade in coffee agroecosystems. Chai and Tanner (2011) demonstrated that human settlement and land use patterns in the Blue Mountains have shifted through numerous cycles throughout the last 150 years, with a coffee boom in the early nineteenth century followed by an abandonment of many large farms prompted by emancipation of slaves in 1838; massive soil erosion, and the removal of preferential trade agreements for Jamaica. Deforestation rates in Jamaica were high in the late 1980s and early 1990s, with annual land clearing estimates at 3.9% between 1987-1992 (Tole 2001), though there is some uncertainty surrounding these figures (Evelyn and Camirand 2003). Contemporary Jamaican deforestation occurs mainly in areas with large numbers of small farmers who live and work under resource-poor conditions (Tole 2001). For such a small island, these statistics of degradation have serious implications for watersheds, forest resources and smallholder peasant farmers. Correspondingly, the deforestation of Jamaica's highlands is not an isolated present-day problem, but rather a system with recurring economic and ecological cycles associated with coffee production that can directly impact forest succession and species richness (Chai and

Tanner 2011). As such, the coffee farms of Jamaica's famed Blue Mountains (Figure 1) offer a useful context to attempt to unravel the ecological, socioeconomic, and political drivers and constraints faced by farmers.

METHODS

We conducted fieldwork for this study from June to July, 2013 and in January, 2014. The study area focused on three Jamaican parishes that form the Blue Mountains: St. Thomas, Portland and St. Andrew. The canyons and rivers located within these parishes provide crucial water reservoirs for the capital city of Kingston as well as farming plots for thousands of peasants (Barker and McGregor 1988). These three parishes range in elevation from 0 to 730 m (St. Thomas), 2256 m (Portland), and 1353 m (St. Andrew), with coffee cultivation ranging mainly between approximately 800 and 1200 m. Climate in this region varies considerably depending on elevation and orographic effects, but most coffee farms in the region experience temperatures of 18-25°C and annual rainfall around 100-480 mm, with more cloudy days than at lower elevations on the island. Only small pockets of native forest remain in the coffee cultivation belt, interspersed with coffee farms, dispersed rural housing, and regenerating vegetation usually invaded by non-native plants and used for local harvesting or browsing livestock (mainly goats).

We conducted sixty-two semi-structured interviews: 48 in St. Thomas, 7 in Portland and 7 within St. Andrew Parish. With the aid of a local field assistant, Junior Carson, we used snowball sampling to gain access for interviews with coffee farmers from these regions (Bernard 2001). To compile a broad perspective of Jamaican coffee management styles, we surveyed large coffee estates (>8 hectares), mid-sized coffee farms (2-20 hectares) and small-scale farmers (<2 hectares). Within this dataset, 80% of respondents were male and 20% were female farm owners.

The layout of our interview guide was informed by Sudman & Bradburn (1982). The interview guide covered three broad sections: socio-economic, ecological, and socio-political questions. We asked participants a mixture of open and closed questions designed to unearth farmer motivations and constraints for implementing shade cultivation practices. The chosen interview questions reflected the interdisciplinary perspective of political ecology and ranged from inquiries about livelihood strategies to perceptions of political influence over coffee production techniques to tree preference criteria to ecological factors affecting tree placement in farms. We also collected basic demographic and household primary data for each farmer. Aside from farmer interviews, we also questioned a few anonymous industry informants to cross-reference the information shared by coffee cultivators. The majority (92%) of interviews included a visit to each farmer's coffee parcel with a typical duration of twenty minutes to two hours (depending on respondent's willingness to engage in the questions). The remaining 8% of interviews were conducted over the phone

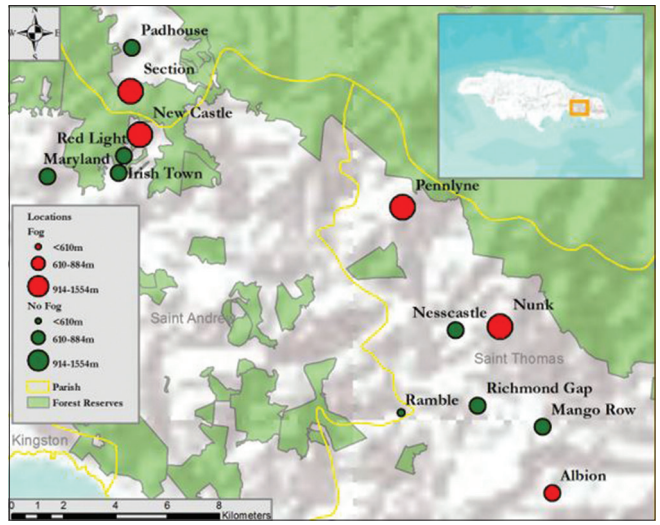

Figure 1
The Blue Mountain study region included communities from Portland, St. Andrew and St. Thomas parishes. In this map, these regions are classified by elevation and local farmer's perceptions of fog as a barrier for including shade trees on their property

and at roadside gathering places. Respondents were guaranteed confidentiality at the onset of each interview.

We transcribed the recorded interviews and inputted them to Atlas ti 7.0 software for qualitative analysis. Excerpts from the transcripts were classified into code families based on barriers to shade, coffee cultivation practices, economics of shade trees, livelihood strategies, politics of coffee production regulations, shade tree preferences and ecological factors affecting coffee farming. We used output from these code families to inductively extract themes and emerging patterns from the transcripts (Friese 2012; Miles et al. 2014). We also categorised each interview by farm type, and the output of queries based on the conglomeration of multiple codes created in Atlas ti were used to assess patterns. The interview data was then triangulated by comparing digital images taken in the field along with participant observations, farmer primary data, basic species composition inventories of shade trees for each farm (planned biodiversity), and information collected from coffee industry informants. This cross-checking of results was utilised to generate a fuller picture of the research setting (Newing 2010).

ARGUMENT

The 62 semi-structured interviews of farmers carried out in the Blue Mountains corresponded to farms that ranged from 300-1500 m in elevation. Approximately one-third of the farmers surveyed were cultivating coffee on less than two hectares. Only four of the 62 farms were less than three years old and not yet producing coffee fruit. Of the 57 visited farms, only one was exclusively organic. The remainder relied on one or several forms of agrochemicals for fertilisation and control of insect, weed, and fungal pests. The farms visited were privately owned, leased, or, in one case, illegally

cultivated on government land. From this diverse dataset and coded analysis of interviews, drivers and constraints emerged and were categorised based on their economic, political and socio-ecological foundations (Table 1).

Socio-Ecological Drivers & Constraints

When farmers discussed ecological factors affecting shade cover, their responses were based on the interplay of abiotic and biotic factors associated with the physical geography and human presence in this steep mountainous terrain. These attributes in turn had major influence on an individual's coffee growing land management techniques.

Abiotic Factors Affecting the Distribution of Shade Trees in the Blue Mountains

In coffee producing landscapes, 'climatic conditions' and 'site conditions' are cited as the most influential abiotic factors shaping the distribution of shade trees (Beer et al. 1997:140; DaMatta 2004). Throughout the Blue Mountains, the most often mentioned climatic conditions influencing the distribution of shade trees were regional microclimates based on slope, aspect, and cooler temperatures at higher elevations. The site conditions that were recurrent during conversations about shade were: erosion control, and damage from hurricanes and tropical storms.

The interviews suggest that the consequences for reduced canopy cover on steep slopes is loss of topsoil and greater risk of erosion. As discovered, this abiotic factor is so widespread in the Blue Mountains that it is reflected in popular folklore. During an interview a Saint Andrew farmer, recounted a local song:

"Muddy water
Muddy water
Running, running to the sea
Muddy water
Muddy water
Taking all my precious soil from me
I will stop the likkle trickle with a barrier
I will check the bigger rushes with a trench
I will work and will not rest
And will do my level best
To stop muddy water from going to the sea…"

The deleterious effects of erosion are compounded by unpredictable abiotic events such as hurricanes and tropical storms. Because many farmers remove competing vegetative cover from their coffee plots, the exposed soil is susceptible to 'rain splash' that facilitates the loss of topsoil during intense tropical downpours (Barker and McGregor 1988:121).

The omnipresent threat of hurricanes and tropical storms is a major driver for the cultivation of shade trees in Blue Mountain coffee farms. Jamaica experiences the direct impact of a hurricane's eye on average every 25 years (Tanner and Bellingham 2006). In 1988, the trajectory of Hurricane Gilbert passed directly over the island and left behind high death tolls and rampant destruction of the forested environment (National Hurricane Center 2012).

To mitigate the detrimental effects of hurricanes and damage from strong wind, farmers are motivated to plant shade trees. Even shade-free coffee farms in the Blue Mountains often include a narrow row of fast-growing trees along the perimeter of their property to buffer strong winds (Harvey et al. 2004).

Table 1
Drivers and constraints that influence shade tree inclusion/exclusion on Blue Mountain coffee farms

Drivers		Constraints	
Socio-Ecological	Protection from strong sun (especially at lower elevation). Tree roots reduce erosion. Trees act as windbreaks.	Socio-Ecological	Shade may reduce yield in some microclimates. Shade may encourage pests & leaf rust.
Political	Free tree planting programs can be provided by government and aid agencies.	Political	Government provides insufficient agricultural extension services. Farmers too busy farming or don't have motivation/funds to attend government workshops. Lack of inter-agency collaboration to organise tree planting programs. Hurricane relief aid often geared to short-term solutions (fertiliser) instead of tree planting programs. Government branding strategies offer no support for organic or shade-grown coffee.
Economic	Trees can provide food security & supplemental income. Trees can provide lumber & supplemental income.	Economic	There are no coffee cooperatives to help promote using trees. Farmers prioritise short-term yield over long-term sustainability of growing coffee under a shade canopy. Japan (primary consumer of Blue Mountain coffee) does not demand shade-grown coffee and/or organically certified coffee beans. Coffee buyers promote 'technified' coffee production from which they profit from the sale of fertiliser to farmers Most intermediary coffee buyers do not endorse or pursue conservation coffee niche markets.

The use of shade trees as windbreaks is consistent with previous findings in coffee agroforestry literature (Willson 1985).

Biotic Factors Affecting the Distribution of Shade Trees in the Blue Mountains

In the Blue Mountains, the dominant biotic factors driving or constraining shade distribution on coffee farms were: fungal disease, tree attributes that are favored for their ecosystem services, and insect pests.

Subsequent to the farm damage from hurricane Sandy in 2012, coffee farmers throughout the Blue Mountains began experiencing massive outbreaks of *Hemileia vastatrix*, or coffee leaf rust. The majority of farmers interviewed were extremely concerned and alarmed by the widespread die-off of coffee plants from leaf rust on their farms. However, the interviews revealed a lack of agreement as to whether shade trees reduce or increase outbreaks of leaf rust. Some believed that, "if it havn' a whole heap of shade and cluster up and sometimes you get a lot of disease, the leaf rust, ya undastand?" Whereas, others suggested, "not sure if sun helps with leaf rust." Johnson et al. (2009) found that leafspot fungi (especially *Cercospora coffeicola* and (*Mycena citricolor*) showed a modest asymptotic increase with percent shade cover, but their survey did not specifically identify *Hemileia vastatrix*, which was not yet problematic in Jamaica at the time.

The majority of tree-crop interactions that provided ecological services to farmers were described as enhancing moisture maintenance and seasonal deciduous shade; these attributes tend to coincide with reasons cited by Soto-Pinto et al. (2007) and are described in Table 2. However, the majority of farmers were not aware of nitrogen fixing properties or the correlation between shade trees and beneficial pest reduction services by birds attracted to farms in part by the shade trees.

Instead, most Blue Mountain farmers did not consider insect infestation to be a major threat to coffee cultivation. Pests such as the coffee berry borer (*Hypothenemus hampei*) have, in recent years, been a major concern in Jamaican coffee (Martin-Wilkins 2012). However, some farmers, especially at lower elevations, suggested shade cover could exacerbate insect pests. For example, one lower elevation farmer explained, "Coffee yes, we need the shade but comes again with another thing: the insects like the shade also. So once you do that again you have to fight the insects with pesticide more than if it is sunlight."

This perception is at odds with the published literature suggesting that insect pests are generally diminished at moderate levels of shade (Beer 1987; Soto-Pinto et al. 2002; Vandermeer et al. 2010; Vandermeer et al. 2014). More specifically, ecological research in Jamaica has shown that insect-eating birds attracted by shade trees can help reduce insect pests and boost farm income in western parishes (Johnson et al. 2010), and to a lesser extent, in the Blue Mountains as well (Kellermann et al. 2008). This discrepancy underscores the inadequacy of dissemination from the academy via the dispersion of agricultural extension services.

Political Drivers & Constraints

Demystifying the Political Economy of Jamaica's Blue Mountain Coffee

In Jamaica, the buyer driven coffee chain is skewed to favour greater profit for transnational corporations. The origins of this monopolistic method of regulation initially began with altruistic origins of Jamaican government purporting to regulate and sanction quality of product produced. It is difficult to disentangle political and economic factors, and indeed, the chains of explanation theoretical framework applied in this research illuminates that Jamaican agricultural policy has historically been interconnected with economic factors that influence shade coffee cultivation practices in the Blue Mountains.

After the abolition of slavery by the British Parliament on all of its colonies in 1834, and the consequent collapse of Jamaica's sugar and banana industries, coffee cultivation increased (Smith 1998; Benghiat 2008). In the eastern mountainous region of Jamaica, cultivators became aware that the high altitude and misty climate of the Blue Mountains creates extremely favourable growing conditions for highly prized, smooth, low acid coffee beans (Wintgens 2004). However, a lack of standardised quality and fluctuating growing conditions threatened the growing reputation of Jamaica's coffee, and the Jamaican state began inspecting and regulating coffee export in an effort to control supply and maintain quality (Williams 1972; Black 1990; Benghiat 2008). In 1948 the Coffee Industry Regulation Act legitimised government power to administer all of Jamaica's coffee agricultural sectors (Coffee Industry Regulation Act 1948). Because the 'coffee product' from the eastern mountains was especially prized, the subsequent 1953 Coffee Regulation Act established geographic parameters for legally defining the 'Blue Mountain' growing region. Evidence indicates that coffee grown under cool cloudy conditions like those of the Blue Mountains may not need as much shade as at lower, sunnier elevations (Beer et al. 1997). Seeds of this reality grew to full pillars of dogma propelled by a global trend toward less shade promoted by perceived increases in yield and disease resistance, propelled by international aid policies (Penelope 1986; Perfecto et al. 1996; Jha et al. 2014,), and locally reinforced by Jamaican agricultural extension information suggesting shade trees are only needed in lower elevation and outside the Blue Mountain region (Budhlall 1986), though more recently this position has softened (Campbell 2010). By the 1980s, many Blue Mountain farms lacked much shade.

In order for roasted coffee to carry the Blue Mountain ® label, the beans must be grown in the geographically delineated region of eastern Jamaican and between 610-1675 meters of elevation (Hughes 2009), without any requirement concerning shade. Specifically, this includes mountainous regions above 600 meters in the parishes of St. Mary, Portland, St. Thomas and St. Andrews. While farmers still maintain control and ownership of their land, the Jamaican government utilised the 1948 Act to establish authoritarian control over most of the Jamaican coffee commodity chain. Specifically, it included

Table 2
Most commonly cited ecological benefits and disadvantages of Blue Mountain shade trees. Farmers did not make reference to nitrogen fixing properties of Gliricidia sepium and Samanea saman

Local Name	Scientific name	Benefits	Disadvantages
Banana & Plantain	*Musa sp.*	Adds to groundwater reservoir, easy to manage, grows quickly, provides money and food for farmer, leaves shelter young coffee plants, bears more when planted with coffee that is fertilised.	Easily damaged or razed by strong winds from tropical storms.
Breadfruit	*Artocarpus altilis*	Large leaves good for shade, possible insecticide value (study needed).	
Cedar	*Cedrela odorata*	Lumber; leaf-dropping season overlaps with period when coffee needs most sun for berry production.	
Citrus	*Citrus x*	Shade, food.	
Silky Oak	*Grevillea robusta*	Shade, lumber, windbreaks.	
Pimento	*Pimenta dioica*	Tall, allowing air to circulate between coffee shrubs and canopy cover.	
Lucinea	*Leucaena leuocephala*	Keeps coffee cool during dry season.	Abundant seeds enable rapid spread of saplings
Mango	*Magnifera indica*	Tall shade, food.	
Ackee	*Blighia sapida*	Tall shade, food.	
Quick Stick	*Gliricidia sepium*	Grows rapidly, windbreaker, property boundary marker, leaf-dropping season overlaps with period when coffee needs most sun for berry production.	
Guango	*Samanea saman*	Lumber, grows high (enabling multi-layer tree canopy); spreading limbs allow air circulation between canopy cover and coffee shrubs; at night leaves close and allow dew to fall on coffee.	
Trumpet Tree	*Cecropia obtusifolia*		Large leaves create too much shade.
Pear (Avocado)	*Persea americana*	Food source.	
June Plum	*Spondias dulcis*	Leaf-dropping season overlaps with period when coffee needs most sun for berry production.	
Fig	*Ficus sp.*		Roots compete with coffee roots for nutrients.

the requirement that all Jamaican coffee growers must be registered with the Coffee Industry Board (CIB).

The CIB maintains control of the intellectual property rights (also known as geographic indications) for the branding of the majority of coffee produced within the politically delineated Blue Mountain geographic region (Benghiat 2008; Hughes 2009; Teuber 2010). By strategically branding Blue Mountain Coffee ® as an intellectual property, the Jamaican government effectively created and maintained a perceived level of high quality and status for its export product. As a Canadian-Jamaican coffee business man informed me, "The CIB verifies the grade and quantity of the coffee being shipped."

Pricing for a box (60 lbs) of ripe coffee berries from the Blue Mountains depends on the elevation at which it was grown (Benghiat 2008). During the summer of 2013 coffee cultivation was dwindling at lower elevations (such as Mango Row, Ramble, Section and Albion). In these areas farmers were discouraged by lower prices paid for their crop ($28 USD per box of ripe coffee berries). Whereas, in Nunk, Pennlyne Castle and Section, the majority of arable land was under production and here where the farmers are paid more for their crops ($32-$35 USD per box of ripe coffee berries), the least amount of trees were observed. A farmer growing coffee in Nunk said that if he had access to more property he would expand his farm except that, "they [the government] put restriction on us, we can't cut no more land." This farmer was referring to government protected areas above five thousand feet (Figure 2).

In 1983, the CIB deregulated certain sectors of Jamaica's coffee commodity chain. Until this point, the CIB managed and owned all of the processing facilities where removal of coffee from its fruit flesh (pulping), drying and hulling occurred, and it was responsible for the purchase of all ripe coffee cherries from farmers. Following this partial deregulation of the CIB, private entities were able to apply for licenses to purchase raw beans from farmers, operate processing facilities and cultivate export markets abroad.

Only four of the farmers interviewed had sufficient resources, appropriate licenses, and infrastructure to process their own coffee berries[1]. Because processing licenses are costly and require growers to produce at least 10,000 boxes of coffee, the remaining farms relied on privatised coffee buyers that are licensed by the CIB to purchase and process their ripe coffee berries.

Agricultural Extension

Generally, farmers' perspectives were that their government (in particular, the Coffee Industry Board) was not endorsing the cultivation of shade coffee. In Mango Row, whenever asked, "*does the CIB encourage you to plant more shade trees,"* the type of response was, "no they don't really encourage us. But we know that planting shade is central. Because if you notice if you have coffee and just plant it on a plain, it didn't grab.

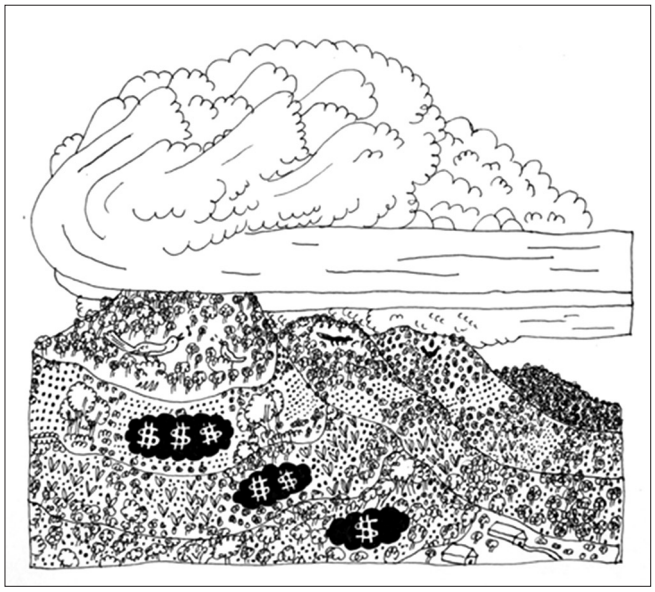

Figure 2
Depiction of Jamaican Blue Mountain Coffee pricing based on elevation. $$$ represents the highest elevation belt (3,000-4,000 feet) where coffee is permitted to be grown by government and is the most lucrative area for growing this product. To protect watersheds and keep ecosystems intact, the Jamaican government put into protection all land above 5,000 feet. Illustration by Wyatt Hersey

And if you don't plant a major tree like that, it don't come to nothin'."

The reach of extension services and support from the CIB appears to vary with farm size. Farmers with less than three acres of coffee crops consistently mentioned to us that they did not receive support from CIB extension officers; this absence of technical assistance was most evident on small farms where owners were unsure of how to properly prune their coffee or shade trees. Whenever questioned about extension services and the endorsement of shade trees, smallholder farmers responded: "CIB is only helping the bigga man." In contrast, a few cultivators with farms larger than 2 hectares acknowledged their intermittent access to agricultural extension services. The omnipresent frustration discussed by farmers was also compounded by the compulsory 'sinking fund', or tax applied to each box of coffee berries sold to the coffee selectors. Farmers explained that the $91 Jamaican dollar tax ($0.95 USD in 2013) deducted from the sale of a box of coffee is supposed to finance extension services. Although, as previously mentioned, "but them not come look upon your farm."

Nonetheless, the larger farmers also complained about the lack of efficiency and presence of the CIB throughout their region. In Portland Parish a large-scale farmer confirmed this by poignantly stating, "Why is there no research? I suspect they cut the funding, long term. It's not just last year. It's long term absence of funding. But I think it is more than simply funding. I think it's been a bit of a political thing. Agriculture is where we are coming from, not where we are going to." [2]

Farmer interviews suggested that inter-agency collaboration between the CIB, RADA (Rural Agricultural Development Authority) and the Jamaican Forestry Department appears to be uncommon. The Ministry of Forestry also promotes tree plantings, and in some cases provides saplings and labour for shade trees on coffee farms, though these are often non-native species. Of the 62 farmers interviewed, two mentioned the Jamaican Forestry Department. Both of these farmers cultivate coffee in Portland and had capital resources and farmed more than five acres.

Guango (*Samanea saman*), blue mahoe (*Talipariti elatum*) and cedar (*Cedrela odorata*) are the only three native Jamaican species regularly regarded by farmers as useful for shading coffee plants. During interviews, blue mahoe was found on more coffee farms in St. Andrew Parish, whereas guango trees were detected at lower elevations within St. Thomas parish and cedar, due to its economic value as a lumber tree was found throughout all Blue Mountain parishes. Some farmers indicated a desire to plant guango, but there are barriers for farmers to access guango and blue mahoe within St. Thomas. When inquiring about the absence of guango, it was explained that, "me don't see these people really plant it as shade in the coffee. You would have to go out and get it," as well as, "guango is very good but we don't have a lot of guangos here."

> *Why?*
> "I don't know…. from my father's days I haven't seen much guango around here."
> *"Were they cut down?"*
> "No we wouldn't cut them because the guango is a very good shade and them don't really hang low, they grow high. The guango tree is very cool and don't really make anything happen to the coffee because the tree they high so they can get a lot of ventilation and spread out."
> *"Would you plant guango if you had access to it?"*
> "We happy for some guango on this side because we have some ridges and gulleys which other trees easily wash away."

This dialogue illustrates that farmers would be willing to include guango on their farms. However, they do not have access to native trees. This access is in part impeded by a lack of nurseries. Collectively, these issues underscore the point that access to existing services is a significant constraint on the cultivation of shade tree on farms in the study area.

The Disease

Compounding the inadequate dissemination of the benefits of shade trees by extension services, the widespread occurrence of coffee leaf rust (*Hemileia vastatrix*) was causing concern that excessive shade could exacerbate the disease. During the period of interviews, apprehension for this disease had prompted some recommendations for a *reduction* in shade, especially at middle elevations. In addition, some farmers described that extension services recommended the use of synthetic fungicides to combat the devastating disease.

Avelino et al. (2004) suggest that whether employing shade or sun coffee cultivation, it is important to acknowledge that both require different crop management strategies for

controlling the spread of this disease. Strategies promoted by the CIB for mitigating the leaf rust epidemic in Jamaica were contrary to recommendations in scientific literature (Avelino et al. 2004; Soto-Pinto et al. 2002); this contradiction may be due to the fact that leaf rust research throughout the Americas is localised and information is not often disseminated amongst countries. Coupled with the endorsement of synthetic fertiliser application in coffee fields, an outdated leaf rust pamphlet available on the CIB's website (CIB 2012) and leaf rust posters encountered at local gathering sites, these pieces of information demonstrated that at the institutional level, there exists a lack of understanding surrounding the pathology and spread of leaf rust as well as its complex relationship with shade management.

Economic Drivers & Constraints

Not all respondents were full-time coffee growers. Two thirds of those interviewed relied on supplemental incomes to sustain their households. Fifty of the interviewees were male and the remaining 12 were females. Further, three fourths of the farmers were above the age of forty, suggesting that coffee farming is not attractive enough to recruit younger farmers. Eight farmers confided that they were "throwin up da farm" (abandoning their coffee farms) because of a lack of financial incentive to continue cultivating coffee. Integrating these demographic variables with the interview responses and evaluation of on-farm, on-island and global forces revealed several economic forces driving and constraining shade coffee cultivation in the Blue Mountains.

The Land of Fruit Trees & Driving Forces for Shade Cultivation

For many medium to large size coffee farms in the Blue Mountains (> 2.4 ha), a delicate tipping point exists where value-add from shade trees can become a barrier to profit and yield, though full understanding of the benefits of shade trees was lacking. As observed in other coffee growing regions, the belief that increased shade density reduces coffee berry yield (Perfecto et al. 2005) was prevalent among those interviewed, and was the primary constraint on motivation for planting more shade trees. Small farmers (< 2 ha) felt that they were trapped in a low-income and low-yield conundrum; their slim profit margins have magnified this economic desperation and increased the fundamental need to rely on food-bearing trees.

Prior research reveals that the primary economic drivers for including shade trees on small coffee farms throughout the world is their associated value for lumber or fruit, and as a risk aversion strategy (Perfecto et al. 1996; Albertin 2002; Rice 2011; Davis 2017), with less recognition of their ecological benefits to the farm. The interviews and farm visits in the Blue Mountains also demonstrated that the majority of shade trees on coffee farms were non-native (in many cases pan-tropical) fruit and timber trees (Table 3), some of which are unique to the Afro-Caribbean agricultural legacy in Jamaica (Carney and Rosomoff 2011), and relatively few of them were native 'forest remnants' (Bentley et al. 2004:242).

Cedar (*Cedrela odorata*), the most widespread lumber tree recorded on farms, is one of the few native trees that Blue Mountain farmers retain on their land when clearing and making room for coffee. These trees are valued as a long-term investment for selling or for household uses because the "boards make house and bed". Contemporary research suggests that native shade tree species may provide the most ecological benefit and aid in pest control (Narango et al. 2019), but this research work has not typically also considered the breadth of value of trees to farmers, and to date very little of this work has been conducted in the Caribbean (Davis et al. 2017).

Within the Blue Mountains, inflated costs for staple foods (such as flour, rice, bread, canned foods) encourages farmers to adapt food security mechanisms on their cultivated landscapes. This risk avoidance strategy was explained as, "if you just plant coffee alone, when the coffee finish, there is nothing else there." However, due to poor transportation infrastructure within the Blue Mountains (such as roads washed away from landslides, lack of reliable transportation for access to urban markets), the economic value of fruit products outside of the farm is often underutilised (Davis et al. 2017), and the majority of fruit grown on coffee farms (that did not decompose in the field) is consumed by the primary household.

Jamaican food staples include boiled starchy tubers such as yams (*Dioscorea cayenensis*) and dasheen (or taro, *Colocasia esculenta*), often grown on the margins of coffee farms, as well as fruits such green bananas and breadfruit, which are often grown as shade trees. Bananas were preferred over breadfruit trees as shade on coffee for several reasons: breadfruit requires several years of growth and development to produce fruit and necessitate more care and management. Of these two fruits, when farmers were asked about 'shade' in all regions and elevations gradients, overwhelmingly the consensus from farmers was that bananas are the ideal shading tree[3]. Interviewees extolled the benefits of bananas by proclaiming it the 'quick shade' ideal for planting amongst young coffee starts, incredibly easy to propagate, a source of surplus cash and, for its ability to quickly produce

Table 3
Fruit & timber trees most commonly mentioned for intercropping on Blue Mountain coffee farms

Local name	Scientific name	Native or non-native
Banana & Plantain	*Musa sp.*	Non-native
Citrus	*Citrus sp.*	Non-native
Ackee	*Blighia sapida*	Non-native
Pear (Avocado)	*Persea americana*	Non-native
Mango	*Magnifera indica*	Non-native
Otaheite apple	*Syzygium malaccense*	Non-native
Breadfruit	*Artocarpus altilis*	Non-native
Jackfruit	*Artocarpus heterophyllus*	Non-native
Peach	*Prunus sp.* (only above 1200 meters)	Non-native
Cedar	*Cedrela odorata*	Native
June Plum	*Spondias dulcis*	Non-native

fruits within ten months of planting. Their perceptions of the economic value of banana are confirmed by empirical data in other regions (van Asten et al. 2011). While banana may provide some ecological benefits (e.g., protection of soil and mulching, [Jassogne et al. 2013]), banana does not help build soil fertility, a perennial challenge among those interviewed.

The Fertilizer Trap & Economies of Scale: On-Farm Economic Constraints to Shade Cultivation

The second most conspicuous constraint perceived by farmers in the study was soil fertility. The majority of interviewees mentioned that they could not effectively grow coffee without using synthetic fertiliser; in Mango Row almost every farmer vocalised a need for 'help' with chemical inputs after natural disasters. One farmer from St. Andrew went so far as to beg for the money to purchase a bag of fertiliser. To maintain constant yields, farmers must be able to provide the high nutrient demands required by coffee plants (Barham and Weber 2012). In other coffee growing countries, agricultural and environmental research has established that soil fertility on coffee farms can be maintained without synthetic fertilisers, by the application of organic inputs and the use of nitrogen fixing shade trees (Rice and Ward 1996; Beer et al. 1997; DaMatta 2004; Perfecto et al. 2005). In the Blue Mountains, this reality was clearly under-recognised, again illustrating a shortcoming in political and informational support for farmers.

The majority of farmers interviewed were unaware of the nitrogen-fixing benefits of certain shade trees and leguminous plants. Less than ten farmers surveyed discussed the use of homemade compost remedies. The few who did compost had learned how to do so from other farmers or environmentalists. Over all, the application of fertilisers was perceived as the only means to maintain consistent levels of coffee berry production and lamented as the most expensive input for growing coffee.

From a market perspective, a reliance on fertiliser, especially for small scale farmers, is entrenched over other means of maintaining soil fertility by political and market forces: a bag of imported agrochemicals generates more profit for green coffee bean buyers and international companies. Industry informants and farmers explained that licensed coffee buyers have sufficient liquidity to purchase agrochemical inputs at bulk rates and resell this product with a markup to small scale farmers through a credit based-system. Additionally, production costs are compounded due to a lack of collective bargaining power of small scale coffee growers. The 'farm-gate' prices paid to them by coffee selectors was lower than the negotiated prices received by larger farms.

In the aftermath of the damage caused by Hurricane Sandy, Fersan Fertilizer Company[4] donated 1,000 bags of fertiliser and the Jamaican government purchased 900,000 kilograms to donate to farmers in the most heavily affected regions of the island, specifically in St. Thomas, St. Andrew, Portland, St. Catherine, St. Ann and Clarendon (JIS 2012). Political backing viewed this fertiliser support strategy as a means "to assist farmers to get back into production in the shortest possible time" (JIS 2012). However, these short-term political solutions do not take into consideration the long-term economic and ecological consequences of maintaining soil fertility solely by external chemical inputs. This issue could have been partially mitigated by providing native nitrogen-fixing saplings adapted to withstand hurricanes. This lack of recognition of ecological benefits of shade, in theory, could be addressed with effective farmer trainings and access to tree plantings, but these services have generally been lacking in Jamaica.

Moy Hall Cooperative & the Privatisation of Coffee: On-Island Constraints to Shade Cultivation

Beuchelt and Zeller (2011) advise that certification schemes alone cannot curtail the low revenue from coffee. Instead, investments should be in the form of farm and business management skills. Blue Mountain interviewees explained that after the semi-deregulation of Jamaica's coffee sector, coffee selectors sometimes provide technical assistance and workshops as a recruitment incentive. However, these services did not include farm business and management skills nor do coffee selectors provide access to tree plantings or information about cultivating shade coffee.

In response, farmers were asked if there were community-based programs to teach farmers about the merits of shade trees. A long-standing coffee farmer in Richmond Gap recounted that during its early successful days, the now defunct Moy Hall Coffee Cooperative used to invest in trainings, equipment, and also provided member farmers with free shade trees.

Farmers throughout St. Thomas attributed the demise of Moy Hall to 'bad management' associated with embezzlement and corruption. In the last few years of its existence, this cooperative was managed by the upper echelon of Jamaica (instead of by local, mountain community members). As funds were misallocated and misspent, debt accrued. To reconcile this dilemma, multi-lateral aid funding was provided by the EU to resuscitate Moy Hall. This transnational 'eco-governmentality' approach for bolstering local economies failed (Goldman 2001).

Since the collapse of the Blue Mountain's Moy Hall coffee cooperative, farmers acknowledge their community's lack of bargaining power for incentivising and implementing a shade coffee certification scheme. Consequently, the majority of coffee growers in the Blue Mountains do not benefit from producer-level benefits of sustainability certification (Blackman and Rivera 2011) such as Rainforest Alliance or Smithsonian's Bird Friendly label, nor are they capturing greater profit margins within the coffee processing stages through forward integration of the commodity chain (Talbot 2002).

The Asian Tiger & Global Constraints for Shade Coffee Cultivation

In 1984 the Overseas Economic Cooperation of Japan (OECF) loaned the Jamaican government 5,941,000 yen (~$27,000 USD in 1984) to expand coffee cultivation (via deforestation) in marginal and/or erodible terrain (Lundy 1999). Japan's penchant for this gourmet coffee encouraged a direct trade for

green coffee beans as a method of repayment (Black 1990). To date, "because the Blue Mountain coffee is a highly prized luxury good in Japan, demand is price inelastic and consistently exceeds available supply by a large margin" (Black 1987:5). Approximately 80-90% of dried Blue Mountain green coffee beans are purchased by Japan (All Japan Coffee Association n.d.; Marshall 1983; Black 1987; Benghiat 2008), but Japanese consumers as yet have shown little interest in a shade coffee, limiting the market incentive for shade exerted by other export markets. This market monopoly is vulnerable: due to lack of a diversified market, if Japan's economy weakens, so will Jamaica's coffee sector.

Jamaican farmers, government employees and coffee buyers adamantly believed and championed that their coffee is the world's most premier product. Farmers boasted that, "the Japanese are experts... the world experts on coffee and they want the best". Alas, this domestic pride for Blue Mountain coffee might in part foster a complacency that inhibits innovation and progress towards experimenting with and pursuing sustainable modes of shaded coffee certification and production. This mindset could also suppress the search for new niche markets that mirror current trends in consumer interests, including certified shade grown and organic coffees, which are among the fastest growing coffee sectors in the world (Van Loo et al. 2015). After all, if Japan, the primary purchasing agent does not specifically request shade coffee as a finished product, farmers, the CIB and buying agencies may feel no need to challenge the status quo.

CONCLUSION

As conveyed throughout, analysing the interplay of the political, economic and socio-ecological drivers is critical for generating 'chains of explanations' that in turn can lead to understanding the factors governing a farmer's choice to include shade trees on their coffee farms. The demographic analysis of the interviewed farmers indicated that the majority of growers have been cultivating coffee on and off as a lifelong occupation. These farmers have seen many price fluctuations for Blue Mountain coffee. Unfortunately, as costs of production become inflated and fertilising becomes more inaccessible to small scale producers hindered by oligopolistic market forces (Piyapromdee et al. 2013), the Blue Mountain landscape begins exhibiting symptoms of degraded soils and overtaxed coffee plants that are susceptible to leaf rust pandemics. As this vicious cycle generates a coffee bean scarcity compounded by rising prices for boxes of coffee, farmers gain a renewed hope that this tropical commodity will once again become profitable, prompting more planting with inadequate measures to maintain soil fertility, and the cycle is once again repeated.

Politically, Jamaica's Coffee Board's (CIB) institutional endorsement for high input, industrial-scale farming further validates planting sun coffee. Reduced extension services and insufficient financial resources for sustainable coffee cultivation research serve to further perpetuate a sun coffee paradigm. In the process of maintaining an exemplary geographic indication standard for the Blue Mountain coffee label, the CIB has committed minimal institutional energy towards developing ecologically sound strategies for producing shade coffee (be they extension services or certification schemes).

Throughout the last four decades, the maintenance of a lucrative coffee export economy in Jamaica can be attributed in large part to extensive government backing. One could argue that the CIB exhibited brilliant providence in branding Blue Mountain coffee. On the one hand, Jamaica made moves economically and politically to position itself favourably (despite some of the geographical and ecological limitations imposed by being an island). However, socio-economic inequities and power imbalances within Jamaica do not enable greater profit margins to reach small-scale farmers, a reality likely operating in many other systems marked by historic coloniality. The current system favours expensive licensing geared towards large-scale farming. Consequently, small-scale farmers receive sub-par financial returns on their crops and are politically constrained from forming cooperatives. These marginalised growers are unable to directly export their coffee beans and are thus reliant on the intervention of the government.

Unfortunately, because of the political and economic structure of Jamaica's coffee sector, both government entities and the privatised market force perpetuate a technified coffee production ideology in which small farmers, especially those at lower elevations, pay high prices for agrochemical inputs and yet are paid comparatively little money for their coffee. In contrast, large-scale coffee producers at higher elevations can potentially afford shade-friendly certification and licensing fees. However, these farmers revealed that they were not very inclined to pursue these avenues because of a perceived marginal profit gain that outweighs effort.

Because coffee cultivation plays such a large role in the Blue Mountains' agricultural sector, encouraging farming techniques that are less environmentally destructive and that incorporate agroforestry practices is of utmost importance. As previously mentioned in the social ecology section, evidence from interviews suggests that there is still a small reservoir of local ecological knowledge associated with the benefits of shade trees. Sadly, as the research demonstrates, the benefits of these ecosystem services are being stymied on several cultural, economic and political fronts.

Therefore, the academy and political institutions need to find a formidable method of re-framing the value of ecosystem services provided by shade trees into a cohesive argument that resonates with the specific needs of Blue Mountain coffee farmers. For instance, the majority of interviewees expressed that they pursue a farming lifestyle because it enables them to be mostly autonomous within an oppressive system. Thus, couching the soil fertility and nitrogen-fixing shade tree line of reasoning through the lens of independence and economic self-sufficiency is one alternative. Other innovative efforts to empower rural populations and reassert agency with grassroots conservation measures, such as the successful tree-planting efforts of the Greenbelt Movement (Taylor 2013), have

proven effective. Likewise, casting the value of shade trees for attracting insect-eating birds as a tool to liberate farmers from reliance on government-regulated pesticides, coupled with programs providing farmers with sapling trees, could resonate and benefit farmers and the environment alike.

NOTES

1. Since the partial deregulation of the CIB in 2001, the purchase of coffee berries is privatised. Prior to this, berries were purchased by the government-owned processing facilities and the now defunct Moy Hall Coffee Cooperative.
2. According to an interview with a CIB employee, the Coffee Board's involvement with farmers has decreased since its partial deregulation in 2002. Consequently, as of 2004, the CIB is solely responsible for the regulatory actions associated with coffee production and exportation. An informant from the private coffee sector explained to us that, "the [coffee] industry has been divested so that the government's role is almost insignificant. It's all been privatised." However, the market sector fails to compensate for the lack of political backing for extension services.
3. Conversely, in the Nicoya region of Costa Rica Albertin (2002) claims that Inga sp. are the preferred best shade species by farmers. Inga with banana is also by the far the most common in central and western Jamaica (Johnson et al. 2010). In Africa the benefits and drawbacks of coffee-banana intercropping technique have also been described in Ugandan smallholder farming systems (van Asten et al. 2011).
4. The majority of fertiliser used by Jamaican coffee growers is purchased from the Chinese company Fersan. Their product is imported from China and packaged in Kingston, Jamaica for sale throughout the island.

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