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Agroforestry transitions: The good, the bad and the ugly

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ABSTRACT

This article canvasses the current definitions and framings of "agroforestry" in different academic literature and policies. Three key framings of "agroforestry" are identified in the scholarship and explored for their differences. The findings suggest that the distinct schools of research on "agroforestry" focus on distinct points of departure, and these baseline situations from which transitions to what is called "agroforestry" occur vary in distinct ways from monoculture plantations to primary forests. Political-economic analysis is used to scrutinize three key "agroforestry" transition categories: agroecological, agribusiness, and forest degradation, which the article identifies as agroecoforestry (the good), agrobizforestry (the bad), and agrodeforestry (the ugly) transitions, respectively. Examples of each type are provided based on field research in Brazil, and the results are put into a global perspective. The categories are helpful in identifying the "agroforestry" transitions that are currently marketed as good solutions but might also have negative impacts and in highlighting the agroecological agroforestry transitions that would help simultaneously increase global food production, adapt to and mitigate the climate crisis, and achieve equity and social justice.

1. Introduction

A growing body of research suggests that agroforestry practices can provide a wide range of benefits in response to the deepening sustainability and climate crisis (Jose, 2009; Schwab et al., 2015; Siminski et al., 2016). Agroforestry has been described as a solution to environmental problems, such as land degradation and the accompanying loss of soil carbon and fertility, loss of biodiversity, deforestation, overdraft of and threats to the long-term supply of water, and greenhouse gas emissions, as well as to many social ills, such as rural exodus, the concentration of power among only a few agribusiness corporations, increased risks related to climate change, and increasing malnutrition (e.g., IAASTD, 2009; Kloppenburg, 1991; McMichael, 2016; Patel and Moore, 2017; Weis, 2010). The climate crisis is also making agroforestry ever more relevant as agroforestry is seen by many as the best solution for carbon sequestration after native forests (e.g., Abbas et al., 2017; Elevitch et al., 2018; Toensmeier, 2016; Tomich et al., 2001). The proliferation of academic and other research and empirical practices that show the persistently and overwhelmingly positive impacts of agroforestry have given legitimacy to the concept across different fields (Jose, 2009; Mercer, 2004; Nair and Garrity, 2012; Vandermeer et al., 1998). Agroforestry has also featured prominently in documents produced by international organizations (IAASTD, 2009; World Bank, 2008). Based on this interest and support, one could assume that food systems would show major policy support for massive diffusion and geographical expansion of agroforestry practices.

However, no such sweeping agroforestry transition, whatever the demand, has taken place.

This, in our view, is because agroforestry goes directly against the defining characteristics of the modernization paradigm: single-species land-use logic and treeless monocultures (but also single-species tree plantations). As academic literature remains focused on farm-level techniques, the larger picture remains obscured and cannot be addressed within the current scope of most agroforestry research.

This article shows that there are many distinct literatures on "agroforestry", each framing it differently. The key difference among them lies in their different baselines for transitions to what are considered forms of "agroforestry". These forms of agroforestry are, furthermore, often loosely defined. However, in policymaking, the different agroforestry literatures tend to be conflated, which may have partly impacted the thus-far incomplete transition from agribusiness to agroforestry production models. In one study, for example, agroforestry is framed as "multifaceted, multicomponent and multiproduct activity with many purposes and benefits" (Jerneck and Olsson, 2013: 115). Such overtly

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loose definitions end up saying very little and permit a cooptation of the concept of agroforestry, a similar threat to what is happening to the concept of "agroecology" (Giraldo and Rosset, 2018; Rosset and Altieri, 2017).

To steer away from this danger and make sense of how "agroforestry" is currently and should be used, we suggest expanding the focus of attention from just farm-level biotechnical studies to include broader political and economic aspects of given agroforestry transitions, such as socioecological sustainability and equity. This means analyzing agroforestry transitions within the global food system. We identify different types of agroforestry transitions from the literature and analyze how they impact power relations and do or do not fit into the still-dominant frame of agricultural modernization. The critical agrarian studies perspective (Andreucci et al., 2017; Borras et al., 2011; Feldman and Biggs, 2012; McMichael, 2016; Schneider and McMichael, 2010; Weis, 2010) is used to identify and situate good agroforestry transitions, acknowledging that "different trajectories and practices might be known under different names and the particular histories and spatial distributions of the different experiences vary considerably" (van der Ploeg et al., 2019: 47).

The article distinguishes three types of agroforestry transitions—'the good', 'the bad', and 'the ugly'—explaining what each entails and provides examples of each from our field research in different parts of Brazil. Political economies of these categories help analyze the wide spectrum of proposals to diversify land use through blending annual crops and trees that are currently framed as "agroforestry" in the literature. We do not necessarily agree that all these transitions should be called agroforestry but provide a table and analysis to clarify the key differences among these conflated literatures and uses of the concept. Table 1 summarizes the typical points of departure, interventions, biophysical changes, and sociopolitical changes in different Brazilian cases and the specific literatures that study the transition as "agroforestry". First, 'the good' of agroforestry—which we call *agroecoforestry*—refers to agroforestry transitions that are ecologically beneficial for particular territories and help strengthen social justice in those territories. Second, we identify 'the bad' of agroforestry—which we call *agrobizforestry*—as such transitions that help further root and institutionalize agribusiness practices that harm the environment and/or social equity yet are framed as "agroforestry" in some literatures. Third, 'ugly' agroforestry practices are identified as transitions that directly spur the deforestation and/or degradation of primary or seminatural forests yet are called "agroforestry" in some literatures; this takes place especially through the transformation of forests on tree plantations or 'planted forests'. We show how labeling an activity as "agroforestry" provides a means to carry on and spread 'bad' or even 'ugly' practices under the legitimating disguise of sustainability, even though they do not fit accepted definitions of agroforestry.

While the literature predominantly focuses on the good agroforestry practices, the wide spectrum of proposals for diversifying agricultural production through tree-planting activities and enriching forests with useful plant species (Schroth et al., 2004; Wiersum, 2004) marketed as good solutions might also have negative social or even environmental impacts. Our division of these proposals into three categories is helpful in exploring the political-economic causes behind the lack of 'good' agroforestry transitions and explicating how the 'bad' and 'ugly' types are more easily adapted and promoted by the powerful actors in the land-use sector. The 'bad' type of transitions have been promulgated or framed as "agroforestry" within literatures on "industrial agroforestry", "commercial agroforestry" and "agroforestry plantations" (e.g., Dhiman, 2013; Dube et al., 2002; Evans, 1992; Phimmavong, 2019; Verma, 2017; Whitman and Burwell, 1986). The 'ugly' transitions have been framed as "agroforestry" in REDD+ (efforts to Reduce emissions from deforestation and forest degradation in developing countries) and other conservation-related literatures (e.g., Angelsen and Kaimowitz, 2001; Rolim and Chiarello, 2004; Rosenstock et al., 2019). However, insofar as agroforestry refers to systems in which woody perennials have to be deliberately grown on the same unit of land as agricultural crops (Dagar and Tewari, 2017), these two latter types are not necessarily identifiable as agroforestry, even though they may be labeled as such.

This article focuses on "agroforestry" *transitions,* as happening in different rural realities, and what to consider when studying them. We analyze how different types of "agroforestry" transitions can impact land and wealth distribution and social justice, as called for by prior research on agroecology (Altieri, 1989; Clapp et al., 2018; Karlsson et al., 2018; Pollini, 2009). As the field of agroforestry research has expanded to include many literatures, as pointed out above, this complex situation requires an article such as this one to disaggregate the meanings of different agroforestry discourses and framings. We thus follow the social constructivist approach (Berger and Luckmann, 1966), which has been used in assessing environmental discourses and framings (Nygren, 1998). We scrutinize the productive, adaptive, and mitigative potential of different types of "agroforestry". As the categories of good, bad and ugly agroforestry practices (henceforth, we use these words without brackets for the sake of readability) are 'ideal types' (Schutz, 1962), they cannot be found as such in empirical reality. However, these shorthand identifiers can help identify what would be the best kind of agroforestry transition and what should be avoided. This is important to promote cooperation and decentralized alternatives to the current paradigmatic competition-driven large-scale development patterns and to elaborate agroforestry as a development strategy—acknowledging that such a

Table 1
Three key types of "agroforestry" transitions, as present in scholarship.

Type	Good: agroecoforestry	Bad: agrobizforestry	Ugly: agrodeforestry
Typical points of departure	degraded lands, pastures, monocultures, forests	monocultures, pastures, degraded lands, secondary forests	primary forests
Typical interventions	planting native tree species, other perennials and food crops using agroecological principles	planting selected trees, typically exotic species, crop rotation, 'intercropping' in parallel plots	clear-cutting to establish commercial tree plantations, typically of exotic species, planting one species in detriment to others
Typical biophysical changes	enhances biodiversity, increases average age of cultivation, soil carbon and overall soil health, mimics native vegetation/ forests	enhances productivity and biodiversity (but introduces exotic species), increases soil carbon and health, and diversifies production at the local level; may have deleterious impacts on, for instance, the availability of water and biodiversity; drives the expansion of the agricultural frontier at system levels	degrades forests, spurs deforestation, expands single-species plantations
Typical sociopolitical changes	cooperativization, decentralization of land ownership, secure land tenure, absence of rural exodus, vitalization of rural areas	land concentration, rural exodus, rise in income inequality, gradual financialization, savage competition, increase in farm income of the fittest, further root the 'get big or get out' paradigm	introduction of dependency on monetary income, growth in income, inequalities within and among some communities, speculative investment, absentee ownership growth, influx of migrants into conservation areas or forests
Specific literatures that study the transition as "agroforestry"	agroforestry, agroecology, permaculture, peasant studies, critical agrarian studies, agrarian political economy, rural studies	industrial agroforestry, commercial agroforestry, agroforestry plantations	REDD+, conservation biology

strategy has to work at the territorial level and must be adapted to the different cultural and environmental settings in each locality (Iiyama et al., 2018). Furthermore, the three ideal types help identify and delegitimize empirical practices, proposals and transitions labeled as agroforestry that are harmful to rural populations, social justice, family farmers, soil carbon storage and/or the biodiversity of the natural environment.

We will first situate and explore the definitions of agroforestry and explain why agroforestry is needed from the perspective of the global agriculture crisis. After explaining how and when agroforestry can serve as a solution, we explore what kinds of agroforestry solutions are offered and where. We dedicate specific sections to agroecoforestry (the good), agrobizforestry (the bad), and agrodeforestry (the ugly), first in theoretical terms and then by offering some illustrative examples of each category from Brazil.

2. Material and methods

The material and methods for this research included both field research and a literature review. We first conducted field research and interviews in different parts of Brazil. The agroforestry sites visited in 2018 included a single farm agroforest that was part of a cooperative, two Landless Rural Workers' (MST) settlements in the Federal District that included various single farms and cooperative agroforests, and two agroforestry farms in Bahia, one in the Caatinga biome and another in the Atlantic forest. In 2020, as part of EMBRAPA's research project on agroforestry (Projeto Bem Diverso), we visited a region of Alto Rio Pardo in northern Minas Gerais state with various cooperative agroforestry schemes producing Araticum *(Annona crassiflora)*, Umbu (*Spondias tuberosa*), Pequi (*Caryocar brasiliense Camb*) and a range of other products, such as coffee. Interviews included government officials from the Ministry of Agriculture, the former Ministry for Agricultural Development, other government agencies (EMBRAPA, INCRA, FUNAI), consultants, technicians, researchers, politicians, activists, indigenous peoples' representatives, NGO personnel, and agroforesters. Overall, more than 30 interviews were conducted; all of the interviews were recorded, some were filmed, and all were conducted in the native language of the interviewee, Portuguese. Informal discussions during the field trips totaled tens of hours and involved tens of people involved in agroforestry. Our aggregated field research experience in Brazil is extensive, covering all the regions of the country and research on the forests and agricultural policies in each region.

We also conducted an integrative literature review with a focus on the conceptualizations of agroforestry in the existing literature. The aim was to critically reread and reanalyze the topic to view the existing technical definitions in a new way—through an agrarian political-economic lens. The reason for conducting this type of literature review is to be able to offer a contribution to overall studies on agroforestry, agricultural transitions, and forest and land-use policy. These kinds of integrative reviews (Torraco, 2005) entail not only reviewing but also essentially criticizing and synthesizing the representative literature to gain "a more comprehensive understanding of a particular phenomenon" (Whittemore and Knafl, 2005: 546). Such reviews are helpful when there is a large body of studies on a certain topic, including reviews, but where more conceptual work is needed to offer a new way of looking at it.

For the review, we read the literature against our empirical experiences from the field and our conceptual background in critical agrarian studies, agrarian political economy, and critical social theoretical frameworks. We reviewed the bulk of the existing research on the topic in academic journals and—typically—edited books, organized into groups to answer the following questions: What does "agroforestry" refer to in the given text, and why is this label used there? What is the scale of analysis in the given publication? What are the main focuses in the given research? What are the different power transformations that an agroforestry transition, as envisioned in the literature or policy, could produce? How does what is framed as "agroforestry" differ from conventional agriculture and forestry and from agricultural agroecology? What are the key paradigms of "agroforestry" transitions currently being promulgated in the setting of the climate crisis and other crises? How do these differ? Finally, as our overarching research theme and guiding question, we asked: Why has a sweeping agroforestry transition not taken place?

3. Theory

3.1. Conceptualizing agroforestry types and contributions

This section starts by identifying how agroforestry should be defined and discussing the known benefits of agroforestry. In the 40-plus years of agroforestry research, the literature on this topic has grown to form a substantial field (Liu et al., 2019). A Google Scholar search for the word 'agroforestry' yields some 1.7 million hits; for comparison, the term 'agroecology' returns only 120 thousand items at the time of writing (November 2020). In the academic literature, agroforestry has been characterized as "an interface between agriculture and forestry" (Dagar and Tewari, 2017: 23); it is both and neither at the same time. However, as agroforestry is founded on interactions between different species, even a small step from single-species agriculture or from forestry plantation toward agroforestry revolutionizes the logic of land use as it entails multi-species land use (Vandermeer et al., 1998); it should be seen as a radical proposal going beyond the merely biophysical dimension.

Just as there are vastly different forests, there are vastly different ways of using trees in agriculture; what is labeled "agroforestry" might include almost anything from growing eucalyptus to obtain timber and fuel to collecting fruits from naturally growing trees in tropical forests while aiming to simultaneously conserve natural resources. Typically, the agroforestry farmer "seeks an approximation of agricultural systems to natural ecosystems through the integration of perennial plants and an increase of the functional diversity of plants in agricultural systems" (Schultz, 2011: 4), but animals can also be integrated into agroforestry systems. Certainly, some agroforestry systems, such as wind walls or riparian systems, never aim to approximate natural forests. Atangana et al. (2014) identify over 100 distinct agroforestry systems, and because they always have to be adapted to the local context, the different types of empirical agroforestry practices—used by over one billion people globally—are countless. Classically, however, for a practice to be identified as agroforestry—for the World Agroforestry Centre (ICRAF) at least—it has to meet two requirements: woody perennials have to be deliberately grown on the same unit of land as agricultural crops, and there must be significant interactions between the woody and nonwoody components of the system (Dagar and Tewari, 2017). In agroforests, one can produce a vast range of products such as "fruit, nuts, oils, beverages, gums, resins, latex, flavours, leaves for food and nutrition, fodder for livestock, timber, fuel wood and biomass for energy production, and medicines that treat disease" (ICRAF, 2020). Agroforestry has been practiced for many millennia, predating the agricultural revolution (Miller and Nair, 2006). Estimates suggest that approximately 1.2 billion people still practice some sort of agroforestry (Atangana et al., 2014), but the bulk of this practice appears to be merely the remnants of agroforestry that have survived the expansion of industrial agriculture.

Agroforestry, in its various manifestations, seems to be a very positive concept, and very little that is negative has been said about it. The most critical stance may come from conservation biology, where particularly intensively managed agroforestry systems can be seen as harmful to biodiversity (Rolim and Chiarello, 2004; Santos-Heredia et al., 2018). Additionally, some studies claim that some shade-tree species reduce the yields of the crops they shade (Santos et al., 2012); however, other studies show the opposite (Roupsard et al., 2020). By far, the most common point in the literature on agroforestry is the benefits it brings, whether to the producer (farmer, peasant, etc.), to the environment (biodiversity), to the economy (increased returns) or to all of the

above (Jose, 2009). Agroforestry offers groundbreaking—or rather groundfixing—biophysical benefits, such as enhancing rainwater capture and carbon sequestration, reducing runoff and flooding and improving soil fertility (Elevitch et al., 2018; Toensmeier, 2016) and other types of benefits such as shade, wind protection and aesthetic and spiritual value (Scherr, 1995). Agroforests constitute a "habitat for both the conservation of wildlife and the utilization of many nontimber forest products that people harvest, including a number of valuable plants, fungi and game animals" (Schroth et al., 2004: 2).

One key idea of agroforestry in biophysical terms, as it were, is "the greater ability of agroforestry systems to capture and utilize growth resources (i.e., light, nutrients, water) compared to single-species systems" (Lorenz and Lal, 2018: 235). Multistrata growing allows more sunlight to be captured, and because the soil ecosystems grow more vigorous as the agroforest matures, much more water and carbon are retained within the system than in conventional systems (Toensmeier, 2016). Agroforestry, by virtue of its beneficial impacts on biodiversity, features prominently in ecosystem service projects and is claimed to "provide a new platform for the old challenge of aligning conservation and development" (Tallis et al., 2009: 12). The potential of agroforestry in terms of carbon sequestration and storage, biofuels and climate change mitigation in general has been another prominent focus (Agevi et al., 2017; Faβe et al., 2014; Kumar and Nair, 2011; Ramos et al., 2017; Shi et al., 2018; Siqueira et al., 2019; Srivastava et al., 2012; Unruh, 1995) since, as written, it is seen— save natural forests—as the best method of carbon sequestration.

3.2. The scope of the agroforestry literature

There are, however, distinct literatures on agroforestry, many of which do not follow the above definitional criteria but describe other types of rural transitions as "agroforestry". In this section, we explore the benefits of a broader political-economic approach to identify these distinct literatures and thus make a contribution. Most of the existing literature on agroforestry revolves around technical-productivist dimensions at the farm or even plot level (Jerneck and Olsson, 2013; Liu et al., 2019). This focus is in line with the bulk of the research on forestry within tree plantations, whose overt focus on technical or productivist criteria has been criticized by critical agrarian studies (Kröger, 2014). An agrarian political-economic approach is required to reveal the involved power relations that tend to determine the sociopolitical impacts of agricultural practices (Borras and Franco, 2018; Clapp et al., 2018). It is not sufficient to analyze, for instance, how much carbon agroforestry can capture, as emphasized in today's bioeconomy policy and research, if social inequalities and injustices—and therefore poverty, misery and social restlessness—are proliferating. Political-economic and political-ecological categories need to be used alongside technical criteria to distinguish different agroforestry practices, and it is crucial to go beyond farm-level analysis and employ system-level analysis (Nygren, 1998).

However, as our political-economic analysis here will argue, agroforestry can and often does exhibit much more than technical or ecological characteristics, offering the possibility of, for example, increasing farmers' autonomy with regard to chemical input producers (Coolsaet, 2016) and therefore also of the (re)democratization of the countryside. Agroforestry quite naturally relates to issues of irrigation-free farming and inherently longer-term planning (Brockington et al., 2016; Scherr, 1995), which disrupts established policy practices related to, for instance, agricultural credit that are currently mainly oriented toward chemical inputs. Overall, the existing analysis needs to be reassessed through the lens of critical agrarian studies to highlight crucial yet typically overlooked political-economic dimensions. This reassessment will help us differentiate the good, bad and ugly forms of agroforestry transitions.

The determination of the good, bad, and ugly forms of agroforestry transitions introduced here is obviously normative, and these are *relational* categories, as the 'goodness' of practices fundamentally depends on one's point of view, values, assumptions and understandings. Here, the point of view follows agroecological principles that underscore the health of the soil, the above-soil biodiversity and social justice (Altieri, 1989; Borras and Franco, 2018; IAASTD, 2009).

3.3. Why agroforestry? Conspicuous failings of industrial agriculture

Many agree that there is a need to change or even transform farming methods due to the "increasingly conspicuous failings of conventional industrial agriculture" (Kloppenburg, 1991: 535; see also Foley et al., 2011; Godfray et al., 2010; Waldron et al., 2017). However, it seems that homogeneous thinking among dominant organizations, such as the World Bank, FAO, and CGIAR, and transnational agribusiness still remain (Ehrnström-Fuentes and Kröger, 2018; Feldman and Biggs, 2012; González and Kröger, 2020; McMichael, 2016). While the modernization of agriculture is celebrated because of its productivity gains, this productivity is only short-term and depends on a broad array of unvalued and undervalued costs that range from the diffuse impacts of fertilizers and chemical and other runoff on watersheds to the deterioration of the very biophysical foundations of agriculture (Weis, 2010) and to the creation of an obsolete surplus population that cannot find its function elsewhere in society (Borras and Franco, 2018; Li, 2017). The resulting emptying of rural areas has been—and still is—accompanied by a proliferation of semiurban areas, especially slums (Davis, 2006).

The conventional development paradigm in agriculture aims to increase productivity through capital-intensive production replete with chemical inputs, such as fertilizers, pesticides and herbicides, modified seeds and technologies, all of which are externally produced. This paradigm entails a single-species land-use logic, which means cultivating one species in one place and preventing all the other species from growing there. This task has proven exceedingly difficult because other species naturally invade biodiversity voids. These unwanted species—pests—also effectively surmount attempts to prevent invasions (van den Bosch, 1978). It is estimated that globally some 40% of crops are lost to pests annually, regardless of the heavy application of pesticides (Pimentel and Peshin, 2014). Against this background, single-species land use is problematic from the outset, yet monocultures currently "dominate 80% of the 1.5 billion hectares of arable land" (Altieri and Nicholls, 2020: 882) in agriculture. In this setting, proposing agroforestry means going against the mainstream and agrochemical giants that act as powerful operational centers extracting huge value flows from the system (Ye et al., 2020).

Agriculture is a special sector with regard to climate crisis: it is highly vulnerable to changing climatic conditions and at the same time one of the main culprits of the climate emergency (Clapp et al., 2018). The climate crisis has prompted the addition of climate change mitigation and adaptation to the mainstream literature on agricultural development, which has previously focused on increasing global food production (Godfray et al., 2010), even though at the aggregate level sufficient food has long been produced (Vandermeer and Perfecto, 1995). Increasing global food production while adapting to and mitigating climate change is called a 'triple challenge'. To respond to this challenge, industrial agricultural approaches have urged the engagement of *all* solutions, even when they contradict each other (Karlsson et al., 2018). These discourses, such as that on climate-smart agriculture (CSA), have major impacts on power relations and tend to "obscure the deeper questions regarding power and influence over the agenda and therefore reify dominant relations" (Clapp et al., 2018: 83). Agroforestry appears to be a similarly 'production-oriented', 'apolitical' and managerial approach (Jerneck and Olsson, 2013; Pollini, 2009). Clapp et al. (2018) observe that CSA ignores issues around *equity*; if there is no discussion on equity, the status quo, with its drastic power disparities and inequalities, including gender inequalities (Gebrehiwot et al., 2018), both within and between countries, tends to remain in place and be further exacerbated.

Misery, powerlessness, exploitation, and inequity are acute problems in the Global South due to the risks that peasants face (Borras and Franco, 2018; Li, 2017). Therefore, instead of a triple challenge, there is actually a *quadruple challenge* in agricultural development. In addition to increasing global food production and climate change mitigation and adaptation, agroforestry transitions also need to directly address equity and social justice. What we call "agroecological agroforestry" is well suited for this quadruple challenge (see Pullanikkatil and Shackleton, 2019; Waldron et al., 2017).

3.4. What do agroforestry transitions entail and necessitate?

This section further examines why agroforestry has not advanced based on a political-economic and political-ecological analysis of how agroforestry tends to transform power relations in the global-local agricultural nexus. The corpus of agroforestry research has documented that agroforests can reverse vicious cycles of land degradation, desertification and biodiversity loss (Jose, 2009; Siqueira et al., 2019). While agroforests, especially those in the Southern Hemisphere, provide the best carbon storage (Toensmeier, 2016), deep-rooted trees also help during droughts by accessing deeper soil water, protect against extreme heat by reducing soil and air temperature, and absorb water better during storms. Chemical fertilizers, pesticides and herbicides are not needed, or, at least, the need to use such products is radically reduced in agroforests, meaning that producers do not have to buy these products, liberating them from using credit, at least for these kinds of purchases. Producers also need not depend on fossil fuels, scale enlargement, monoculture, specialization or mechanization in their production to increase productivity and diversify production (Rosset and Altieri, 2017).

Agroforestry has been characterized as having low-risk, low-investment, and high-carbon sequestration possibilities and potential benefits, especially for the poorest farmers (IAASTD, 2009; Iiyama et al., 2018; Toensmeier, 2016). Because expensive production inputs are not needed, agroforesters tend to gain autonomy vis-à-vis the upstream of the system, that is, freedom from agrochemical giants. The mere possibility of small farmers avoiding the debt trap is historically unique and important (Gerber, 2014; Graeber, 2011; Hudson, 2018) and a potentially crucial aspect of agroforestry transitions, as it, at least in theory, translates into the (re)democratization of rural areas and would allow retaining long-established forest and swidden commons (Toivanen and Kröger, 2019). On the other side, however, are powerful economic interests obstructing the spread of truly sustainable forms of land use (Altieri and Nicholis, 2005). Indeed, the fact that large agribusiness corporations may lose revenue due to agroecological transitions may be the single most important barrier inhibiting global agroecological or agroecoforestry transition—and may also be a sign of their radical nature and contentiousness as political-economic processes. In agroforestry research, analyses of such barriers have been virtually absent thus far.

Even though transnational corporations still hold tightly to the institutional structures of agriculture, transnational and national peasant movements have already attained genuine and important successes in the struggle (Scoones et al., 2018; Wittman and Blesh, 2017). As major evidence of this, at the end of 2018, the UN General Assembly adopted a declaration about safeguarding the rights of peasants and other people working in rural areas (UN, 2018). Additionally, even key international organizations have proposed paradigmatic changes to how agriculture is organized and developed. The IAASTD report, similar to ICPP reports in that it was compiled by hundreds of researchers (Feldman and Biggs, 2012; IAASTD, 2009; Scoones, 2009), stands out among the propositions. For its part, the World Bank's 2008 World Development report, which gave significant space to agroforestry, failed to propose transformative changes to agricultural development (Akram-Lodhi, 2008; Li, 2009; Oya, 2009). Global mobilizations have shown members of the peasantry to be a major social force that can drive ecological practices forward (Borras and Franco, 2018; Rosset and Altieri, 2017; Scoones et al., 2018; Van der Ploeg, 2012). Helping such movements should be seen as a major way of helping agroecological agroforestry transitions gain momentum, yet this is seldom acknowledged in the agroforestry literature.

Land politics and peasant tenure insecurity also obstruct agroforestry transitions. Miguel Altieri (1989: 43) wrote thirty years ago that igniting such a process to substantially benefit the rural poor "is not really possible without facilitating the access of peasants to land, water and other natural resources, as well as to equitable credit, markets, appropriate technologies, etc." The importance of secure land tenure cannot be overemphasized when talking about naturalizing agroforestry: the importance of long-term tenure security has long been viewed as the key to achieving lasting policy changes in forest and agricultural land use (Fortmann, 1985; Khaleque and Gold, 1993; Sanchez, 1999; Weinstock and Vergara, 1987). This is even more so in agroforestry due to the longer planning and investment periods involved (Lawin and Tamini, 2019; Neef and Heidhues, 1994): without confidence that the land will be there twenty years in the future (and will still belong to them), farmers are unlikely to invest in, for instance, nut trees, which often take a long time to bear nuts. As Thomas Rudel puts it (2005: 199), "a fluctuating, uncertain institutional context makes land tenure arrangements unstable, so the poor have few incentives to think in terms of long-term investments in the lands and forests around them." Indeed, the question of land ownership and access to land should become central in agroforestry research, following the questions posed by critical agrarian studies of "who ought to get which land, for how long, for what purposes and with what implications, and who ought to decide?" (Borras and Franco, 2018: 2).

The question of markets looms larger in agroforestry due to the typical absence of even local markets for the rich variety of agroforestry products, such as endogenous fruits, nuts, and mycorrhizal mushrooms. The state has an indispensable role in creating niche markets that can be created, for instance, through public procurement programs (Wittman and Blesh, 2017). Here, producers' cooperatives should play a salient role (Altman, 2015; Emery et al., 2017; Sharzer, 2017). Questions about land and markets highlight the key role of state support in agroforestry transitions. These are important lessons from the critical agrarian studies perspective and are helpful in emphasizing the crucial role of the state and peasant mobilization in ensuring agroecologically and sociopolitically equitable agroforestry transitions—which we will discuss next.

3.5. What kind of agroforestry? Assessing the 'goodness' of agroforestry

Before exploring the troika—the good, the bad, and the ugly—of "agroforestry" transitions present in the current literature, we explore how we identified and named these three categories. All measurements are contingent on the point of departure, the baseline, and this also applies in assessing agroforestry *transitions*, or what are framed as such. It is generally understood that agroforestry transitions entail two basic pathways: "the incorporation of trees in agricultural cropping systems or the incorporation of crops in forest systems" (Wiersum, 2004: 123). Analyzing the *unfolding* of distinct trajectories can be assessed at the conceptual level by examining models, policies and empirical practices that aim to develop rural areas. What it means to adopt agroforestry practices can vary greatly depending on the scale of activity, what kind of practices are sought, and which type of intensification practice is implemented. As in agroecology, agroforestry transition is typically "a process that extends over time and occurs through incremental improvements" rather than a single-step change (van der Ploeg et al., 2019: 47). The impacts of such transitions are broad; for instance, at the landscape or territorial level, "the presence and dispersal of fauna and flora, water and nutrient flows, microclimate, and pest and disease dynamics are significantly influenced by trees" (Schroth et al., 2004; see also Vandermeer and Perfecto, 1995), which co-constitute the context in

which particular farmers operate.

In the biophysical dimension, the type of transition, 'from buzz cut to long hair', provides a vast range of low-risk, low-investment, and high-carbon sequestration possibilities and potential benefits, especially for the poorest farmers (Erskine, 1991; Nair and Garrity, 2012; Toensmeier, 2016; Waldron et al., 2017). Most harmful "agroforestry" transition can be characterized as a 'long hair to buzz cut' in which a naturally grown forest is more or less gradually taken over by economic interests in the guise of sustainability, as will be discussed. Determining what is good in sociopolitical terms, that is, what constitutes social justice, always depends on (political) values and impacts on land and wealth distribution: "who wins and who loses, who is able to participate and whose knowledge and perspectives count in the process" (Karlsson et al., 2018: 150). This also depends on issues such as who produces what, as well as where and under what kind of land ownership, supply chain and credit system. This context is constituted by the global political economy in which agriculture operates but over which single farmers have little control.

What may be good at the farm level is not necessarily good in terms of the larger food system. For this reason, key in our identification of three "agroforestry" framings is emphasizing the systemic origin and setting in which the transition is taking place. We thus identify transitions that take place in the context of—and through actors involved in—smaller-scale or cooperative agroecology, large-scale conventional agriculture, and monocultural expansions that displace forests in the name of agroforestry. With these points in mind, we next analyze the three framings.

4. The troika of "agroforestry"

4.1. The good: Agroecoforestry

What we label good agroforestry is based on an adaptation of the agroecology literature, where concepts such as labor driven intensification (Van der Ploeg, 2012), sustainable intensification (Pretty and Bharucha, 2014, cf. Akram-Lodhi, 2008; Oya, 2009), and agroecological transitions (Rosset and Altieri, 2017) have been used to denote what good agroecological transitions entail. In referring to the good agroforestry practices or *agroecoforestry*, we refer to biophysical practices that enhance the overall biodiversity and soil ecosystems of the local environment and gradually increase the average age of perennial cultivation. Even though some forms of swidden agriculture can also be seen as sustainable (Ickowitz, 2006; Rodríguez-Robayo et al., 2020), our ideal type of agroforestry matures over many decades; some trees may live to be multiple centuries old, making the soil ecosystems grow deeper and denser and stabilizing the metabolism of the ecosystem and therefore affording it protection against external shocks, such as droughts and other extreme weather events (IAASTD, 2009). When such agroforestry matures, it comes to resemble natural forests of that particular biome (González and Kröger, 2020; Montoya et al., 2020).

In agroecology, one major aim is "to replace external inputs of chemicals with knowledge-intensive practices that make use of natural processes" (Röling and Van De Fliert, 1994: 97). While these practices are certainly labor intensive, this intensity tends to decrease in more mature phases, as the forces of nature kick in. The gradual reduction—and eventual abolition—of externally produced inputs is, in fact, a powerful process through which farmers gain autonomy from the agro-industrial complex—for example, large agrochemical producers such as Bayer and Syngenta. Gaining autonomy entails not only the political empowerment of small farmers but also the fundamental rethinking of feasibility calculations (Gerber, 2020; van der Ploeg et al., 2019). Since there is no need to use credit for annually purchased inputs (nor a need to pay interest rates), the pressure to sell and make profits is reduced. This release from indebtedness may be the most important feature of low-cost agroecoforestry transitions, as indebtedness has been a major source of farmers' misery for millennia (Gerber, 2014; Hudson, 2018) and a catalyst for socioecologically destructive transitions (Toivanen and Kröger, 2019).

Because agroecoforestry practices are radical solutions, they must be pushed forward, and neither major corporations, mainstream agronomy nor agricultural economics will do that. Peasants should be, and sometimes already are, organizing into larger units to survive in the harsh global agricultural context, and cooperatives have been described as vital for organizing the food system (Altman, 2015; Emery et al., 2017; Tilzey, 2017). Through cooperation, the central process so typical to the conventional development model, the differentiation of small farmers under the 'get big or get out' pattern, which is one of the root causes of the rural exodus, can be avoided (Gray and Dowd-Uribe, 2013; Li, 2009; Newsome, 2020). For this, we see agroforestry cooperatives as a particularly important path to follow; cooperation, instead of competition, should be the basic mode of organizing within agroecoforestry. Cooperatives should have a salient role in agroforestry for other purposes, creating new and high value-added niches for produce together with the state. However, cooperatives could also be the medium through which agroforestry could acquire an organized and locally rooted social carrier.

The most typical empirical manifestation of a good agroforestry transition is that in which peasant, small or even larger farms begin the transformation toward agroecological practices that entail cultivating trees and other perennials. The most obvious points of departure of such agroecoforestry practices are 'conventional' single-species monocultures under chemically intensive industrial farming and vast areas of cow pastures. However, degraded lands or land areas with challenging water and climatic conditions can also be transformed into productive agroforestry systems without the need for irrigation systems, chemical fertilizers or pesticides, with low capital costs. Such restoration can be seen as the specialty of agroforestry practices.

What we describe here as agroecoforestry is thus not only an environmentally sustainable model but also one that almost inherently improves social justice and equity by creating a decentralized production system that enhances producers' autonomy and prevents them from overly differentiating through cooperative arrangements (Emery et al., 2017; Gray and Dowd-Uribe, 2013) of some sort. It should be evident that such a model sometimes even entails radical political means such as mobilizations, protests and other strategies to foster contentious agency (Kröger, 2014) to break free from the cage of global agro-industrial complex and especially from the dependency of input and debt relations (van der Ploeg et al., 2019). Table 1 provides some examples of these agroforestry transitions and distinguishes the good, bad, and ugly agroforestry transitions.

4.2. The bad: Agrobizforestry

There are also practices that have been called "agroforestry" but that have negative overall impacts. These might not have immediate detrimental impacts on the natural environment—and may ease previous harm—but may ultimately have negative impacts through their interactions with other practices in biophysical and/or social dimensions. These advantageous practices, marketed as "agroforestry", may be adopted to gain the upper hand against other producers whose positions are gradually weakened and who are ultimately forced to surrender their lands and move elsewhere. If these practices play a part in helping reproduce environmentally harmful patterns at the systemic level or spur the 'get big or get out' (Newsome, 2020) pattern of development, even indirectly, they may be categorized as bad practices, despite being called "agroforestry".

In the academic literature, "industrial" or "commercial agroforestry" or "agroforestry plantations" (Ariza-Montobbio et al., 2010; Carvalho et al., 2019; Costa et al., 2018; Dube et al., 2002; Evans, 1992; Sone et al., 2019), particularly widespread in Brazil and India (Balandier and Dupraz, 1999; Dhiman, 2013; Phimmavong, 2019), can be identified as predominantly, but not always, as bad. Scholars claim that there are

ecological, economic, and social benefits to such "agroforestry", but this is always relative to continuous cropping or livestock production (César et al., 2020; Costa et al., 2018) instead of agroecological alternatives. Typically, such industrial-level "agroforestry" entails only very limited intercropping or even just crop rotation with timber the dominant product (Dhiman, 2013; Whitman and Burwell, 1986), which means that these rural transitions rarely comport with the agroforestry definition used by the ICRAF. Under "industrial agroforestry", most typically forestry companies have created various arrangements that either ease the environmental impacts of their plantations or more typically help acquire social consent from or even labor by local populations for their production (Whitman and Burwell, 1986).

Defining or giving examples of these bad "agroforestry" transitions is not a straightforward process because some might call a practice "agroforestry" (Balbino et al., 2011; Carvalho et al., 2019; Sone et al., 2019) and others might not, even though all refer to the same agroforestry literature (Costa et al., 2018; Pacheco et al., 2013). The practices of the Low Carbon Agriculture program of the Brazilian Ministry of Agriculture involving crop-livestock-forest systems (Integração Lavoura-Pecuária-Floresta, iLPF) are a case in point. Researchers have shown that using such systems instead of conventional agricultural practices can significantly boost productivity and reduce environmental impacts (Pacheco et al., 2013). For instance, Costa et al. (2018) calculate that in only 70 ha, such systems can produce as much as 240 ha cultivated with conventional practices.

There are problems with such practices, the first of which is that exotic species are often used in areas that cannot absorb their impacts. For example, planting eucalyptus in the Cerrado biome means that much more water will evaporate than does so among native vegetation, leading to the drying-up of rivers and groundwater (according to interviews with EMBRAPA technicians and farmers in Minas Gerais; see also Kröger, 2014). Another problem with such practices is that they allow for further differentiation of rural producers fortifying the 'get big or get out' pattern (Newsome, 2020) leading to land and income concentration through insidious cumulative change (Ollinaho, 2016). However, the ultimate issue is that such practices help reproduce the highly destructive global industrial grain-oilseed-livestock complex (Weis, 2013), which is replacing the rainforest of the Amazon (Kröger, 2020) while promoting the 'agrarian extractivist project' (Alonso-Fradejas, 2015).

Rural realities and their development should be conceived of in their entirety (Bernstein, 2006) and entail many interconnecting components—the "web of causality" as Vandermeer and Perfecto (1995) call it—which means that studying farming practices alone is not sufficient. What may be feasible at one level—for instance, at the farm level—can result in negative systemic-level impacts, such as acceleration of deforestation or massive rural exodus. Adopting production-enhancing agroforestry practices that focus narrowly on the single-farm level should be seen as highly legitimate not only in mainstream agronomy and agricultural economics but also in agroforestry research, regardless of the broader impacts of such practices.

4.3. The ugly: Agrodeforestry

Conservation biologists and environmentalists typically view primary forests as pristine and of incalculable value, as any monetary value is not commensurate with the living "web of life" (Mukerjee, 1930), which is particularly rich in old growth forests. Ugly "agroforestry" transitions either *de facto* end up destroying primary forests, regardless of their stated intention not to do so, or increase the risk that such deforestation will happen. Such ugly practices refer primarily to legitimated schemes such as extending 'planted forests' (Kröger 2014)—often referred to as part of agroforestry practice—that end up transforming pristine forests into mixed plantations of cacao, coffee, banana, and açai or even a mix of eucalyptus, acacia, and pine or oil palm alongside which some land is dedicated to agriculture (Koussihouèdé et al., 2020; Kröger, 2018; Marie-Vivien et al., 2014).

Additionally, subtle ways of enriching forests with useful plant species that may not appear ugly at all may end up with a similar result, putting an end to a primary forest by transforming it into an inhabited and increasingly 'civilized' area and drawing it gradually into capitalist relations of production. As Angelsen and Kaimowitz write, "[f]armers could make forest conversion more profitable by using agroforestry, which in turn could give them an incentive for further forest encroachment. Better profitability can also attract new migrants, further multiplying the effects" (Angelsen and Kaimowitz, 2004: 87). In other words, such practices increase the *risk* of deforestation through degradation and commodification. Sensitivity is critical when beginning economic activity in the vicinity of—or within—primary forests because such practices, whenever successful in generating local income, can often be multiplied and lead to large-scale interventions in these primary forests (Kröger, 2018; Kröger and Nygren, 2020; Vandermeer and Perfecto, 1995).

Due to the prominence of environmentalists' and conservationists' claims of biodiversity in the Amazon, Borneo and other rapidly diminishing sanctuaries of biodiversity, ugly transitions may not have the explicit blessings of mainstream agronomy, agricultural economics or even transnational companies. Ugly practices are therefore typically disguised behind certificates of different types that are manufactured by different roundtable groups chaired by the same transnational companies that either themselves carry out these practices or, more often, buy the produce of smaller producers that do the dirty work. It is often difficult to trace ugly practices, as the value webs of flex crops such as oil palms are increasingly complex (Alonso-Fradejas, 2015) and entail both small and large producers. In this way, the destruction of the Amazonian and Bornean forests continues under the disguise of sustainable palm oil, sustainable soy and other "sustainable" products (Córdoba et al., 2018). Notably, the mainstream model of conservation in which local people cannot even touch primary forests has been discredited as dysfunctional in social terms (Vandermeer et al., 1998). Typically, the populations living within or in the immediate vicinity of primary forests are the best forest wardens if they are allowed to use the forests for their subsistence (González and Kröger, 2020).

As in bad transitions, ugly practices are often cumbersome to analyze empirically. While forest plantations in the tropics used to be called "agroforestry" (Evans, 1992), today, they may gain REDD + status or other carbon-trading value through "the commodification and fetishing of carbon" (Lyons and Westoby, 2014: 13). If these schemes are expanded, agroforestry may become associated with or increase the risk of the degradation of natural forests or deforestation through 'carbon farming' by virtue of the so-called agroforestry systems being identified as the best option (after natural forests) to sequester carbon. What is often at stake in emissions-compensating schemes is green grabbing, "the appropriation of land and resources for environmental ends" (Fairhead et al., 2012: 237) through colonial mechanisms (Lyons and Westoby, 2014).

5. Discussion: How are good agroforestry transitions possible?

A particularly important power-related issue inherent in agro-ecoforestry transitions is the reduction and eventual abolition of externally produced inputs, which makes good agroforestry transitions a radical proposition. The transition to pro-poor agroecological agroforestry requires confidence in one's land tenure, seeds and seedlings for different perennials, skills and motivation derived from knowledge about the benefits of agroforestry and, last but not least, the ability to create short-circuit markets for the rich produce of agroforests. This should translate into increased autonomy for producers and contribute to the (re)democratization of rural areas. However, such requirements raise structural-level issues, such as the need to redesign agricultural credit uses, the support system for agriculture and create new markets for agroforestry products, and in many cases conduct even a

redistributive land reform. In Brazil, for instance, the highly subsidized agricultural credit used to purchase chemical inputs as well as tax exemptions that alone subsidize purchasing pesticides for over 2 billion USD annually (Soares Lopes et al., 2020) effectively disincentivize broader agroecological transitions and should be reversed to enable agroecological transitions. The pursuit of agroecoforestry as a policy option with multiple benefits compared to agribusiness, while appearing unfeasible for export-oriented agricultural entrepreneurs based on further mechanization (Nygren, 1998: 217), has become possible and ever more pressing with the large number of so-called 'surplus populations' (Li, 2017), whom agroecoforestry could absorb and to whom it could offer a livable environment and livelihoods.

Taking seriously the cautions discussed in terms of bad and ugly "agroforestry" practices, agroforestry appears ready for the next phase: its naturalization as the typical way of increasing land productivity and, subsequently, as the normal way of farming. This is because, as research has made clear, agroforests also provide a *stupendous* range of beneficial effects at the plot, farm, landscape and system levels. As written, one important impact in this era of climate change is that genuine long rotation agroforestry systems are superior to all other human-influenced land uses with regard to their ability to store carbon. However, no one tree species works everywhere. Eucalyptus, for instance, transpires much more water than the Cerrado or Caatinga biomes can afford to lose. Planting eucalyptus in such biomes, therefore, dries them up; a similar consequence sparked the social uprisings in the Brazilian state of Minas Gerais that resulted in the creation of the sustainable development reserve 'Nascentes Geraizeiras' (ICMBio, 2020), the site of one of our field research visits. As a general rule, planting native perennials is a safe bet. The selection of perennial species is important to the actual functioning of agroforestry at the farm level, and as most agroforestry research has focused on the farm level, there is abundant related biological and agronomical knowledge that can help with this selection process.

Finally, creating an organized social carrier for agroforestry should be seen as perhaps the largest hurdle in agroforestry transitions. While there are various actors attempting to build a social organization for agroforestry, such as the World Agroforestry Centre (ICRAF) and the Agroforestry Innovation Network (AFINET), such a barrier is scarcely acknowledged in the literature. As agroforestry is predominantly practiced by small farmers scattered around the globe, there is no organized social carrier of agroforestry comparable to industry associations, and large populations of actors within forestry and agriculture that see those sectors thrive in the global and national policy arenas. Despite the existence of the abovementioned ICRAF and AFINET, which certainly have relevant roles in advancing agroforestry, agroforestry lacks muscle within policy arenas and public discourses. Muscles are needed since agroforestry is mutually exclusive land use alternative with regard to both agriculture *qua* monoculture and forestry *qua* plantations and entails extensive changes in the entire food system, which latter should be clarified by agroforestry research.

Academic research and the farming practices of peasants all over the world have matured agroforestry so that it is ready to enter the main arenas of discussion where food system structures are being decided. Indeed, agroforestry has been referred to as 'low hanging fruit', mature to be collected (Chavan et al., 2015). Agroforestry research, however, has been part of "technological optimist managerial approaches" that disregard "the issue of unequal power between stakeholders" (Pollini, 2009: 48). It should be seen that there are powerful interests hostile to wide-ranging transitions towards agroforestry. Furthermore, if massive diffusion or adoption of agroforestry practices occurs on both small and large farms, it will be important to take stock of the sociopolitical dimension of such a potentially revolutionary transition. It is not sufficient to analyze how much carbon agroforests can capture if social inequalities and injustices and therefore poverty, misery and social restlessness continue proliferating—or if deforestation of primary forests continues unbound.

What research should analyze in terms of the 'natural' environment in agroforestry transitions is the point of departure. As agroforestry practices have long been shown to have the ability to restore degraded soils, focusing policy on those main areas would be justified.

The safest way to embrace and incentivize agroforestry practices is to start planting native tree species on normal agricultural land or on depleted or degraded soils. Such soils are increasingly found in northeastern Brazil (Young, 2017) and in areas that have previously cultivated soybeans resulting "in various levels of soil degradation through wind and water, erosion, soil compaction, soil organic matter (SOM) depletion, and nutrient losses" as well as a "general lack of biodiversity" (Wingeyer et al., 2015: 2213–2214, 2235). Another safe, yet more controversial, target of agroforestry practices is conserving primary forests that are under threat of deforestation due to the expansion of the commodity frontiers (in the Amazon, these typically include mines, soya, large hydropower structures or pastures), and in this, indigenous populations and practices should be drawn to the fore (González and Kröger, 2020). As understood here, the aim of agroecoforestry is not to abandon indigenous knowledges but, on the contrary, to help legitimize indigenous political ontologies.

6. Conclusions

With this paper, we have sought to provide scholars with guidance on considerations in agroforestry transitions and what good agroforestry transitions should look like. The reasons to support agroecological agroforestry transitions that are socioecologically just were analyzed, as well as why these transitions have not yet occurred. The pitfalls and potentially harmful solutions that are framed as "agroforestry" were also identified through a review of the literature. Three types of "agroforestry" transitions as presented in the literature, were identified and analyzed based on the context, actors and baselines involved: smaller-scale or cooperative agroecology (good), large-scale conventional agriculture (bad), and monocultural expansions that displace forests in the name of agroforestry (ugly).

The results suggest that agroforestry is an ambiguous and often loosely defined concept and that there is a wide variety of so-called agroforestry practices across the world. We divided these practices based on the different political-ecological and power relations they involve. When assessing the goodness (not feasibility) of these agroforestry transitions, scholars should empirically examine such practices in the context in which they unfold and as a part of the history of that context. It is essential to assess the point of departure of these transitions, particularly because of the vulnerability of primary forests under the domination of industrial agriculture, industrial forestry, and other extractivist paradigms. Inseparable from this conceptual scrutiny is addressing the sociopolitical dimension of agroforestry, which is typically absent from the natural science-dominated literature on agroforestry's biophysical dimensions.

The different framings of "agroforestry" transitions outlined in this paper offer several contributions to both research and policy. First, our paper calls for a focus on agroforestry *transitions* rather than on the synchronic technical analysis of agroforestry systems. In other words, it recommends the use of longitudinal or diachronic research designs and the broadening of the time period of research to include the period before any transition has begun in the wider context. Second, the categories serve to identify and delegitimize empirical agroforestry transitions that are—even if only indirectly—harmful to rural populations, social justice, family farmers, soil carbon storage and/or the biodiversity of 'natural' environments. Third, categorization can be used to identify and promote cooperation-seeking alternatives to paradigmatic competition-driven large-scale development projects and incubate an organized social carrier for such alternatives. Fourth, the political-economic analysis here is helpful for developing agroforestry as a *development strategy* at the system level rather than the farm level, acknowledging that such a strategy should be adapted to the different

cultural and environmental settings in each locality. In other words, the agroforestry transitions being scaled out, even if designed at the territorial level, must be decentralized from the outset. Fifth, this paper urges widening the time scale of agricultural planning at the policy level, since agroforestry transitions take place over decades rather than years. Finally, we recommend that agroforestry policy interventions establish secure land tenures and focus on degraded lands and monocultures that are most problematic in terms of farmers' indebtedness and that are in the vicinity of primary forests and risk expanding into such forests.

We see that to a large extent, in both practice and the literature, agroforestry practices belong to the "good" category. However, if agroforestry is understood as a very general concept and if there is to be a sweeping agroforestry transition, the germ of which may be seen in Africa (Reij and Garrity, 2016), the sociopolitical dimension must be taken fully into account. The narrow technic-productivist research on the farm level, which neglects the broader agricultural system constituting the conditions for farmers, appears to be in a deadlock that cannot be resolved at the farm level, especially if export-oriented mechanization is seen as an imperative that cannot be transformed (Nygren, 1998). Agroforestry transitions are system-level issues, and system-level research should directly address the social dimension, including both power-related issues and issues of equity and social justice (Le et al., 2012). While the key barriers are politico-economic rather than techno-scientific ones, the orthodoxies within agronomy and agricultural economics may hold back such transitions (Sumberg et al., 2013). In the current global political-economic context, agroecoforestry transitions are tantamount to *reversing* the modernization of agriculture, which is, if not defined by, at least historically closely associated with deforestation. Such a revolutionary transition entails wide-ranging changes in the complex constellation of the global food system and cannot be approached only by means of techno-scientific research but requires using an agrarian political economy lens in theory and practice.

Even though academic research has provided abundant knowledge about the benefits of agroforestry, such transitions are difficult to realize. It is not sufficient to *know* about the wide range of benefits of agroforestry, as land use depends on historically rooted and highly institutionalized practices, politics and power relations, as well as underlying taken for granted cosmologies. A particular instance of land use practice is much easier to problematize and disrupt than the logic underlying such land use; these two ought to be seen as distinct challenges. While any material practices can be disrupted through overt actions, cognitive practices, such as logics of land use must be disrupted also at the conceptual level (Maguire and Hardy, 2009; Ollinaho and Pajunen, 2019). Building alternative modes of development that promote agroforestry and disrupt established practices and power relations demands an organized and locally rooted social carrier (Van der Ploeg, 2012) that goes beyond actors such as ICRAF and AFINET, organizations which should, however, be pivotal in the process of politicization, mobilization and education based on knowledge and consciousness.

Credit author statement

Ossi I. Ollinaho: Investigation, Conceptualization, Writing – original draft, Writing - Reviewing and Editing, Methodology, Formal analysis, Markus Kröger: Investigation, Resources, Funding acquisition, Methodology, Formal analysis, Writing - Reviewing & Editing.

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