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Aarti Krishnan, Valentina De Marchi & Stefano Ponte

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Aarti Krishnan
Global Development Institute
University of Manchester
Manchester M13 9PL
UK
aarti.krishnan-2@manchester.ac.uk

Valentina De Marchi
Department of Economics and Management 'Marco Fanno'
University of Padova
35123 Padova
Italy
valentina.demarchi@unipd.it and

Stefano Ponte
Department of Management, Society and Communication
Copenhagen Business School
2000 Frederiksberg
Denmark
and
Centre for Competition, Regulation and Economic Development (CCRED)
University of Johannesburg
Johannesburg 2092
South Africa
spo.msc@cbs.dk

abstract

A key concern of the global value chain (GVC) and global production network (GPN) literature relates to whether and how actors, especially in the Global South, upgrade by generating and capturing more value. To date, such research has predominantly focused on the economic and social aspects of upgrading. In this article, we leverage selected insights from economic geography to advance our understanding of the environmental dimensions of upgrading and downgrading in GVCs and GPNs. We develop an analytical framework that distinguishes the *processes* of environmental upgrading, in terms of value creation and appropriation, from the resultant *outcomes* (biophysical manifestations, impacts on market access, and reputation). Furthermore, the framework is considered from the upgrading perspectives of multiple actors instead of focusing only on lead firms and other powerful actors. We illustrate how to apply this framework through a case study of the Kenya–UK horticulture value chains. We show that despite the uptake of environmental upgrading practices, as required by UK supermarkets and transmitted by Kenyan export firms with the facilitation of government agencies, Kenyan farmers have mostly experienced environmental downgrading, with some negative effects also affecting farmers and other resource users beyond the value chain.

Key words:
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A key driver of research on global value chains (GVCs) and global production networks (GPNs)[1] has been the need to understand whether, to what extent, and under what circumstances, farms, firms, regions, and countries participate in global industries and what benefits and costs arise as a consequence. These discussions have centered on two main aspects: the first involves power dynamics and governance structures within value chains and production networks that shape the rules of participation and determine how and where value is created and distributed (Gereffi, Humphrey, and Sturgeon 2005; Ponte and Sturgeon 2014; Yeung and Coe 2015; Dallas, Ponte, and Sturgeon 2019); the second involves the upgrading processes that may facilitate value creation for Global South suppliers, and what spatial and distributional consequences may arise (Henderson et al. 2002; Humphrey and Schmitz 2002; Gereffi 2019).

Research on upgrading has mostly focused on the economic dimensions of changes in products, processes, and functions (Humphrey and Schmitz 2002), and related social dimensions—such as working conditions, labor rights, and gender equity (Barrientos, Gereffi, and Rossi 2011; Barrientos 2019). The environmental dimensions of upgrading have also started gaining attention (e.g., Bolwig et al. 2010; Goger 2013; Khattak et al. 2015; Campling and Havice 2019; Ponte 2019; Khan, Ponte, and Lund-Thomsen 2020) as scholars have sought to account for the ecosystem impacts of business operations along the chain. Following De Marchi, Di Maria, and Micelli (2013), environmental upgrading has been predominantly understood as a process by which value chain actors design or modify production systems and practices in view of improving the environmental impacts of GVC operations—with downgrading indicating practices that have negative impacts or effects. An increasing number of contributions have addressed the actions implemented by specific actors in GVCs to mitigate

[1] Given the close relationship between the GVC and GPN literature, in this article we use the terminology of GVCs but refer to both approaches collectively—unless we are referring specifically to the GPN strand of the literature (as in Neilson, Pritchard, and Yeung 2014, and many other contributions).

environmental damage, with some reflections extending to how value chains themselves operate as part of the wider socioecological machinery of capitalism (Havice and Campling 2017), and/or highlighting the dialectical relationships between socioecological processes and chain structures (Bridge and Bradshaw 2017; Campling and Havice 2019).

In this article, we argue that the current literature on environmental upgrading in GVCs suffers from important gaps. First, it has mostly focused on processes so far—the various practices applied by firms in attempting to address the environmental impacts of value chain operations. While some contributions also examine the economic outcomes arising from these processes (e.g., Jia, Gong, and Brown 2019), much less attention has been paid to the related environmental impacts on value chain actors and other actors beyond the value chain. Such a lacuna is particularly challenging given that there is often a disconnect between the tasks performed under the aegis of environmental upgrading and the intended biophysical outcomes (Halme et al. 2020; Khan, Ponte, and Lund-Thomsen 2020).

Second, existing work focuses predominantly on lead firms or large first-tier suppliers—with far less research covering lower-tier actors like farmers and workers—a problem common also in studies focusing on economic or social upgrading (see similar arguments in Murphy 2012 and Barrientos 2019). Missing is an explicit framework that allows for analyses of environmental upgrading from the perspective of different actors along (and beyond) the chain. Environmental upgrading processes may result in improved outcomes for some actors, while having deleterious impacts on others. For example, a case study of the Nicaragua-to-Germany cocoa value chain (Krauss and Barrientos 2021) indicates that lead firms may gain from reducing their emissions, but adhering to the organic standards required by upstream actors ends up worsening Nicaraguan farmers' soil quality.

To address these gaps, this article provides a framework for analyzing environmental upgrading and downgrading in GVCs. Building on the GVC and GPN literature on upgrading and on other economic geography insights, we develop a conceptualization of environmental upgrading that (1) accounts for a much-needed distinction between processes and outcomes, (2) highlights the value creation and appropriation dynamics that underpin environmental upgrading processes, and (3) explicitly adopts a multiactor perspective. Furthermore, we illustrate how our framework can be applied through the case study of Kenya–UK horticulture value chains. We analyze processes and outcomes as they pertain to different sets of actors: UK supermarkets, Kenyan exporting firms (KEFs), Kenyan public sector agencies, and Kenyan farmers. We show that environmental upgrading enhances the reputations and market access of UK supermarkets, KEFs, and public agencies, while Kenyan farmers and other non–value chain actors face mostly negative environmental outcomes.

The article proceeds as follows. In the next section, we provide an overview of the various conceptual underpinnings of environmental upgrading in GVCs. In the third section, we outline our framework for analyzing environmental upgrading. In the fourth section, we apply this framework to the case study of Kenya–UK horticulture value chains. In the final section, we provide some conclusions and reflections for further research.

Conceptualizations of Environmental Upgrading and Their Critiques

Particularly for firms based in the Global South, the unbundling of production activities and proliferation of global interfirm networks have provided important channels for industrial development and access to knowledge (Giuliani, Pietrobelli, and Rabellotti 2005). The classic understanding of economic upgrading in the GVC literature is linked to improvements in the ability of firms to move into more profitable and/or technologically sophisticated economic niches (Gereffi 2019). The concept of upgrading has been adopted widely to explain the trajectories of economic development in a variety of settings and scales (firm/actor, value chain, sector, country and/or region). Accordingly, it has been closely linked to the analysis of *value creation*, which, in much of the GVC and GPN literature, primarily refers to exchange value (see, e.g., Henderson et al. 2002; Gereffi, Humphrey, and Sturgeon 2005; Coe and Yeung 2015) and *value appropriation*—explaining the (often unequal) distribution of such value and related appropriation dynamics across actors in different places or regions (Yeung and Coe 2015; Neilson et al. 2018; Ponte 2019).[2]

The concept of upgrading has contributed significantly to studies of industrialization processes and the development of policies aimed at improving participation in GVC activities as well as showing which actors are able to capture higher shares of value and how (see, *inter alia*, Mayer and Gereffi 2019; De Marchi and Alford 2022). The expansion of GVCs has also brought mounting pressure on firms to reduce the environmental footprint of operations along the value chain (Golgeci, Makhmadshoev, and Demirbag 2021). But early conceptualizations of upgrading in the GVC literature have been criticized for being biased toward lead firm perspectives (Bair and Werner 2011) and/or for focusing mostly on first-tier suppliers (Ivarsson and Alvstam 2011; De Marchi, Di Maria, and Ponte 2013; Lund-Thomsen and Lindgreen 2014).

In this context, the concept of disarticulation can help extend the analysis beyond lead firms, since it questions the inclusionary bias of the chain construct. It calls for analyses of upgrading and downgrading in value chains through the lenses of exclusion, fissure, fracture, exit, contestation, divestment, and devaluation—highlighting the multidimensional and multilevel (individual and collective) nature of agency (Bair and Werner 2011). As highlighted by Carswell and De Neve (2013), lower-tier value chain actors can challenge existing relations, proactively negotiate their position within an existing structure, and/or adapt or cope. While most of the disarticulation literature is focused on economic and social aspects of upgrading, some work has started to examine its environmental aspects. For instance, Havice and Campling (2013) show that, in the tuna industry, small island states have been able to exert control over the chain and upgrade by setting limits on the number of fishing days, by leveraging sustainability certifications, and by attracting new investments. However, they have also experienced downgrading in terms of adoption of environmentally deteriorating production techniques and worsening labor conditions during tuna processing.

[2]The discussion of value in the GVC literature is also liked to the possibilities of generating or improving various forms of rent (technological, organizational, relational, brand, and trade policy-related rents—as in Kaplinsky 2013). For a reflection on other conceptualizations of value in GVCs, see Havice and Pickles (2019).

A second critique of environmental upgrading is linked to the lack of a systemic perspective that can encompass broader ecosystem dynamics. Much of the extant understanding of environmental upgrading is focused on what happens within the chain, in often overly simplistic and linear ways (De Marchi, Di Maria, and Ponte 2013; Khattak et al. 2015). Recent literature, drawn from the theorization of commodity frontiers (see, e.g., Moore 2011, 2015; Ouma 2015), has attempted to address this critique (Campling 2012; Baglioni and Campling 2017). The literature suggests that relations between actors in GVCs needs to be understood within the broader social and ecological dynamics of environmental production, which shape and co-constitute chain dynamics. It is argued that lead firms engaged in GVCs tend to enter commodity frontiers that have possibilities for the appropriation and accumulation of resources and the extraction of value. This results in the appropriation of labor and natural resources, which continues until the socioecological conditions of reproduction stagnate, when, even with new socio-technological innovations, the production-output ratio converges to a below-sector average (see also Moore 2011). When the scope of accumulation is exhausted in a region by lower (volume and quality) material throughput and falling labor-energy surplus and biophysical degradation, a frontier becomes mature and a new frontier is sought (Baglioni and Campling 2017).

From this perspective, understanding processes of environmental upgrading must thus involve the various ways in which commodity frontiers are created and exhausted by different actors (see also Ouma 2015). Through the case study of the tuna fishery value chain, for example, Campling (2012) shows that fishing vessel owners in the Western Indian Ocean and Eastern Tropical Atlantic employed various strategies to maximize the extraction of fish from the ocean (e.g., by maximizing fishing time while simultaneously minimizing travel time). However, over time, overfishing undermines the biological ability of fishing stocks to reproduce. These frontier dynamics and their environmental impacts are clearly related to value chain operations. Havice and Campling (2013, 2017) explain how local tuna manufacturers in Papua New Guinea and the Seychelles were effectively downgraded by international lead firms that have local political influence over tuna access. This was compounded by the state through national environmental regulation that acted as a gatekeeper to access tuna markets, leading to a lowering of wages of tuna manufacturers' workers and to an intensification of fishing efforts.

These critiques raise fundamental challenges to the concept of environmental upgrading as operationalized in existing GVC research. But rather than abandoning a concept that has resonance with a large and growing community of scholars and policy makers, we offer a more nuanced and multiactor framework to study environmental upgrading. We argue that the critiques on the ineffectiveness of earlier conceptualization can be overcome by (1) developing a distinction between environmental upgrading in terms of processes and in terms of outcomes and (2) providing multiple accounts from the perspective of different actors.

Environmental upgrading seen as a set of *processes* relates to the complex ways in which changes are applied to environmental management of products and operations along a GVC. These changes are applied through the strategic organization of specific GVC actors, which enables value to be created and appropriated (akin to Henderson et al. 2002, we discuss value in terms of exchange value). For instance, these processes can include using more energy-efficient technology to develop new production techniques or more environmentally-friendly product lines (e.g., Khattak et al. 2015). Environmental upgrading seen as a set of *outcomes* refers to (1) the biophysical environmental impacts of these processes (such as the reduction or mitigation of pollution, the reduction/efficiency in the use of inputs, or the improvement of biodiversity) and (2) the impact on the environmental reputation of a firm and/or its legitimacy and social license to operate. Downgrading, in relation to both processes and outcomes, simply indicates involution (degrading processes, negative outcomes).

For the most part, research on environmental upgrading and downgrading has paid more attention to processes rather than outcomes (Krishnan 2018), conflating the processes performed to upgrade with the related outcomes that arise from these processes (for a notable exception, see Goger 2013). When outcomes are analyzed, the focus has been mostly on economic aspects, for example, in terms of changes in earnings or learning (Kia et al. 2019). However, much evidence suggests that environmental upgrading processes do not necessarily achieve their intended outcomes (Halme et al. 2020). For example, Khan, Ponte, and Lund-Thomsen (2020) show how, in the Pakistani apparel value chain, suppliers heavily modified their activities to comply with environmental management standards required by their buyers. Yet, they did not achieve positive environmental outcomes. Clarke and Boersma (2017) point to important increasing emissions related to the production of Apple products, despite the undertaking of important greening investments.

We also observe that many studies tend to focus on how lead firms facilitate or carry out environmental innovation (Jeppesen and Hansen 2004; De Marchi, Di Maria, and Ponte 2013; De Marchi and Di Maria 2019). These are useful in explaining which governing structures are more effective in engaging suppliers in environmental upgrading trajectories but are not particularly effective in explaining how more powerful actors may accumulate gains from environmental upgrading processes carried out by other actors along the chain (see Goger 2013; Ponte 2019). Furthermore, the focus on one or two groups of actors inhibits an understanding of the diverging upgrading and downgrading outcomes that can affect other actors within and beyond a value chain.

A Framework for Analyzing Environmental Upgrading and Downgrading in GVCs

Against this background and drawing additional insights from (environmental) economic geography (e.g., Bush et al. 2015; Khattak and Pinto 2018; Campling and Havice 2019; Golgeci, Makhmadshoev, and Demirbag 2021), we propose a framework for analyzing environmental upgrading and downgrading in GVCs that accounts for processes and outcomes, and that considers both from the perspective of different groups of actors. For this purpose, we build on extant definitions (e.g., De Marchi, Di Maria, and Ponte 2013) to redefine environmental upgrading as occurring when specific sets of actors attempt to improve the environmental processes related to their own production systems and those of their buyers/suppliers, which in turn result in positive environmental outcomes. In other words, environmental upgrading occurs only when improved processes also lead to improved environmental outcomes; if the latter do not occur

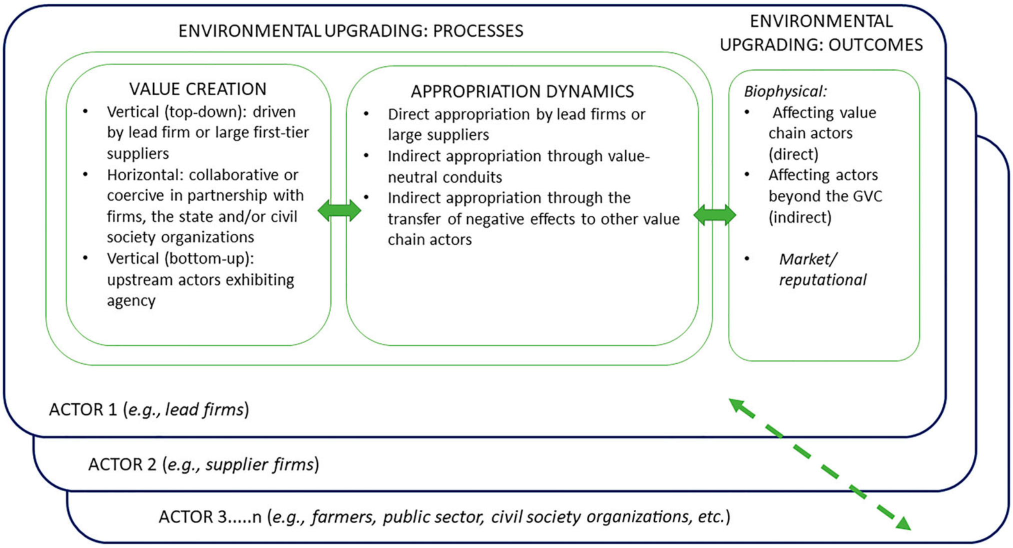

Figure 1. A multiactor framework for the analysis of environmental upgrading.
Source: Elaboration by authors.

(or occur only in relation to improved market or reputational outcomes), we then observe environmental downgrading. Figure 1 summarizes the key elements of the multiactor framework (as evidenced in the overlapping rectangles), which we develop in detail in the rest of this section.

Environmental Upgrading Processes: Value Creation

The *value creation* processes of environmental upgrading can be conceived primarily in relation to the management, marketing, and/or branding of the natural environment, which occurs through strategic actions of specific sets of actors that impinge on their own practices or the practices of other value chain actors (e.g., their buyers, suppliers, or subcontracted suppliers). To do so, for instance, actors implement strategic actions that transform their use of materials (e.g., Bridge 2002; Gibson and Warren 2016; Bridge and Bradshaw 2017) or methods of production. Other actions include implementing or adopting more eco-efficient technologies, developing environmentally friendly product lines, or developing more sophisticated products (see De Marchi, Di Maria, and Ponte 2013; Khattak et al. 2015).

Through inductive analysis based on the review of literature, we highlight three overarching types of value creation linked to environmental upgrading processes: (1) vertical (top-down), (2) horizontal, and/or (3) vertical (bottom-up) (see Figure 1). *Vertical (top-down)* processes are controlled and directed by lead firms or by large first-tier suppliers over suppliers further upstream. These are most frequently discussed in the context of buyer driven GVCs. Vertical processes can be either standard driven (also known as compliance oriented) or mentor driven (also known as cooperation oriented; see De Marchi, Di Maria, and Ponte 2013; Lund-Thomsen and Lindgreen 2014). In standard driven processes, lead firms embed complex environmental information into (own or third-party) standards that suppliers have to comply with, often replacing local and indigenous environmental practices (Evers, Amoding, and Krishnan 2014). These efforts involve knowledge transfer in a relatively top-down manner (De Marchi, Di Maria, and Ponte 2013), are often linked to a *sustainability supplier squeeze* (Ponte 2019), and tend to be common in the agriculture and mining sectors (Ponte 2020). Mentor driven processes also involve direct interactions between the lead firm and supplier firms/actors, but in this case, actors tend to be mutually dependent and acquire specialized know-how and skills (De Marchi, Di Maria, and Ponte 2013; Khattak et al. 2015). In this context, lead firms are found to engage more cooperatively; they mentor suppliers, co-invest in supporting environmental practices, and even collaborate on innovation (De Marchi, Di Maria, and Ponte 2013). Often, firms implement a mix of these two approaches, as several case studies demonstrate (see Jia, Gong, and Brown 2019). Broadly speaking, in top-down value creation processes, lead firms have access to, and control over, the environment and natural resources in host countries where they territorially embed themselves, that is, they control the environmental conditions of production of suppliers and are thus able to transform and/or modify the environment to enhance productivity.

Horizontal processes of value creation involve lead firm collaboration with nonfirm actors such as state agencies and/or civil society groups. These are horizontal in the sense that they do not follow the vertical supplier–buyer dynamics within value chains, but rather operate sideways in interactions that include non–value chain actors. For instance, many lead firms have formed partnerships and associations with civil society groups and/or governments to develop new partnerships to tackle sustainability challenges and to push for specific environmental standards (see, e.g., Alexander 2020; Richey and Ponte 2021). In several primary sectors, the state, of course, can act as a resource owner or gatekeeper, dictating how state–firm relationships play out (Campling and Havice 2019). These interactions can also deepen asymmetries of access and control over natural resources. Lead firms can work through the state to shape advantageous environmental regulation and/or watered-down environmental standards to push specific top-down agendas. Partnerships involving nongovernmental organizations (NGOs) and multistakeholder initiatives can also be an important tool for lead firms to ensure supplier compliance (see a systematic review in De Bakker, Rasche, and Ponte 2019).

Finally, *vertical* (*bottom-up)* processes of value creation are those where lower-tier and less powerful actors in a value chain exhibit substantial agency. For example, Selwyn (2007) finds that agricultural laborers in Brazil were able to align industrial action (and thus resistance) with the seasonality of grape ripening, thereby facilitating the adoption of environmental practices that best suited them. Alford, Barrientos, and Visser (2017) find that South African grape farmers and workers, with support from international and local civil society groups, were able to gain labor representation and bargain for better pay and work conditions. De Marchi and Di Maria (2019) show how tanneries in the Italian leather value chain proactively developed circular economy strategies by anticipating the requests of lead firms in the automotive and fashion sectors. Such examples are clear instances of the possibility for actors to recalibrate or disentangle themselves from uneven and exploitative GVCs relations, to refuse/renegotiate participation (Bair and Werner 2011; Nickow 2015), and/or to display proactive agency (Riisgaard 2009).

Environmental Upgrading Processes: Value Appropriation

Asymmetric power relations along the GVC mean that the value created through processes of environmental upgrading is not necessarily retained or appropriated by the actors that created or enhanced value. Instead, value can be appropriated by other actors (e.g., by lead firms) and (re)distributed according to their priorities. Although we distinguish between value creation and appropriation, we do not necessarily suggest that the two must take place in such sequence. Value creation processes may be devised by a value chain actor to also serve as a tool of appropriating the value created by other actors. We argue that these appropriation dynamics occur in three main ways (see Figure 1), yielding heterogenous outcomes for different actors in the value chain and beyond.

The first form is *direct appropriation of value by lead firms* (or large first-tier suppliers)—value that was originally created or enhanced by the labor of other actors (e.g., farmers, fishers) along the chain. This usually entails the draining of resources through the control of property rights, entitlements, and access (Havice and Campling 2013). Ponte (2019) provides several examples of how environmental upgrading processes adopted by suppliers creates value that is appropriated by large buyers through the expectation that these new features are to be delivered at the same price as in previous transactions. The second form is *indirect appropriation through value neutral conduits*. These are actors who do not appropriate value themselves but allow the transfer of value to other, more powerful actors, without adequately compensating less powerful value chain actors (see "Value Creation" and "Value Appropriation"). The third form is *indirect appropriation through the transfer of negative environmental effects* to others GVC actors (see, e.g., Krishnan 2018). This occurs when some GVC actors (e.g., farmers, workers) have to absorb, or accept, the deterioration of natural resources in the localities where they live and/or operate. Ideally, these forms are not to be studied in isolation from each other—given that they can occur concurrently and have important mutual interactions.

Environmental Upgrading Outcomes

In our framework, we approach environmental upgrading not only as a set of processes but also in relation to the outcomes shaped by these processes. We operate with two simple distinctions in our framework (see Figure 1): (1) between outcomes that affect value chain actors and those that also affect larger communities beyond the value chain and (2) between outcomes that have biophysical manifestations and those that have market and/or reputational features related to the environment.

The analysis of biophysical aspects is important because changes in the ecological carrying capacity and the quality of natural resources in the localities where a value chain operates in turn can affect the environmental conditions of production and thus affect primary producers in the long term (Senbel, McDaniels, and Dowlatabadi 2003). These affected outcomes can include the quality and volume of natural resources, their use and flows, and changes in rates of wastage (see, e.g., Bridge 2002; Campling 2012). They can refer to air quality, water and energy efficiency; soil and water quality; material flow and loss; biodiversity; waste circulation; and carbon sinks in production areas. But they can also have impacts at broader territorial scales such as on ocean acidification or regional greenhouse gas emissions. Therefore, these outcomes can be examined in their *localized* manifestations (in relation to activities within the value chain) but also at a *regional or more global* scale. The specific aspects included in such analysis will vary depending on the GVC under study and the spatial scope of the study itself. However, often several outcomes need to be assessed and compared—for example, energy efficiency vis-á-vis water availability (see, e.g., Goger 2013)—raising challenges in terms of commensurability and the evaluation of trade-offs.

Several indicators and proxies can be adopted to measure environmental outcomes (see, e.g., Akcakaya, Kennedy, and Hilton-Taylor 2006). At global and national scales, they can be categorized by drawing on the nine planetary boundaries by the Stockholm Resilience Centre (Rockström et al. 2009) ranging from biodiversity loss, ocean acidification, and land system change to territorial emissions, or on the OECD set of environmental indicators (OECD 2008). Firm-level self-reported data have also been used to shed light on the environmental impacts of value chain activities (e.g., emissions, material flows). The Global Reporting Initiative (GRI) provides the most widely adopted standards guiding firms in measuring (and reporting) their impacts, listing twelve areas, including firm-level metrics on materials, energy, waters, biodiversity, transport, waste, and metrics on supplier environmental performance (GRI 2021). However, this data are usually only available for larger firms and in particular geographic contexts, and rarely provide a full account of the impacts of an entire value chain (Schaltegger et al. 2014).

The scarcity or incompleteness of data has thus far limited the ability to accurately assess the impact of environmental upgrading processes on actual outcomes that affect various groups of actors. These outcomes are also experienced heterogeneously by different sets of actors, in both direct and indirect ways. Certain GVC actors can reap benefits by appropriation while others experience a drainage of their environmental resources. As the environment alters the quality and the regenerative capacity of provision, regulation, and production, its decreasing carrying capacity (the maximum use that the biota can withstand before becoming irreversibly damaged) may create a cycle of negative implications for GVC actors.

In Figure 1, we highlight that environmental upgrading can affect value chain actors (direct outcomes) but also actors beyond the value chain (indirect outcomes). While the case for studying direct outcomes is self-explanatory, an analysis of environmental upgrading should also consider outcomes that affect other nonparticipating actors that may be affected from the negative environmental spillovers of value chain operations. For example, lack of water circulation for farmers participating in a specific GVC may affect the water table and soil quality in the whole region, thus impacting other local farmers and other actors who are not participating in GVCs. By considering the indirect environmental outcomes for those residing in spatial proximity to GVC participants, we can better understand the broader region-specific effects on local communities. Finally, in Figure 1 we also indicate that environmental upgrading outcomes can also be ascribed to enhancing market access and/or reputation (see "Environmental Upgrading Outcomes").

Applying the Framework: A Case Study of the Kenya–UK Horticulture Value Chains

Kenya's horticulture sector is one of the country's foremost foreign exchange earners (Barrientos 2019). In 2018, 65 percent of Kenya's horticulture exports went to Europe of which 80 percent went to the UK. Vegetables (primarily green beans, snow peas, garden peas, and snap peas) are the main contributor to Kenya's exports in this sector, followed by fresh fruit (mainly avocados and mangoes) (International Trade Centre [ITC] 2020). The 1990s saw the introduction of new products, such as green beans and new varieties of avocados, by British and Dutch firms in Kenya. Kenyan farmers were incentivized by the Horticultural Crops Development Authority (HCD)[3] through seed subsidies, and by KEFs through credit, to move away from maize and indigenous varieties of avocados and toward planting green beans (runner varieties) and export varieties of avocados (Hass and Fuerte). Moreover, the HCD and KEFs encouraged the use of specific seeds that were sold through large multinational corporations (MNCs), which had not been extensively tested on Kenyan soil.

Kenyan horticulture has been the subject of much research through the lens of GVC analysis. One of the earliest studies by Dolan and Humphrey (2000) traced the historical political economy of the rise of the horticultural GVC in Kenya and its transformation from serving bulk markets to catering to supermarket chains in the UK. Several studies have subsequently unpacked the possibilities for economic and social upgrading, specifically in light of the emergence of stringent food standards such as GlobalGAP (see, among others, Ouma 2010; Barrientos 2019). However, until recently (see Krishnan 2018), little research had specifically focused on the environmental upgrading aspects of value chain operations.

Farmers in Kenya are doubly exposed to the threats of marginalization and environmental change (O'Brien and Leichenko 2000). While Kenyan horticultural exports increased at a compound rate of 11 percent per annum between 2001 and 2018 (ITC 2020), the industry is under pressure not only from mounting standards but also from emerging competitors in neighboring Ethiopia, Tanzania, and Uganda. To respond to such pressure, unsustainable agricultural intensification methods (e.g., monocropping) are advocated by KEFs. This is causing exhaustion or damage to local natural resources (e.g., degrading soil and water quality, ground water shortages), the escalation of inorganic waste and greenhouse gas (GHG) emissions, and a reduction in biodiversity—to the detriment of both participant farmers and others living in these areas (Mulinge et al. 2016). Furthermore, most Kenyan horticultural exports are air freighted, thus adding considerable GHG emissions. Thus, this case study is not only of considerable economic significance to the country but is also particularly relevant to our discussion on upgrading due to the environmental challenges the sector is facing.

Data and Methods for Measuring Environmental Upgrading

Data for this case study was collected using a longitudinal mixed-method approach, based on fieldwork undertaken in 2015 and 2019 on the green beans and avocado value chains. The counties selected were Meru (about 250 kilometers northwest of Nairobi), Murang'a (approximately 60 kilometers to the north of Nairobi), and Machakos (borders Nairobi to the south), which are high production zones with a high density

[3]The HCD regulates the horticulture industry, provide export licenses, enforces contracts, and provides conflict resolution mechanisms in order to reduce contract noncompliance risk. Known as the Horticultural Crops Development Authority (HCDA) until 2014, post devolution the HCD was converted into a directorate, and given more autonomy to regulate the horticulture industry.

of farmers. For mapping environmental issues within the horticulture GVC in Kenya, secondary data was collected and analyzed, including academic publications and the gray literature published by the Kenyan Agricultural and Livestock Research Organization (KARLO), the National Environment Monitoring Authority (NEMA), the Kenyan Department of Remote Sensing (KDRS), and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Kenya.

Primary data was collected in 2015 and 2019 in three stages. Stage 1 included conducting in-depth semistructured interviews with thirty-one respondents, including (1) farmers selling to the local and to global markets; (2) government institutions (at the national and county level); (3) associations, standard bodies, and NGOs (e.g., the Fresh Produce Exporters Association of Kenya [FPEAK], the East African Farmers' Cooperative); and (4) KEFs (see Appendix Table 1 in the online material for a full list of actors). Analysis of qualitative data were performed with NVivo software, while the quantitative analysis involved the production of descriptive statistics. Stage 2 involved collecting survey data in 2015 and a repeated survey with the same farmers in 2019. Since secondary GVC data do not exist, to create a close to a representative sample of avocado and green bean farmers, sampling involved creating a universe of farmers identified from the HCD, which collects traceability data, including farmer production and location, along with farmer lists from subcounty governments. Data from this universe was then stratified by county according to volume of production and number of farmers. A sample of 391 farmers was then randomly selected across the counties of Meru, Murang'a, and Machakos of which 47 percent of the total farmers sold predominantly into GVCs, and 54 percent sold into local markets. In the rest of this article, we draw on a combination of secondary data, interviews, and survey data to develop each aspect of the environmental upgrading framework developed in the previous section (see Figure 1).

First, we assessed *value creation* processes by using qualitative data emerging from interviews—when possible, triangulating with secondary data. This approach, based on subjective evidence, is often used to investigate the practices implemented by GVC actors (see, e.g., Havice and Campling 2013; Lund-Thomsen and Lindgreen 2014; Ponte 2019). In Appendix Table 2 in the online material, we provide a summary of some of the key interview questions related to value creation.

Second, we measured *direct value appropriation* by downstream GVC actors in relation to the natural resource, labor, and other costs incurred by farmers as a proportion of their sale price to KEFs. We collated this information from interviews with farmers and extension officers from the HCD and then triangulated it through interviews with experts (from KARLO, NEMA, ICRISAT, and FPEAK) to develop a robust set of indicators (see Appendix Table 3, row 2 in the online material). Such an approach to develop indicators, based on expert judgment, is commonly used by international organizations to capture complex and multidimensional elements.[4] Once the indicators were identified, data was gathered through farmer surveys, and the results triangulated with evidence from further interviews with experts, and secondary location-specific data collected by the KARLO, to ensure data validity.

[4]For example, see UN Gender Inequality Index.

Third, we assessed *indirect value appropriation* with two separate approaches. We measured value appropriation through value neutral conduits qualitatively by tapping into interview material with experts at the HCD, NEMA, and FPEAK —to examine the way these actors either facilitated or inadvertently enabled transfer of value from farmers to lead firms and KEFs. We examined indirect appropriation through the transfer of negative environmental effects to other GVC actors in terms of the costs farmers incur for addressing the environmental problems caused by GVC activities (driven by powerful GVC actors). For farmers, conserving their environment is critical not only from the perspective of maintaining their GVC participation but also to bequest land to their families in the future and maintain their livelihoods in the long term. Negative environmental effects from intensive commercialization create fears of environmental degradation that could prevent the intergenerational transfer of good quality property. Data to capture this used a similar approach to that for direct appropriation: identifying indicators based on expert judgment and then measuring it via secondary data, interviews, and the survey (see Appendix Table 3, row 3 in the online material). To assess to what extent direct and indirect appropriation dynamics affect productivity, we also examined various ratios of crop yields to costs of production, which includes direct and indirect appropriation (see "Value Appropriation"). Productivity, is considered a good proxy, since it internalizes various negative environmental effects (e.g., Shiferaw and Holden 1999) and is a particularly useful measure especially in regions/countries where environmental data collected are scarce.

Fourth, we assessed *direct and indirect biophysical outcomes* along three categories: (1) protection of natural capital, (2) efficient and sustainable resource use, and (3) regenerative capacity. The classification of these environmental issues is drawn from the Green Growth Knowledge platform indicators and was refined through expert interviews with farmers, the NEMA, the KARLO, and publications focusing on this industry. To measure the first two categories, objective data are combined with subjective data. Objective data are collated from the KDRS, meteorological department and the ICRISAT soil maps (pH, nutrients), precipitation and temperature, and tree cover at the subcounty level. The data was imputed at the farm level through global positioning system (GPS) locations. Similar to Rigby et al. (2001), objective subcounty-level data are triangulated with subjective information to provide robust estimation of outcomes at the level of specific actors. For the third regenerative category, we drew from KDRS data and environmental impact assessments conducted at the subcounty level by the NEMA every three to five years.[5] Finally, we assessed *market access and reputation outcomes* qualitatively by drawing from our interviews with all categories of GVC actors.

The Kenya–UK Horticulture Value Chains

A simplified representation of the Kenya–UK horticulture value chain is shown in Figure 2, which shows the first stage relates to agricultural inputs (fertilizers, pesticides, herbicides, and fungicides) that are imported from international suppliers—often MNCs based in the Netherlands and India. Seeds are predominantly imported and provided by

[5]Most of the reports by the NEMA, KDRS, and KARLO are internal documentation that are available on request and not published online.

MNCs, such as Monsanto and Syngenta, in addition to the Kenyan Seed Company. When it comes to production, contracts (oral or written) are drawn between farmers, farmers groups/cooperatives, and Kenyan export firms and/or directly with UK retailers (e.g., Tesco, Sainsbury's, Marks & Spencer). Most contracts state the price and list the mandatory requirements that farmers/cooperatives need to follow. In the production stage, farmers source inputs (e.g., fertilizers, chemicals) primarily from large MNCs such as Amirian. These are specifically required by lead firms/KEFs. Farmers also access technical advice from extension officers (the HCD county staff, subcounty staff), various organizations (including the FPEAK), agricultural universities, and NGOs. The HCD is the main regulator and is responsible for releasing export licenses to KEFs, enforcing contracts, providing extension services, and supporting conflict resolution mechanisms in order to reduce the risk of contract noncompliance. Green beans and avocados are then collected in selected collection hotspots or warehouses managed by KEFs (or through intermediaries) where they are weighed and graded before export. KEFs then often package the produce and sell it directly to UK supermarkets. In the analysis below, we focus on the key actors that are highlighted within black outlined boxes in Figure 2: farmers, KEFs, Kenyan government actors (specifically, the HCD), and UK retailers.

UK supermarkets (the lead firms in this value chain) are influenced by the pressures of consumers and NGOs (e.g., Oxfam) to source ethically, conserve the environment, and provide fair wages (Krauss and Krishnan 2021). Furthermore, peer pressure through business associations, such as the British Retail Consortium (BRC), has led to the harmonization of a *base* level of sustainable procurement requirements across UK supermarkets (BRC 2018). In an attempt to seek legitimacy and to be seen as transparent, mechanisms such as the GRI, were adopted in the UK in view of generating a green competitive advantage (see, e.g., Lund-Thomsen and Lindgreen 2014). Consequently, in order to market products as *green*, UK retailers require upstream actors (e.g., KEFs, farmers/cooperatives) to meet environmental requirements (e.g., organic production, circulation of crop production waste into energy) that are included in their private codes of conduct and/or by demanding stringent compliance to voluntary standards (such as GlobalGAP).

In the rest of this section, we apply the framework we illustrated in Figure 1 to the case study of Kenya–UK horticulture value chains and specifically those for green

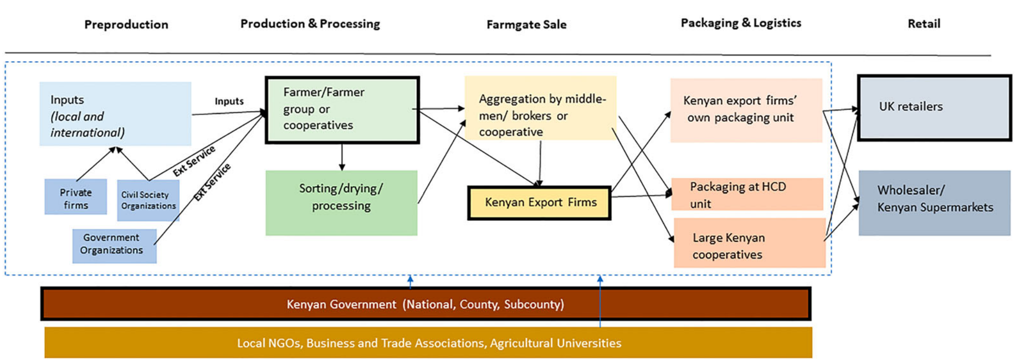

Figure 2. Simplified representation of the Kenya-UK horticulture value chain.
Source: Elaboration by authors.

beans and avocados. We follow the same steps and graphic representation highlighted in the first part of this article to analyze processes (value creation, value appropriation) and outcomes (both biophysical and in relation to market access/reputation) for four sets of actors: UK supermarkets, KEFs, the HCD, and farmers (see summary results in Figure 3).

Value Creation

Lead firms in the horticultural GVC adopt vertical (top-down) approaches to value creation that are standard driven, affecting other actors throughout the value chain. UK supermarkets require KEFs to comply with stringent standards (e.g., GlobalGAP, Rainforest Alliance) and/or with their own codes of conducts (e.g., Tesco Nature, M&S Farm to Fork). KEFs, in turn, thrust standard compliance onto farmers.

Compliance with standards to participate in the GVC requires Kenyan farmers to use new environmental practices, such as integrated pest management, irrigation schedules, and soil testing, which are often complex and considered *alien* to the local context. To facilitate adoption, KEFs employ horizontal processes in view of collaborating with training associations, such as the FPEAK, other NGOs, such as CARE and Technoserve, and the HCD for extension service provision. These are often delivered only through demonstration farms in specific locations a few times a year, forcing farmers to travel to these locations at their own expense or to wait for long periods if they cannot travel; this makes adopting and implementing these new practices difficult for farmers.

KEFs draw up standard-specific contracts with farmers. These contracts not only list the types of standard-driven practices that need to be undertaken but also the exact volume of the produce that will be purchased. Prices set in these contracts typically do not account for changes in production costs (including chemical inputs and labor) or for the impact of production on the quality of soil and water. This enables KEFs to make farmers absorb the possible environmental costs (e.g., related to water testing, soil conservation efforts, energy consumption, erosion maintenance) without compensation. Despite several complaints raised by farmers and farmer groups (see below), interviews with KEFs suggest that contracts are strategically kept short term and low priced because of the high costs involved in subsidizing standard-compliant seeds and chemicals for farmers and the losses accrued when farmers default on contract terms by opportunistically selling to competitors. Due to this risk, KEFs often superficially demonstrate *commitments* to environmental upgrading processes but do not meaningfully invest in making improvements to the natural environments from where they source.

Implementing standards requires farmers to make significant asset-specific investments (e.g., on pesticide sprayers, protective clothing, drip irrigation, improved seeds). Many farmers struggle to afford this and receive insufficient technical and infrastructural support from UK supermarkets, KEFs, and/or the HCD. Although the HCD contracted the Kenya Plant Health Inspectorate Service (KePHIS) to provide support for soil testing and the Pest Control Products Board (PCPB) to perform stress tests to measure the suitability of pesticide and fertilizers, these initiatives were meant to help KEFs meet UK supermarket requirements rather than addressing the environmental concerns of farmers. Furthermore, KEFs received additional support through the four

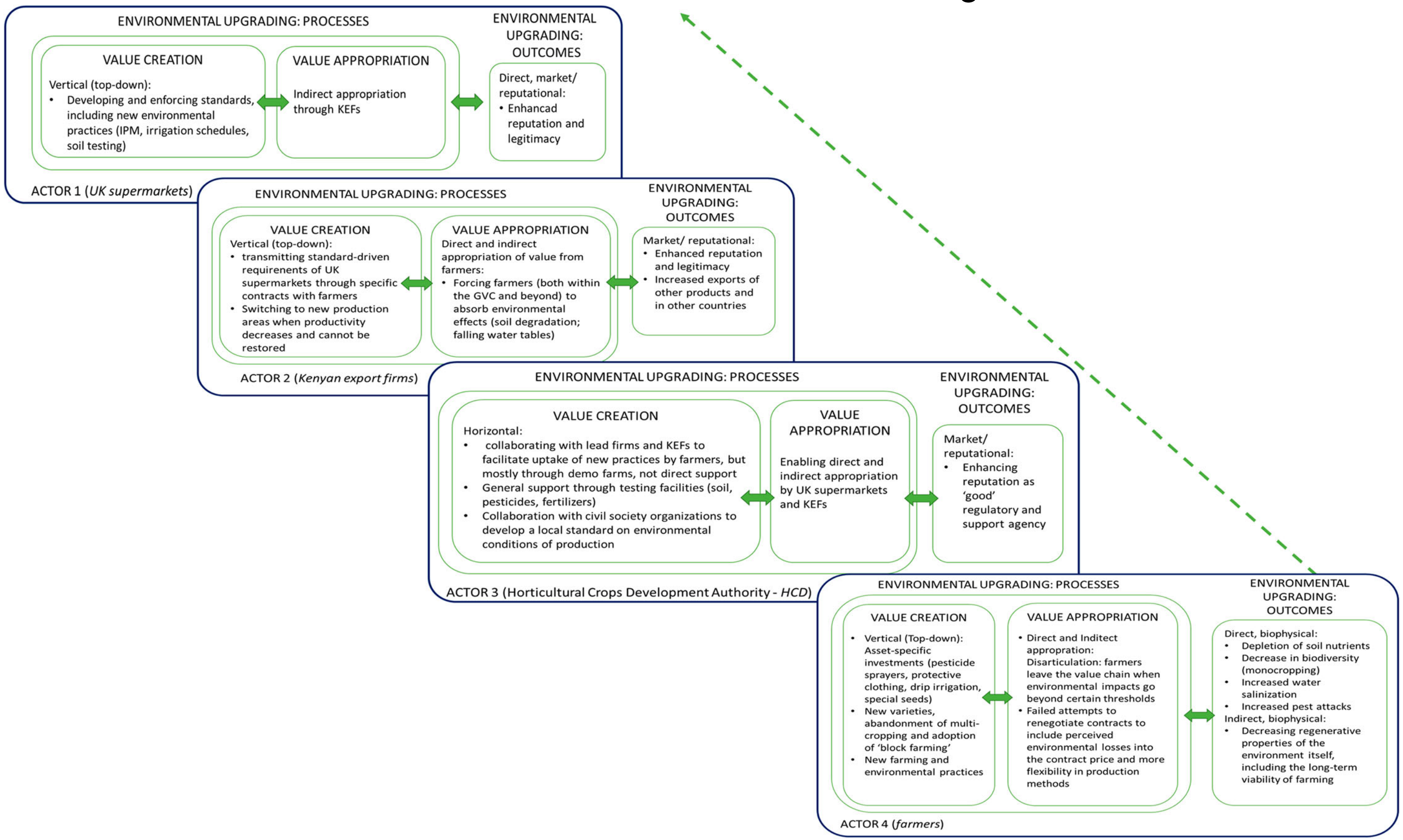

Figure 3. Environmental upgrading in the Kenya-UK horticulture value chain.

economic parks that were set up by the Kenyan Ministry of Trade and Industry between 2008 and 2019, with support from the Export Processing Zone Authority. Several tax benefits are also provided to large exporting KEFs that are predominantly Kenyan owned, reducing their variable costs and therefore allowing export prices to remain competitive. These public-sector interventions are largely geared to support export promotion rather than directly support farmers and their livelihoods.

Our interview material also suggests that the HCD has employed horizontal value creation processes to work closely with the civil-society organization ColeACP to develop a local standard (KS 1758) aimed at supporting farmers to level up to international food safety and traceability standards. This was done after the failure of Kenya-GAP, which was created as a benchmark to GlobalGAP (Ouma 2010). The standard-related investments of the HCD in extension service and the subsidies provided for high-yielding seeds have facilitated an increase in crop yields and a decrease in production costs.

However, these upgrading processes have had significant implications on the environment over time. Rather than using indigenous multicropping systems where different crops are grown next to each other to facilitate a symbiotic relationship, farmers reported that KEFs (and UK supermarkets) expected them to grow crops in blocks (intensive planting of the same crop side-by-side)—a custom reinforced by the HCD through its extension services. Such block growing aims to keep compliance costs down by applying GlobalGAP standards for only one crop. Over 90 percent of farmers reported that increased block intensification has caused soil depletion and/or the altering of nutrients in time and thus has affected crop quality. They have faced escalating costs due to increased pest attacks (linked to increasing temperatures), frequent droughts and floods, and an increasing salinization of water. These factors are degrading the environmental conditions of production (see "Value Appropriation"). Farmers replaced local and indigenous environmental practices and gave KEFs and UK supermarkets indirect access to natural resources (such as soil and water) by growing crops on their behalf. In essence, in the early 1990s, UK supermarkets and KEFs (in collaboration with the HCD) created a commodity frontier for green beans and new variety avocados in the high potential areas of Murang'a, Meru, and Machakos, which are proximate to Nairobi. As we will see in the next section, however, this frontier is nearing maturity.

Value Appropriation

Through their labor, farmers transform natural resources into standard-specific crops that meet the sustainability requirements of export markets. The processes of environmental upgrading through value creation discussed above allow UK supermarkets and KEFs to directly appropriate the value created by farmers and their natural environments. In order to assess value appropriation, we use a series of proxies as indicated in Table 1. As we can see, the proportion of production costs related to natural resource use and labor incurred by farmers has been increasing across the board (measured as a proportion of the final sale price to KEFs). This indicates a trend toward lower margins for farmers and increasing and direct value appropriation by KEFs (line A). In the case of avocados, farmers are shown to have operated at a net loss in 2019.

Table 1

Appropriation Potential by KEFs (2015, 2019)

		As % of Total Farmers' Sale Price to KEFs			
		Green Beans		Avocados	
		2015	2019	2015	2019
A1	Costs of exploiting natural resources for farmers	55	72	35	45
A2	Labor costs*	38	39	42	49
A	Total direct costs**	93	111	77	94
B	Indirect costs of addressing negative environmental effects	46	58	28	41
C	Total costs	139	169	105	135

Source: Calculation from survey data and KDRS, ICRISAT, KARLO.
Notes: * Includes only hired labor, not household labor inputs. ** Does not include costs of borrowing, leasing machinery, and other input costs.

Furthermore, farmers also face indirect costs in the sense that they have to mitigate the negative environmental effects of GVC production. This is value appropriation in the sense that farmers face costs that remain unpaid by their buyers such as those related to soil improvement and erosion maintenance, building furrows, and setting up rainwater harvesting. These costs are substantial and increasing as a proportion of farmers' sales price to KEFs (see Table 1, line B).

Thus, rather than creating positive effects for farmers via resource efficiency gains through the transfer of good environmental practices, and/or developing skills to enhance practices (e.g., to combat climate variability and/or pest attacks), KEFs essentially appropriate value related to the draining of the productive potential of farmers' land and other natural resources.

Looking at productivity, as Table 1 suggests, if we include indirect costs to mitigate environmental damage (line C in Table 1), farmers operate major and increasing losses. In the aggregate, these results suggest that, from 2015 to 2019, a continuous and growing process of value appropriation by KEFs has taken place.[6] The commodity frontier across the three counties, however, may be maturing. As we can see in Table 2, while aggregate yields are generally increasing, productivity measured over direct costs of production is falling. If we account for indirect environmental costs as well, productivity is falling even more steeply.

Interviews with seven large KEFs suggests that even with escalating investment in integrated pest management initiatives, training in handling chemicals, improved traceability of produce, and the setting up of new soil and water testing facilities, productivity has not improved. Furthermore, the slow regenerative capacity of soil fertility appears to be a key reason for UK supermarkets and KEFs to be switching to new frontiers. For KEFs, this predominantly involves moving to other villages in Meru, Machakos, Murang'a, or new counties entirely (such as Kirinyaga, which neighbors Meru or

[6] Due to lack of space, we do not extend this analysis to appropriation dynamics between KEFs and UK supermarkets, but it is quite likely that a large proportion of this value is transferred downstream in the value chain, as other case studies in agrofood industries attest (Ponte 2019).

Table 2

Average Productivity of Green Beans and Avocado (2015, 2019)

Crop	Yield (kg/acre) *			Yield/Costs of Production (A) (kg/USD)*			Yield/Total Costs (A + B = C) (kg/USD)*		
	2015	2019	% Change	2015	2019	% Change	2015	2019	% Change
Green Beans	3,500	4,600	31	3.21	2.89	-10	1.73	1.21	-30
Avocados	3,100	4,050	30	3.87	3.24	-16	2.79	1.91	-32

Source: Authors' elaboration from survey data and information provided in Table 1.
Notes: *data is calculated as the average values across Meru, Murang'a, and Machakos counties.

Kiambu county bordering Nairobi to the north) and sometimes even across the border to Uganda or Tanzania. However, in some cases, UK supermarkets discontinued working with KEFs to source green beans and avocados from alternative suppliers in Uganda and Tanzania.

These dynamics of appropriation also occur because of the role played by value-neutral conduits such as the HCD. There are no regulations or procedures, such as climate insurance or social protection schemes, that can protect farmers against exploitative practices. For instance, the HCD did not set up any dispute settlement or conflict resolution mechanism through which farmers could voice their problems and seek accountability from lead firms or KEFs. Furthermore, the lack of investment by the HCD to improve the environmental conditions of production for farmers further enabled direct appropriation by KEFs. In sum, the HCD did not initially set its own standards, leading to the proliferation of international private standards demanded by UK supermarkets in governing exports in GVCs. Over time, the HCD implicitly adopted these private standards and increased support for UK supermarkets and KEFs by providing infrastructure such as International Organization for Standardization–certified packaging facilities.

Farmers were not provided with any specific support to mitigate the negative environmental effects that they encounter. There are no clauses in local standard KS 1758 to provide environmental protection for farmers, not even in case of shocks such as droughts or floods. Therefore, the HCD supported environmental upgrading of KEFs and UK supermarkets who in turn engendered environmental downgrading pressures on farmers. While the HCD did not actively seek to undermine farmers, it did not intervene to prevent downgrading either (for similar dynamics, see Ouma 2010, 2015; Baglioni and Campling 2017).

Farmers have tacit knowledge of the environmental limits of their land and other natural resources. They appear willing (even if reluctantly) to exploit resources for commercial purposes by participating in the green bean and avocado value chains but only up to a certain threshold, after which they no longer wish to continue participating on the same terms. This tacit threshold was described by farmers as the deterioration of land beyond repair (when the marginal improvement in natural resources begins to fall). Sociocultural factors tied to the natural environment also hastened reaching these thresholds. For example, about 25 percent of the farmers surveyed in 2015 believed

Table 3

Direct Environmental Outcomes Affecting GVC Farmers

Environmental Indicators		Environmental Outcomes (Subindicators)	Average % Change in Number of GVC Farmers Experiencing the Outcome between 2015 and 2019 GB (%)	Avo (%)
Protection of natural capital	Soil and water	Increases soil erosion, compacting, pH balance	74	52
		Increased leaching (loss of water-soluble nutrients)	38	20
		Decreased freshwater availability	85	70
		Increased wind erosion	-34	8
	Biodiversity	Fall in number of local flora and fauna	54	-4
		Fall in levels of pollination	55	7
Efficient and sustainable resource use	Water use	Fall in water table	98	85
	Waste	Increase in inorganic waste generation	16	20
	Energy use	Increase in electricity use	12	1
Regenerative capacity	Soil	Decrease in rate of soil formation	68	30
		Decrease in nutrient cycle balance (N, P, K) for soil quality	80	55
	Water	Decrease in rate of water recharge	45	45

Source: Authors' construction from secondary and survey data.

that their land was not *good quality enough* to be inherited by their children. About 10 percent mentioned the lack of trees and poor biodiversity in flora and fauna. All these factors were directly tied to GVC participation by responding farmers.

A combination of nonnegotiable practices, poor contracts (frequently offering payments below the costs of production), high crop rejection rates (20–25 percent in 2015 and 2019) by KEFs, and the deterioration of the natural environment have pushed farmers to adopt vertical bottom-up processes in an attempt to renegotiate the terms of their participation (see Figure 3, bottom part). For instance, over 150 farmers in the Gatanga cooperative in Murang'a launched a strike against two large KEFs in 2015, demanding better prices. They wanted contract prices to factor in their perceived environmental losses, which meant including the cost of depleted natural resources and related impacts on the carrying capacity of nature. They worked out that they would need an increase in the contracted price by over 90 percent. Our calculations in Table 1 suggest that they were not too far off the mark.

In another instance in 2018, eighty-five farmers in Meru (part of Meru Friends Savings and Credit Cooperative Organization) attempted to negotiate more flexibility in applying different chemicals and in following local practices, for example, applying organic manure. In both cases, KEFs did not yield to any of the farmers' demands. In Machakos, several farmer groups downright resisted using integrated pest management

Table 4

Indirect Environmental Outcomes Affecting Non-GVC Farmers

Environmental Indicators		Environmental Outcomes (Subindicators)	Average % Change in Number of GVC Farmers Experiencing the Outcome between 2015 and 2019 *GB* (%)	*Avo* (%)
Natural Capital Protection	Soil and water	Increased soil erosion, compacting, pH balance	60	45
		Increased leaching (loss of water-soluble nutrients)	16	12
		Decreased freshwater availability	80	81
		Increased wind erosion	-20	-10
	Biodiversity	Fall in number of local flora and fauna	10	2
		Fall in levels of pollination	60	35
Efficient and sustainable resource use	Water	Fall in water table	90	90
	Waste	Increase in inorganic waste generation	5	12
	Energy	Increase in electricity use	5	2

Source: Authors' elaboration from own survey data.
Notes: We do not display regenerative results here, since they are calculated with reference to GPS coordinates at the village level, and thus are the same for GVC and non-GVC farmers.

techniques. This forced the four KEFs buying in that area to open discussions around environmental practices but, ultimately, KEFs switched to new farmer groups instead. Rather than yielding to farmers' fights against value appropriation, KEFs moved the commodity frontier instead (to new villages in the same county or new counties like Kirinyaga). All in all, between 2015 to 2019, about 7 percent of farmers were excluded from GVC participation, reportedly due to poor environmental conditions, while about 8.5 percent of farmers chose to disarticulate from the value chain and engaged in other livelihood activities such as livestock, dairy, and growing other crops for the local market, the production of which entails more freedom to use indigenous practices and more autonomy in the decisions they make.

Environmental Upgrading Outcomes

In our framework, we have highlighted two kinds of outcomes arising from environmental upgrading—those directly affecting GVC farmers (see Table 3) and those indirectly affecting non-GVC farmers (see Table 4). We also distinguished between biophysical manifestations of upgrading processes and those related to market access and reputation.

When it comes to biophysical environmental outcomes, the results of our analysis (as indicated in Table 3) suggest that, almost across all indicators, farmers have experienced environmental downgrading. Furthermore, indirect environmental outcomes also affect larger communities due to the broader effects of value chain activities.

In Table 4, we show data for a 20 kilometer radius (which is often the size of a large village) that originates from a sample of 211 farmers. Across almost all environmental outcomes, non-GVC farmers have also experienced increasingly negative repercussions between 2015 and 2019, even though these were not of their own making.

In relation to market and reputational outcomes linked to the environment, interviews with two UK supermarkets' representatives suggest that they benefit from the enhanced reputation and legitimacy (at least in green beans and avocados) that come with procuring certified produce (see Figure 3). Similarly, KEFs mentioned an increase in exports of products that are grown with *good agricultural practices* as well as reporting new investments in greener technologies (e.g., recyclable packaging). These aspects facilitate their *green marketing* to lead firms in different countries. Thus, KEFs enhanced their market access and improved their reputation vis-á-vis their buyers in different end-markets.

Conclusion

In this article, we have developed a framework that provides a roadmap for conducting empirical research on environmental upgrading (and downgrading) in relation to processes and outcomes. This framework accounts for the varied and often simultaneous implications for different groups of actors in the value chain. It also allows an understanding of how environmental upgrading may create ripple effects beyond the GVC and how these effects may impact how the GVC itself operates.

By applying this framework to the case study of Kenya–UK horticulture value chains, we were able to show that UK supermarkets and KEFs have been able to benefit from positive environmental upgrading outcomes in terms of reputation and opening up markets for products that are environmentally friendly. At the same time, Kenyan farmers have experienced mostly environmental downgrading outcomes. In other words, the value created through environmental upgrading processes by farmers is mostly appropriated by other actors downstream in the chain—yet another case of *green capital accumulation* by lead firms and concurrent *sustainability supplier squeeze* (Ponte 2019).

The size of value appropriation becomes even more stunning once we factor in the costs of mitigating the environmental degradation that comes with GVC horticultural production. This, and the resultant deterioration in productivity relative to direct and indirect production costs, is leading KEFs to move to other production areas and UK supermarkets to partly source from other producers in nearby countries. The commodity frontier is thus moving both within and outside the country, with farmers having to deal with environmental degradation and depleted natural resources.

Future research is needed to further unpack the extent to which environmental upgrading and downgrading outcomes affect various actors operating in and beyond GVCs, the level of damage caused or benefit created, and the trade-offs that may exist between different kinds of environmental outcomes. Another area for further research should aim at systematically integrating the analysis of environmental upgrading with that of economic and social upgrading. The nature of this agenda requires multidisciplinary approaches, with economic geography offering strong potential along with related fields such as political ecology. Ultimately, we hope that the framework we introduced in this article will prove useful for the ongoing project of ensuring that the environment is taken more seriously in GVC research and policy making—in a context of vast global and local environmental challenges.

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