

Review

Similarities and Differences between International REDD+ and Transnational Deforestation-Free Supply Chain Initiatives—A Review

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Received: 6 November 2019; Accepted: 14 January 2020; Published: 25 January 2020

Abstract: After years of multilateral deliberations on how to stop global deforestation, such as REDD+ under the UNFCCC, deforestation-free supply chain (DFSC) initiatives emerged from the private sector. Linking both concepts conceptually and in policy practice could provide for synergies and enable more effective approaches against global deforestation. To operationalise such a linkage, a prerequisite is the knowledge of both concepts' key characteristics, as well as resulting similarities and differences. This literature review firstly identifies key characteristics that affects the potential impact of such concepts, secondly analyses if and how REDD+ and DFSC define these characteristics, and thirdly compares both concepts towards a potential linkage. The results show that a linkage of REDD+ and DFSC provides numerous complementarities which could foster the goal of halting deforestation. This includes for example the driver commercial agriculture, and in terms of permanence, leakage, and degradation. But close coordination is needed to avoid unintended negative consequences, especially for subsistence and smallholder agriculture. The comparison shows that the political consensus found under REDD+ provides a good basis to be supplemented with private sectors' DFSC initiatives, but additional initiatives like the Bonn Challenge and investments in agroforestry are needed in order to ensure the long-term effect on forest conversion.

Keywords: UNFCCC REDD+; deforestation-free supply chains; zero-deforestation commitments; state & private regimes

1. Introduction and Background

For decades, industrial production of agriculture commodities has been the main driver of deforestation of primary forests in the tropics [1]. The negative impacts of the ongoing exploitation of forests on the local population, on biodiversity [2,3], and its contribution to climatic change [4] reached broader society and policy. In 2013, governments finally agreed on UNFCCC REDD+ (United Nations Framework Convention on Climate Change reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries), a state-driven, intergovernmental approach, incentivising inter alia the reduction of tropical deforestation in developing and emerging economies [5]. These countries are supported in changing their forestry policies towards a more sustainable use and restoration of forests [6,7]. However, the overall pledged finance does not correspond with the long-term needed finance of REDD+ [8,9], a global REDD+ market has not materialized [10,11], and

the applied rules for accounting emissions/deforestation reductions have received criticism [12,13]. Further, it is difficult to assess the actual contribution on deforestation reduction so far [14,15]. In the context of these challenges, civil society and science discuss the concept's future viability [16–19].

Under rising societal pressure and possible market implications, the private sector initiated the concept of deforestation-free supply chains (DFSC), as the Deforestation Resolution from The Consumer Goods Forum (TCGF) in 2010 illustrates [20]. DFSC can be categorized as a transnational approach, which Biermann and Pattberg [21] define as: driven by societal, private, and nongovernmental players, also suitable in a context, where political international approaches are lacking or have failed. DFSC are mainly implemented by private companies which are linked directly to deforestation through the production or processing of agriculture commodities, such as palm oil, soy, beef, coffee, or cacao [22]. Companies argue that legal conditions and weak law enforcement in the producing countries, seen in conflicting policies or ongoing illegal deforestation, are major challenges for their commitments [23]. Therefore, the two global companies, Unilever and Marks & Spencer [24], declared in 2015 to apply the Produce and Protect sourcing approach, aiming to identify regions or jurisdictions with favourable political conditions for production and sourcing. Further, they call to make REDD+ priority in producing countries [25].

Besides this explicit support of REDD+ from global companies, some major consuming countries foster the private sector's commitment to eliminate deforestation from their supply chains, as shown in the Amsterdam Declaration [26]. This mutual support by policy and the private sector has the potential to create reinforcing synergies for both concepts, enhancing the overall impact on forest conservation. However, it is unclear whether the two systems actually fit together or if there are conflicting characteristics between the two approaches. Furthermore, despite a large number of REDD+ studies [27–32] and an emerging number of researches on DFSC initiatives [33–36], no systematic comparison of the two concepts based on the relating literature exists.

So far, the scientific literature offers two articles that discuss the spatial linkage of UNFCCC REDD+ and DFSC. With a commentary on the idea of Zero Deforestation Zones, Meyer and Miller [37] provide an introduction into the potential synergies of a spatial linkage, like reduced costs or compliance with laws, and call attention to foreseeable barriers, as missing finance or the danger of creating conservation islands. They highlight reporting implications of a Zero Deforestation Zone as how to design a reference level required under UNFCCC REDD+ in order to combine the zero-deforestation aspiration of DFSC, and the "reduced deforestation compared to a reference" claim of REDD+. The commentary does not follow a structured approach and does not claim to give a more comprehensive overview on the topic of combining REDD+ and zero-deforestation initiatives. In the second article, Nepstad, et al. [38] promote a performance-based incentive system that aims at reducing deforestation while sustainably improving livelihood, build on the pillars REDD+, DFSC, and domestic policy and finance [39–41]. Their system includes four indicators—amongst others, reduced deforestation. The better the jurisdictions' performance in terms of the indicators is, the higher the potential benefits for farmers, companies, indigenous peoples, and, on an infrastructural and a prosperity level, the whole jurisdiction. The authors draw parallels to the actual developments and the future perspectives in former deforestation hotspots such as Brazil's Mato Grosso, Indonesia's Central Kalimantan, and Colombia [38]. Further studies have critically analysed interactions and outcomes of such public–private partnerships which have arisen around DFSC initiatives [42–49].

No study has yet compared the general design of REDD+ and DFSC. This is of importance in order to know the similarities and differences between both concepts, especially if aiming at linking them spatially, as in the suggested Zero Deforestation Zones [37]. When looking at the two concepts separately, different studies strive to analyse their implications. For national REDD+ implementation, the "3Es" are highly debated: effectiveness, efficiency, and equity [50,51]. For the variety of DFSC, the challenge has rather been to come up with relevant criteria a companies' commitment should cover in order to have impact. Based on expert consultations, a literature review of "zero deforestation risks", and the analysis of some relevant certification schemes, Jopke and Schoneveld [36] developed a hierarchical framework with seven principles and 12 criteria for evaluating DFSC

regarding “externality problems and implementation gaps”. Garret et al. [35] used a deductive approach, starting with “an interdisciplinary meeting of scientists and practitioners” and developed a conceptual framework with 11 criteria “which are most likely to generate commitments that achieve progress towards zero-deforestation at the global scale”. While there are overlaps between the results of both studies, the respective criteria are not fully suited to compare DFSC and REDD+ as they are tailored to voluntary zero-deforestation commitments from companies. In contrast to these two studies that started with experts’ ratings, we started with a structured literature search in order to identify our criteria or key characteristics from the broad scientific discourse.

This study contributes to the ongoing academic and policy debate on how to prepare and develop public–private partnerships aiming at the reduction of forest conversion by providing a valid systematic framework with key characteristics that have to be considered when linking concepts around deforestation. In a second step, this framework is applied to REDD+ and DFSC with the objective to systematically identify similarities and differences between these concepts. Therefore, the research questions are defined as follows: (1) which key characteristics have been identified by the literature that are supposed to influence the potential impact of a concept aiming at reducing/avoiding deforestation (Section 2.2)? (2) Do UNFCCC REDD+ and DFSC take the key characteristics into consideration (Section 3)? (3) Which similarities and differences between both concepts can be deduced (Section 3)? (4) Which synergies and unintended negative consequences could arise from these that would need further political input or investments (Section 4)?

After defining the scope of REDD+ and DFSC for this study, the analytical framework is described in Section 2, which is based on a literature review and a qualitative content analysis. Similarities and differences will be presented in the Results (Section 3), followed by a discussion (Section 4) on synergies and unintended negative consequences.

Defining the Scope of UNFCCC REDD+ and DFSC for This Study

In the context of REDD+, this study is focused on the political framework UNFCCC REDD+, intended for governmental national implementation. Many studies which treated REDD+ used definitions like “projects included activities that are considered part of REDD+ as defined by the UNFCCC” [52], and/or analysed forest projects which are certified according to, e.g., the voluntary carbon standard [53]. Fischer et al. [27] conducted a content analysis of a literature review for studies analysing REDD+ projects with differing definitions. Their analysis came to the result that REDD+ core aspects, which shall ensure the concept’s climate effectivity, as to how to avoid leakage and how to assure permanence, are hardly reflected at all in the analysed projects. REDD+ on the ground projects are adapted to local circumstances, often building on formerly established development projects, and they provide valuable lessons on the local implementation of forest-related activities. In the best case, they contribute to forest conservation and the improvement of livelihood [54,55]. However, these projects are intended only for the second (interim) phase of REDD+ and in general they do not meet the requirements as they have been decided under UNFCCC for national REDD+ implementation. It is the consensus that only the national long-term implementation of policies and programs can stop deforestation sustainably [56,57]. Against this backdrop, REDD+ on-the-ground projects are not considered in this study.

In this study, REDD+ is restricted to the international concept, which is providing financial incentives for countries to reduce their deforestation relative to a calculated reference (see Table 1). This is a crucial difference compared to DFSC, where the goal is to eliminate deforestation from a company’s supply chain until a certain cut-off date. Within the REDD+ framework, governments have the responsibility to create a political and financial environment that stops illegal deforestation on the one hand and restricts legal deforestation on the other hand.

Table 1. Defining the analytical scope of UNFCCC REDD+ and deforestation-free supply chains (DFSC) for this study.

	DFSC	UNFCCC REDD+
Framing	Voluntary initiatives for forest-risk commodities	Political framework under the UNFCCC, not equal to a national commitment
Scope	Decoupling deforestation from agricultural production for a supply chain	Verified emission/deforestation reductions
Level of implementation	Companies commit to deforestation-free sourcing of a product from farm level	Governments/national level
Reference	Cut-off date	Actual/future deforestation compared to a reference level, often historical average
Examples for implementation	The Consumer Goods Forum's (TCGF) Deforestation Resolution with Nestlé, Marks & Spencer, Unilever...	Exemplary technically assessed reference levels [58]: Brazil, Indonesia, Peru, Chile, Colombia, Congo, Guyana, Ecuador, Vietnam, Paraguay, Costa Rica
Affected area/potential impact	TCGF combined sales of EUR 2.5 trillion [34]; Certified area globally for palm, soy and cattle [59]: 0.038 Mio km ² , timber, pulp and paper [60]: 0.3 Mio km ²	Total area of 11 technically assessed reference levels [58] for reduced deforestation: 7.5 Mio km ²

In contrast to UNFCCC REDD+, DFSCs are not based on common and clearly defined rules. DFSCs cover a range of initiatives, also called trend, movement, or approach [23]. Taking into account the overlapping results from Jopke and Schoneveld [36] and Garrett et al. [35], we define DFSC as a concept for companies' voluntary, time-bound zero-deforestation commitments for forest-risk commodities' supply chains. An example for a private sector commitment is the TCGF Deforestation Resolution of 400 major global companies with combined sales of EUR 2.5 Trillion (see Table 1), which could have major implications on supply chains [34]. To give a rough idea on the potential impact of both concepts, we use the affected area as a proxy. Technically assessed UNFCCC REDD+ reference levels of 11 countries cover approximately 7.5 Mio km². The use of certification schemes is the most commonly used approach to ensure deforestation-free production. The area under forest certification is only a fraction in comparison to the forest area considered under the REDD+ reference levels. From 4.4 Mio km² of forest management certification [61], only 0.3 Mio km² of certified forest are located in developing and emerging economies [62,63]. The area certified for other forest-risk commodities is even smaller with 0.038 Mio km² of agricultural land distributed unequally between oil palm (0.032 Mio km²), soy (0.006 Mio km²), and cattle (<0.001 Mio km²) [59]. As the REDD+ area is referring to standing forests and agricultural certification to non-forested land, these numbers are not comparable, but they illustrate the difference between the potential impacts of a national concept compared to an approach implemented on farm-level. Based on the design of the Produce and Protect approach from the companies Marks & Spencer and Unilever [64], it can be assumed that these companies strive to move away from the costly certification of single suppliers towards meeting overall commitments on a jurisdictional scale [65].

2. Methodology

The objective of the study is the comparison of state-driven REDD+ and the private sector's DFSC for similarities and differences, and the subsequent derivation of policy recommendations. To realize this in a systematic, transparent, and reproducible manner, an analytical framework was developed which consists of key characteristics that are relevant to the potential impact of any general concept aiming at the reduction of deforestation. These key characteristics are based on a literature review and subsequent content analysis of the publications [66,67], which will be described in Section 2.1. The analytical framework that is built on these key characteristics is introduced in Section 2.2. As the framework is applied to both concepts, the literature on UNFCCC REDD+ and DFSC was searched to analyse if and how each concept is taking the key characteristics into consideration. This is described in Section 2.3. Resulting similarities and differences between both concepts were deduced. On this basis, synergies and unintended negative consequences that could arise from a linkage and areas that need further political input or investments are discussed in Section 4.

2.1. Literature Review and Content Analysis for the Identification of Key Characteristics

Over 15 years of climate negotiations on the topic of how to include forests and how to incentivise reductions of deforestation and degradation, scientific and social discourses have identified a number of aspects considered as crucial for forest conservation concepts. Hereafter, we will refer to these aspects as key characteristics. Using the structured qualitative content analysis after Mayring [68] and aiming at a comprehensive collection of key characteristics from the literature, key words have been determined for how the impact of a characteristic could be phrased in the literature. These key words provided guidance for the adjacent literature screening to decide which articles would be relevant for the review [69] and to extract key characteristics [70].

A broad Scopus search for “reduc* OR avoid* AND deforestation” in titles and key words of peer-reviewed articles from 2000 to 2018 was conducted. The search was restricted to titles and key words in order to focus on studies that primarily dealt with reduced deforestation. The year 2000 was chosen because in this year the first IPCC (Intergovernmental Panel on Climate Change) report on Land Use, Land Use-Change, and Forestry [71] was released and prepared the basis for international negotiations under the UNFCCC regarding the consideration of forests under a climate treaty. Specific suggestions presented and negotiated in this context fuelled and influenced the scientific discourse on how to reduce deforestation for almost two decades, and implications of potential definitions or reporting requirements have been scientifically analysed and assessed [72–75]. Although Haddaway et al. [69] recommend to include grey literature for literature reviews, we decided against its inclusion in the initial literature search (grey literature was included for the analysis of REDD+ and DFSC). Besides the wealth of documents from grey literature which would have overstrained the capacities for analysing them, we argue that due to the long time period covered, relevant key characteristics are included in the peer-reviewed articles and therefore should be covered. The search came up with 204 peer-reviewed articles, including case studies, literature reviews, comments, or cross-country studies.

Using the structured qualitative content analysis after Mayring [68] and aiming at a comprehensive collection of key characteristics from the literature, key words were determined for how the impact of a characteristic could be phrased in the literature [70]. Those key words were for example implication*, impact, conflict*, limit*, enable*, require*, etc. The abstracts of the 204 articles were screened, and those articles with key words indicating a relevant characteristic for deforestation concepts were chosen. Thus, the number of articles was reduced from 204 to 37. The 37 articles were read, and 13 key characteristics could be extracted, which were all mentioned at least in five articles. The structured literature search with a qualitative content analysis resulted in 13 key characteristics, which will be described in Section 2.2., as they are building the analytical framework.

2.2. Analytical Framework

In total, 13 key characteristics built the analytical framework for the adjacent comparison of REDD+ and DFSC (see Table 2) and are clustered in three categories. Besides the forest definition, the key characteristics monitoring, permanence, leakage, and scale are clustered in the category technical

aspects. The following key characteristics are clustered as contributing factors: drivers (includes 2 characteristics: commercial and subsistence agriculture), degradation, opportunity costs, and forest tenure. In the third cluster, key characteristics are summarized which are mentioned in the context of increasing the acceptance among those affected: stakeholder participation, rights of indigenous people (in the following indigenous' rights), and environmental co-benefits. The latter collects a number of aspects which were mentioned less than five times, but all point into the same direction of strengthening environmental aspects, like the provision of ecosystem services [76–79], especially biodiversity conservation [77,80,81], or the enhancement of natural resilience [77,82].

From the 37 articles, 16 are in the context of REDD+ with the majority (11 from 16) dating from before 2013, analysing potential reporting requirements and implications for developing countries before the REDD+ framework was decided [83]. The country focus is on Asia (Indonesia [84,85], Laos [86,87], Cambodia [87]). Four articles analyse DFSC initiatives, such as the moratoria in Indonesia [48] and Brazil [88,89]. Other concepts for reducing deforestation discussed in the articles (partly overlapping) are payments for ecosystem services [90–93], conservation [84,90,93,94], and community forest management [92]. The overall most frequently mentioned key characteristic is leakage (17), which can be assessed as major concern for concepts aiming at forest conservation, followed by monitoring, drivers, opportunity costs (all 13 times), and land tenure (11). Based on the literature review, we conclude that these 13 key characteristics drastically affect the potential impact of reduced deforestation concepts or actions, although we cannot claim that the list of characteristics is fully exhaustive. The mere number of 13 identified characteristics is comparable to the results of Jopke and Schoneveld [36] with 12 criteria, and Garret et al. [35] with 11 criteria.

Table 2. Literature-based analytical framework: technical aspects, contributing factors, and increasing acceptance as categories with respective key characteristics from the literature (references and number of articles with citation).

	Key Characteristic	References	Frequency
Technical aspects	Forest definition	[48,78,86,95,96]	5
	Monitoring	[76,79,81,82,88,89,95–101]	13
	Permanence	[75,76,81,90,97]	5
	Leakage	[48,75,76,80,81,84,88,89,93,97,99,102–107]	17
	Scale	[80,86,87,91,108]	5
Contributing factors	Drivers (Il~/Legal)	[78,80,90,92,93,99–101,103,107–110]	13
	Degradation	[48,78,86,87,95,109,110]	7
	Opportunity costs	[77,79,85,89–91,97,99–101,103,105,107]	13
	Land tenure	[77,79,82,86,87,91,94,98,100,101,108,111]	11
Increasing acceptance	Environmental co-benefits	[75,77–82,104]	8
	Stakeholder participation	[82,89,94,98,105]	5
	Indigenous' Rights	[77,82,87,89,98,100,111]	7

In the following, research question (1) will be answered: the key characteristics are introduced and put into context as to why the literature identified them as relevant.

2.2.1. Technical Aspects

International negotiations on the sustainable management of forests have shown that one universal forest definition is not feasible, and considering the diversity of forest types and potential implications of a sole definition, it may not even be desirable [112]. Nevertheless, the term forest has to be defined [113] because “forest concepts and definitions influence how we assess and interpret

forest transitions (...)” and therefore “influence policy-making, monitoring and reporting regarding forests” [114]. Two types of forest definitions can be distinguished: quantitative and qualitative definitions. Quantitative definitions are based on a range of minimum parameters: area of land (0.05–1.0 hectares), tree crown cover (10%–30%), and tree height at maturity (2–5 m). This type of definition, as used for comparable global [115] and national forest reporting [116], is appropriate for management objectives like the sustainable production of timber or the maximisation of forests’ potential to store carbon [114]. It “is not likely to be appropriate for monitoring biodiversity losses” [78] as ecosystem functions can be harmed before the forest falls below its quantitative threshold [96,117]. Further, the definition does not intuitively differentiate between plantations or reforested areas and primary forests, which could result in the conversion of primary forests into plantations [118,119].

Qualitative forest definitions aim at identifying forests for conservation. The two best-established approaches are high conservation value and high carbon stocks [23,120]. High conservation value areas are defined by several environmental (biodiversity, endangered ecosystems and species, etc.) and social/cultural aspects (ecosystem services, critical for local communities, etc.) [121]. The high carbon stock approach adds the ecosystem’s contribution to carbon fluxes as pool or sink [120]. The strength of these definitions and the consideration of multiple forest characteristics implies weakness, as the identification depends on further definitions (e.g., grade of human intervention, endangered species) and its monitoring requires high technical and financial capacities.

The monitoring of forest cover and state over time in order to assess whether deforestation takes place and, if so, to react with respective policies or programmes, is crucial for every concept aiming to reduce deforestation [28,122–124]. Depending on the forest definition and the implementation scale, there are differing demands on the monitoring approaches [52,95,125].

Monitoring is also relevant to assure the permanence of avoided deforestation over time, so that the liability of relevant players’ increases, and environmental integrity can be ensured [76,97,126]. Otherwise, deforestation could just be displaced in time. The displacement of deforestation in space is called leakage [104]. Deforestation leakage to adjacent forests, ecosystems, or countries is an emerging phenomenon [127,128], threatening those ecosystems that are not in the focus of protection [129]. While concepts should make clear statements on how to ensure permanence and how to avoid leakage, the spatial scale of a zero-deforestation initiative influences its impact—the larger the scale, the lower the risk of leakage [56,80,91].

2.2.2. Contributing Factors

The most important drivers in deforestation hot-spots are known—commercial agriculture in the Amazon, the Sahel, the South of Africa, and Indochina; subsistence agriculture in Indonesia, Malaysia, the Congo Basin, Columbia, Peru, and Central America [1]. For the deforestation driven by commercial agriculture, Lawson [130] estimates that between 2000 and 2012, half of it was illegal and identifies Brazil and Indonesia to account for 75% of illegally converted forest for commercial agricultural use. Other drivers of deforestation are mining, infrastructure, and urban expansion [109]. Underlying causes behind the drivers are global market forces which can be fuelled by conflicting international policies (e.g., bioenergy from renewable sources), poor national governance (e.g., weak law enforcement), lacking livelihood alternatives for the local population, population growth, and the impacts of climate change on natural resources [131–133]. Focusing on agriculture as the most important driver, deforestation concepts should reflect the importance of agriculture and associated conflicts, like food security, in their design [23,134–136].

Forest degradation due to timber extraction, charcoal production, and livestock grazing disturbs forests in all tropical countries [1]. In interaction with the forest definition, degraded forests are often assumed to be of little conservation value [137]. This can foster the subsequent conversion of forests [86]. As it is a relevant precursor, deforestation concepts should include actions to avoid degradation [56,93]. Otherwise, unconsidered degradation could be a loophole for ongoing deforestation.

Opportunity costs are missed revenues due to avoided deforestation, e.g., revenues from timber sales or agricultural use [138]. Köthke [139] provides a state of knowledge over studies calculating

opportunity costs of avoided deforestation, which estimate the costs of stopping global deforestation at several billion USD/year. As long as the conversion of forests and the subsequent agricultural use promise to be more profitable than forest conservation and sustainable management, the risk of (illegal) deforestation remains. Therefore, it is common understanding that the viability of deforestation concepts depends to a large part on their opportunity costs [138,140–143]. Besides the compensation for missed revenues, respectively, payments for forest conservation, reduced pressure from the land user's side to convert forests to other land uses, and thus reduced demand for forested land, could lead to a reduction of opportunity costs [144–146]. Other costs linked to the implementation of deforestation concepts can include transaction and implementation costs and, from a societal perspective, costs of negative external effects [147–150].

Land tenure is a reoccurring topic in the context of stopping deforestation [30,100,111,151]. Hatcher [152] defines tenure as a “bundle of rights (the rights to access, use, manage, exclude and alienate) of people and groups to resources”. Tenure insecurity includes potential risks of land grabbing by outsiders and loss of local and customary user rights, both threatening especially indigenous and forest dependent communities [153]. Further, it comes along with unclear responsibility for the use of the forest and its role in (illegal) deforestation is widely acknowledged [154]. Therefore, tenure security needs to be addressed.

2.2.3. Increasing Acceptance

The conservation of natural forests and the reduction of global forest loss offer the opportunity to provide a number of environmental co-benefits, besides the positive contribution to the carbon dioxide circle [155,156]. The quality of the co-benefits is closely linked to other key characteristics described above, as forest definition, degradation, or permanence. The most frequently mentioned benefits in the initial literature review are the provision of ecosystem services in general and their contribution to human well-being [157,158], especially the conservation of biodiversity as one integral element [52,80,159], and further the enhancement of natural resilience with respect to changing environmental conditions [82,160–162].

Stakeholder participation is of high relevance in order to identify potential missing aspects of a concept, commitment or regulation, and to reach a broad acceptance. Stakeholders can include: local communities depending on forests for livelihoods, civil society, government agencies, environmental law enforcement agencies, the private sector, academia, and indigenous [163]. A broad participation of stakeholders can define further relevant social aspects of zero-deforestation concepts such as benefit-sharing or gender equality [161,164]. As mentioned in the context of tenure insecurity, indigenous' rights are a very sensitive subject [165] and the participation of indigenous stakeholders, especially in the tropics, has been identified as crucial [166,167]. For this reason, stakeholder participation, in particular of indigenous groups, should be part of the design of a deforestation concept.

2.3. Application of the Analytical Framework to REDD+ and DFSC

The analytical framework was applied to compare intergovernmental REDD+ and transnational DFSC initiatives along key characteristics. In contrast to the systematic literature review and content analysis for the identification of key characteristics, it was not the intention to cover a broad number of articles. This time, the objective was to extract conceptual information on the concept's consideration of the key characteristics where possible, or if necessary, to complement with findings from actual implementation. For REDD+, the relevant documents are well known and the basic information sources were UNFCCC documents around the REDD+ framework [58,83] and on UNFCCC reporting [7,71,168–171], supplemented by feedback from scientific discourse and implementation experiences. Therefore, we searched with the search terms “REDD+ AND key characteristic” Scopus (title, key words, abstracts) and Google Scholar for 2000 to 2018, screened titles and, if promising, abstracts, and ended up with additionally 29 peer-reviewed articles and 19 from grey literature.

As there is no common conceptual basis for DFSC and even the wording for similar commitments can be different, we had to screen a broader field of search terms (e.g., under Scopus 2000–2018 for titles, key words, abstracts “deforestation-free”: 14, “zero-deforestation” 26), without the key characteristics. They were searched for in each case when the documents were screened. We came up with 24 peer-reviewed articles on voluntary commitments we identified as useful for our comparison, and 35 more documents from grey literature. The comparable high number of grey literature on DFSC in comparison to REDD+ is due to the vivid exchange outside the peer-reviewed journals in the form of discussion papers [23,65,172–176], progress reports on supply-chain initiatives [177–182], statements as from NGOs [22,183,184], and companies themselves [20,24,25,185]. During the ongoing comparison of both concepts along the key characteristics, more articles were mutually added. In the end, for DFSC we mainly relied on discussion papers and reports from grey literature, which provide condensate information and useful discussions on the variety and status-quo of DFSC initiatives [22,23,65,125,172,174,175,177,186–188].

3. Results from the Comparison: Similarities and Differences

UNFCCC REDD+ is a political concept for countries that aim at reducing deforestation and seek to receive financial support by the international governmental donor community. Companies’ voluntary, time-bound zero-deforestation commitments for forest-risk commodities’ supply chains are gathered under the umbrella of DFSC. Both concepts are compared for similarities and conflicts along the key characteristics of our analytical framework (research question 2). Further, we provide an outlook what these similarities and differences could mean regarding a linkage of both concepts, based on reasonable interpretations through the authors and references from literature (research question 3). The results for the technical aspects are displayed in Table 3, for contributing factors in Table 4, and for increasing acceptance in Table 5. A summary of the results can be found in the discussion in Section 4.2.

3.1. Technical Aspects

The key characteristic forest definitions are considered under both concepts but interpreted in a sometimes contrasting manner. As the chosen forest definition defines the monitoring approach, both aspects are compared jointly (see Table 3). The quantitative forest definition applicable under REDD+ is tailored to the aim of comprehensive monitoring and reporting of forest area and the incorporated carbon [168]. Requirements for national forest monitoring systems are defined by the UNFCCC [169], guidance for reporting is provided by IPCC [71,170,171], and the technically compliance has to be assessed by independent experts [5]. As REDD+ intends to cover forests on national scale, monitoring is based mainly on satellite data and national forest inventories [114].

Table 3. Comparison of DFSC and UNFCCC REDD+ along key characteristics: technical aspects.

Characteristics	DFSC	Comparison		Assessment
		UNFCCC REDD+	Similarities/Differences	Outlook/Comment
Technical Aspects				
Forest definition	If at all [189], for certification in general qualitative (e.g., HCV) [185], sometimes combination of qual./quant. [190], for forest cover monitoring rather quantitative [178].	Quantitative, nationally defined [168].	In case of differing definitions, common forest definitions increase potential synergies for monitoring [37].	Harmonization needed in order to create synergies.
Monitoring	Depends on approach used by the company [172]. (a) Certification schemes for farm-level. (b) Procurement from low-risk jurisdictions. (c) Direct monitoring of forest cover in sourcing areas.	Robust monitoring system (in general satellite data and forest inventories), use of the IPCC Guidelines [171], technically assessed by independent experts [5].	Basic differences mainly for the reporting: Time horizons, Scales, Objectives, Target audiences.	REDD+ monitoring can be compatible with large scale monitoring of sourcing areas under DFSC, respectively provide valuable information [178]; a common monitoring system could provide financial synergies, lowering the barriers for companies willing to commit [37].
Permanence	Not addressed.	“Actions to address the risk of reversals should be promoted and supported” [7].	Although addressed under REDD+, in both cases no guarantee for permanence in case of changing policy/business or weak implementation [191–193].	Failure/change of policy by one sector could be softened by the other sector.

Leakage	Not directly addressed, but threat for biomes outside of DFSC focus is acknowledged [185].	“Actions to reduce displacement of emissions should be promoted and supported” [7].	Explicitly addressed under REDD+, risk of leakage under both concepts [56].	Linkage of both concepts can lead to higher pressure on national level to compensate potential leakage effects.
Scale	(Transnational) Supply chain of a companies’ product or a type of commodity, originating from farm-level or sourcing region.	(Sub)National level.	Farm-level versus national level not compatible, but compatibility increases with enlargement of DFSC scale [56].	Potential overlapping for DFSC sourcing regions with jurisdictions with ambitious REDD+ programs [39,64,65].

The monitoring of DFSC depends on the approach used by the company. Neeff and Linhares-Juvenal [172] differentiate between: (a) the use of certification schemes on farm level, (b) the procurement from low-risk jurisdictions, and (c) the direct area monitoring (Table 3). Certification schemes often put primary forests in the focus of conservation and tend to apply qualitative definitions, like the high conservation value approach [190,194], which comes along with respective forest assessment and monitoring requirements [121]. However, the broader the commitment and the larger the area included, e.g., the Soy Moratorium for the Amazon biome [178], the more the monitoring is comparable with the one as required under REDD+ [195]. Further, some relevant certification schemes as ISCC or RTRS use combined forest definitions with qualitative and quantitative characteristics [194,196]. In the best case, different forest definitions between concepts can complement each other; in the worst, they are not compatible and a barrier for common monitoring. For the monitoring and especially reporting, the comparison indicates the following general differences: (1) different time horizons (e.g., 5 year-evaluation for REDD+ versus “real time” monitoring for DFSC), (2) different scales (national level for REDD+ versus supplier/farmer level), (3) different objectives (reduced deforestation/emissions versus no deforestation), and (4) different target audiences (technical experts who assess for compliance with IPCC guidelines vs. companies, NGOs, and other stakeholder). Despite these differences, a harmonization of forest definitions can drastically reduce barriers for a common monitoring approach as data can be used by both concepts [178], which would reduce respective costs [37].

In contrast to REDD+, DFSC do not directly address permanence and leakage of avoided deforestation. As companies’ zero-deforestation commitments are confronted with the perception of being “purely a business decision” [197], there is the risk of changes in business strategies in the future. Jopke and Schoneveld [36] evaluated “externality problems and implementation gaps” of 50 major companies with zero-deforestation commitments, and concluded that 75% of assessed companies did not pass the commitment to their suppliers, indicating that the companies are not yet reliable regarding their long-term zero-deforestation commitments. Further, as long as suppliers have not to be fully compliant on deforestation-free production, parallel marketing of commodities with and without deforestation is possible. This leakage is of high relevance as long as non-sensitive markets exist, as for example the largest markets for palm oil are Indonesia, China, and India [135]. While leakage is not explicitly addressed under DFSC, companies are more and more aware of the danger to create conservation islands on the costs of adjacent ecosystems [185,198], as happened under the Soy-Moratorium [129]. The REDD+ Safeguards require that “actions to reduce

displacement of emissions should be promoted and supported” and that the risk of reversal is addressed [169]. The linkage of deforestation-free sourcing by major companies from countries with national REDD+ implementation, could have the potential to reduce leakage. However, potential leakage effects of DFSC with subnational focus could not be completely avoided since cause-effect chains of the processes are different, and the related administrative boundaries do not necessarily match with private tenure dedicated to DFSC. However, combining both approaches could lead to higher pressure on a national level to compensate potential leakage effects. REDD+ is implemented by a government and intended on national scale. While the non-deforestation claim of a commodity targets the producer or supplier on farm-level, the request often comes from companies which bring the final product to the market. While this transparency needs to be assured along the transnational supply chain [199], the main implementation scale is on the farm-level. Compatibility between both concepts increases, if the scale of DFSC commitments are expanded [200], as under the Brazilian beef and soy moratoria for the Amazon [42].

3.2. Contributing Factors

When it comes to the contributing factors (see Table 4), DFSC commitments for commercial agriculture commodities address the most important large-scale driver of global deforestation directly [109]. This is a weakness of REDD+, which was negotiated without direct recommendations for agricultural driven deforestation [201,202] due to the high political relevance of the agriculture sector for food security, especially in developing countries. An analysis on countries’ intended nationally determined contributions (INDC) shows that policy measures targeting agriculture production are only present in a fraction of the overall national REDD+ strategies [203]. DFSC can support national policies that aim at forest conservation but at the same time, they depend on national frameworks that support the non-conversion of forests in favour of their economic exploitation (compare Indonesia’s concession regime for oil palm plantations) [23,204].

In contrast to industrial agriculture, agriculturally driven forest conversion for subsistence is by definition not part of the supply chain, and therefore not considered under DFSC. Subsistence might include a relevant share of indigenous people, who are defined as “naturally existing in a place or country rather than arriving from another place” [205] and are under special consideration under both concepts, REDD+ and DFSC. However, this definition excludes people who relocated from their place of origin due to armed conflicts, climate change impacts, or scarcity of resources, etc., or just do subsistence farming due to a lack of alternatives. Further, subsistence can overlap with the group of smallholders, which can contribute to commercial supply chains [23,172].

Table 4. Comparison of DFSC and UNFCCC REDD+ along key characteristics: contributing factors.

Characteristics	Comparison		Assessment	
	DFSC	UNFCCC REDD+	Similarities/Differences	Outlook/Comment
Contributing Factors				
Driver: commercial agriculture	Direct impact on most important commodities: soy, beef, palm oil [26].	No direct linkage in UNFCCC REDD+ documents, rather part of UNFCCC NAMAs.	Both concepts come from different angles; DFSC can complement and strengthen national land use policies that support forest conservation under REDD+.	Companies need supporting national policies and legal framework to fulfil their commitments [23,176].

Driver: subsistence agriculture	Per definition not part of supply chains, but potential overlapping with smallholders contributing to commercial supply chains [23,206].	“Respect for the knowledge and rights of indigenous peoples and members of local communities, by taking into account relevant international obligations, (...)” [7].	Not explicitly considered under DFSC; Part of REDD+ safeguards, supposed to be addressed under nationally appropriate mitigation actions (e.g., low emission rural development) [207].	Ongoing informal/illegal deforestation within a sourcing area (e.g., for subsistence) represents reputational risk for companies’ commitments, danger of pushing those depending on subsistence into illegality.
Consideration of degradation	Considered for timber [208], but not relevant for agricultural products.	When it is a relevant source of emissions it should be included the moment robust data is available [209].	Consideration under REDD+ could reduce forest degradation, which otherwise could be a precursor for ongoing deforestation of degraded forests.	Degradation often part of subsistence [1], therefore its drivers needs to be addressed by policy.
Opportunity costs	With increasing demand for DFSC products, opportunity costs could decrease.	Payments for verified emission reductions, estimated USD 5/tC [210].	Reinforcing synergies possible: decrease in demand for commodities linked to deforestation could reduce the opportunity costs and make the REDD+ payments more competitive.	Unsecure finance under REDD+ can weaken governments’ willingness/ability to engage in forest conservation.
Land tenure	Compliance with law, all land has to be owned/rented with contract [194,211].	“To address (...) land tenure issues”[7].	Governmental tenure clarification provides legal certainty for all involved parties.	Unsecure tenure fuels conflicts between different parties and can result in ongoing deforestation; Responsibility for clarification lies with the governments.

Pirard et al. [47] warn that DFSC initiatives, including certification schemes, can have negative impacts on smallholders as they are not able to compete with larger-sized planters due to implementation costs. Aware of the limits that come along with certification, some initiatives test alternative approaches to actively include smallholders in their DFSC [206]. As the theoretical design

of REDD+ is quite imprecise regarding the consideration of subsistence, the authors fall back on an example taken from REDD+ projects to peak into actual implementation. Duker, et al. [212] analysed two REDD+ project sides and came to the result “that smallholder agricultural interests are not thoroughly understood nor recognized in the objectives and implementation of REDD+”. This might be rooted in the overall design of REDD+ as framework for the forest sector, not directly linked to the other land uses [213]. Strategies for low-emission rural development programs, including agricultural programs, are rather part of UNFCCC national appropriate mitigation actions (NAMA).

In any case, the provision of livelihood for those relying on subsistence need to be considered under concepts that restrict the usage and conversion of forests. Otherwise, ongoing illegal or informal deforestation can lead to conflicts with companies that are confronted with reputational damage, either because of ongoing forest loss in their sourcing regions, or because their commitment pushes those depending on subsistence into illegality or adjacent landscapes.

Although timber logging is not listed as a deforestation but as a degradation driver, the role of commercial logging as indirect driver is acknowledged [214]. Indeed, degradation is a topic for certification of timber and pulp and paper, but not of agricultural commodities [23]. Some DFSC declare zero-net deforestation with a focus on natural forests, allowing the conversion of degraded forests on the condition that the deforestation is compensated by afforestation. So, while DFSC can contribute to preserving natural forests from conversion, they do not contribute to reducing degradation of natural forests, and partly allow the deforestation of degraded forests. In contrast to that, REDD+ requires the inclusion of degradation and its reduction in case it is a relevant source of emissions [7].

The so-called results-based payments under UNFCCC REDD+ compensate ex-post for avoided deforestation and are supposed to reflect the value of forests for carbon storage. The circulating USD 5 US/ton carbon [210] cannot compete with the values of agricultural land use as result of deforestation [11,138,158,215]. If a huge number of enterprises would adopt DFSC, the opportunity costs of avoided deforestation for commercial agriculture could decrease as the number of purchasers willing to buy commodities linked to deforestation would decrease (demand), and consequently also the supply. This could increase the attractiveness of UNFCCC REDD+, but further research is needed to prove this hypothesis. In any case, secure long-term finance under UNFCCC REDD+ is needed so countries can rely on the ongoing support for building technical capacities and introducing forest conservation programs [11,16,216]. Besides a required safeguards information system [7], UNFCCC REDD+ does not go into any further detail about how countries should treat or solve insecure land tenure and informal deforestation due to customary rights, as this lies within the countries' sovereignty. Under DFSC, compliance with legal requirements is the baseline, partly supplemented by the provision to avoid areas with unresolved or ongoing land conflicts. Tenure clarification is a basic asset for all decisions and programs affecting land use.

3.3. Increasing Acceptance

The ideally holistic consideration of forest uses, as included under the REDD+ acronym (reduction of deforestation and degradation, plus conservation, sustainable forest management, and afforestation/reforestation), which is further complemented by the safeguards (no conversion of primary forests for plantations, conservation of biodiversity, multiple functions of ecosystems, etc.) [7], is supposed to deliver multiple environmental co-benefits (Table 5). For companies, the co-benefits of DFSC should as well be of high interest as they are very suitable to communicate vividly corporate social responsibility (CSR) [217,218]. The application of the HCV approach provides multiple positive outcomes for CSR communication such as the protection of rare and endemic species or vital ecosystem services [130]. Studies on DFSC indicate the qualitative difference for environmental benefits between zero-gross (no deforestation at all) and zero-net (compensation of potential deforestation of non-HCV/HCS forests) commitments [174,219,220]. If zero-net is applied, the definition of forest needs specification in order to guarantee environmental integrity [172,175]. With a common understanding between REDD+ and DFSC for the concepts' contribution to multiple

environmental co-benefits, both concepts could direct economic development (as agricultural expansion) to areas of lesser environmental value.

Table 5. Comparison of DFSC and UNFCCC REDD+ along key characteristics, increasing acceptance.

Characteristics	Comparison		Assessment	
	DFSC	UNFCCC REDD+	Similarities /Differences	Outlook/ Comment
Increasing Acceptance				
Environmental co-benefits	Certification has potential to provide multiple benefits [221,222], HCS [223] or HCV [121] approach attractive for CSR, zero-gross vs. zero-net.	Acknowledged in the Safeguards [7], ideally inherent in REDD+ understanding, implementation of REDD+ in biodiversity hotspots [58].	Acknowledged under both concepts [22,27,52]; positive contribution by HCV/HCS approaches expected [120,175].	Successful implementation of both concepts can direct economic development to areas of lower carbon and biodiversity value [224].
Stakeholder participation	Multistakeholder initiatives are relevant aspect for DFSC, e.g., in Round Tables [184].	“Full and effective participation of relevant stakeholders” [7].	Required under both concepts and essential part of DFSC as these are based on civil society’s demand.	Involvement of other sectors and stakeholders is in the interest of both concepts.
Indigenous’ rights	Mainly in the context of free, prior, and informed consent (FPIC) [225,226], but no common binding procedure [227].	“Respect of knowledge and rights of indigenous peoples” [7].	Aspect acknowledged under both concepts, also linked partly to tenure and usage rights.	Sensitive aspect for all interventions affecting forest-dependent communities and/or traditional usage rights.

In the context of DFSC, stakeholder participation is an essential element for companies engagement, as the pressure to commit rooted in civil society’s engagement [219,228–230]. The REDD+ safeguards put special consideration on the “respect for the knowledge and rights of indigenous peoples and members of local communities” and “the full and effective participation of relevant stakeholder, in particular indigenous peoples and local communities” [7]. Indigenous’ rights have to be considered under all concepts and programs affecting the usage and access of natural resources, and therefore are a sensitive aspect for both, REDD+ and DFSC.

4. Discussion

Numerous companies committed to decoupling their agricultural production from deforestation until 2020 [20] and more than 40 governments “endorsed a global timeline to cut natural forest loss in half by 2020, and strive to end it by 2030” [231]. To reach these ambitious goals, existing initiatives, concepts, and programs need to be linked to create mutual synergies and complemented with additional actions where necessary. Based on an extensive literature review, this study contributes to

this effort by disentangling the two concepts of private sector DFSC initiatives and governmental REDD+ through a comparison along key characteristics, which are based on a structured literature review. In Section 4.1., methodological issues are discussed. Section 4.2 starts with a summary of the compared key characteristics before the potential implications of a REDD+ and DFSC linkage are reflected.

4.1. Methodology and the Identification of Key Characteristics

To identify key characteristics from the scientific literature, we started with a structured literature search on Scopus for “reduce* OR avoid* AND deforestation” in articles’ titles and key words between 2000 and 2018, and an adjacent qualitative content analysis after Mayring [68]. By the application of key words for the identification of key characteristics to the articles’ abstracts, we reduced the number of articles from 204 to 37. This literature review does neither claim to extract all potential characteristics of forest concepts nor was the goal to provide a ranking of characteristics, which would be based on a meta-analysis of the characteristics’ frequency. As it was out of the scope of our study to screen all 4000 Scopus-articles on the search term “deforestation” (plus an unknown amount of grey literature), it cannot be claimed that our collection of 13 characteristics is exhaustive. It can be assumed that the number of characteristics is not likely to be a straight line increasing eternally in correlation with the increasing number of articles added to the basic amount of literature. Most likely, some more characteristics could be added to the list, but the beforehand identified 13 characteristics will remain crucial. Therefore, there is no contradiction between the applied method and a potential supplementation of further characteristics to the framework. While the aim of the literature search was to cover a relatively neutral spectrum of literature, the analysed articles are biased towards REDD+, as 16 out of 37 are on REDD+ and only four of 37 are on DFSC. As REDD+ is not a commitment to stop, but a framework for a relative (emission) reduction, this might have influenced the discussion around its essential components (see also the discussion on characteristics). The underrepresentation of DFSC articles can be due to the fact that, compared to the REDD+ discourse, they are a rather young phenomenon, starting with the moratoria for the Amazon in 2008 and the TCGF declaration for DFSC in 2010, and are operating with another set of terms around deforestation—free, zero, eliminate, halt, etc. instead of “reduced”. Those search terms were applied in a later step for identifying literature on DFSC and its design components. Two relevant studies on criteria for DFSC [35,36] are not included in the literature review as they were published after the cut-off date. In the following, they serve for the discussion and the comparison with our applied methodology and results.

The mere number of 13 identified characteristics is comparable to the results of Jopke and Schoneveld [36], who developed 12 criteria to evaluate DFSC on externality problems and implementation gaps, and to Garret et al. [35] who deduced 11 criteria for effective DFSC implementation, regionally and globally. The direct alignment between the criteria of their studies and the present framework is partly hampered due to a different wording and slightly divergent levels of dimensions. This is illustrated with two examples. While Garret et al. [35] differentiate between the three different criteria (C) C9 regions, C10 actors, and C11 commodities (covered by a commitment), all these could be subsumed under the key characteristic scale. Leakage, on the other hand, is not listed as criterion by Garret et al. [35], but as “regional spillovers”. In contrast, Jopke and Schoneveld [36] differentiate between two criteria to prevent harmful indirect land use change (C7.1 and C7.2), which could also be named leakage. Thus, the two studies partly set different priorities, Jopke and Schoneveld [36] are stronger on criteria that we summed up as technical aspects and increasing acceptance, while Garret et al. [35] emphasize the need to consider the different scales of supply-chains, the drivers, and to cover a large market share. Due to these difficulties in clearly aligning the criteria and characteristics, we focus on the differences between our results and theirs, instead of categorising and discussing each single criterion of all three studies in comparison.

A discrepancy to the presented results is that both studies agree on the necessity of a specific time-bound reduction target (C1 and C8 [35], C1.1 [36]). This can be explained by the studies’ focus on zero-deforestation commitments, which are generally defined with the goal to stop deforestation.

As already mentioned above, the factor that REDD+ is a framework for reaching a target, which is not part of the concepts itself, might have strongly influenced the scientific discourse on relevant characteristics in the years covered by our literature review. In comparison to companies' zero-deforestation targets, national targets for the forest sector are not part of UNFCCC REDD+ but of the intended nationally determined contributions (INDC) [232,233]. Thus, criteria defining a zero-deforestation target are indeed relevant for the actual effectiveness on the ground and could be supplemented to the framework, but are not necessarily part of a concept tackling deforestation in general. Further, both studies highlight the need of a commodities' traceability down to the point of origin (C10 [35], C2.1 [36]) which is clearly attributed to the nature of transnational supply-chains, including indirect suppliers and multiple intermediaries. A traceability system is a specific challenge for DFSC under the broader umbrella of a general monitoring system (C3 [35], C2.1 [36]), which is without doubt relevant to assess a concept's effectiveness on deforestation. Although we do not claim that both studies exclude them, we argue that the importance of degradation and subsistence as precursor, respectively driver of deforestation, is not explicitly emphasized in their criteria. DFSC implications for those depending on subsistence could be attributed to the spillovers, "changes in patterns of deforestation among other regional actors" [35], and criterion 6.2, "producers do not jeopardize food security through their land acquisitions" [36]. Why our results indicate the need to highlight these two key characteristics' relevance will be discussed in Section 4.2. To close the comparison with the results from Garret et al. [35] and Jopke and Schoneveld [36], one can conclude that, in both cases, there are more overlaps than differences, and the latter are attributed to the studies' sole focus on DFSC. Hence, the applied methodology of a structured literature review with qualitative content analysis is proven to result in a set of plausible key characteristics. The differences with criteria from other studies [35,36] are due to the fact that the identification of the characteristics was conducted on a neutral basis, applicable for all concepts or programs tackling deforestation. Therefore, the framework's potential area of application is broader than those from Garret et al. [35] and Jopke and Schoneveld [36], which solely focused on DFSC.

Regarding the presented key characteristics (and the criteria in general), one could criticise that social safeguards [161] are not explicitly listed. Aspects that could be attributed to the category "increasing acceptance" would enable benefit-sharing [234] through gender equality [164], or targeted and tailored design to local conditions and needs [234]. Nevertheless, stakeholder participation, indigenous' rights, land tenure, and subsistence can be allocated to social safeguards as well [235]. Thus, the most frequently cited social aspects that were mentioned five times and more, are included in this study. In general, most characteristics do not stand alone but are somehow interlinked to or influence each other, as are for example forest definition, monitoring, degradation, leakage, scale, and environmental co-benefits.

4.2. Comparison for Similarities/Differences and Outlook/Comment

For this study, we restricted UNFCCC REDD+ to the officially decided design for the framework to be implemented nationally. As DFSC do not follow such a common and strict outline, we used a definition based on Garrett et al.'s [35] results and defined DFSC as a concept for companies' voluntary, time-bound zero-deforestation commitments for forest-risk commodities' supply chains. It is not likely that all articles, reports, or statements of the wide variety of existing DFSC initiatives have been covered, as there is no generally valid term for these commitments, as is UNFCCC REDD+. Still, based on the iterative literature search process and the use of review reports on DFSC initiatives [22,172,174,177,179], it can be assumed that the presented information is representative for the majority of DFSC. In this Section, the results from Section 3 are summarized briefly. Then, the results and potential implications for a linkage of REDD+ and DFSC are discussed in two subsections, focussing first on synergies respectively low hanging fruits, and secondly discussing areas where further input is needed as REDD+ and DFSC are not able to solve the identified gaps and challenges.

4.2.1. Summary of the Results

The comparison of REDD+ and DFSC along the 13 key characteristics results in similarities and differences. While no insurmountable barrier could be deduced, for some characteristics the comparison indicated synergies. Differing forest definitions, closely linked with different monitoring requirements at different scales, seem to be one main obstacle for a common monitoring system. A harmonization of the forest definitions and a spatial upscaling of DFSC could result in overall cost savings, as both concepts could fall back on the same monitoring data, provided by the governmental side, respectively the data collected in each case could be used for mutual verification. Permanence and leakage are both not in the focus of business decisions, although companies cannot deny their relevance. Both aspects heavily lie in the responsibility of the governmental implementation of national, long-term policy programs as envisioned for REDD+. At the same time, these national programs need to be reinforced and supported by DFSC commitments. The same is true for land tenure clarification. Under DFSC, companies can commit themselves to operate in compliance with law and to avoid sourcing from areas with unsolved land conflicts. The obligation to provide tenure clarification lies with the governments and is also needed for REDD+ implementation. Both concepts do not directly refer to opportunity costs for reduced deforestation, but are closely linked to them. With DFSC, commercial agriculture as the most important deforestation driver is targeted. DFSC could result in a decreased demand for commodities linked to deforestation and thus reduce the opportunity costs of no-deforestation. This could be positive for the verified emission reductions payments under REDD+, which are not competitive at the moment. Same would be valid for reduced pressure from the second important deforestation driver: subsistence agriculture. Subsistence per se is not part of DFSC, therefore it lies in the responsibility of the governments to provide livelihood in a sustainable way. Although REDD+ programs need to consider local communities and therefore also subsistence agriculture, it is not the core aspect of REDD+, as it is designed for the forest and not for the agricultural sector. Degradation is not part of agriculture commodity DFSC, but a relevant aspect under DFSC for timber and pulp and paper. As it is a core aspect of REDD+, it needs to be addressed there in order to avoid ongoing deforestation of previously strongly degraded forests. A common understanding between REDD+ and DFSC regarding the positive impacts of achieved environmental co-benefits for both, society and the companies' reputation, should be obvious for both sectors. This understanding would help to direct necessary economic development (as agricultural expansion) to areas of lesser environmental value. Stakeholder participation and the consideration of indigenous' rights are in the interest of both, the public and the private sector, because they constitute essential prerequisites for installing initiatives or programs that affect the use of land and forests.

4.2.2. Potential Synergies of Linking REDD+ and DFSC

In the context of DFSC, Garrett et al. [35] and Jopke and Schoneveld [36] emphasized the need for a forest definition and sound forest monitoring, aka the presence of reliable geospatial forest information [35]. The relevance of these assets for concepts around forests is uncontroversial [37] and supported by our results. While the comparison shows that to a certain degree, DFSC and REDD+ tend to apply different forest definitions, there are also examples from practice where a harmonized forest definition and an upscaling of DFSC resulted in the common use of the governmental forest monitoring data. This common monitoring system promises multiple financial synergies, which can result in overall cost savings, as highlighted by Meyer and Miller [37] in their commentary on Zero Deforestation Zones, and by Nepstad et al. [38] with their approach for a Jurisdictional Performance System. Most prominent example for a common monitoring is Brazil's PRODES-monitoring, where the data is used for REDD+ reporting [195] and monitoring of the soy moratorium, a collaboration of governmental institutions, NGOs, and industry lobby [178]. Other components that contributed to the deforestation reduction in the Amazon are Brazil's forest code and the rural environmental registry (CAR), where rural properties have to be registered, and companies can check whether the properties they are sourcing from are in line with the forest code's legal requirements [236]. The limitation in this case is that legislation lags behind companies' commitments, as the forest code allows conversion of natural forests to a certain share, not to mention the ongoing illegal deforestation

on registered properties [237]. This supports our findings, which, once more, emphasize the need for a supporting legal framework and the respective law enforcement [23].

Ensuring permanence and avoiding leakage of deforestation are two key characteristics, which are of high priority to ensure long-term forest conservation effects [30,56]. While both are acknowledged under REDD+, they are not inherent parts of DFSC. Permanence is no key principle of the time horizons of business operations [197], and leakage is not in the focus of the transnational and often spatially restricted nature of supply chain initiatives [56]. Therefore, a spatial linkage of both concepts can provide reinforcing synergies on national scale, with positive impacts on both, the permanence of forest conservation, and the reduction or avoidance of deforestation leakage into other regions. While the conceptual comparison indicates that REDD+ and therefore the governmental side has a comparably stronger interest in both characteristics, this theoretical assumption could be caught up by reality, if governments turn away from ambitious forest conservation policies in favor of economic exploitation, as most recently happens under the new legislation in Brazil [191]. In this specific case, companies are now calling the Brazilian government to stick to its commitments, because otherwise “this will risk [their] business with Brazilian soy” [238]. The implications of this policy change on Brazil’s participation in the UNFCCC process and especially in REDD+ are not yet clear [239,240]. This illustrates the limitations of REDD+, which is a concept not a national commitment but, in any case, it shows the importance of actual political will for forest conservation.

DFSC promise a strong support for the core of REDD+, a reduction of deforestation, by reducing the pressure from one of the most important drivers, commercial agriculture. This can close an important gap of REDD+, as an analysis on countries INDCs shows that policy measures targeting agriculture production are only present in a fraction of the overall national REDD+ strategies [203]. On the other side, the focus of REDD+ on forest degradation, which is not only damaging forests’ ecosystem functions but also a deforestation precursor, can close a loophole of DFSC, as it is no inherent part of supply-chains for agricultural commodities. Degradation roots in two main drivers, one is commercial timber logging, and the other are activities for subsistence. For the first part, the important timber certification schemes include the mitigation of degradation, but only with limited geographical extent in the tropics [208,241]. For the second, the main activities causing degradation are: the production of charcoal, the collection of fuelwood and timber for construction, and livestock grazing [109]. These activities contribute to subsistence and can only partly addressed by programs and laws for the forest sector. Therefore, degradation and especially subsistence will also be discussed below, in the context of areas where further actions are needed.

As it is financially attractive to convert a forest in agricultural land, the opportunity costs of avoided deforestation challenge every forest conservation program. While both concepts are not explicitly referring to them, both influence and are influenced by opportunity costs. A global increase in the demand for deforestation-free commodities could theoretically reduce the opportunity costs of avoided deforestation. Reduced opportunity costs again could increase the competitiveness and attractiveness of REDD+ payments for verified emission/deforestation reductions, provided that the long-term finance of capacity-building and verified emission reductions is ensured. But this effect is threatened by the leakage of commodities from deforestation to other markets and illegal activities. In their criteria analysis, Garrett et al. [35] highlight therefore the importance of market share (C7) and conclude that “leakage will only be minimized once the entire global market for a particular commodity and its substitutes (...) are fully covered” [242]. Otherwise, “changes in market prices for the committed commodity” as global spillover could fuel the undermining of a DFSC commitment by cheaper substitutes originating from deforestation [35]. This leads over to the scale of deforestation concepts. In the best case, nationally implemented REDD+ fosters the upscaling of DFSC commitments, from farm-level certification up to nation-wide moratoria, which not only reduces leakage but also contributes to environmental co-benefits. The conservation of biodiversity, the provision of ecosystem services, and natural resilience against changing climate conditions all benefit in particular from the conservation of remaining natural forests. Land tenure, indigenous’ rights, and stakeholder participation are all part of the REDD+ design and the latter two are acknowledged under DSFC. Despite the consideration under REDD+, indigenous and local people have publicly opposed

REDD+ due to potential risks of land grabbing by outsiders and loss of local user rights to forests and forest land [153]. One could argue that these problems arising with REDD+ (and partly also with certification schemes [243]), such as “conflicts, forced relocation, threats to the cultural survival and violations of the rights of Indigenous peoples” [244], are not inherent in the framework itself, but root in the national implementation and missing national land tenure reform programs [153]. Scientific literature reiterates the need for nationally tailored solutions under UNFCCC REDD+ regarding the complex relationships of forest-dependent communities with their natural environment, and strong law enforcement concerning their rights [245–247]. The same is valid for land tenure, which need to be clarified in order to avoid conflicts and ongoing illegal deforestation. While DFSC can make compliance with law a prerequisite for sourcing and land acquisition, they rely on governmental tenure clarification. A spatial linkage of REDD+ and DFSC with the inclusion of all relevant stakeholders at the start and during the implementation could help to identify and solve such potential conflicts, and further could strengthen the role of smallholders contributing to commercial supply chains.

4.2.3. Challenges that Cannot be Solved by Linking REDD+ and DFSC

As already mentioned in the Section 4.1., besides the majority of synergies that result from the comparison of REDD+ and DFSC and a potential spatial linkage, our results indicate to have a closer look at the key characteristic subsistence. For the year 2050, the FAO estimates an increase in global food demand by 54% which could be covered by intensified agriculture (higher yields and more intensive land use) up to 90% [248]. Other global economic models predict an increase in the demand for food somewhere between 59%–98% [249], which significantly exceeds the potential of agricultural intensification and would further increase the pressure on tropical forests. Assuming successfully implemented DFSC for commercial agriculture, under this scenario subsistence driven forest conversion and degradation could become the most important drivers of deforestation. Further, strong law enforcement around forest conservation and the strong interest of companies’ that their sourcing regions are actually deforestation-free, will restrict the availability and the potential output of forests as natural resource. This could foster food-insecurity [36] and shift land use conflicts to non-forested regions (with “changes in land-prices in non-targeted regions” [35]), or push those depending on subsistence into illegality. To ensure sufficient and secure livelihood across landscapes and sectors exceeds the scope of DFSC and REDD+. Companies are aware of that, as the Produce and Protect approach from Marks & Spencer and Unilever [64] illustrates, according to which jurisdictions for preferential sourcing “must have: A strategy for how to reduce emissions from forests and other lands whilst increasing agricultural productivity and improving livelihoods”. Nepstad et al. [38] suggest that governments should reward jurisdictions, which do not only highly perform in the reduction of deforestation, but at the same time in the percentage of protected or indigenous land, the reduction of forced labour, and the increase in agricultural production. Additionally, to that and regarding the availability of land as natural resource, we see the strong need for further investments in actions around restoration of degraded land and agroforestry. Political negotiations around restoration of degraded landscapes culminated 2011 in the Bonn Challenge, aiming at the restoration of 150 Million ha until 2020, and 350 Million ha until 2030 [250]. Agroforestry summarizes land-use systems “where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals” and “is crucial to smallholder farmers and other rural people because it can enhance their food supply, income and health” [251]. Agroforestry can be implemented on restored land and can contribute to an increase in agricultural productivity [252], a major pillar for the improvement of livelihood. Further, as the FAO states, it contributes to the livelihood of smallholders and rural people, touching upon the needs of subsistence. Both actions can contribute to the compensation of lost land use opportunities by the provision of livelihood [253,254], and additionally contribute to climate change mitigation and adaptation [255,256].

5. Conclusions

The present study is a timely and strategic effort to compare UNFCCC REDD+ and DFSC with regard to a spatial linkage of both concepts, especially in the light of the 2020 timeline on commitments from the public- and the private sector [20,231]. We structured the comparison along relevant key characteristics, which were derived in a transparent and reproducible manner from a rich base of existing literature and a qualitative content analysis. The comparison of both concepts was conducted with representative information on the design of REDD+ and DFSC. The results partly confirm existing findings on relevant criteria for DFSC initiatives, which mainly emerged from approaches using key informants [35,36], and add new recommendations on how to avoid potential unintended negative consequences from a thoroughly implementation of zero-deforestation concepts.

The key characteristics that build the analytical framework cover almost 20 years of discourse and proved to be relevant. They provide a collection of aspects that need to be considered to ensure the integrity of deforestation concepts. While the scientific discourse on how to reduce global deforestation was strongly dominated by the UNFCCC negotiations on the REDD+ framework, especially in the years from 2000 to 2013, this has influenced the debate on relevant characteristics and their implications. Therefore, the collected characteristics are biased towards the REDD+ safeguards [7]. With approaching deadlines for stopping global deforestation, the relevance of actual zero-deforestation commitments is increasing. At least at the moment, the commitments from the private sector are more concrete in terms than those from deforesting countries, and companies are more directly confronted with the consumers' reaction in case of failing. Therefore, it is possible that the overall discussion is shifting further away from criteria reflecting governmental responsibilities, towards the design of actual and robust commitments [35,36], and more characteristics could be added to the presented analytical framework in order to provide a comprehensive consideration of evolving approaches.

At the moment, the REDD+ framework takes almost all of the identified characteristics into consideration. Some are not inherent part of DFSC, but need to be tackled in order to (A) create a supportive legal frame for DFSC (land tenure), but also (B) to strengthen environmental integrity (permanence, leakage, degradation). At the same time, DFSCs are crucial for the goal of stopping deforestation as they complement a big gap within REDD+, commercial agriculture as deforestation driver. Both concepts can benefit from a common monitoring system, especially for companies this could reduce costs and help to bring more suppliers and companies in compliance with DFSC.

The results of the comparison and its discussion, especially in the context of subsistence as degradation and deforestation driver, show that REDD+ alone cannot foster the transformational change that is needed across landscapes and sectors. REDD+ needs to be embedded in other national programs which pave the way towards sustainable development. Besides programs that explicitly target increasing yields, initiatives around restoration and agroforestry provide multiple benefits for livelihood, and could soften potential implications of zero-deforestation commitments for those depending on forest use for subsistence.

Author Contributions: Conceptualization, Y.H.; methodology, Y.H. and L.G.; writing—original draft preparation, Y.H.; writing—review and editing, all; supervision, L.G. and S.G.; project administration, S.G. All authors have read and agree to the published version of the manuscript.

Funding: This research is funded by German Federal Office of Agriculture and Food (BLE) due to a decision of the Deutscher Bundestag, project number 281-006-01. The usual disclaimers apply.

Acknowledgments: The authors thank Matthias Dieter and Margret Köthke for their valuable feedback, and further Holger Weimar for his emotional support. Further we like to thank the reviewers for their constructive and really helpful comments.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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