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RESEARCH ARTICLE

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Improving smallholder livelihoods and ecosystems through direct trade relations: High-quality cocoa producers in Ecuador

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Abstract

Global trade in niche commodities has increased the influence of consumers' choices on land use change and livelihoods in developing rural areas. New niche commodity markets for fine cocoa—produced by old tree varieties frequently grown in shaded agroforestry systems—create more direct linkages between producers and buyers. We explored the socioeconomic and environmental outcomes for cocoa smallholders that participated in direct trade relations compared with smallholders that sold through mainstream markets. Household interviews were conducted with cocoa smallholders in northern Ecuador. Biodiversity conditions at farm level were monitored for 75% of surveyed households. Using a counterfactual based on genetic matching, we found that smallholders engaged in direct trade (a) captured superior prices for cocoa sales; (b) had greater access to agricultural training, technical assistance, and improved social networks; and (b) applied more nature-friendly management practices, compared with smallholders selling through mainstream markets. However, a strong overlap between direct trading practices and organic certification made attribution of environmental benefits difficult. This overlap likely explained why farmers engaged in direct trade used more organic fertilizers and less herbicide. Shade level and plant species richness and abundance in plantations were unrelated to market participation. Additional qualitative analyses suggest that certification facilitates engagement in direct trade and that some direct buyers request certification. This study provides insights on the potential of developing value chain innovations for high-quality commodity trade. The success of value chain innovations hinges on the competitiveness of farmers' cooperatives and involvement of governments, nongovernmental organizations, and private actors.

KEYWORDS

agroforestry, certification, direct trade, Ecuador, fine cacao

1 | INTRODUCTION

Smallholder agroforestry systems are widespread across the tropics. The intentional integration of trees in orchards, woodlots, and home gardens provides an opportunity to consolidate agricultural production and biodiversity conservation in human-dominated landscapes. Indeed, many scholars have argued that agroforests can maintain high levels of biodiversity and ecosystem services supply, while supporting livelihoods of local communities (Bhagwat, Willis, Birks, & Whittaker, 2008; Fischer et al., 2008; Perfecto, Armbrecht, Philpott, Soto-Pinto, & Dietsch, 2007; Schroth & Harvey, 2007; Steffan-Dewenter et al., 2007; Tscharntke et al., 2011; Tscharntke et al., 2015; Vaast & Somarriba, 2014). Yet smallholders struggle worldwide with low access to credit, technology, and market outlets. The growing concentration of value chains and downward pressure on prices meanwhile increase farmers' vulnerability to volatile international markets (Hernández, Martínez Piva, & Mulder, 2014). As a result, many smallholders convert shaded agroforests to more intensively managed plantations by reducing the number of shade trees, attempting to secure short-term income (Clough, Faust, & Tscharntke, 2009; Philpott et al., 2008; Steffan-Dewenter et al., 2007; Vaast & Somarriba, 2014). This trend threatens the resilience of tropical agricultural landscapes, while failing to ensure more stable household incomes (Jacobi et al., 2014; Tscharntke et al., 2011).

Governments, corporations, consumers, and scholars alike have expressed concern about the impacts on sustainability of highly concentrated global commodity value chains (Lambin & Thorlakson, 2018). Two major market-based governance mechanisms have emerged that aim to increase the social and environmental benefits of tropical commodity markets: voluntary sustainability standards and direct trade of high-quality agricultural products in specialty markets (Ingram, Van Rijn, Waarts, & Gilhuis, 2018; Thorlakson, 2018). Private corporations promote sustainable practices to consumers by means of sustainability standards with specific certification labels, such as Fairtrade, Organic, Rainforest Alliance, or UTZ certified (Potts et al., 2014). Specialty markets meet rising consumer demands for high-quality agricultural products that are sourced sustainably and often that originate from specific *terroirs* (Lambin, 2015). Manufacturers establish direct trade relationships with producers, thus involving no or few intermediaries, and commit to improve the social, economic, and environmental conditions in producing regions. Farmers that participate in these alternative market channels may receive price premiums for certified or high-quality products and may benefit from additional agricultural training, reinforced social networks, and access to credit (Gereffi, Humphrey, & Sturgeon, 2005; Lee, Gereffi, & Beauvais, 2012). Recent studies have found mixed evidence on environmental and socioeconomic impacts of certifications and voluntary certification programs: They sometimes have positive impacts but are not a panacea to improve social outcomes (Blackman & Naranjo, 2012; Blackman & Rivera, 2010). A recent meta-analysis of 24 unique certification programs reported positive outcomes for 34% of response variables, with inconsistencies across cases (DeFries, Fanzo, Mondal, Remans, & Wood, 2017). A few studies have explored the outcomes of direct trade of high-quality agricultural products for specialty markets, reporting ambiguous outcomes (Borrella, Mataix, & Carrasco-Gallego, 2015; Hernandez-Aguilera et al., 2018; le Polain de Waroux & Lambin, 2013; Neilson & Shonk, 2014; Tobin, Brennan, & Radhakrishna, 2015). To our knowledge, no peer-reviewed study has yet compared economic, social, and environmental outcomes of direct trade of high-quality cocoa beans versus mainstream trade. This emphasizes the need for rigorous analyses and independent evaluation to assess effectiveness of market-based interventions, especially direct trade in high-quality specialty markets.

This study took the case of cocoa smallholders in northern Ecuador. We aimed to evaluate the socioeconomic and environmental outcomes of direct trading relationships, focusing on the impacts of specialty markets of fine cocoa beans versus mainstream trade of bulk cocoa. Constructing a credible counterfactual based on a statistical pair matching method, we compared households engaged in direct trade and households selling to the mainstream market in northern Ecuador. As direct trade relations and certification schemes were partially overlapping in our region, additional qualitative data were collected to refine and interpret our quantitative results. We conducted in-depth interviews and subsequently organized a workshop with international market actors, focusing on environmental, economic, and social aspects of the Ecuadorian cocoa market. We also relied on secondary sources, including scientific, governmental, and private publications. Section 2 describes the organization of the Ecuadorian cocoa sector and details the hypotheses tested in this study. This study offers insight on the potential of developing value chain innovations for high-quality agricultural commodities, such as direct trade schemes that include environmental specifications into producer–manufacturer contracts.

2 | BACKGROUND

2.1 | Ecuadorian cocoa sector

Cocoa remains an agricultural commodity produced mainly by smallholders: an estimated five to six million farmers who own on average 3 ha of land produce over 90% of world's supply (WCF, 2013). Ecuador has a long tradition of cocoa production, providing up to 50% of world supply during the 19th century (Poelmans & Swinnen, 2016). Attacks of fungal pathogens, namely, witch's broom (*Crinipellis perniciosa*) and frosty-pod (*Moniliophthora roreri*), decimated many plantations and led to the collapse of the industry by the 1930s (Griffith, Nicholson, Nenninger, Birch, & Hedger, 2003). Today, cocoa still serves as a cash crop for about 100,000 small- and medium-size Ecuadorian farmers that cultivate an estimated 490,000 ha (ESPAC, 2014). Although in 2015, Ecuador was responsible for only 6% of global exports (261,000 of 4,251,000 tons), it remains the world's largest producer of fine cocoa beans originating from the genetically distinct *Nacional Forastero* tree (about 60% of global supply) (ANECACAO, 2016; FAO, 2014; ICCO, 2016). Chocolatiers and chefs worldwide demand these beans for their unique taste and floral aromas. High-quality sustainable dark chocolates have gained popularity among urban consumers, resulting in a rising demand for fine cocoa beans of known origin (Daniels, Laderach, & Paschall, 2012; Lambin, 2015).

In contrast with rising demand, supply of high-quality Nacional beans from Ecuador has decreased. In an attempt to increase short-term income, many Ecuadorian farmers have replaced Nacional varieties with the presumably more productive and disease-resistant hybrid variety named CCN-51 (Griffith et al., 2003; Melo & Hollander, 2013). This clone produces beans with a sour or bitter taste and lacks the flavorful aromas present in Nacional beans. Economic marginalization, genetic erosion of the original genotype, changes in management practices, and the continued mixing of varieties resulted in the progressive loss of Ecuadorian cocoa quality (Deheuvels, Decazy, Perez, Roche, & Amores, 2004). The International Cocoa Organization has downgraded the country's cocoa rating from 100% fine flavor to 75% in 2004 and has cautioned against further downgrading (ICCO, 2015). Today, CCN-51 beans compose 30% of total exports, compared with Nacional beans with ascending quality ratings: ASE (*Arriba Superior Epoca*, 47%), ASS (*Arriba Superior Selecta*, 18%), and ASSS (*Arriba Superior Summer Selecta*, 5%) (ANECACAO, 2016). Nacional and CCN-51 varieties are complementary in the Ecuadorian market, as each satisfies the demand of a different market.

Scholars have cautioned that the area expansion of CCN-51 may concur with a decrease in shaded agroforestry systems (Bentley, Boa, & Stonehouse, 2004; Useche & Blare, 2013). As CCN-51 is less susceptible to sun damage, it is often grown under reduced shade levels or in full-sun conditions. Shaded agroforestry systems, traditionally associated with Nacional varieties, can harbor high levels of biodiversity (Clough et al., 2011; De Beenhouwer, Aerts, & Honnay, 2013; Middendorp, Vanacker, & Lambin, 2019), sequester large amounts of carbon (Somarriba et al., 2013; Wade et al., 2010), and improve soil management (Vanhove, Vanhoudt, & Van Damme, 2016). Shade reduction in agroforestry systems has been found to reduce biodiversity levels (Clough et al., 2009; Deheuvels et al., 2014; Maas, Tscharntke, Saleh, Dwi Putra, & Clough, 2015) and ecosystem services (Franzen & Borgerhoff Mulder, 2007; Tondoh et al., 2015). In addition, full-sun cacao, especially CCN51, encourages ground weeds and farmers tend to use more herbicides and pesticides (Bentley et al., 2004; Jano & Mainville, 2007). Payments for ecosystem services or ecocertification schemes can incentivize the maintenance of traditional cocoa agroforests and associated nature-friendly management practices by compensating farmers for lower yields (Tscharntke et al., 2012; Tscharntke et al., 2015).

2.2 | Differentiated cocoa markets

2.2.1 | Mainstream cocoa

In the mainstream cocoa chain, individual farmers sell partially dried or dry beans to local intermediaries after which the product moves from exporters to foreign buyers (Figure 1). A study from the German International Cooperation estimated that about 1,000 intermediaries are active in Ecuador. Monopsony conditions (i.e., only one potential buyer) occur frequently in remote areas (van der Kooij, 2013). Intermediaries have been found to take advantage of smallholders who have little access to information by paying reduced prices (Jano, Hueth, & Director, 2013; Jano & Mainville, 2007). Exporters ship to countries where processing and manufacturing occur, through

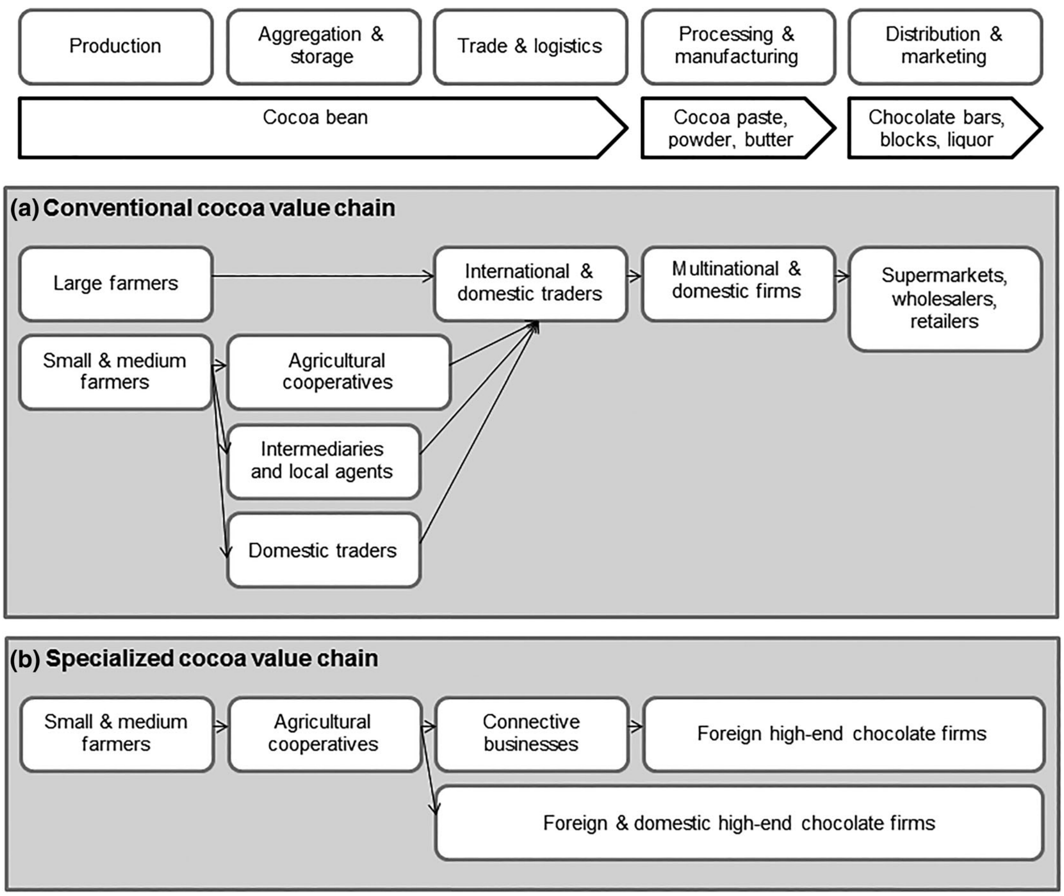

FIGURE 1 Outline of (a) mainstream and (b) specialized cocoa value chains in Ecuador (based on Ahmed & Hamrick, 2015; Donovan, 2006; Fernandez-Stark, Bamber, & Gereffi, 2012; Jano & Mainville, 2007; Lehmann & Springer-Heinze, 2014; Melo & Hollander, 2013; Poelmans & Swinnen, 2016; Vellema, Laven, Ton, & Muilerman, 2016)

value chains that are dominated by a few large multinational companies located mainly in North America and Europe (Kaplinsky, 2004; WCF, 2014). Ecuadorian enterprises process a very small (less than 5%) but growing fraction of the cocoa.

Concerns about the sustainability in the cocoa value chain have resulted in new arrangements between private chain partners, the state, and nongovernmental organizations (NGOs; Ton, Hagelaars, Laven, & Vellema, 2008). Following devaluation of national cocoa quality, Ecuadorian policy makers have become involved in the cocoa industry, putting in place policies and projects intended to vitalize the niche market for fine Nacional beans. The state has facilitated the establishment of value chain partnerships and development efforts, while reducing traditional state-led regulatory functions in the cocoa value chain (Vellema et al., 2016). It has likewise implemented several national plans and laws to strengthen its position on the global national fine cocoa market (Ahmed & Hamrick, 2015; van der Kooij, 2013).

The Ecuadorian Association of Cocoa Exporters (ANECACAO) sets a daily "referential" price based on data from Stock Exchanges in New York and London, which determines cocoa prices in the mainstream market. This price reflects the price for ASE beans, the default rating of Nacional. CCN-51 beans capture roughly the same price (ANECACAO, 2016; PRAGMATICA, 2016). The average referential daily price in August 2015, at the time of our field survey, was US $3,153 per ton (ICCO, 2015). The farm-gate price is subsequently determined by subtracting intermediation costs from the referential price. In other words, the gate price negatively correlates with the number of actors in the value chain (Melo & Hollander, 2013). In Esmeraldas, the average farm-gate price was US$1.93 and US$2.02 per kilogram for CCN-51 and Nacional beans for 2014 (US$89 and US$93 per quintal; 1 quintal equals 46 kg; PRAGMATICA, 2016; SINAGAP, 2015).

2.2.2 | Certified cocoa

Private companies have invested heavily in third-party certifications mainly as a response to growing consumer awareness around sustainability issues and recognition that intergovernmental collaboration fails to address global supply chain sustainability issues (Ingram et al., 2018; Rueda & Lambin, 2013a; Thorlakson, 2018). These private investments aim to improve living conditions of farmers, while promoting better environmental practices (Lee et al., 2012). In Ecuador, certified farmers often sell wet beans directly after harvesting to a farmers' cooperative that ferments and dries beans collectively. If possible, the cooperative acts as an exporter and sells the beans directly to foreign buyers at a higher price through a mandated or market-based premium (Tampe, 2016).

Farmer's price setting differs across standards (Tampe, 2016). Fairtrade certified beans always capture a stipulated premium of at least US$200 and a minimum price of US$1,750 per metric ton, whereas premiums for organic, UTZ certified, and Rainforest Alliance are based on market demand. Cooperatives hold the certificate and manage the internal control system, ensuring that member farmers comply with labor, environmental, and record keeping requirements. Voluntary sustainability standards started gaining ground in Ecuador during the early 2000s, facilitated by donor funding for rural developmental projects (Tampe, 2016). Today, major sustainability standards in the Ecuadorian cocoa sector include organic, Fairtrade, UTZ certified, and Rainforest Alliance, accounting for respectively 2.8%, 4.3%, 8.8%, and 4.7% of total cocoa area in Ecuador in 2015 (Lernoud et al., 2017).

Several studies have found positive economic and environmental impacts of coffee certification in Latin America, mainly for Fairtrade (Arnould, Plastina, & Ball, 2009; Ruben & Fort, 2012; Ruben, Fort, & Zúñiga-Arias, 2009; Ruben & Zuniga, 2011) and Rainforest Alliance (Rueda & Lambin, 2013b; Rueda, Thomas, & Lambin, 2015). These studies explicitly accounted for the risk of selection bias in comparing certified and noncertified farmers, using rigorous matching procedures and constructing a counter factual control group. Fewer studies have explored outcomes of cocoa certification by implementing these rigorous criteria (Blackman & Rivera, 2010; DeFries et al., 2017). In a non-peer-reviewed study, Cepeda et al. (2013) found positive effects of organic, Fairtrade, and Rainforest Alliance certification on quality improvements, income, and food security for 550 Ecuadorian cocoa smallholders, accounting for selection bias. Due to the evolving nature of sustainability standards, it is difficult to draw clear conclusions on impacts from individual certifications (Cepeda et al., 2013). Ingram et al. (2018) examined the social, economic, and environmental effects of UTZ certification of cocoa in Ghana and Ivory Coast, based on a large sample of panel data and a robust counterfactual. They observed mixed and modest outcomes, which were more positive for farmers having benefited from an intensive package of services and farm inputs.

Sustainability standards have drawn criticisms despite their growing popularity over the recent years. As compliance is costly, standards can create barriers for market entry for poor marginal farmers with financial constraints or generate dependency on financial aid from developing organizations (Matissek, Reinecke, Von Hagen, & Manning, 2012). Less than half of certified cocoa beans are eventually sold as such to final consumers, reflecting similar issues found in coffee and other commodity certification markets (Potts et al., 2014). This oversupply of certified beans diminishes premiums paid, resulting in low producers prices as faced by the mainstream market (Jaffee & Howard, 2009; Raynolds, Murray, & Heller, 2007). Certification outcomes are context dependent, and in the case of Ecuadorian cocoa, only few certified cooperatives were documented as being able to create lasting benefits for producers (Melo & Hollander, 2013; Tampe, 2016).

2.3 | Direct trade arrangements for high-quality cocoa

These shortcomings have prompted other forms of corporate engagement in commodity value chains beyond "traditional" certification schemes. Direct trade is a form of engagement in which buyers that are looking for scarce high-quality products establish strategic alliances with farmers that meet quality and production requirements (Holland, Kjeldsen, & Kerndrup, 2016). Buyers can share a larger portion of the final price with the farmers by skipping traders and thus ensuring a better traceability and supply of the product (Porter & Kramer, 2011). These markets develop around commodities where traditional production practices already incorporate "environmentally friendly" attributes. The focus lies on marketing those attributes explicitly to consumers. Examples of direct trade markets are relationship coffee (Borrella et al., 2015; Hernandez-Aguilera et al., 2018; Vicol, Neilson, Hartatri, & Cooper, 2018) and bean-to-bar cocoa (Butcher & Wilson, 2014).

Farmers' cooperatives play an important role in establishing direct trade relationships by improving the bargaining position and knowledge appropriation of individual farmers (Gereffi, 1999; Gereffi et al., 2005; Lee et al., 2012). Buyers who are informationally close to farmers, particularly farmers' cooperatives, have been found to reward farmers for higher value characteristics of quality beans, compared with buyers who purchase at distant spot markets (Jano et al., 2013; Moe, 2008). Access to specialty markets for fine cocoa requires improved production methods and postharvest processing systems, which are unavailable to smallholders and cooperatives with low asset endowment. Some Ecuadorian farmers' cooperatives have gained access to specialty markets, mainly through the establishment of sustainable buyer ties and appropriation of knowledge on new production practices (Melo & Hollander, 2013; Tampe, 2016). A tendency for increased exports through farmers' cooperatives has been observed in Ecuador but still accounted for only 5% to 10% of total exports in 2015 (Ahmed & Hamrick, 2015; PRAGMATICA, 2016). These cooperatives focus mainly on smallholders producing Nacional beans, with less than 10% of their sales composed of CCN-51 beans (PRAGMATICA, 2016).

A few studies on other commodities have found positive impacts on smallholder well-being and environmental conservation from participations in direct trade markets for high-quality commodities, but outcomes are context dependent (Borrella et al., 2015; le Polain de Waroux & Lambin, 2013; Neilson & Shonk, 2014; Tobin et al., 2015). Participation in high-quality coffee value chains improved smallholders' use of sustainable management practices, access to credit, and knowledge and optimism about the coffee business (Hernandez-Aguilera et al., 2018). Indonesian coffee farmers received increased prices and revenues, as well as access to knowledge on coffee supply, processing, and new technologies through the direct relationships with private exporters and retailers (Neilson, 2014; Neilson & Shonk, 2014). However, although the relationship coffee model creates opportunities for producer upgrading, there is a risk of capture of benefits by a few individuals within the producer community, therefore increasing inequality rather than alleviating poverty (Vicol et al., 2018). In sum, the impacts of specialty markets on smallholder livelihoods and the environment remain contentious as these impacts depend on supply chain organization, production costs, and price premia.

2.4 | Hypotheses

Our research question is the following: What are the socioeconomic and environmental outcomes for smallholders participating in direct cocoa trade compared with farmers in the mainstream cocoa market in northern Ecuador? We tested four hypotheses (Table 1) to address this question. We expected smallholders engaged in direct trade to capture a larger portion of the value added through superior prices paid for quality (Hypothesis 1) and to receive more nonmonetary benefits such as technical assistance, improved market access, and improved social networks (Hypothesis 2) than smallholders selling cocoa through mainstream markets. We expected smallholders engaged in direct trade to adopt more nature-friendly farming practices such as using organic fertilizers, shading by noncocoa trees, and restricting the use of chemicals (Hypothesis 3). We also expected farms engaged in direct trade to have different ecological attributes, with more Nacional than CCN-51 cocoa varieties, higher noncocoa species richness and abundance, and increased shade levels in plantations (Hypothesis 4) than farms engaged in the mainstream markets.

3 | METHODS

3.1 | Study area

We conducted our study in the provinces of Esmeraldas and Santo Domingo de los Tsáchilas in northern Ecuador, which are responsible for 17% of national cocoa production (SINAGAP, 2015). This region is recognized as a main origin of high-quality Nacional beans. The region is poor, with a high percentage of smallholders owning less than 5 ha of land (ESPAC, 2014; ICCO, 2016). Cocoa agroforestry systems are still largely present. They often struggle with limited market access and low productivity in aged plantations. International buyers have shown particular interest in this region to establish direct trade initiatives, increasingly branding chocolate bars as "Ecuador" or "Nacional."

TABLE 1 Hypotheses tested in this study

Compared with smallholders who sell cocoa to mainstream markets, we expect that smallholders engaged in direct markets …
1 … capture a larger portion of the value added through price premiums for quality
2 … receive more nonmonetary benefits such as technical assistance, improved market access, or investments into their social networks
3 … adopt more nature-friendlier management practices, such as the use of organic fertilizers, shading by noncocoa trees, and the restricted use of chemicals
4 … maintain diversity of both cocoa and noncocoa tree species, and shade levels associated with traditional agroforestry systems as measured at farm level

3.2 | Quantitative analyses

3.2.1 | Household surveys

We conducted a survey with 57 households during August and September 2015 (for a total of 35 fieldwork days, or 1.6 farms visited on average per fieldwork day; Figure 2), to collect data on socioeconomic conditions and management practices of cocoa smallholders participating in mainstream market and direct trade initiatives. From this set of households, 27 sold most of their cocoa through three farmers' cooperatives that established direct trade connections with national or international buyers (labeled "treatment group"). The 30 remaining households sold cocoa to three other cooperatives selling cocoa on the mainstream market or to local independent buyers (labeled "control group").

We applied a snowball sampling strategy (i.e., a technique where interviewees help recruiting more participants) to identify interviewees, starting with the treatment group. With the help of farmers' cooperatives, local market actors, and governmental institutions, we randomly selected an initial household per fieldwork day and subsequently localized nearby members of the cocoa farmer community, generally acquaintances but not always participants to the same supply chain. During the course of data collection, we increased the number of interviewees in the control group with comparable farm size with smallholders selling through direct trade to diminish sampling bias. This increased the likelihood of a successful posterior matching of pairs. The survey included socioeconomic variables related to land use and management practices, farmer demographics, cocoa varieties cultivated, and land use decision-making process.

3.2.2 | Plantation surveys

We randomly established a north facing 20 × 50 m (0.1 ha) plot on 75% of the surveyed cocoa farms to assess tree species richness and forest structure. We recorded woody species richness as the number of different woody species >2 m within the plot. Along the longitudinal 50-m plot midline, we classified ground cover as saplings, weeds, dead leaves, or bare soil at each 0.5 m and estimated shade levels by visually determining the percentage of a densiometer occupied by canopy cover above cocoa trees at each 10 m. We recorded the complexity of forest structure as the presence or absence of four height strata (<0.5 m, 0.5–1.5 m, 1.5–3 m, and >3 m). Within four 10-m quadrants located at the corners of each plot, we measured diameter at breast height (dbh) and height of each woody individual >2 m.

3.2.3 | Matching analyses

We recognize that the most reliable method to detect treatment effects is a randomized sample selection model, which would be difficult to implement in a setting with widely dispersed smallholders, limited geographical information, and high data collection costs. Smallholders that already meet requirements for alternative markets have strong incentives to self-select into these markets, which results in a selection bias. A credible evaluation of the impacts of differentiated market participation must therefore construct a counterfactual outcome (Blackman & Rivera, 2010). The counterfactual was used to estimate the socioeconomic and environmental outcomes for treatment group observations, had they sold their beans on the mainstream

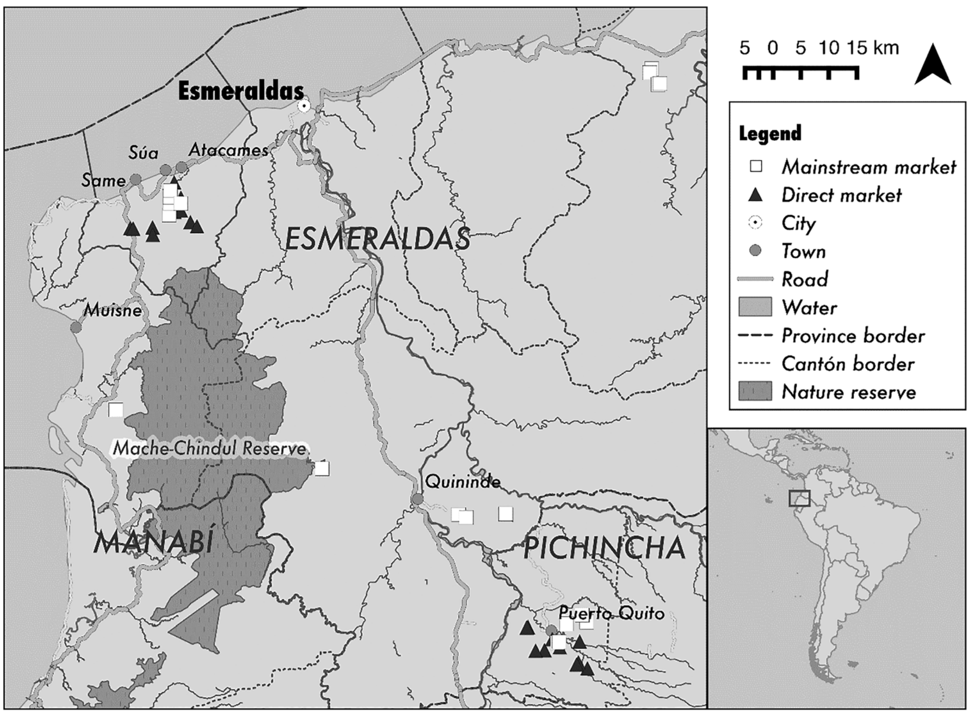

FIGURE 2 Locations of the surveyed households engaged in mainstream (triangles) and direct (squares) cocoa trade from Esmeraldas and Pichincha, Ecuador

market. Many ex post statistical methods are available to estimate such a counterfactual, but a common method of selection and adjustment is matched sampling (Rosenbaum & Rubin, 1983; Rosenbaum & Rubin, 1985). Matched sampling is able to estimate effects even with a relatively small sample population, due to its refined control observation selection (Quigley, 2003). Matched sampling creates a control group of modest size from a larger pool of potential controls that resembles the treatment group with respect to a selection of observed covariates. Covariates were farm and household characteristics, and outcome variables described economic, social, and environmental impacts that were potentially influenced by the adoption of specific farm practices and marketing strategy. Matching on a correct propensity score model thus means that the treatment and control groups have the same joint distribution of observed covariates (Rosenbaum & Rubin, 1983).

Here, we estimated the average treatment effect on the treated (ATT) by one-to-one pairwise matching with replacement, using the genetic matching algorithm (i.e., GenMatch) in the matching package in R (R Development Core Team, 2008; Sekhon, 2011) that optimizes postmatching covariate balance (Diamond & Sekhon, 2013). Standard errors were Kolmogorov–Smirnov bootstrapped with 1,000 replications, following Dehejia and Wahba (2002). We conducted several nearest neighborhood matching methods to test the robustness of genetic matching outcomes (Caliendo & Kopeinig, 2008; Holmes & Olsen, 2010), which resulted in similar qualitative conclusions as presented here (Tables A1–A3).

3.2.4 | Covariate and outcome variable selection for matching

We selected five farm and grower characteristics on which we matched mainstream and direct households (i.e., covariates): total farm size (in ha), area cultivated in cocoa (in ha), altitude of the farm (in masl), education of the household head (in number of years of school attendance), and family size (in number of family members in the household; Table 2). Farm size and area in cocoa affect the grower's production potential and her or his access to additional resources. Elevation influences biophysical conditions for cocoa production and market access. Education and family size represent important aspects of the growers' ability to learn and implement specific management practices required for alternative market participation. All farmers in our sample are member of a cooperative, which is either engaged in direct trade or in mainstream market. This prevented using cooperative membership as a covariate. Other potential variables such as distance to markets or age of the cocoa plantations were too similar between farms to be useful covariates.

To test our hypotheses, outcome variables were grouped based on (a) economic benefits, (b) nonmonetary benefits, (c) farming management practices, and (d) biodiversity conditions on the farm. Variables in the first three groups originated from household survey data and the fourth group from farm survey data. Farm-gate prices were determined as the average price received for wet cocoa beans over the last 3 months as indicated by the producer. Due to the mixing of beans from different varieties in the mainstream market, we were unable to segregate pricing based on cocoa varieties. Before matching, we compared outcome variables between households from both test groups using Wilcoxon rank-sum tests for continuous variables and Fisher's exact tests for binary variables (Table 2). Matching was done independently for household and farm survey data, as the latter were only collected for 75% of the participants. For all analyses, all covariates achieved balance without dropping treatment observations (Table 3). Numerical and visual comparison of propensity scores before and after matching showed that matching improved covariate balance (Table 3 and Figures A1 and A2).

3.2.5 | Underlying matching assumptions and limitations

Although matching is the analog of randomization in ideal observation experiments, it can only balance the distribution of observed covariates (Rubin & Thomas, 2000). All matching methods assume underlying “confoundedness” and require therefore that treatment selection occurs based on the selected covariates. Matching cannot directly account for unmeasured third factors associated with both potential outcomes and treatment selection (Imbens, 2015; Imbens & Wooldridge, 2009). Different matching estimators provide somewhat different interpretations of causal effects, but no “best” practice has yet been identified (Morgan & Winship, 2014). We tested for the sensitivity of results from matching estimators to hidden bias with Rosenbaum bounds, which is a sensitivity analysis evaluating whether an estimate based on matching is robust to the possible presence of an unobserved confounder. There is a risk of endogeneity between unobserved variables and selected covariates or outcome variables that matching cannot account for. Therefore, caution is required when inferring strong causality between treatment participation and outcomes.

3.3 | Qualitative analyses

We conducted additional qualitative analyses to provide context and a better understanding of the processes at play. First, unstructured interviews were conducted with private, public, and market actors. Public actors included governmental officers involved in state-led cocoa market initiatives (*Minga del Cacao* and *Proyecto de Reactivación del cacao Fino de Aroma* initiated by the Ecuadorian Ministry of Agriculture, Livestock, Aquaculture, and Fisheries), Ecuadorian NGO officers (*Conservación and Desarrollo* and *VECO Andino*), and two Ecuadorian scientists (*Escuela Superior Politécnica del Litoral*, Guayaquil, and *Instituto Nacional de Investigaciones Agropecuarias*, Santo Domingo). Private actors included presidents of all farmers' cooperatives included in this study, several mainstream intermediaries working in the field, two managers of mainstream cocoa collection centers, two Ecuadorian chocolatiers, and one international exporter. Insights from these interviews supported interpretation of field observations.

Second, a workshop was organized in collaboration with the Ecuadorian NGO *VECO Andino* on July 27, 2016, in Quito. The aim of this

TABLE 2 Covariates and outcome variables, means, and *p* value for unmatched observations for direct (treatment) and mainstream (control) households surveyed

Variable	Mean all	Mean treatment (*n* = 27)	Mean control (*n* = 30)	Test *p* value[a]
Covariates				
Farm characteristics				
Farm size (ha)	15.99	12.86	18.80	.33
Area in cocoa (ha)	5.76	4.46	6.92	.02*
Altitude (masl)	117.9	130.3	106.8	.30
Producer's characteristics				
Education hh (year)	7.56	8.41	6.80	.07
Family size	5.95	5.96	5.93	.96
Outcome variables				
Economic benefits (Hypothesis 1)				
Wet price (ct pound^{-1})	46.38	58.54	35.43	<.001***
Premium for certification (1/0)	0.37	0.70	0.07	<.001***
Premium for quality (1/0)	0.49	0.93	0.10	<.001***
Nonmonetary benefits (Hypothesis 2)				
Access to credit (1/0)	0.04	0.04	0.03	1.00
Technical assistance (1/0)	0.74	0.93	0.57	.003*
Farmers' cooperative membership (1/0)	0.77	1.00	0.57	<.001***
Workers hired on farm (1/0)	0.44	0.56	0.33	.11
Cocoa as the main source of income (1/0)	0.77	0.78	0.77	1.00
Management practices (Hypothesis 3)				
Organic fertilizer (1/0)	0.47	0.67	0.30	.008*
Chemical fertilizer (1/0)	0.11	0.00	0.20	.03*
Insecticides (1/0)	0.05	0.00	0.10	.24
Fungicides (1/0)	0.02	0.00	0.03	1.00
Herbicides (1/0)	0.28	0.11	0.43	.009**
Presence of Nacional (1/0)	0.93	1.00	0.87	.11
Presence of CCN-51 (1/0)	0.42	0.22	0.60	.007**
Preference for Nacional (1/0)	0.67	0.78	0.57	.16
Shade of noncocoa trees (1/0)	0.96	1.00	0.93	.49
Noncocoa tree species richness stated by farmer (1/0)	4.33	5.04	3.70	<.001***
Irrigation (1/0)	0.05	0.00	0.10	.24
Grafting of cocoa trees (1/0)	0.54	0.44	0.63	.19
Pruning of cocoa trees (1/0)	0.91	0.96	0.87	.36
Used fire before planting (1/0)	0.16	0.04	0.27	.03*
Area in cocoa increased in past 5 years (1/0)	0.51	0.52	0.50	1.00
Biodiversity conditions (Hypothesis 4)				
Noncocoa species richness (species ha^{-1})	6.95	7.57	6.36	.46
Abundance of noncocoa trees (ha^{-1})	21.81	25.29	18.50	.09
Basal area of noncocoa trees (m^2 ha^{-1})	52.12	53.40	50.89	.65
Average height of noncocoa trees (m)	12.97	13.41	12.55	.62
Average shade level index	2.1	2.3	1.90	.32
Nacional density (trees ha^{-1})	619.8	627.4	612.5	.85
CCN51 density (trees ha^{-1})	140.7	11.00	275.0	<.001***

Note. Covariates served as input for matching.

[a]The Wilcoxon rank-sum test *p* value was calculated for continuous variables; the Fisher's exact *p* value was calculated for binary variables.

***$p < .001$.

**$p < .01$.

*$p < .05$.

TABLE 3 Test for covariate balance before and after genetic matching on household and farm surveys

	Household survey data		Farm survey data	
Covariate	Before matching	After matching	Before matching	After matching
Farm size (ha)	0.17	0.15	0.27	0.24
Area in cocoa (ha)	0.32*	0.15	0.41*	0.14
Altitude (masl)	0.19	0.22	0.22	0.24
Education hh (year)	0.23	0.11	0.18	0.14
Family size	0.15	0.11	0.25	0.19

Note. Balance is achieved for all covariates, as indicated by an insignificant Kolmogorov–Smirnos test value after matching, based on 1,000 bootstrap samples.

*$p < .05$.

workshop was to bring together international and national market actors to discuss economic, social, and environmental sustainability of the Ecuadorian cocoa chain. The main questions addressed during roundtable sessions were (a) how to improve the relationship between smallholders and the private sector? (b) how to enhance the inclusion of smallholders and young farmers? and (c) how to incentivize environmentally friendly management on cocoa plantations? Finally, we relied on secondary sources, including scientific, governmental, and private reports, to gain insights on long-term trends in cooperative export prices.

4 | RESULTS

4.1 | Quantitative results

4.1.1 | Cocoa smallholders in northern Ecuador

Interviewees owned on average about 16 ha of land with 6 ha cultivated with cocoa trees (Table 2). Prematching data show that households engaged in direct trade tended to own less land with a significantly smaller area cultivated with cocoa compared with households engaged in mainstream trade. Cocoa provided the main source of income for approximately 80% of the surveyed households. Production diversification was limited to trading fruits (bananas, *maracuya*, and guavas) or livestock (chickens and pigs) on local markets. Few farmers had access to credit, additional labor, or agricultural inputs, such as insecticides, fungicides, or herbicides.

Direct trade arrangements and certification schemes were partially overlapping in our study region. Over 80% of farmers engaged in direct trade were also organic certified, compared with no organic certified farmers selling through mainstream markets. As a result, it is impossible to attribute to direct trade rather than to organic certification the observed differences in outcome variables between treatment and control groups. In contrast, an equal share of farmers from direct and mainstream trade groups were Fairtrade certified. We conducted an additional matching analysis comparing Fairtrade and non-Fairtrade farmers to evaluate the impact of Fairtrade certification on selected outcome variables, independently from the marketing strategy (Table 4). This second analysis showed that the impacts of direct trade on outcome variables were unrelated to Fairtrade certification. We found few differences between Fairtrade-certified and other farmers—noting that it was not the focus of the study design. Results give no indication that Fairtrade improved farmers' well-being or stimulated the adoption of nature-friendly farming. For example, prices for Fairtrade and non-Fairtrade cocoa were similar. Cooperatives did capture a price premium for Fairtrade production that they invested in communal goods and services, such as farmers' pension funds or postharvesting capacity at cooperative level.

4.1.2 | Socioeconomic outcomes

We found that high-quality cocoa beans captured superior prices in the direct trade market compared with bulk cocoa sold through the mainstream chain (Table 4), thus supporting Hypothesis 1. Farmers stated that they received price premiums for both quality and certification, which could not be separated. Consistent with Hypothesis 2, more households engaged in direct trade received technical assistance in the form of agricultural training and on-farm assistance by farmers' cooperatives or governmental institutions (the government of Ecuador is supporting an upgrading of its cocoa sector; Table 4). Thus, cooperatives provided the gateway to direct markets for farmers that were part of the cooperatives' social networks. Besides improved prices, farmers engaged in direct trade more often mentioned other benefits of cooperative membership, such as cocoa quality enhancement, access to logistic or technical assistance, better information, and provision of seeds (Figure 3a,b).

4.1.3 | Environmental outcomes

More smallholders engaged in direct trade applied nature-friendly management practices compared with smallholders engaged in mainstream market (Table 4), supporting Hypothesis 3. Significantly more farmers engaged in direct trade applied organic fertilizer and avoided chemical fertilizers or herbicides compared with the control group. Most farmers preferred to plant Nacional trees, but more farmers engaged in direct trade confirmed the presence of Nacional trees on their farms. This finding was confirmed by the quantitative analyses, showing a higher density of CCN-51 cocoa trees on nondirect trade plantations (Table 4). The majority of the farms were shaded with noncocoa trees, but farmers engaged in direct trade mentioned a significantly greater number of tree species during interviews than farmers selling through mainstream markets. Farmers from both groups who expanded their plantation in the last 5 years did so by replacing remnant forest, with more plantations of farmers engaged in mainstream trade that replaced secondary forests (Figure 3c). This indicates that deforestation may be related to cocoa plantation expansion.

Even though farmers engaged in direct trade adopted more nature-friendly management practices, we did not find a difference in

TABLE 4 Estimates of the average treatment effect on the treated (ATT) for matched observations of direct versus mainstream (Treatment 1) and Fairtrade versus non-Fairtrade (Treatment 2) households surveyed, using genetic matching

	Direct vs. mainstream trade				Fairtrade vs. non-Fairtrade			
Outcome variables	ATT	*SE*	*t* test	Γ[a]	ATT	*SE*	*t* test	Γ[a]
Economic benefits (Hypothesis 1)								
Wet price (ct pound^{-1})	24.35	0.75	25.18***	7.7	4.80	5.00	0.96	—
Premium for certification (1/0)	0.67	0.13	5.77***	6.7	0.26	0.12	2.15*	2.6
Premium for quality (1/0)	0.78	0.10	6.43***	7.9	0.00	0.22	0.00	—
Nonmonetary benefits (Hypothesis 2)								
Access to credit (1/0)	0.00	0.08	0.00	—	−0.22	0.11	−1.95	—
Technical assistance (1/0)	0.30	0.12	2.43*	3.0	0.22	0.16	1.43	—
Farmers' cooperative membership (1/0)	0.70	0.11	5.77***	7.1	0.30	0.13	2.36*	3.0
Workers hired on farm (1/0)	0.22	0.18	1.87	—	0.19	0.20	0.93	—
Cocoa as the main source of income (1/0)	−0.07	0.13	−0.51	—	−0.19	0.13	−1.42	—
Management practices (Hypothesis 3)								
Organic fertilizer (1/0)	0.48	0.16	2.86**	2.0	0.52	0.17	2.99*	2.5
Chemical fertilizer (1/0)	−0.22	0.10	−3.10**	2.3	0.04	0.09	0.41	—
Insecticides (1/0)	−0.18	0.09	−1.06	—	−0.11	0.09	−1.29	—
Fungicides (1/0)	0.00	0.00	0.00	—	0.00	0.00	0.00	—
Herbicides (1/0)	−0.37	0.12	−2.94**	3.7	0.00	0.00	0.00	—
Presence of Nacional (1/0)	0.30	0.11	2.58**	3.0	0.00	0.07	0.00	—
Presence of CCN-51 (1/0)	−0.26	0.12	−2.18*	1.7	0.19	0.18	1.81	—
Preference for Nacional (1/0)	0.19	0.16	1.87	—	0.11	0.17	−1.03	—
Shade of noncocoa trees (1/0)	0.11	0.08	0.73	—	−0.04	0.05	−0.71	—
Noncocoa tree species richness stated by farmer (1/0)	2.37	0.65	3.67***	3.0	1.33	0.75	0.88	—
Irrigation (1/0)	0.00	0.00	0.00	—	0.07	0.07	1.03	—
Grafting of cocoa trees (1/0)	−0.04	0.17	0.20	—	0.37	0.16	1.47*	1.9
Pruning of cocoa trees (1/0)	0.14	0.11	1.24	—	0.30	0.14	1.93*	1.9
Used fire before planting (1/0)	−0.19	0.11	−0.73	—	−0.11	0.15	−0.53	—
Area in cocoa increased in the past 5 years (1/0)	0.07	0.16	0.20	—	0.00	0.18	0.00	—
Biodiversity conditions (Hypothesis 4)								
Noncocoa species richness (species ha^{-1})	2.10	1.65	1.27	—	2.27	1.79	0.74	—
Abundance of noncocoa trees (ha^{-1})	4.33	5.41	0.75	—	8.53	4.85	0.78	—
Basal area of noncocoa trees (m^2 ha^{-1})	5.96	30.24	0.44	—	2.11	27.9	0.11	—
Average height of noncocoa trees (m)	4.85	2.80	1.90	—	2.37	2.57	0.43	—
Average shade level index	0.67	0.34	1.95	1.6	0.59	0.52	0.26	—
Nacional density (trees ha^{-1})	108.3	143.2	0.76	—	−186.7	127.4	−2.40	—
CCN51 density (trees ha^{-1})	−297.6	126.1	−2.36*	3.6	5.00	102.7	0.63	—

Note. The critical value of Rosenbaum's Γ is provided.

[a]Critical value of odds of differential assignment to direct market due to unobserved factors (i.e., value above which ATT is no longer significant).

*$p < .05$.

**$p < .01$.

***$p < .001$.

biodiversity conditions of the tree cover at farm-level compared with farmers selling through mainstream markets (Table 4), thus not supporting Hypothesis 4. We found comparable species richness, abundance, and basal area for noncocoa trees on farms owned by households from both test groups. The density of Nacional trees was comparable on farms from both test groups, whereas only the density of CCN-51 plots was significantly higher on farms from households engaged in mainstream trade.

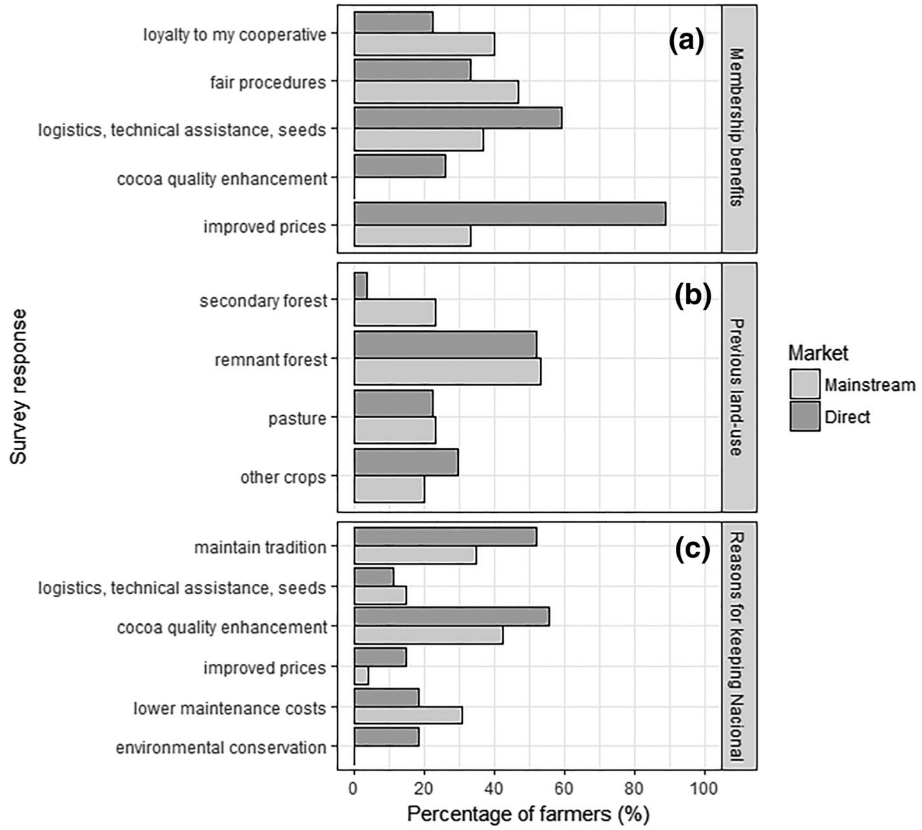

FIGURE 3 Qualitative survey responses of smallholders (n = 57) engaged in direct or mainstream trade on (a) perceived benefits of cooperative membership; (b) previous land cover of plantations expansions, if applicable; and (c) reasons for keeping Nacional varieties. The questions were open ended, and responses were categorized a posteriori

4.2 | Qualitative results

Interviews with presidents of the farmers' cooperatives that established direct relationships with multiple buyers confirmed that cooperatives were increasing farmer's price for cocoa due to higher prices from buyers. Part of these premiums was invested in improvements of cooperative's infrastructure, such as drying or fermentation installations, or to contract local labor for transport or extension and technical services, directly benefitting member farmers. Although several buyers stated that their main interest for direct relationships was access to high-quality cocoa beans, many favored beans with organic or Fairtrade certification to satisfy demand by wealthy consumers for quality chocolates with an environmental or social label. Cooperatives invested some of the price premiums for high-quality beans to cover certification costs, resulting in a reduction of the price transfer to farmers. Data collected by PRAGMATICA (2016), comparing cocoa bean export volumes and sales from mainstream exporters and farmers' cooperatives at the national level, showed that farmers' cooperatives participating in this study captured higher prices for Nacional ASE quality beans during some years (Figure 4a). Our field observations also revealed higher farm-gate prices for Nacional beans compared with beans for mainstream markets, which is related to differences in both quality and number of intermediaries. Total export volumes showed that farmers' cooperatives mainly focused on Nacional cocoa beans, whereas CCN-51 beans composed over 50% of exports through mainstream markets between January 2012 and September 2015 (Figure 4b).

Participants from the workshop recognized the need to consolidate the economic sustainability of the Ecuadorian cocoa market. Ecuador has a unique position on the global cocoa market by being recognized as the main producer of Nacional *fino de aroma* beans. According to participants, a growing number of cases of direct associative commercialization exist, which successfully improve sustainability. Combined with a growing demand for high-quality chocolates in specialty markets, this offers opportunities for further differentiation in the Ecuadorian cocoa value chain.

Nonetheless, participants expressed concern about the decreasing quality of Nacional beans and the lack of inclusion of smallholders and multiple generations in the value chain. Most Nacional producing smallholders struggle economically because of low productivity on aged plantations, poor access to genetic material, and lack of agricultural inputs and assistance. Participants recognized that an emphasis should be placed on improving cocoa quality to exploit the country's competitive benefit, requiring a long-term vision of both producers and buyers for direct trade relationships to succeed. It was recognized that the Ecuadorian Ministry of Agriculture, Livestock, Aquaculture, and Fisheries could play a key role in strengthening the competitive advantage of Nacional producers by setting a price difference between Nacional and CCN-51 beans, improving smallholder access to genetically improved Nacional clones with high yield potential, and promoting commercialization based

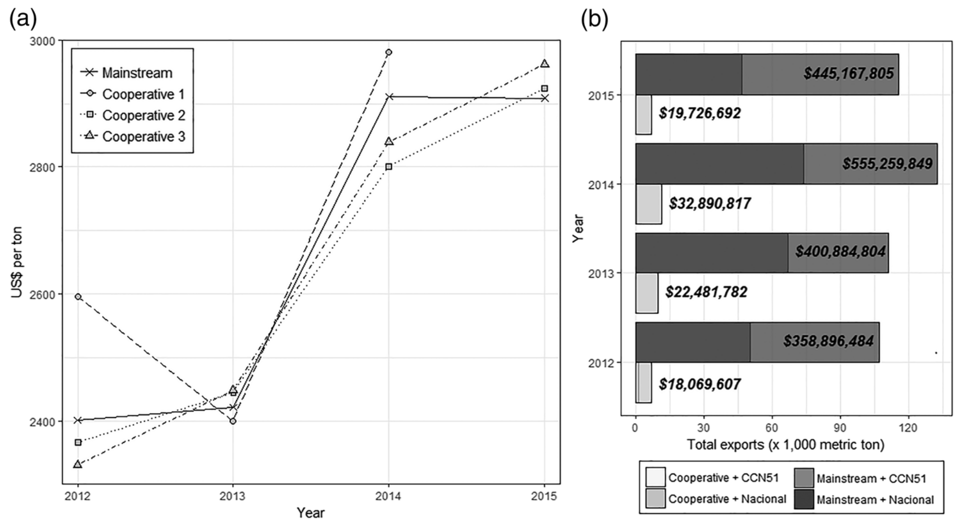

FIGURE 4 (a) Average market price (in US$) per ton of cocoa beans for mainstream cooperatives (ASE quality; solid line) and three farmers' cooperatives visited in northern Esmeraldas engaged in direct trade relationships with buyers between 2012 and September 2015. (b) Total volumes (in 1,000 metric ton) exported by mainstream exporters (dark grey) and small farmers' cooperatives (light grey) for CCN-51 and Nacional beans between 2012 and September 2015. Accumulated market prices (in US$) for all exports are shown. Data from PRAGMATICA (2016)

on specific cocoa flavors and production methods. Although smallholders expressed a strong preference for agroforestry systems, they felt that environmentally friendly management practices were not sufficiently valued and rewarded economically by buyers.

5 | DISCUSSION

5.1 | Smallholder livelihoods

We found that smallholders engaged in direct trade captured about 70% per pound dry cocoa beans above average farm-gate prices for mainstream cocoa. This finding supports other studies that have found greater earnings and reduced price volatility for high-quality products sold through differentiated market channels (Borrella et al., 2015; Neilson & Shonk, 2014; Reardon, Barrett, Berdegué, & Swinnen, 2009; Rueda & Lambin, 2013a). However, a study on the relationship coffee model in Colombia found that participants did not get a significantly higher farm-gate price compared with nonparticipants (Hernandez-Aguilera et al., 2018). Nevertheless, total household income needs to be considered to assess the overall impact on households' livelihoods (Nelson & Phillips, 2018). Superior prices for differentiated products can fail to increase per hectare gross margins and profits due to low yields, high production costs, and land or labor constraints (Beuchelt & Zeller, 2011; le Polain de Waroux & Lambin, 2013; Ruben & Fort, 2012; Schipmann & Qaim, 2010). Few studies have explored the impacts of market participation on total household income. In addition to raising rural incomes, quality-standards trade can also alleviate poverty by stimulating local labor markets (Maertens & Swinnen, 2009). Research suggests that improving food security and reducing poverty over the medium term can be achieved through increasing farmers' income as well as agricultural labor productivity (de Janvry & Sadoulet, 2010). This might be the case in northern Ecuador, as farmers' cooperatives hired local workforce to participate in transport and extension services.

Besides superior prices, we found that smallholders engaged in direct trade had greater access to agricultural training, technical assistance, and improved social networks through cooperative membership, compared with smallholders selling through mainstream markets. Our results are consistent with other studies that have shown that farmers engaged in direct trade had more access to credit, a better understanding of the market, a more optimistic view of the future, and increased homogeneity and quality of fermentation and drying processes through cooperative-managed processing units (Hernandez-Aguilera et al., 2018; Neilson & Shonk, 2014). Several studies have raised concerns about the exclusion of small farmers from high-quality value chains, because disadvantaged farmers have greater difficulties meeting strict quality standards (Reardon et al., 2009). Lack of access to agricultural inputs, credit, and extension services can be an important barrier to the entry in niche markets. This underlines the importance of policy support, such as training and credit access, to help smallholders to comply with stringent quality standards.

Our finding that the interviewed farmers owned on average about 16 ha of land may place some of them in the category of medium land holders rather than smallholders. However, by comparison with cocoa farmers in the neighboring provinces of Ecuador where land holdings of 30 to 50 ha were common (Rueda et al., 2018), the farmers we interviewed were in the lower end of the land holding distribution for the region.

5.2 | Nature-friendly management practices and on-farm biodiversity

As expected given the overlap between direct trading practices and organic certification, we observed that farmers engaged in direct trade used more organic fertilizers and less chemical fertilizers and herbicide. They also adopted less CCN-51 monocultures. Despite the adoption of different management practices, we observed insignificant differences in shade levels and noncocoa tree species richness and abundance in plantations of farmers engaged in direct and mainstream trade. Positive impacts on biodiversity and vegetation structure may lag behind direct trade participation. A more likely explanation is that most interviewees were small farmers who maintain traditional agroforestry systems due to insufficient financial assets to switch to more intensive production systems. In an attempt to increase yields by reducing shade, many farmers deliberately fell noncocoa trees in traditionally shaded agroforestry systems. Even though many scholars have found that cocoa growth and production decreased nonlinearly with increasing shade (Steffan-Dewenter et al., 2007; Wade et al., 2010; Gockowski, Afari-Sefa, Bruce Sarpong, Osei-Asare, & Dziwornu, 2011; Blaser, Oppong, Yeboah, & Six, 2017; Middendorp, Vanacker, & Lambin, 2019), others have shown that intermediate levels of canopy shade of 40% to 60% protected cocoa trees from drought (Abou Rajab, Leuschner, Barus, Tjoa, & Hertel, 2016) and allowed to maintain high cocoa production (Gras et al., 2016; Waldron, Justicia, Smith, & Sanchez, 2012). Intermediate shade levels might thus be combined with high yields (Bisseleua, Missoup, & Vidal, 2009; Clough et al., 2011), given appropriate management knowledge and more labor-intensive farming strategy (Andres & Bhullar, 2016; Somarriba et al., 2013). Useche and Blare (2013) found that Ecuadorian cocoa producers preferred agroforestry production systems to more intensified systems when nonmarket ecological and social benefits are accounted for.

The absence of an observable biodiversity benefit following direct trade participation underlines the need to include specific ecosystem criteria in contracts between producers and buyers, such as requiring minimum shade and biodiversity levels on plantations. Contract farming may also reduce market risks for smallholders (Henson, Masakure, & Boselie, 2005). We also found indications that continued clearance of remnant forest is associated with cocoa agroforestry. Even though shaded agroforestry systems provide many ecosystem services, they do not equate to primary forests. Eliminating deforestation for cocoa plantations needs to be an explicit standard to prevent misinforming consumers on the conservation value of cocoa agroforestry. Biodiversity benefits are expected from both low-intensity agricultural production associated with agroforestry systems and the conservation of natural landscape elements that enhance the matrix quality of the human-dominated agricultural landscapes found in this region of Ecuador.

5.3 | Improving Ecuadorian value chains: Keys to success

Farmers' cooperatives played an important role in improving the bargaining position, establishing agreements with buyers, and appropriating management knowledge of smallholders in our study region. We observed a large overlap between organic certification and direct trade. Research suggests that certification may play an important role for smallholders to gain access to niche markets, including direct trade, through improvements of economic, social, and environmental conditions, following the standards-as-catalyst view proposed by Jaffee and Henson (2005).

This idea is supported by our observations that direct trade engagements and certification are largely overlapping in our region, with certification schemes preceding direct trade relationships in most cases and direct buyers demanding certification in some instances. Farmers, cooperatives, and buyers stated during interviews that price premiums for quality were offered on top of price premiums for organic cocoa, suggesting that the economic impacts we observed were unlikely caused by organic certification alone. Fairtrade certification alone could not explain positive outcomes of direct trade relationships, as also found by other studies. For example, Hernandez-Aguilera et al. (2018) concluded that Fairtrade certification stimulated the use of protective equipment during fumigation but was not responsible for any of the other positive outcomes for smallholders participating in direct trade of high-quality coffee in Colombia. We were unable to separate outcomes deriving from organic certification. Furthermore, farmers, cooperatives, and some market actors confirmed in interviews that the organizational improvements, upgraded postharvesting processes, and improved management practices following quality recommendation by buyers were made possible by initial access to certification. Access to niche markets for fine cocoa requires improved production methods and postharvest processing systems, which are unavailable to smallholders and cooperatives with low asset endowment. Certification schemes may support necessary quality improvements as participating farmers comply with standards for farm management practices, including the preselection of fungus-free beans and an adequate agrochemical use. Quality is essential for consumers looking to buy Nacional chocolates, as they pay a price premium primarily for quality and then for certification (Cepeda et al., 2013). Entry to niche markets is likewise facilitated by a certain level of infrastructure, agricultural inputs, and technical skills, often associated with success in certification schemes (Donovan & Poole, 2013).

Other studies in Ecuador have examined conditions for success of direct trading initiatives. Melo and Hollander (2013) have suggested that differentiated cocoa trade may be successful if, (a) premiums for Nacional beans compensate for the lower productivity compared to CCN-51, (b) farmers' collectivism is stimulated through investments in social networks, and (c) farmers refrain from replanting CCN-51 following incentives to conserve traditional plantations. In a matched case comparison of two certified rural cooperatives in Ecuador, Tampe (2016) found that standards failed to improve conditions of farmers but suppliers could leverage standards to create value from vertical relationships with buyers by developing a close and learning-oriented relationship with the buyer. Lack of trust in the value chain, contractual insecurity, and weak farmers associations are potential barriers to successful upgrading in the Ecuadorian value chain (Ahmed & Hamrick, 2015; Lehmann & Springer-Heinze, 2014). These factors were broadly confirmed by Rueda et al. (2018), who showed that Ecuadorian farmers were allowed to thrive in the cocoa niche markets when (a) they had the organizational capabilities to improve quality, (b) buyers were willing to transfer knowledge and value to farmers, and (c) farmers were diversifying their production system to enhance ecosystem service provision.

6 | CONCLUSION

Global trade in niche commodities continuously expands the assortment of exotic goods produced worldwide for the tastes of wealthy consumers. These new niche commodity markets create a more direct linkage between consumers' choices, and livelihoods and ecosystems in places of production. Our study suggested that consumers who prefer chocolate made from directly sourced high-quality cocoa beans might help to enhance smallholder livelihoods and the adoption of some nature-friendly management practices. In addition, certification standards may provide smallholders with easier access to high-value niche markets. This study was unable to separate outcomes from organic certification and direct trade markets and is thus inconclusive on whether the adoption of nature-friendly farming practices can be attributed to direct trade or certification. However, the two interventions are largely synergistic, as certification facilitates engagement in direct trade and some direct buyers request certification. Longitudinal studies are needed to reveal long-term socioeconomic and environmental outcomes.

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APPENDIX A.

TABLE A1 Test for covariate balance before and after matching for household and farm survey data, using genetic matching (GM) as presented in the manuscript and nearest neighborhood matching (NN) 1–1 and 1–2

	Household survey data				Farm survey data			
Covariate	Before matching	GM	NN 1–1	NN 1–2	Before matching	GM	NN 1–1	NN 1–2
Farm size (ha)	0.17	0.15	0.39	0.30***	0.27	0.24	0.33	0.30**
Area in cocoa (ha)	0.32**	0.15	0.36**	0.28***	0.41**	0.14	0.29	0.19
Altitude (masl)	0.19	0.22	0.25	0.20	0.22	0.24	0.24	0.35**
Education hh (year)	0.23	0.11	0.11	0.13	0.18	0.14	0.14	0.12
Family size	0.15	0.11	0.21	0.22.	0.25	0.19	0.24	0.23*

Note. Insignificant Kolmogorov–Smirnov test values based on 1,000 bootstrap samples after matching indicated that covariate balance was achieved. If after matching, all covariate test values were insignificant, an optimal pair of matched points was found.

*$p < .1$.

**$p < .05$.

***$p < .01$.

TABLE A2 Propensity scores (i.e., the likelihood of participation in direct trade as predicted by a regression model) for input variables based on probit regression results with direct market as dependent variable for household and farm survey data

	Household survey data			Farm survey data		
Variable	Coefficient	*SE*	*p* value	Coefficient	*SE*	*p* value
Farm size (ha)	−0.79	0.01	.43	−0.60	0.01	.55
Area in cocoa (ha)	−1.59	0.05	.11	−1.90	0.7	.06*
Altitude (masl)	0.52	0.00	.60	0.78	0.00	.44
Education hh (year)	1.91	0.05	.06*	1.49	0.06	.14
Family size	1.19	0.08	.24	0.37	0.08	.71
Intercept	−1.08	0.82	.28	−0.30	0.90	.77

Note. Scores were used for nearest neighbor matching methods.

*$p < .1$.

TABLE A3 Estimates of the average treatment effect on the treated (ATT) for matched observations of direct versus mainstream household surveyed, comparing nearest neighbor 1–1 and nearest neighbor 1–2 with genetic matching results

	Genetic matching			Nearest neighbor 1–1			Nearest neighbor 1–2		
Outcome variables	ATT	*SE*	*t* test	ATT	*SE*	*t* test	ATT	*SE*	*t* test
Economic benefits (Hypothesis 1)									
Wet price (ct pound^{-1})	24.35	0.75	25.18***	23.48	1.10	21.26***	23.61	0.96	24.72***
Premium for certification (1/0)	0.67	0.13	5.77***	0.56	0.19	2.93**	0.59	0.16	3.80***
Premium for quality (1/0)	0.78	0.10	6.43***	0.69	0.14	4.9***	0.78	0.11	7.27***
Nonmonetary benefits (Hypothesis 2)									
Access to credit (1/0)	0.00	0.08	0.00	0.04	0.06	0.65	0.04	0.05	0.75
Technical assistance (1/0)	0.30	0.12	2.43*	0.43	0.19	2.26*	0.41	0.14	2.92**
Farmers' cooperative membership (1/0)	0.70	0.11	5.77***	0.44	0.15	2.96**	0.52	0.12	4.36***
Workers hired on farm (1/0)	0.22	0.18	1.87	0.02	0.20	0.09	0.24	0.16	1.53
Cocoa as the main source of income (1/0)	−0.07	0.13	−0.51	0.15	0.16	0.94	0.04	0.13	0.28

(Continues)

TABLE A3 (Continued)

	Genetic matching			Nearest neighbor 1–1			Nearest neighbor 1–2		
Outcome variables	ATT	*SE*	*t* test	ATT	*SE*	*t* test	ATT	*SE*	*t* test
Management practices (Hypothesis 3)									
Organic fertilizer (1/0)	0.48	0.16	2.86**	0.09	0.22	0.41	0.30	0.17	1.80
Chemical fertilizer (1/0)	−0.22	0.10	−3.10**	−0.56	0.07	−0.83	−0.22	0.09	−2.56*
Insecticides (1/0)	−0.18	0.09	−1.06	−0.30	0.14	−2.15*	−0.17	0.08	−2.10*
Fungicides (1/0)	0.00	0.00	0.00	0.00	0.00	0.00	−0.02	0.03	−0.62
Herbicides (1/0)	−0.37	0.12	−2.94**	−0.50	0.19	−2.64**	−0.26	0.14	−1.80*
Presence of Nacional (1/0)	0.30	0.11	2.58**	0.26	0.13	1.96*	0.15	0.08	1.95*
Presence of CCN-51 (1/0)	−0.26	0.12	−2.18*	−0.50	0.17	−2.93**	−0.31	0.15	−2.13*
Preference for Nacional (1/0)	0.19	0.16	1.87	0.24	0.19	1.26	0.11	0.14	0.78
Shade of noncocoa trees (1/0)	0.11	0.08	0.73	0.30	0.14	2.15*	0.15	0.08	1.95*
Noncocoa tree species richness stated by farmer (1/0)	2.37	0.65	3.67***	1.74	1.16	1.50	1.48	0.94	1.57
Irrigation (1/0)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grafting of cocoa trees (1/0)	−0.04	0.17	0.20	−0.28	0.20	−1.42	−0.19	0.16	−1.16
Pruning of cocoa trees (1/0)	0.14	0.11	1.24	0.00	0.08	0.00	0.13	0.10	1.33
Used fire before planting (1/0)	−0.19	0.11	−0.73	−0.52	0.17	−3.02**	−0.31	0.10	−3.06**
Area in cocoa increased in the past 5 years (1/0)	0.07	0.16	0.20	0.28	0.20	1.36	0.07	0.19	0.40
Biodiversity conditions (Hypothesis 4)									
Noncocoa species richness (species ha^{-1})	2.10	1.65	1.27	2.43	1.22	1.98*	2.10	1.10	1.91
Abundance of noncocoa trees (ha^{-1})	4.33	5.41	0.75	5.52	4.87	1.14	4.83	4.28	1.13
Basal area of noncocoa trees (m^2 ha^{-1})	5.96	30.24	0.44	14.91	26.98	0.55	11.12	27.18	0.41
Average height of noncocoa trees (m)	4.85	2.80	1.90	3.09	2.65	1.16	3.02	2.71	1.11
Average shade level index	0.67	0.34	1.95	0.70	0.42	1.65	0.38	0.37	1.04
Nacional density (trees ha^{-1})	108.3	143.2	0.76	3.29	5.62	0.58	−0.31	4.52	−0.07
CCN51 density (trees ha^{-1})	−297.6	126.1	−2.36*	−13.76	4.64	−2.96**	−10.61	3.69	−2.88**

*$p < .05$.
**$p < .01$.
***$p < .001$.

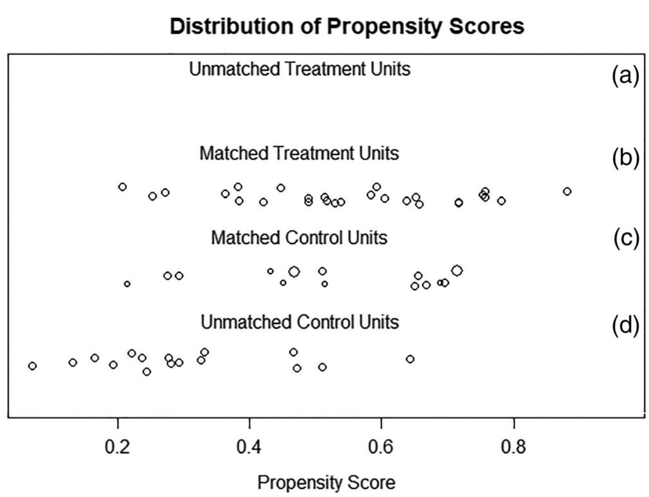

FIGURE A1 Jitter plot of propensity score for genetic matching. Each point represents a case's propensity score. This propensity score distribution indicates that (a) there were no unmatched control observations; (b and c) there was a close match between the treatment observations and the matched control observations, and several control observations were used multiple times to improve matching results; and (d) there were 16 unmatched control observations

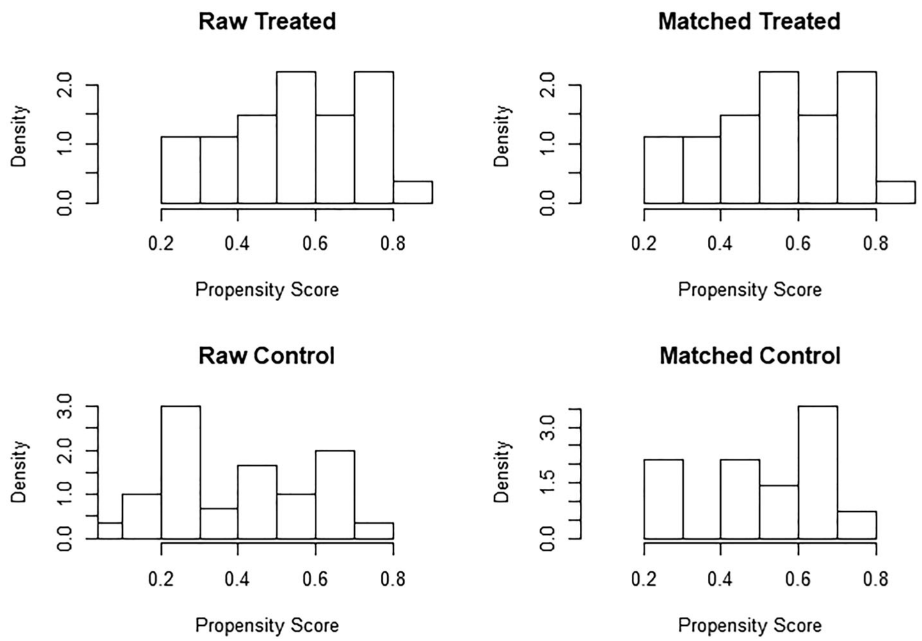

FIGURE A2 Histogram of propensity scores before and after genetic matching. The histograms of treatment and control observations are slightly more similar after matching (right) compared to before matching (left)