Tensions among knowledges, environments and forms of governing – an ontological question?[1]

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Introduction

The greatest challenges of the twenty-first century are linked to the recognition that we are now living in a new epoch – the Anthropocene (Crutzen, 2006). The human footprint on the planet can no longer be denied and one of the greatest human innovations – agriculture – is increasingly recognized as a leading contributor to climate change (Shukla et al., 2019). The most recent estimates identify food systems as being responsible for a third of global anthropogenic greenhouse gas (GHG) emissions, with 71% of these coming from agricultural land use/land-use change and 10% from the supply chain activities that bring food to eaters (Crippa et al., 2021). Despite the intensification of agriculture that has driven the sharp rises in GHG emissions, in 2017, the Food and Agriculture Organization of the United Nations' (FAO) observed that the progress made in reducing food insecurity over the previous ten years had probably been reversed (FAO et al., 2017).

While global governance bodies have seemed to agree that the world will need to feed a predicted nine billion people by 2050 (Fouilleux et al., 2017), the recognition of the Anthropocene reveals the need to reduce environmental externalities and inequalities in how these people will be fed. The surging push from social movements to foster more democratic food systems demonstrates that these sorts of debates must be social as well as technical, as the problems, as well as the solutions are highly contested (Constance et al., 2018). These contestations are often at the intersections of knowledge and governance as the ability to contest a proposed solution to a societal problem is often derived from the inability to find consensus in scientific and political definitions of the problem itself (Loconto and Fouillieux, 2019). This knowledge-environment-governance nexus in studies of agriculture and food is encapsulated in the term agrifood, which has been mobilized by anglophone sociologists, anthropologists, economists and geographers for the past 60 years within the sub-discipline of the sociology of agriculture and food.

Knowing the Anthropocene?

Discussions of the Anthropocene have been dominated by natural and life scientists, who have raised the alarm and have proposed technical solutions. Within the social sciences more broadly a number of epistemic communities have been working on the political and economic

[1] This text is based off of extracts from the forthcoming book: Loconto, A. and D. Constance. 2023. Agrifood Transitions in the Anthropocene. London: SAGE.

questions of how to shift towards sustainability. Researchers in the fields of sustainability transitions, social movements, transformative innovation policy, and behavioral and institutional economics have all been putting forward proposals on how to encourage change that both creates sustainable societies and is itself sustainable as a process (Köhler et al., 2019; McGreevy et al., 2022). Anthropologists (Haraway et al., 2016) and historians (Hamilton et al., 2015) have explored what this epoch means for human-nature relations and how humans have and will shape history. Mainstream sociologists have been surprisingly quiet in their engagement with, or theorizing of, the Anthropocene. However, the sub-discipline of environmental sociology is where we find the majority of sociological contributions. These scholars have put forward challenges to the Anthropocene as a way to tell time, as a way to know and tell stories about the planet, and as a condition of social change (Lidskog and Waterton, 2016a; Bowden, 2017).

In the next section, we engage with this literature[2] as a means to position ourselves within the traditions of environmental sociology and science and technology studies (STS), which have cross-fertilized the sub-discipline of the sociology of agriculture and food since their parallel emergences in the 1980s. Thus, we begin by positioning the Anthropocene and the fundamental question that it poses about human-nature interactions. We then explore the core concerns related to agriculture and food and the debates around the need for agrifood system transitions. In the section that follows we use two cases – international public and private systems of research – to illustrate some of the contemporary controversies at the intersections of knowledges, environments and forms of governing. We conclude with a call for sociologists of agriculture and food to engage more strongly with the controversies unfolding in the Anthropocene. Our call does not just call sociologists to study these controversies from the comforts of existing organizations of research, but we call for sociologists to also get their hands dirty. A sociology of agriculture and food in the Anthropocene should be an engaged, empirically-focused exploration of society as it emerges from the human and non-human relations on Earth.

The Anthropocene as a modern construct?

A 2015 report by the International Panel on Climate Change indicated that although their 1990 report did not include a quantification of the impact of human activities on climate change, by 2013 it was "extremely likely" (95% chance) that human-emitted greenhouse gasses were responsible for more than one-half of the Earth's temperature rise since 1951.[3] In 2019 the Anthropocene Working Group voted to officially designate the Anthropocene Epoch, indicating the evidence is overwhelming that human activity – we, Anthropos – is drastically affecting the Earth's climate in the atmosphere, biosphere, and hydrosphere.[4] The implications of the Anthropocene go well beyond the stratigrapher's narrow geologic concerns. This convergence of human and geologic history – of the human species as a 'telluric

[2] We do acknowledge that our review of the literature is not exhaustive and our vision is of course partial, but we have done our best to engage the core debates that have been taken up by agrifood scholars.
[3] IPCC Report (https://www.ipcc.ch/report/ar5/syr/), accessed 29/07/2022
[4] Anthropocene Working Group (http://quaternary.stratigraphy.org/working-groups/anthropocene/), accessed 29/07/2022

force' - calls into question the assumptions of Holocene[5] thinking, of Cartesian dualism, of the received modernist view of the clear separation of humans and nature; it raises to prominence 'the politics of unsustainability' (Hamilton et al., 2015). It requires a new way of thinking in the natural and social sciences; it requires exploring new ontological assumptions about the human/nature relationship.

The 'noösphere' – the world of thought – was the 1924 proposition to explain this recognizable role of 'mankind's brainpower and technological talents in shaping its own future and environment' (Crutzen and Stoermer, 2000: 17). Sociologists have long referred to this as the modernist vision – a techno optimist one in fact – that asserts an empire of man over nature where science and technology create a technical paradise where all things are possible. This vision was first applied to English agriculture, then to the ideology of manifest destiny in the American West and colonialism globally, and finally to the post-World War II techno-engineered utopia. Today, the battle lines are drawn between those who plan to force the Earth into submission and those who see this as ultimate folly (Hamilton, 2015).

Social scientists have thus argued that this new epoch requires a drastic rethinking of modernity's assumptions about the relationships between nature and humans, between the boundaries of the natural and social sciences, and calls for a deliberate deconstruction and reconsideration of the types of knowledge that should be prioritized (Bowden, 2017; Hamilton and Grinevald, 2015). The social science debates about the Anthropocene are varied, with numerous sub-camps that can be generally grouped within the "Bad Anthropocene" (global ecological, social and economic disaster) and "Good Anthropocene" (humans achieve total control over the Earth) camps, and then the ugly ontological politics, like the climate change deniers (Dalby, 2016). The optimistic eco-pragmatists and eco-modernists continue to trust in human reason and technology. The eco-modernists build on reflexive modernization perspectives to advance a model of green capitalism and technical stewardship of the planet (Mol, 1997). The eco-modernist trope that 'Nature no longer runs the Earth. We do.' (Lynas, 2011: 8 Bonneuil, 2015: 25) has been critiqued as not only unrealistic, but dangerous (Pavesich, 2022). Unsurprisingly, it has received a lot of attention by policy makers and promotors of evolutionary 'transitions' rather than system transformations, particularly in the energy sector (Szarka, 2016).

The pessimistic eco-catastrophists and eco-Marxists warn that modernity's project has hit the wall of planetary finitude. For eco-catastrophists, the tipping point is surpassed as we need to acknowledge the imminent collapse of industrial society and prepare for a new 'post-growth resilient society' in the *Small is Beautiful* model of E. F. Schumacher (Schumacher, 1989; Semal, 2015). Eco-Marxists prefer the term 'Capitalocene' (Moore, 2017; Moore, 2018), grounded in the metabolic rift and second contradiction of capitalism. For them, capitalism – specifically capitalists in core countries – and its world system of colonial expansion are the true culprits in the Anthropocene, rather than the species Anthropos. The Core has externalized its ecological and social debt into the Periphery through imperialism, cultural genocide, large-scale agriculture for cash/luxury crops, slave-based agriculture, large-scale deforestation, rare mineral plunder, mining for industrial processes, and species depletion for

[5] The Holocene is the epoch that began 12K years ago at the end of the last ice age, which stabilized global temperatures and supported the development of agriculture.

food provisioning and predator control. Sociologists are thus suggesting that Wallerstein's (1975) concept of the 'World System' is far more valuable than the concept of 'Species' to understand the drivers of the conditions that are now characterized as the Anthropocene.

This specific kind of social order grounded in power asymmetries was created by a small percentage of humans in a few countries and a few companies (Bonneuil, 2015). This reading of the Anthropocene has been coined by anthropologists and feminist scholars of science as the "Plantationocene" (Haraway et al., 2016). Wolford (2021) argues – and we agree – that the power of this term lies in the way this form of social order encapsulates the historical path towards the agrifood systems and societies that we know today. 'Plantations are inherently power-laden social structures found in every modern economic system. They embody both racial violence and resistance, straddling or bridging the divide between rural and urban, agriculture and industry, town and country, and local and global' (Wolford, 2021: 1624). The emancipatory power of using the plantation as a metaphor for capitalist modernity is that the resistances that have been traced over the centuries have been against the notion of large-scale that characterizes a plantation economy. It avoids romanticizing the small-scale farmer, but it does offer an analytical tool to identify this scale that is within the limits of agro-ecosystems as a form of resistance to the social order that has come to characterize the Anthropocene.

Nonetheless, even in the face of undeniable atmospheric, geologic and social science, the 'politics of unsustainability' is the 'condition and predicament of eco-politics in the Anthropocene' (Blühdorn, 2015: 152). After many conferences diagnosing the problem and prescribing solutions, political leaders have little appetite for the needed sweeping changes to neoliberal consumer capitalism. The enthusiasm and hope for the Sustainable Development Goals of the Rio Summit have dissipated in the face of eco-politics. Ecological modernization utilizing a technology-based and policy-oriented approach became the dominant model for increasing the efficient use of natural resources and providing co-benefits for both ecology and economy. The empirical facts got enmeshed in eco-politics powered by concerns and values, where politics trumps science. The science was not politically palatable, so eco-modernism maneuvered it into the safe territory of metrics and standards and multi-stakeholder coalitions – the world of certified sustainability (Loconto and Barbier, 2014) – where the radicals were purged and the politics of the possible was elevated, thereby extending the life expectancy of the unsustainable system (Constance et al., 2018).

Although the warnings are not new, through 'Agnotology' – the purposeful creation of ignorance by the 'merchants of doubt' (see Latour, 2005) – the scientific knowledge has been managed deliberately through a 'history of political and techno-scientific strategies to govern and channel fears and opposition, and to disinhibit Anthropocene agency from initial environmental cautiousness' (Bonneuil, 2015: 22-23). 'Sustaining the established socio-economic order has itself evolved into a categorical imperative' (Blühdorn, 2015: 164). The politics of unsustainability has abandoned any attempt to change individual lifestyles and society structures to comply with the eco-imperative of the Anthropocene. Instead, it focuses on managing the inevitable social, economic, and ecological consequences. Rather than trying to reverse the prevailing trends toward catastrophe, it promotes societal adaption and resilience to sustained unsustainability.

What then, can we say about transitions within such an epoch?

Blanchette (2018) opens his article on industrial meat production with the story of one of the possible indicators of the Anthropocene that was debated by the Working Group on the Anthropocene – the enlarged skeleton of the post-WWII chicken. This particular fossil record was remarkable in that not only was there a massive increase in the numbers of bones discovered over such a short period of time, but in that the human influence in this form of material accumulation was clear: the carcasses were significantly larger, but the lifetimes of the animals much shorter. This 'chickenized stratigraphic record' offers a prescient vision of what the global agrifood system looked like in 2015[6]: a system where the bodies of animals and the humans who slaughter them are reciprocally shaped according to unfair working and living conditions, while the chemical and biological compositions of the air, water, land and microbial communities within which they live are likewise irreversibly altered. Blanchette argues that unless agrifood systems change, 'the future stratigraphic record may come to read as a branded reflection of a moment in time when a few corporations had nearly monopolized the killing of a species' (Blanchette, 2018: 186). Since the turn of the twenty-first century, such changes have been referred to in agrifood studies as transitions.

Transitions is a concept that is subject to constant innovation in sociology (cf. Lidskog and Waterton, 2016b). A concept from chemistry that was applied originally to large-scale societal change like the demographic and nutrition transitions, it has been picked up by social scientists to describe the ongoing co-production (Jasanoff, 2004) of societies and environments. Transitions are at once a political imperative of the early twenty-first century that is analyzed by political scientists and sociologists as public policy rhetoric (Aykut and Evrard, 2017), and an emerging epistemic community in STS (Köhler et al., 2019). In line with the notion of the Anthropocene, which stresses the need for systems perspectives, the Transitions Studies community has created, and continuously improves upon, approaches to studying transitions as interactions within socio-technical systems that can profoundly affect their governance. Studies of social innovations explore the changing socio-political roles and routines, beliefs and justifications, knowledge, power and material flows among actors within systems (McGowan and Westley, 2015; Moulaert et al., 2005). Other approaches examine how the socio-technical system and its constituent actors can learn to adapt and bounce forward (Davoudi et al., 2012), or backward through detachment (Goulet and Vinck, 2012) or be completely reconfigured (or not) (Geels and Turnheim, 2022).

As the pioneering approach in this field, the multi-level perspective (MLP) of technological innovation (Geels, 2002; Geels, 2010; Geels et al., 2008; Rip and Kemp, 1998; Hillman et al., 2011) theorizes that it is the way niches, regimes and landscape processes interact that determines a specific transition. This framework is helpful for conceptualizing shifts in socio-technical paradigms over the 'longue durée,' particularly when one can examine technological development retrospectively, like the shift from sailing to steam ships (Geels, 2002). Recent advances in this theory have focused on whole system reconfiguration that pays attention to techno-economic developments and changes in actor networks, rules and modes of governing (Geels and Turnheim, 2022). This theory places the analyst in a position

[6] The date of 2015 is important here as it marks the pivot point between the 8 Millenium Development Goals that were not achieved by this date and the 17 Sustainable Development Goals that are supposed to be achieved by 2030. All indicators point to the fact that these goals will most likely not be met either.

to look in from the outside and characterize how multiple, interacting systems and their actors produce and use technical artifacts in attempts to render modern society more sustainable. Their focus on the urgency of whole system change is in line with systems focus that is also found in the concept of the Anthropocene and promoted by Earth System scientists.

However, if the urgency of the Anthropocene is to be taken seriously in the sociology of agriculture and food, we must acknowledge that we are already within the midst of transitions towards agrifood systems that value sustainability differently from the those of the past. For example, a February 2022 press release on the IPPC's Sixth Assessment Report notes that progress on adaptation is uneven and there are increasing gaps between action taken and what is needed to deal with the increasing risks. The report re-emphasizes the 'urgency of immediate and more ambitious action to address climate risks. Half measures are no longer an option.'[7] The report is emblematic of the increasing pressures at a landscape level to change practices at a global scale, and there is significant mobilization from the bottom-up to propose alternative means to govern and practice this transition (Grin, 2006; Elzen et al., 2012). However, what this approach to transitions seems to forget about working within the Anthropocene is that we – the analysts – cannot be removed from the systems that we analyze. We are at once both producing and using the knowledge about change, which needs to be included in our analyses, our own actions within nature and in our reactions to societal change. This is clear if we take seriously the ontological challenge that is posed by the scientific debates over when, where, and how the Anthropocene emerged (Head, 2014).

Put differently, the Anthropocene (in all of its different definitions), if understood as a crisis, should reveal the persistent problems in the current agrifood system and offer opportunities for change. Grin et al. (2010) argue that crises are symptomatic of illness in current socio-technical landscapes and push existing institutions to the limits of their current normative frameworks. This can bring both disaster like that seen with Hurricane Katrina (Freudenburg, 2009) and opportunities to seek-out alternative values and norms that may govern a transition to a different socio-technical reality – transformed agrifood systems (Kropp et al., 2020). Thus, transitions are understood as changes in the relationships between public, civic and private actors who know and value sustainability differently (see Grin et al., 2010). To study them, as they unfold, we need to recognize them as processes of learning, interaction and transformation (Elzen et al., 2017).

A relational, sociological imagination for agrifood transitions in the Anthropocene

Sklair (2017) claims that rarely has a scientific term – the Anthropocene – moved so quickly into wide acceptance and general use. She suggests that part of the reason for this is that most scholars agree that scientists can no longer justifiably argue that there is a Cartesian binary between humans and nature. Humans are part of nature and nature is part of humans – they are related, they interact to co-produce each other (Lidskog and Waterton, 2016a). Relational ontologies are not new in sociology; however, they are far from being accepted as the main ontological approach to understanding the social (see Latour, 2005). Emerging as a

[7] IPCC Sixth Assessment Report. Press release. (https://www.ipcc.ch/report/ar6/wg2/resources/press/press-release/), accessed 21/07/2022

response to a functionalist vision of social structures and agency, interactionists have long argued that a social fact is not a static, predetermined reality of society; but rather a process that is constructed within the framework of concrete situations that have a range of institutions (understood as discourses and rules) that frame the possible range of actions (Carr, 1945; Znaniecki, 1963).

This interactionist approach emerged first from the social psychological philosophy of George Herbert Mead ([1934] 1962) in the American tradition, but also from Gabriel Tarde (1903; Toews, 2003) in the French tradition who argued that actors cannot be recognized other than through their relational contexts (i.e., the theory of imitation-suggestion). It is thus in the dynamics of exchanges between people (interactions), and through the meaning that individuals give to their actions (picked up in both symbolic interactionism, as well as the practice theories (Schatzki et al., 2001; Shove and Spurling, 2013), that the essence of social action can be understood. Interactionist approaches thus consist of the 'study of developmental interaction process – interaction that changes as it continues – as distinct from the relatively static study of the rules that govern interaction' (Glaser and Strauss, 1964: 671). The social order emerging from situations is thus a constitutional process (Hurlbut et al., 2020) where the understandings and orders emerge from social construction, negotiated orders, unintended consequences, and contingent developments (Weik, 2012).

This basic interactionist understanding has been further developed in relational theories of social action where the relations are themselves the results of the interactions. The conceptual innovation of actor-network theory (ANT) is that non-humans are also active participants in the creation of the associations that constitute society (Latour, 2005). Thinking of society in this way means that society is not a structure of objects or signs, but an assemblage of humans and non-humans that maintain relations (Molénat, 2009). Latour proposed 'actant' as a means to capture the fact that interactions are not only the raising of consciousness or simple transactions or exchanges of materials and meanings, but they are also the actions that generate the relations that make up our world. The feminist STS tendency to eliminate fundamental binaries – like human/non-human, nature/society, knowledge/power or structure/agency – offers an approach to understanding change that embraces the complexity of social relations and seeks to breakdown the reproduction of the above and other binaries in society (Haraway, 1988; Haraway, 2008).

Adopting such a relational ontology in our studies requires that we rethink the relationships among knowledge, environment and governance, which constitute classic objects of study in the sociology of agriculture and food. The literature that we reviewed above about the Anthropocene have all touched upon the threats of this Epoch to current modes of knowledge making, the human-nature relationship that constitutes the environment of planet Earth, and current forms of governance in agrifood systems. Thus, the focus on knowledge and artifacts in ANT and STS theories offer means to trace the outcomes of interactions, particularly when those interactions produce new meanings, values and differences between actors – like what is observed in agrifood transitions in the Anthropocene. Change (or resistance to change) in the relationships among these three constitutive aspects of social relations is what is empirically illustrated by the two cases that we now explore.

The naturalist narrative of agri-food transitions

All of the narratives about the Anthropocene described by Bonneuil (2015) argue that business as usual is insufficient for dealing with the societal challenges posed by the Anthropocene. If we begin to interrogate how the current institutions for governing agrifood systems are currently working, particularly related to the dominant discourse around knowledge and the sustainability of global agrifood systems, Bonneuil's (2015) naturalist narrative dominates (Fouilleux et al., 2017). This narrative claims that "the erasure of civil society and lay people as producers of environmental knowledge and solutions, associated with a self-celebration of scientists as shepherds of humankind and of Earth and the advocacy of more science and green technologies to save the planet" (Bonneuil, 2015: 18). As such, we seek here to understand, *what claims do the dominant producers of knowledge in the global agrifood system make to justify their solutions for saving the planet?*

Who is dominating current knowledge production?

According to a 2011 study by the United States Department of Agriculture (USDA), the private sector spent US$19.7 billion on food and agricultural research (56 percent in food manufacturing and 44 percent in agricultural input sectors) and accounted for about half of total public and private spending on food and agricultural research and development (R&D) in high-income countries in 2007 (Fuglie et al., 2011). For research on agrifood systems globally, States created an international mechanism to consolidate research and innovation into what was previously known as the Consultative Group on International Agricultural Research (CGIAR). Created in 1971, the original CGIARs were the culmination of experiments with numerous organizational models of international agricultural research and development reaching back to the early twentieth century. The CGIARs became 'the model' for foreign assistance in agriculture as part of the Green Revolution and became the receiver of the majority of public funds spent on research for the 'global agrifood system' (Byerlee and Lynam, 2020). Today, the CGIAR is the governance structure for a system of 15 international agricultural research centers (IARCs), focusing on research in support of development and food security in the tropics and subtropics. Six of these IARCs existed prior to the formalization of the CGIAR in 1971 as previous efforts carried out by the Ford and Rockefeller Foundations (FF and RF), the FAO, the US National Academy of Sciences (NAS), the Pan-American Union (now the Organization of American States) and remnants of colonial research institutes of the British and French (mostly) in Africa. As of 2018, the CGIAR's total voluntary contributions from donors reached USD 4.12 billion.[8]

According to the 2022 EU Industrial R&D Investment Scoreboard, food producers spent €8.17 billion while chemical companies (the top two – BASF (€2.25 billion) and Syngenta (€1.35 billion) – produce agricultural inputs) spent €25.14 billion.[9] Forty-six percent of the money spent on investment by food producers was spent by five companies and one third of the €8.17 billion was spent by only two companies – Nestlé and Unilever (Table 1). These large firms are multinational corporations (MNCs) who operate within global networks of both R&D

[8] World Bank. "Consultative Group on International Agricultural Research (CGIAR)." Retrieved by May 25, 2018 (http://fiftrustee.worldbank.org/Pages/cgiar.aspx)

[9] 2022 EU Industrial R&D Investment Scoreboard (https://iri.jrc.ec.europa.eu/scoreboard/2022-eu-industrial-rd-investment-scoreboard), accessed 08/02/2023

and marketing. They dominate both global R&D and the global trade in agriculture and food. In this paper, we compare the CSR programs of Nestlé, Syngenta and Unilever as they have been at the forefront of voluntary sustainability initiatives since the 1980s. Thus, beginning their discursive work long before the other top R&D companies. This comparison offers a useful counter point to the story of the publicly funded CGIAR centers as the knowledge produced through these two research systems are constantly interacting – particularly in the global South.

Table 1: R&D investments and net sales for the top five food producer companies and top two agro-chemical companies investing in R&D in 2021

Company	**Country**	**R&D**	**Net sales**	**R&D Intensity (%)[10]**	**Significant agricultural R&D**	**Countries with R&D labs**
		----- € millions -----				
BASF	Germany	2248,0	78598,0	2,9	Ag. chemical, crop seed, animal nutrition	Germany, US, India
Nestlé	**Switzerland**	**1839,9**	**84246,8**	**2,2**	**Cocoa, coffee, cereals, nutrition, packaging**	**Switzerland (~30 countries)**
Syngenta	**Switzerland**	**1346,5**	**14774,0**	**9,1**	**Ag. chemical, crop seed**	**Switzerland, UK, US, China, Australia**
Unilever	**UK**	**847,0**	**52444,0**	**1,6**	**Tea, naturals, ice cream, jelly, reduced fat, packaging**	**UK, India, China, US, Netherlands**
Vilmorin	France	406,2	1476,6	27,5	Seeds	France, Brazil, China, Spain, Italy, Japan, Mexico, Turkey, US
Danone	France	338,0	24281,0	1,4	Dairy, plant, water, nutrition, packaging	Benelux, Brazil, China, Netherlands, Singapore, UK
Kerry	Ireland	308,6	7350,6	4,2	Taste and nutrition ingredients	Australia, Brazil, Canada, China, Costa Rica, Dubai, France, India, Indonesia, Ireland, Italy, Korea, Malaysia, Mexico, Philippines, South Africa, Singapore, Thailand, US, Vietnam

Source: 2022 EU Industrial R&D Investment Scoreboard.

The above noted numbers are significant not just because the private sector spends about as much on R&D as the public sector; but because there are publicly regulated responsibility and accountability mechanisms in place for the expenditure of public R&D funds, while there are no identical mechanisms for private R&D. Private R&D is regulated through controls internal to companies and in those spaces of hybrid control where public and private funds mix. Innovation processes are even less regulated as they are often occurring outside official R&D departments within organizations or through partnerships with start-ups, universities or other private organizations. Most mechanisms that are used to regulate private research and innovation are therefore voluntary instruments that are tied to international, sector-specific, professional or national agreements.

In the next two sections, we focus on how public and private research organizations – represented by the cases of CGIAR, Syngenta, Nestlé and Unilever – have been positioning

[10] R&D investments divided by net sales.

themselves with respect to the societal challenges posed by the Anthropocene. Based on qualitative research (semi-structured interviews, document analysis and participant observations) carried out systematically since 2014, an analysis of the research programs and priorities was conducted. We use these cases as a means to illustrate how the dominant institutions are still operating with non-relational ontologies – despite the strong naturalist and ecomodernist rhetoric that positions them to be seen as the drivers of agrifood transitions.

Public research in the CGIAR system

The IARC model, which forms the basis of the CGIAR system, was designed as centers of excellence to carry out fundamental multidisciplinary research to generate agricultural technologies (originally germplasm and seeds), which through economies of scale and scope would be diffused via research networks across different countries and ecological regions. IARCs were designed originally to substitute for underdeveloped agricultural research facilities in developing countries through capacity building, training local scientists, and supporting national university programs in agricultural modernization. They targeted research on specific commodities (rice, wheat, corn, beans, livestock, etc.) designed to be public goods and reduce hunger. Additionally, the governance structure of the IARC model strove to reduce bureaucratic and political interference by operating as autonomous, non-governmental centers with independent and international boards. Finally, the funding structure was designed to be long-term and sourced from richer countries through the official foreign aid (agencies) and philanthropical organizations, which would align with those organizations' humanitarian and *political objectives* (*italics added;* Byerlee and Lynam, 2020: 2).

The Genesis of the IARC Model

The structure and mission of the IARC system can be traced to the Land Grant University (LGU) model developed in the United States in the late 1800s, in collaboration with the United States Department of Agriculture (USDA), and then embraced by the foundations and the FAO after World War II. The three-pronged LGU research, teaching, and cooperative extension model was designed to develop and diffuse agricultural innovations. The USDA maize (corn) improvement program started in the 1920s at the University of Minnesota. The institutional innovation of cooperative research – organized teams at different locations studying the same topic - accelerated the rate of technological innovations of genetically-improved hybrid maize seed. In 1943 the UN held its first conference on food and agriculture; in 1945 the FAO was formed to modernize food and agriculture and feed the world (well, at the time they only meant to feed Europe) (Loconto, 2022).

After World War II the US used its scientific forces to address the Malthusian challenge, and to use food as a weapon in the Cold War (Perkins, 1997). The USDA/FAO coordinated a hybrid maize program to rebuild European agriculture (Byerlee and Lynam, 2020). During this early period, politics, consumer-demand in the US and Europe, and specific food emergencies inspired the localization of crop-specific research centers in Latin America (maize, wheat and tropical exports (particularly rubber), Asia (rice) and Africa (tropical exports, rice and livestock). The IARCs in Africa followed a different path grounded in the colonial histories of Britain and France. The colonial model consisted of regional research centers supporting

export crops for the core country. With independence, the model shifted to small-holder farming systems, especially the challenges associated with shifting cultivation and animal diseases, but insufficient infrastructure and lack of stable funding hampered these efforts.

By the late 1960s the logistics and costs of running the four existing IARCs pushed the foundations and USAID to consider a comprehensive plan for the IARCs. Several more IARC centers were coming online. The first two IARCs – CIMMYT and IRRI – were credited with much of the success of the Green Revolution in wheat and rice. The FF, RF, UNDP, aid agencies from the US, Great Britain, Canada, Sweden, Japan and other countries, plus the Asian Development Bank and the Inter-American Development Bank, and other interested parties held a series of conferences at the FF's villa in Bellagio, Italy in the late 1960s. The IARC model had significant traction as 'the model' of agricultural development. At the same time the OECD Development Assistance Committee was supporting multi-donor cooperation. Then, the World Bank, through its president Robert McNamara, entered the negotiations. As a trustee of the FF McNamara supported the Green Revolution and brought that agenda to the World Bank as a Cold War tool to blunt the spread of communism. He wanted to scale up the IARCs with World Bank as majority funder. He proposed five new centers and offered the World Bank's unrestricted grant funding. USAID promised to cover 25 percent of total costs. The IARC model dominated the discussions, championed by the FF as 'a new form of truly international organization' (Byerlee and Lynam, 2020: 14). But it was still opposed by the French representatives and other attendees who preferred supporting existing research institutes.

In summary, the IARC organizational model, culminating in CGIAR, originated in the US LGU system around hybrid maize. That model was based on LGU centralized control of multiple trials at once to speed up the genome testing and bring better producing cereal varieties to market. LGU agricultural scientists staffed the FF, RF and USDA. After World War II the growing global concerns about eliminating hunger and feeding the world prompted the foundations to expand their investments in the agricultural sciences. The FAO, USAID, and UNDP supported the model, which was replicated famously by the RF and Borlaug in Mexico for wheat and maize (CIMMYT) and then again for rice in Southeast Asia (IRRI). The model was diffused overseas by the foundations, USAID, UNDP, and then the World Bank as part of the development project – the Green Revolution – where it encountered remnants of colonial models of agricultural development. The French model was based on decentralized national and regional centers, instead of the centralized US-based IARC model. The French often pushed back in negotiations over the structure and form of the IARCs and CGIAR. The IARCs – in the form of CGIAR – were seen as critical for progress in developing countries who had neither the resources nor the infrastructure to carry out agricultural development. The IARC model was also seen as a critical tool in the Cold War to counter the success of communism in the developing world.

The story of CGIAR as a struggle between who funds and who creates knowledge

The Consultative Group on International Agricultural Research (CGIAR) was formalized in December 1971 as a network of independently managed IARCs that worked together to create and disseminate improved plant varieties to alleviate hunger and poverty. Sponsorship of the four original centers (CIMMYT, IRRI, IITA, CIAT) was transferred to the CGIAR and its Technical Advisory Committee (TAC), with offices at the World Bank in Washington, D.C.

(Correa, 2009; Ozgediz, 2012). CGIAR was based on four principles: informal, consensus decision making; donor sovereignty; center autonomy with autonomous governing boards; and science based.

The first two decades were the golden years of CGIAR. Stable core funding of unrestricted funds (from the World Bank), TAC control, autonomous boards, and political consensus about its mission and founding principles allowed the TACs to prioritize research agendas (Petit, 2022). By 1975 there were seven new centers, two more policy centers were added by 1980 (IFPRI and ISNAR), and from 1972 to 1980 donors had increased from 17 to 29 and funding from $21M to $141M. The research agenda also changed from strictly genome improvement to include farming systems, natural resource management (NRM), livestock, and institutional constraints on agricultural development (Ozgediz, 2012). System reviews started in the mid-1970s and were consistently linked to funding problems.

In CGIAR's 4th decade it continued to struggle with how to organize the CGIAR system to meet higher order needs and still retain the positive attributes of the IARC model. In the end the 'one model fits all' approach did not work well for much of what needed to be done – climate change, poverty, and nutrition. Finding stable funding to do the research to deliver the public goods continued to be the challenge (Ozgediz, 2012). CGIAR's research financing shifted from funding centers to funding Challenge Programs (CPs) to better coordinate CGIAR with other research actors and mobilize additional funding. Other changes included transforming the TAC into a Science Council, establishing a CGIAR system office, adopt the Charter of the CGIAR system, and establish regular performance assessments. The Donor group reached 62 members by 2002 and they liked the performance measurement system, but Centers disliked it for the increased transaction costs, especially as restricted funding continued to rise. With this new model, staff positions were no longer secured funding, but were completely tied to resource mobilization by the researcher to pay their salaries, very much in the image of the American-Dutch model of competitively funded research.[11]

The Centers perceived the CP system, with no restriction on who could submit proposals, as a threat. To mollify the Centers, the first pilot CPs funded were submitted by the Centers: *Water and Food* – grow more food with less water; *Harvest Plus* – reduce micronutrient deficiency to breed staples with micronutrients (e.g., Golden Rice); and *Generation* – molecular biology (GMOs) to create a new generation of plants to meet farmer needs. The next CP, submitted by the Forum for Agricultural Research in Africa was *Livelihoods and Natural Resource Management in Sub-Saharan Africa: Securing the Future of Africa's Children*. 'The final CP approved by the CGIAR, after a few years of freeze, was on a much-anticipated subject: climate change', *Climate Change, Agriculture, and Food Security*[12] (Ozgediz, 2012: xvii).

[11] Interview with staff member of the Alliance Bioversity-CIAT in October 2020. This Alliance was forged during the most recent series of mergers within CGIAR in 2019 that is focused on reorienting the entire CGIAR system around 'food systems'.

[12] CGIAR Research Program on Climate Change, Agriculture and Food Security - CGIAR (https://www.cgiar.org/research/program-platform/climate-change-agriculture-and-food-security/), accessed 03/09/2022

The CGIAR approved more changes at the 2008 meeting, again adjusting its mission to: reduce poverty and hunger, improve human health and nutrition, and enhance ecosystem resilience through high-quality international agricultural research, partnership, and leadership (Ozgediz, 2012: xviii). The major outcome of these changes was the separation of 'doers' and 'funders'. The Centers (doers) created a new organization – the Consortium of International Agricultural Research Centers - with a board and an executive office located in Montpellier, France that established global programs called CGIAR Research Programs (CRPs) through the Strategy and Results Framework (SRF). The counterpart (funders) was the CGIAR Trust Fund with the Fund Council performing executive duties. The SRF provided the roadmap for achieving a new vision and strategic outcomes through the CRPs and requested funding for each CRP from the Fund. Final approval for these changes occurred in 2009 when the Bill and Melinda Gates Foundation joined the CGIAR; the foundation had been a major donor to Centers. At this meeting the donors requested and secured a third tier of funding: (1) pooled contributions (unrestricted); (2) restricted – donor to pet project CRP to Center through CGIAR; (3) center direct – donor money passes CGIAR, goes directly to the center, which is 'essentially a by-pass mechanism to channel donor funds to individual Centers' (Ozgediz, 2012: xx). These changes brought an end to the original CGIAR system as a network of consulting international agricultural research centers; the Consultative Group would no longer exist, but the CGIAR name would still be used. The 2009 major restructuring transformed the loose coalition of centers with separate research agendas and donors to 'a coherent, business-like whole' (CGIAR, 2016b).

The new CGIAR became operational in January of 2010 with the CGIAR Trust Fund established at the World Bank, followed by the inaugural meetings of the Consortium and Fund Council. During the transition two CRPs were approved for funding: the Global Rice Science Partnership and the Climate Change, Agriculture, and Food Security ($100M and $65M annually, respectively). By the end of 2011, 24 donors had contributed $332M to the CGIAR Fund. In 2012 the Fund Council approved 15 CRPs for funding, each led by a CGIAR Center. The new CGIAR focused on three new principles: separation of doers and funders; harmonization of research funding and implementation; and managing for results (Ozgediz, 2012).

In 2016 the CGIAR adopted another governance structure, called the CGIAR System Framework, which provides a System Council and CGIAR System Organization (CGIAR, 2016a). In December the CGIAR's 2011-2016 research portfolio of CRPs came to an end and the System Council approved the 2017-2022 Portfolio of Research Programs and Platforms. 'CGIAR remains the world's leading partnership on sustainable crop and animal agriculture, forestry and fisheries, with annual System revenue of $919 million' (CGIAR, 2016b:3). Window 1 (no restrictions) and 2 (funders to specific CRPs) funding was $220M (down 15 percent from 2015). Window 3 (funders to specific Centers) funding was $323M (up 10 percent from 2015); and bilateral project funding was $346M (down 11 percent from 2015). Center funding was $30M, up from $28M in 2015. At the end of 2016 CGIAR's 15 Centers and the CGIAR System Organization employed 10,270 staff in 96 countries.

In summary, the success of the Green Revolution, especially the increase in Mexican wheat and Asian rice, is attributed to the IARC model and the CGIAR as the exemplar (Renkow and Byerlee, 2010). While the original Centers focused on single-crop genome research to

increase productivity and reduce poverty, later Centers researched farming systems, natural resource management, and agricultural policies. Because crop productivity is easier to quantify, some centers were more successful than others at generating positive measurable impacts. As a result, through a series of governance reforms the donors and CGIAR central administration put increasing pressure on the CGIAR research managers and Centers to demonstrate that the money was well spent, eventuating in a shift in power from the TAC to the donors. Reforms in 2015/2016 addressed the continuing disconnect between donor demands and scientific achievability, between 'delivery and uptake of new knowledge' and 'production of international public goods.' The CGIAR struggled to be both a research and development mechanism and failed because you cannot draw a cause-effect line straight from agricultural research today to development tomorrow (Leeuwis et al., 2018).

The long-term view of the SRF conceptual frame operationalized through CRPs and the short-term model of bilateral contracts attached to yearly budget cycles created unrealistic quantitative promises of development impacts by researchers – to secure funding – that could be accomplished (or measured in the short term), which then led to a poor review, and more calls for reforms and accountability. Long term strategic research did not fit with short term development success and the yearly budget cycles. The result was that the new CGIAR model is geared toward quick wins instead of the kind of work needed for long-term transformations to combat poverty, enhance global food security and address climate change. Being responsive to donors, national partners, and place-based contexts distracts from the CGIAR original mandate to produce international public goods (Leeuwis et al., 2018).

The IARC model proved not as useful for NRM activities, such as farming systems, soil erosion, water conservation, nutrient depletion, land degradation and climate change, which are site/region specific. The newer IARCs do have a broader focus on sustainable intensification of farming systems, but as mentioned above, NRM and farming systems are harder to quantify, find the payoff, and see the wide-spread impacts and benefits of the donor's investment for that research. After the 1992 Earth Summit and Brundtland and Brandt reports the CGIAR refocused toward a sustainability agenda, which took it outside its normal agricultural research boundaries into natural resource management and farming systems. For example, IITA developed techniques to sustainably intensify shifting bush/fallow agriculture but needed a 'new type of farmer' to adopt these techniques and integrate them into his/her farming operations. CGIAR is searching for organization models to do both, especially as such 'a model has become essential to a global agenda focused on mitigation and adaptation to climate change, zero deforestation, sustainable use of freshwater resources, and other aspect of the SDGs' (Byerlee and Lynam, 2020: 15).

The 2030 CGIAR goals highlight: health (malnutrition and food safety); reduced Greenhouse Gas (GHG); sustain NRM; poverty and hunger, which are all indivisible. 'We need to find ways of generating healthy diets that are affordable, desirable, environmentally sustainable, and poverty reducing in their generation' (Haddad, 2020: 1). To do this, the CGIAR needed new alliances with upstream and downstream political economy of food choices researchers. CGIAR was considered to be good at doing the science, but not as good on why science-based policies are not enacted. CGIAR 'needs to understand the terrain between food and fork much better than is does now' (Haddad, 2020: 2).

The French Position: Agroecology

An important part of the recent changes in the CGIAR system is the geo and techno-politics revealed through tensions between national and international research (Hainzelin, 2022; Petit, 2022) as well as the most recent conflicts over the agroecological transition in France (Barbier et al., 2023).

The move of the new global center to Montpellier in 2009 was part of an effort to legitimate both the CGIAR system as an international organization and the power of France as an international leader in agricultural research (Hainzelin, 2022). By moving to Montpellier, the headquarters of the CGIAR system is now physically located in the same campus as one of the four branches of International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), an intergovernmental organization created in 1961 to focus on agriculture in the Mediterranean region. This campus is also the site for Agropolis Foundation, which was created in 2007 by the three specialized national agricultural research institutes in France: National Research Institute for Agriculture, Food and Environment (INRAE), the Center for International Cooperation in Agricultural Research for Development (CIRAD), Research Institute for Development (IRD) and the Agricultural Engineering School of Montpellier (Montpellier SupAgro).

The foundation was created to consolidate and increase collaboration within the immense French scientific community working on agriculture, food, the environment and development within the country and so to create a single interlocutor for international negotiations with the Rome-Based Agencies (FAO-IFAD-WFP) as part of France's political ambitions in the agrifood sector (Loconto and Fouillieux, 2019). One of the key ambitions is to promote the agroecology paradigm not only within France, but also in international agricultural research, which has meet with serious resistance, particularly in Africa (Hainzelin, 2022; Petit, 2022). This ambition also cost France the directorship of FAO as the French candidate was perceived by the United States and China (and the numerous African countries who voted for the Chinese candidate) as being too weak in supporting the productivist agenda.[13] Nonetheless, the proposed research mandate is clear – interdisciplinary research that will support the agroecological transition is the future of international agricultural research (Caquet et al., 2019; Soussana, 2021).

In 2021 Agropolis International produced it's 26th dossier entitled '*Agrological transformation for sustainable food systems: Insight on France-CGIAR research'* devoted to research and partnerships in agroecology in support of the CGIAR 2030 Research and Innovation Strategy and the nascent 'One CGIAR' (Atta-Krah et al., 2021). The dossier is the collective work of Agropolis International, CIRAD, INRAE, CGIAR, and IRD. Following a year long process of a series of scientific workshops organized among the four organizations, the dossier includes contributions from five hundred French and CGIAR agroecology scientists and experts from one hundred national and international universities and research organizations to demonstrate that agroecology is now a key focus of the scientific community in the critical work on transformative food systems approaches to address climate change and food security for all. The objective of the dossier is to link the different dimensions of the CGIAR 2030

[13] Review of the official statements of the member states during the vote in 2019, interviews with observers of the vote at FAO and an interview with a member of the French candidate's campaign.

elements 'in a holistic and transformative approach to food systems, *beyond the usual focus of CGIAR research teams on agricultural production' (italics* added; Atta-Krah et al., 2021: 8).

Agropolis dossier #26 builds upon the work of the FAO and the High Level Panel of Experts on Food Security and Nutrition (HLPE) of the UN Committee on World Food Security (CFS) to reflect 'the enormous opportunity ahead' for the 'transdisciplinary research needed to respond to the challenges facing our food, land, and water systems now, in the 21st century' (Atta-Krah et al., 2021: 5). The 'urgency of the agroecological transformation of agriculture and food systems' documented in the dossier is provided in support of the upcoming UN Food Systems Summit to illustrate the 'variety of agroecological transitions pathways' necessary to achieve 'genuinely sustainable food systems' and to avoid the simplification of 'one size fits all' conventional agricultural models that focus on sustainable intensification but too often neglect 'socioeconomic power asymmetries' and thereby fail to develop 'inclusive cooperative systems' (Atta-Krah et al., 2021: 8).

The current approach that has been set out by France and CGIAR is to gradually strengthen linkages between national and international systems in strategies and funding. However, the current reform towards a One CGIAR was carried out without giving a particular place to the regional forums that make up Global Forum for Agricultural Research (GFAR) unlike the 2010 reform (Moreddu, 2022). GFAR was established by FAO, IFAD, the World Bank and CGIAR in 1996 as a project for resource sharing among national, international, private sector, farmer and civil society research organizations.[14] Housed by FAO, it has also undergone its own series of reforms that have made it more responsive to farmers' needs, more focused on participatory and interdisciplinary research, and more inclusive of broader stakeholders in its forum. However, the main national research centers of the G20 countries do not participate.[15]

Within the OECD countries, which are the main donors of international agricultural research including the CGIAR system and the GFAR members, there is no general coordinating institution. Only the European Union has been successful in consolidating investment in research at a regional level, and increasingly internationally with its new Horizon Europe program that finally allows third-party countries to receiving funding.[16] During this period, specifically in 2012, a new multi-donor fund called the AgroEcology Fund was developed and now includes 15 foundations and awards about USD 1.2 million bi-annually.[17] This is just a drop in the bucket compared to what is mobilized by Gates Foundation annually (USD 6,87 billion in total, USD 398 million for agricultural development in 2021).[18] But both of these private foundations are not typically financing research, but rather simply funding the application of their respective technical packets (Boillat et al., 2022).

[14] GFAR – About Us. (https://www.gfar.net/about-us), accessed 07/09/2022

[15] Partners in GFAR. (https://www.gfar.net/about-us/partners?keys=&field_geographic_scope_value=All&field_countries_target_id=All&field_gfar_constituency_target_id=15205), accessed 07/09/2022.

[16] Horizon Europe. (https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en), accessed 07/09/2022.

[17] AgroEcology Fund. (https://www.agroecologyfund.org/history), accessed 07/09/2022.

[18] Bill & Melinda Gates Foundation. Annual Report 2021. (https://www.gatesfoundation.org/about/financials/annual-reports/annual-report-2021), accessed 07/09/2022.

A number of national countries have raised questions about the multiplication of international networks and initiatives, requesting a stronger emphasis on collaborative approaches in funding and evaluation of research (Moreddu, 2022). One proposal has been to return the CGIAR system to be housed within FAO, as this organization tries to increase its role in knowledge management and reduce its role in development projects.[19] However, this type of a move would most likely put the recent shift towards agroecology at risk, considering that this topic is only one of the recent initiatives, and is programed to last only 3 years (in line with the dedicated budget line).[20]

Anthropocene challenges faced by international, publicly-funded research

The global food and climate crisis we face today is 'not spontaneous but rather the consequence of a long struggle over the governance of global food systems' among the private sector, public actors and civil society (Canfield et al., 2021). The case of CGIAR is a long struggle grounded in the original contrasting ethical positions of agrarianism and industrialism and ending with the current ontological tension between rights-based food sovereignty and market-centered food security proponents, aligned with agroecology and sustainable intensification, respectively. The case highlights the role of the Land Grant University system – and the USDA – as a key venue where the competing interests of preservationist versus productivist, world systems versus modernization, and critical versus positivist knowledge systems played out; first in the United States and then in the world as the Green Revolution and the CGIAR.

The CGIAR, supported by the foundations, government agencies, and business interests, became 'the model' to diffuse modern agricultural innovations in the developing world to enhance food security and support geopolitical agendas. The 'one size fits all' model was resisted by the French, who advocated for regional research centers focusing on natural resource management and farming systems. CGIAR system reviews starting in the 1970s led to a series of reorganizations and mission drift from a narrow focus on genome technologies for the public good decided by and administered by the TAC scientists to a corporate model and increasing bilateral contracts between donors and research centers. These changes accelerated after 1990 when the World Bank relinquished its role as the major funder and the foundations, in particular the Gates Foundation, filled the void. The foundation model expected short term pay offs for their research dollars, which compromised the kind of long-term research necessary for poverty reduction and system change. By 2010 the consultant group model of collaborating centers had been replaced by the centralized corporate model, but the name 'CGIAR' was kept. In the 2000s climate change became the driving concern and CGIAR developed various programs on sustainable intensification. In 2021 the French pushed back against sustainable intensification and the 'one size fits all' model through the Agropolis dossier, and thereby put agroecology – and farming systems – in the center of the discourse, but not yet practice.

Private research as a form of corporate social responsibility

[19] Interview with a staff member of FAO legal services in 2020.

[20] Initaitive: transformational Agroecology Across Food, Land and Water Systems. (https://www.cgiar.org/initiative/31-transformational-agroecology-across-food-land-and-water-systems/), accessed 07/09/2022.

The three companies studied in this section have long histories, emerging from industrial and colonial political projects in the 1800s. The current dynamics of at the nexus of knowledge-environment-governance is embedded in the notion of corporate social responsibility (CSR) (Carroll, 1999). CSR is well institutionalized within large companies and it has been the main pathway through which MNCs have expanded their consideration of and collaboration with a broad range of stakeholders. At the European level, CSR is defined as "a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis."[21] In Europe, CSR has been successively institutionalized since 2001 through multi-stakeholder meetings that resulted in a resolution by European Parliament[22] that identified existing guidelines and voluntary standards[23,24] as authoritative, internationally agreed sets of standards for corporate conduct for social and environmental responsibility. The EU focus on reporting requirements and existing policy instruments is the same approach used by MNCs, as many of their claims to sustainability are part of the actions that adopt to comply with regulation and be considered as companies who are responsive to the changing sustainability needs of society.

The 'caring' company as a means to proactively comply with regulations and govern suppliers

The most important concern for private research, which is quite distinct from public research, is the framing of their sustainability work as a tool used to govern their suppliers and their employees.

First, as a reaction to existing regulatory requirements for agricultural research, new products and active ingredients, the MNCs have initiated specific collaborations, programs, and tools. There are two types of reactions: *mandatory measures*, which is a situation in which legal obligations require that the company comply directly (own operations) or indirectly (through their customers) that translates into a market potential for the company. The second is a situation of *early compliance* where a future regulation seems possible due to an increased interest of the public and/or the public sector in the specific subject. The company thus reacts with voluntary standards or projects to pre-comply with upcoming regulation, shape possible regulation, increase investor confidence or get in contact with (local) authorities to facilitate future compliance.

The notion of regulatory compliance is best illustrated by Syngenta's approach to 'Responsible Agriculture', which includes Regulation and registration, Product safe use and stewardship and resource efficiency and biodiversity. Within Syngenta, there is a "Regulatory Policy Division" that orchestrates the work of around 400 staff around the world that spend their time registering molecules and active ingredients in all of the different countries where the products will be sold. Interviewees explained that they were acting responsibly because they were going through this process. They explained that many companies who make generic

[21] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52006DC0136:EN:HTML

[22] European Parliament Resolution, (2006/2133/(INI)) (http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+TA+P6-TA-2007-0062+0+DOC+XML+V0//EN), accessed 03/09/2022

[23] OECD Guidelines for Multinational Enterprises, (http://mneguidelines.oecd.org/), accessed 03/09/2022

[24] ILO MNE Declaration, (http://www.ilo.org/empent/Publications/WCMS_094386/lang--en/index.htm) accessed, 03/09/2022

brand products don't register the molecules or active ingredients before putting them on the market, particularly in developing countries. Many unsustainable agriculture practices can be linked to this because farmers are gaining access to inferior products and using them improperly. Their responsibility ended there with the compliance to regulatory requirements, what farmers did with Syngenta products after purchasing them and reading the labels was the responsibility of farmers and extension systems. However, Syngenta does carry out toxicovigilance programs in 100 countries, which provide medical advice for treating health effects related to 'improper use' of their products.[25]

Second, we see voluntary investments as corporate reactions to 'irresponsible' practices within the industry that are linked to their suppliers. This is a situation in which a company participates independent from legislation. The motivation emerges through reasons located in the production chain of a product and actions aim to reduce production costs, secure long –term availability/ quality of production factors or enhance R&D. Finally, we see the positioning of the organization within global discourses of sustainability (i.e., social and environmental responsibility) through voluntary investments not linked to their direct supplies. This is a situation in which a company engages (usually external) partners through environmental and social initiative without having any direct connection between the investment and the daily business operations. They do this to generate financial return, as a CSR engagement to manage reputation and customer satisfaction, and to improve customer loyalty.

Unilever has joined the Blueprint for Better Business initiative,[26] which helped them to embed the company's purpose within its organization. Unilever's approach for the past 15 years has been a successive restructuring of the company to ensure the incorporation of sustainability throughout their different product lines. While the global sustainability group consists of 12 people, Unilever has identified 'sustainability champions' in every R&D unit of the company: "R&D find new sustainable technologies, marketers listen to consumers to help us make sustainable products consumers desire, supply chain implement our technologies and ideas in our factories, and ensure we source and manufacture in a sustainable way."[27] They have driven this CSR approach from the company leadership by setting ambitious targets along 10 year timelines, including the ambitious goal of halving the environmental footprint of making and using their products by 2020. This is branded as the company's Sustainable Living Plan. The three goals of the plan are: 1) help more than a billion people to improve their health and well-being; 2) halve the environmental footprint of their products; and 3) source 100% of their agricultural raw materials sustainably and enhance the livelihoods of people across their value

[25] Non-financial performance discussion 2014, including The Good Growth Plan and Corporate Responsibility performance, access 12/11/2015 http://www.syngenta.com/global/corporate/SiteCollectionDocuments/pdf/publications/investor/2015/annual-report-2014/syngenta-non-financial-performance-discussion-2014.pdf

[26] Blueprint for Better Business (http://www.blueprintforbusiness.org/), accessed 02/09/2022

[27] Interview – Global Director of Sustainability – Stefano Giolito (http://www.unilevergraduatesblog.com/2011/12/interview-global-director-of-sustainability-stefano-giolito/), accessed 22/10/2018

chain.[28] This mainstreaming approach has propelled them to be considered as one of the top green companies in the world.[29]

The main governance instrument used to organize this work is the voluntary standard, which is owned by an external NGO, but is used to 'co-brand' the products as being responsibly produced. Both companies use voluntary standards for sustainable sourcing, but Unilever has led this approach with its pioneering efforts to create the Marine Stewardship Council (MSC) certification together with the World Wildlife Fund (WWF) in 1995. Unilever has subsequently established commitments for each of its product lines that include the adoption of voluntary standards by producers and innovations in packaging and transport, which enable the company to reduce its environmental footprint. This mainstreaming approach demonstrates a company-wide response to responsibility, where the company has reflected on the stakeholder pressure that was received through both consumer research and NGO lobbying to restructure the priorities for the company's work. In an interview with a Unilever R&D employee, he highlighted the importance the MNC places on listening to stakeholder interests in designing the type of research that is done. For example, animal testing, while not illegal, is not accepted by many consumers, so this approach to product development is not used. Across its different product lines, Unilever has selected the voluntary standards and lines of research that are the most responsive to consumer demand and stakeholder pressure – which represents significant flexibility and autonomy within its governance arrangement

Making 'the business case' for responsibility was another dominant purpose for mobilizing resources and personnel in an attempt to realise responsibility in research and innovation. Making the business case basically means that any research and innovation activity should contribute to the bottom line of the core business. In a discussion about responsible research and innovation at Nestlé, which is not a term that is used in their company, an interviewee noted that "the last phrase of Von Schomberg's statement is key; research and innovation isn't there purely for their own sake, but for the marketable products." Nestlé's 'Corporate Business Principles' incorporates the 10 principles of the UN Global Compact[30] and lays out the responsibilities that the company has towards: consumers, employees, suppliers and customers and to the environment. Nestlé's main responsibility within its R&I processes is thus to ensure that its commercial products deliver nutrition, health and wellness: "With the world's largest private nutrition and food research capability, we are continuously creating nutritional value and health benefits across our product range."[31] This work includes investment in nutrition labelling and communication and primary research into nutrition and other types of research related to their core lines of business: cocoa, palm oil and sugar (for chocolate), coffee (Nescafé), water (infant formula) and other raw ingredients.

The framing of mainstreaming of responsibility and sustainability throughout the company is an aspiration that has been encouraged by Porter and Kramer's most recent business mantra

[28] About Unilever, Responsible Business (https://www.unilever.com/about/who-we-are/about-Unilever/), accessed 22/11/2015

[29] Top 10 Green Companies in the World 2015 (http://www.newsweek.com/green-2015/top-10-green-companies-world-2015), accessed 02/09/2022

[30] Nestlé's Corporate Business Principles, accessed 22/10/2015 http://www.nestle.com/aboutus/businessprinciples

[31] Nutrition, health and wellness, accessed 29/10/2015: http://www.nestle.com/nutrition-health-wellness

"creating shared value" (Porter and Kramer, 2011). The idea is that the success of a company and the health of the communities around it are interdependent, and that economic growth and progress come from capitalizing on these interdependencies. It brings the notion of stakeholder participation to a different level of engagement. Unilever's approach for the past 15 years has been a successive restructuring of the company to ensure the incorporation of sustainability throughout their different product lines. While the global sustainability group consists of 12 people, Unilever has identified 'sustainability champions' in every R&D unit of the company, which ensures mainstreaming of this effort: "R&D find new sustainable technologies, marketers listen to consumers to help us make sustainable products consumers desire, supply chain implement our technologies and ideas in our factories, and ensure we source and manufacture in a sustainable way."[32] They have driven this CSR approach from the company leadership by setting ambitious targets along 10 year timelines, including the ambitious goal of halving the environmental footprint of making and using their products by 2020. This is branded as the company's Sustainable Living Plan.[33] This mainstreaming approach has propelled them to be considered as one of the top green companies in the world.[34]

Increasing demands for accountability has contributed to the global spreading of research operations.

Syngenta, Nestlé and Unilever are large, international companies. Their operations span countries and continents, conducting research and innovation in as many as 14 different countries at the same time and selling products around the world. There are three unique sets of actors who are found across the three companies - R&D units, corporate affairs, and foundations – and are responsible for different aspects of the research and innovation processes. For example, R&D units focus on fundamental and product related R&I, corporate affairs manage the relationship between CSR and responsibility within R&I processes and Foundations expand on the core framing of each company's vision of responsibility to conduct research and development with a specific philanthropic focus on developing countries. Forging partnerships is fundamental to the MNC approach. Partnerships take different forms, depending on the department that leads the effort. Partners include suppliers, start-ups, universities, donors, private research companies, NGOs, public actors (including extension) and intergovernmental bodies.

There is a mix of existing instruments, accompanied by reporting requirements, currently in use inside these companies. The mix includes human resource incentives, private soft regulation (private standards), public voluntary laws and directives, and compliance to mandatory regulations as the foundation of their responsibility. External instruments include the Dow Jones Sustainability Index[35] which encourages competition between companies on responsibility indicators; and The Declaration of Abu Dhabi, which was launched and signed

[32] Interview – Global Director of Sustainability – Stefano Giolito, accessed 14/11/2015: http://www.unilevergraduatesblog.com/2011/12/interview-global-director-of-sustainability-stefano-giolito/

[33] About Unilever, Responsible Business, accessed 22/11/2015 https://www.unilever.com/about/who-we-are/about-Unilever/

[34] Top 10 Green Companies in the World 2015, accessed 14/11/2015: http://www.newsweek.com/green-2015/top-10-green-companies-world-2015

[35] DJ Sustainability Index, accessed 22/11/2015 http://www.sustainability-indices.com/

by all three MNCs in 2014, which is a pre-competitive approach to developing a set of common good agricultural practices globally.

Existing instruments are most effective in two spaces of interaction: 1) the scientific community and 2) international multi-stakeholder initiatives. First, in all three MNCs, interviewees reported that their scientists are first and foremost scientists and therefore they follow the ethics of the scientific communities and professional organizations in which they were trained. Furthermore, they are constantly publishing in the peer-reviewed scientific journals and must follow the protocols and responsibility requirements of any other scientist in the academic community.

Second, voluntary standards are used for sustainable sourcing strategies by each of the companies, however, the MNCs are also involved in what might be called industry 'technical standards' committees whereby they are involved for setting the international standards for pesticide residue levels (Syngenta - The Joint FAO/WHO Meeting on Pesticide Residues (JMPR)), analytical methods for safety in food and beverages (Nestlé - AOAC INTERNATIONAL) and standards for palm oil (Unilever – Roundtable on Sustainable Palm Oil). Additionally, these companies have all been involved in the UN Global Compact's Food and Agriculture Business (FAB) Principles, which are pushing for responsible agribusiness and contribute to the post-2015 Sustainable Development Goals. In these spaces MNCs are engaging with NGOs and governments to define the metrics used to evaluate their responsibility for the products of their R&I processes.

Responsiveness to stakeholders as a strategy

In all three companies there has been a gradual shift in their CSR policies from being *ad hoc* 'window dressing' style programs to embedded approaches to how they do business. This has differed in each company, but has generally included integrating CSR objectives into key performance indicators (Syngenta, Unilever) and introducing design tools that can change the relationships between designers and researchers (Nestlé). There is also a movement towards shifting some research centers to developing countries. In some cases, this is an attempt to be closer to the crop production areas (e.g., coffee, cocoa, tea), in other cases this may be to be closer to collaborating partners who are working on specific technologies, yet still in others it may be a way to conduct research that is not condoned elsewhere.

The work that MNCs are doing to align their governance instruments is moving them in the direction of productive responsibilization. However, it would be naïve to declare that all of these MNCs have transformed their actions; the profit motive and the notion of 'good business' is the fundamental organisational principle for all activities within MNCs. Therefore, they work from the assumption that they must keep the business growing and profitable with all that they do. If they receive public backlash, or significant signs that their products will not make it to market, they will make changes to their R&I program. However, these actions are part of the design process and not necessarily the results of efforts of a concerted responsibilisation process. Unilever is the most far advanced in this direction as its mainstreaming approach has indeed made the whole organisation more responsive towards meeting its sustainability goals.

In line with existing research that explains the civil society dynamics of new social movements that rely on 'naming and shaming' tactics (Bartley and Child, 2014), all three MNCs have become very responsive to stakeholder pressure. I classify Nestlé and Unilever as productively managing this contestation while Syngenta has made strides, but has not yet reached the same level of contestation management. This may be explained, in part, by the nature of Syngenta's products (inputs rather than consumer goods), the severe public backlash against the company's direct competitors that makes dialogue difficult (Monsanto and Dupont), and the only recent move towards engaging in standards and multi-stakeholder initiatives (as an individual company and not through the CropLife lobbying arm).

Anthropocene challenges faced by international, publicly-funded research

MNCs provide a very unique type of organisation that can influence the way in which RRI is defined, constituted and taken up by other actors. The unique positioning of research within a private company, who is responsible not only for conducting new research but also product development and commercialization of innovation, offers insights into how existing tools are being used to transition the global agrifood system.

Through the analysis of these three companies' approaches to responsibility, it is clear that the concept of Corporate Responsibility (or CSR) is very strong and quite well-embedded into the organizational structures of the MNCs. While the companies do take slightly different approaches to the actual placement of CSR incentives either within their Human Resources systems, as an approach to public relations and engagement with NGOs or other private sector actors, and in relation to meeting regulatory requirements, it is clear that CSR and existing regulatory regimes already provide a number of tools that are being used by these companies. CSR tools are often more important for the innovation processes than for the research processes, as the scientists working within these companies view themselves primarily as scientists, and thus are also bound to the ethics and peer-review systems used in scientific communities.

The global scale at which MNCs work poses uncertainties about what happens to the governance of research and innovation processes outside of the core headquarters. All interviewees confirmed that the internal codes of conduct are valid for all employees around the world ("of course there are 'fireable' activities"), which is why these internal codes of conduct are important. However, these companies also utilise the regulatory uncertainties and inconsistencies to their advantages by strategically positioning their research programs within more permissive regulatory environments. This marks a displacement of responsibility from one geographic and regulatory context to another. It is not clear whether or not this approach strengthens or weakens the responsibility of the company, as it can be interpreted in one of two ways. Either as a strong responsibility within the research sphere to pursue promising scientific endeavours and thus promoting the ethic of 'freedom of basic science', or as a way to avoid citizen and public controversy over socially unsustainable practices and thus shirk the responsibility of responding to the needs of society.

What these cases show us is that sustainability and responsibility activities must be thought of outside of fixed regulatory environments and towards fluid systems where there are portfolios of multi-directional initiatives that bring together research, innovation and the sale of products, which are also constantly interacting. In private research, responsibility for sustainability is closely tied to economic interests in terms of the need to commercialise

products that emerge from innovation processes. It is also linked to the strategic interests of balancing controversy with brand reputation, and company sustainability with global societal challenges of sustainable agriculture and food security. The preferred tools from these three companies are: internal codes of conduct, external standards and certification, reporting and indicators, multi-stakeholder dialogues and regulatory compliance. These instruments promote normative visions of responsibility in terms of individual and corporate liability for 'irresponsible' practices, participation, transparency, capacity building and capabilities strengthening. In terms of sustainability, however, they remain very much 'business as usual'.

Discussion

De-institutionalizing knowledge in the Anthropocene?
At the core of the Anthropocene narrative is the idea of transitioning from a broadly 'ecological' perspective to one that defines thinking at the level of the entire Earth System, which requires different forms of knowledge. Who knows? Who can know? How can we know? How must we know to live and survive in the Anthropocene?

Earth System scientists have begun to question the primacy of institutionalized and disciplinary knowledge. In particular, the importance of the social sciences in understanding the Anthropocene has been recognized by natural scientists who claim that capturing the qualitative changes in human-nature relations in predictive, quantitative models will be a challenge (Ellis and Trachtenberg, 2014). Thus, despite these well-intentioned calls for expanding the 'legitimate' knowledge base needed to change agrifood systems, the institutions that govern research and education for agricultural and food sciences are not yet prepared for this transition. Indeed, the insistence that we must still rely upon quantitative models in order to know in the Anthropocene illustrates how deep particular ways of knowing are engrained in our disciplinary biases.

As with all knowledge, even these disciplinary biases are co-created through interactions over time. The case of CGIAR traces how the modern vision of agriculture was inscribed into global agrifood systems since World War II. The CGIAR system is both a microcosm of the global knowledge politics of industrial agriculture and an example of how a particular form of knowledge – chemistry-driven knowledge focused on plant yields – was able to generalize to all corners of the earth. The promotion of standardized technical packages that could be applied pretty much anywhere on Earth is one of the reasons why industrial agriculture is indeed one of the key indicators of the Anthropocene. This approach treated knowledge as something held by scientists and experts in formal organizations who can legitimately know when, how, and where to apply it.

The MNC case demonstrates the persistence of the Plantationocene by exploring the trend towards responsible research and innovation that has emerged as the new mantra of the multi-national companies who drive plant production and protection. In response to interactions with civic and public actors, these companies are leading the much-critiqued, policy-led transitions. However, she shows that these companies limit their responsibility to reducing the harm of their products on humans, they do not take on the responsibility of protecting the environment. The most hazardous forms of agriculture, which have been proven by scientific evidence, are indeed being reduced. Yet, the companies are not changing

their research programs – they still pursue incremental innovation around the twentieth century technologies that contributed to the identification of 1950 as a key marker of the Anthropocene.

Nonetheless, as in all relations on Earth, the research presented in this book demonstrate that there is also space for valuing alternative knowledges within the Anthropocene. One interesting aspect about the conceptualization of the Earth as Gaia, which is the original, creative theory used to describe what has become institutionalized as Earth Systems science, is that it was developed by the independent British scientist James Lovelock. Lovelock conducted all of his experiments outside of the formal institutions of science (Latour, 2015; Poole, 2014) and vocally supported what is referred to as the 'third space of research' or citizen science (Lhoste, 2022; Joly, 2020).

A non-binary environment in the Anthropocene?

This relational ontology is not new to the sociologists who have been long arguing that the human-nature binary is a false one (Catton and Dunlap, 1978; Buttel, 1987; Haraway, 1989). In the sociology of agriculture and food, Carolan and Stuart (2016) have brought forward an important critique of the nature-society binary by explaining how Things – in the Latourian sense – are part of an intermediary layer of 'doing' between social and material worlds. Fox and Alldred (2020) call this layer the 'intricate web of interrelations.' In his original article, Carolan (2005) argued that rather than a nature-society divide, we are actually talking about three natures (i.e., nature as socially understood, nature as socio-technical experience and nature as ecosystem processes). The 2016 update reformulates these layers into what they call 'relational realism', which claims that 'the world is not constituted only of experiences, but also for causally efficacious and afficacious processes and virtual potentials that exist even when not active/enactive' (Carolan and Stuart, 2016: 77). This idea of 'virtual potentials' is emblematic of agrifood transitions in the Anthropocene as the decisions that we must make in the present determine the direction of agrifood system sustainability in the future. This type of thinking pushes us to ask what notion of nature makes the agriculture of the present and that of the future?

The case of CGIAR explains how the industrial agriculture paradigm created vast environmental damage – and that the modernist desire to control nature remains, despite good intentions to shift research foci towards food systems and agroecology. They argue that the way in which the CGIAR system itself is set up – separate research institutes in different parts of the world focused on single crops – cannot escape binary thinking or disciplinary silos. We note a comfortable shift in the timeline of CGIAR from modernist binaries to modern systems thinking, which itself has 'proven unable to think well about sympoiesis, symbiosis, symbiogenesis, development, webbed ecologies, and microbes' (Haraway, 2016).

New forms of agrifood governance for the Anthropocene?

Underlining the spatial and temporal difficulties that the notion of the Anthropocene pose to scholarship, Chakrabarty (2009) argues the scale of our thinking now needs to encompass a planetary dimension. We now inhabit a hybrid Earth where the human-nature binary is not just deflated, but nature has been injected with human will, 'however responsibly or

irresponsibly that will may have been exercised' (Hamilton and Grinevald, 2015). Building on this thinking, Braidotti (2013) suggests that 'the change of location of humans from mere biological to geological agents calls for recompositions of both subjectivity and community'. She also reminds us that the spectre of human extinction requires us to rethink the institutions that govern humans in nature as 'the future is nothing more and nothing less than inter-generational solidarity, responsibility for posterity, but it is also our shared dream, or a consensual hallucination' (Braidotti, 2013).

These considerations push us agrifood sociologists to continue our reflections about the power and the responsibilities of actors in governing the problems and proposed solutions for change (see Arnold et al., 2022). The cases thus also address the question of how we might govern transitions to sustainable, equitable, and healthy agrifood systems in the Anthropocene?

The case of private research continues in this vein by illustrating how the multi-national companies are fast to adapt their strategies to the changing regulatory environments, but both the upcoming regulations and the identification of multi-national organizations as the actors responsible for ensuring the sustainability of agrifood systems fall short. As Latour (1993) has claimed, we still are not modern and despite our best intentions cannot dominate nature. Indeed, we are working within the limits of our natures.

Beyond the question of time, scholars of the Anthropocene and of transitions claim that new forms of governance are needed that rely upon ongoing reflexivity since 'certain governance patterns undermine themselves by inducing changes in the world that then affect their own working' (Voß and Kemp, 2006: 4). One of the new forms that has gained traction is the Hobbesian ideal that responsible scientists should be identifying, diagnosing, warning the public and then solving the societal problems that emerge (Bonneuil, 2015). The quote from the IPPC that we cited earlier in this chapter is emblematic of this narrative of the Anthropocene and the Scientific Group formed as part of the UNFSS reiterated their desire to create an IPPC for Food Systems.

The 'agroecological turn' explored in the CGIAR case, pushes us to question if a transformative reform is underway within the CGIAR system of international research where it appears that the promise of agroecology is gathering momentum. However, they show that agroecology is just the most recent attempt to keep the modern agriculture research agenda pertinent in an Epoch 'when the best biologies of the twenty-first century cannot do their job with bounded individuals plus contexts, when organisms plus environments, or genes plus whatever they need, no longer sustain the overflowing richness of biological knowledges, if they ever did?' (Haraway et al., 2016: 15). Both of our cases demonstrate just how deeply disciplined knowledge is institutionalized in agrifood research and innovation.

Conclusions

The competing agrifood knowledges systems detailed in this paper continue to play out in the current discourse and negotiations over the Anthropocene. The United Nations Food Systems Summit (UNFSS) is the current venue for the contested control of the global food system where the battle between the corporate model of private interest versus the peoples'

coalition model of public interest is being play out (Canfield et al., 2021). If, as the scientific community, we think that counting resources is sufficient without accounting for how and why they are used by different types of actors, we will not be true to our ethical and epistemic values. Identifying and legitimizing situations where farmers come to know their environments in ways that do not privilege humans or individuals and develop forms of governance where decision-making processes are counter-hegemonic is part of the type of scholarship that the recognition of the Anthropocene inspires among sociologists of agriculture and food.

While the term 'Chthulucene' (Haraway, 2016)is both difficult to pronounce and for many even more difficult to comprehend, we want to conclude this introduction with a nod to Haraway's new concept for the simple reason that she calls upon us to think – particularly about how to change the relations that will enable humans to survive on Earth. Escobar (2016) claims "we are facing modern problems for which there are no longer modern solutions," a situation that demands a transition to a world that is not modern (i.e., the pluriverse). But to transition, we cannot use the master's tools to dismantle the master's house (Lorde, 1984), we must think, feel, and do differently. Among the alternatives that have enacted to date, there is a growing trend in civil disobedience by scientists. While this approach is increasingly being considered justifiable as a response to the ethical crisis (Capstick et al., 2022). it remains a risky option for scientists in countries where such type of protest remains severely punished.

We return here to one of the founding principles of the sociology of agriculture and food: agrifood activists and agrifood researchers must work and organize together in order to change agrifood systems (Friedland, 2010). Friedland called not just for greater communication from sociologists to publics, he called for participatory action research and an opening up of the scholarly process to the activists who are in the farms and in the streets. In the sociology of agriculture and food, we have been seeking to forward this call to action as we push the boundaries of the theories of how society emerges through interactions and in our treatment of human and non-humans in our studies. We thus propose that the sociological imagination for the Anthropocene must be closer to the empirics, closer to the humans and non-humans, and closer to the politics. Without this shift in our imagination, we will not succeed in shifting the agrifood systems.

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